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**REPORT OF THE WORKING GROUP ON THE EFFECTS OF EXTRACTION OF
MARINE SEDIMENTS ON FISHERIES
Stromness, Orkney
14-17 May 1991**

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REPORT OF THE ICES WORKING GROUP ON THE EFFECTS OF MARINE AGGREGATE EXTRACTION ON FISHERIES

Stromness
Orkney
14-17 May 1991

1. WELCOME

1.1 As hosts, Dr J C Side and Professor C S Johnstone welcomed the Chairman and members of the Working Group to Stromness.

2. OPENING OF THE MEETING

2.1 The meeting was declared open by the Chairman, Dr S J de Groot.

3. TERMS OF REFERENCE

3.1 The Chairman read out the terms of reference of the group as laid out in Council Resolution 1990/2:33 (Annex I of this report) and emphasized the need for the group to complete the Cooperative Research Report and the Code of Practice at the meeting.

4. APPOINTMENT OF RAPPORTEUR

4.1 On the proposal of the Chairman, the Working Group appointed Mr G Lees as Rapporteur.

5. ADOPTION OF THE AGENDA

5.1 The agenda adopted by the Working Group is at Annex II. Papers and reports submitted for discussion by the Working Group are listed in Annex III.

6. INTRODUCTION OF MEMBERS

6.1 The attendance list is attached as Annex IV. Apologies for absence were received from Dr A P Cressard (France), Dr C Augris (France), Prof H Bokuniewicz (United States), Mr P Hale (Canada), Mr B Wheeler (UK), Dr J Gamble (UK), Dr D Minchin (Ireland), Mr D L Peer (Canada), Dr K Essink (the Netherlands), Dr E Andruliewicz (Poland), Dr K Bjerkli (Norway) and Mr F Parrish (UK).

7. REVIEW OF COMMENTS RECEIVED SINCE THE LAST MEETING RELATING TO THE WORK OF THE GROUP

Draft copies of the "Cooperative Research Report on the Effects of Marine Aggregate Extraction on Fisheries" and the "Code of Practice for the Commercial Extraction of Marine Minerals" had been reviewed and commended by the ICES Advisory Committee on Marine Pollution (ACMP) since the previous years meeting. This had resulted in some

recommendations being made by ACMP as to how the documents could be improved and these had been implemented as appropriate.

In reviewing the Report of the Meeting of the Working Group in Canada in 1990, ACMP considered the following tasks, which the Working Group had proposed to tackle at the 1991 meeting, to be inappropriate:

- to review the seabed disturbance caused by fishing activities, relative to that caused by aggregate extraction;
- to produce an inventory of sediment textural classification and resource definition schemes;
- to produce a chart of surficial sediment maps of the ICES area;
- to review the use of geographical information systems.

8. REVIEW OF NATIONAL MARINE AGGREGATE EXTRACTION ACTIVITIES

8.1 Belgium

In 1989 969,723 m³ of marine aggregate was extracted by private firms under 6 licences, a total which fell slightly in 1990 to 947,215 m³ (Figure 1).

From 1 August 1990 fees were increased from 9 BEF/m³ to 12 BEF/m³, one third each going to The Ministry of Economic Affairs, The Ministry of Agriculture and The Ministry of the Environment.

A study (project Westbank) by Ghent University has shown that the volume of the top layer of the Northern part of the Kwintebank (north of the Red Deccaline G22) has systematically decreased in volume. Therefore, the Ministry of Economic Affairs decided - on the basis of the first results of this study - that extraction of sand from that part of the Kwintebank should be suspended for the period 01.04.90 - 31.12.90.

In 1989 2,251,840 m³ sand was used for beach nourishment. This material was extracted by the Ministry of Public Works.

8.2 Canada

Extraction of marine aggregates remains a low priority because land based supplies continue to be adequate. However, there are localized shortages. One area specifically lacking aggregates suitable for road construction is the province of Prince Edward Island. Consequently, there is some interest in aggregate extraction within the Gulf of St Lawrence. The proposed construction of a 13 km concrete bridge connecting Prince Edward Island to New Brunswick has further increased the interest in offshore aggregates but that proposal has been delayed by at least one year following an unfavourable environmental review of the generic design. Revisions have since been incorporated.

In the Bay of Fundy an area of coarse sand comprising an estimated 35 x 10⁶ m³ has been identified in association with a gyre. This area receives little fishing activity probably because the bottom is extremely dynamic with large sand waves. There has been some expression of interest in extracting this material, possibly for export to the United States but economic conditions are not currently favourable to commence operations.

Most dredging in Canada has been limited to maintenance dredging of shipping channels and ports. Between April 1990 and March 1991, applications were approved to dredge approximately 1.5 x 10⁶ m³ of material but only 637,000 m³ were dredged and dumped at sea. In the Miramichi River applications to dredge some areas have been refused because contaminants in the spoil exceed levels permitted for Ocean Dumping. Material dredged from Belledune Harbour in New Brunswick has been placed in containment cells adjacent to shore because of high cadmium contamination. Some rock being excavated from the bottom of Belledune Harbour to accommodate larger vessels is being dumped at sea in an attempt to enhance lobster habitat.

In parts of the Canadian Great Lakes there has been a flurry of interest in extracting gravel from the aquatic environment. Although not entirely comparable to marine conditions, colleagues in the Ontario Ministry of Natural Resources have relied heavily on literature produced by this ICES Working Group and its members.

In addition to the general interest in extraction of marine aggregates there has been some interest shown in placer mining for gold, chromium and other metals. Unfortunately the work started on development of regulations for ocean mining remains incomplete and every application must therefore undergo thorough review on an *ad hoc* basis.

8.3 Denmark

The amount of aggregate dredged from the Danish seabed in 1989 was:-

- 5.3 x 10⁶ m³ sand fill;
- 1.3 x 10⁶ m³ sand for construction;
- 0.6 x 10⁶ m³ gravel up to 20 mm diameter;
- 0.5 x 10⁶ m³ gravel from 6-300 mm diameter;
- 1.5 x 10⁶ m³ sand for beach nourishment mainly on the Jutland west coast.

Most of the sand fill has been extracted from 3 localities in the Great Belt and used for the construction of the fixed link across the Great Belt.

In the period from late 1989-early 1991 ~6 x 10⁶ m³ of glacial till were dredged and used as "engineered fill" in the construction.

There has been a slight reduction in extraction of aggregates due to very low building activity.

Further data relating to aggregate extraction activities in Denmark between 1980 and 1989 are presented in figures 2-6.

8.4 Finland

The city of Helsinki had applied for a permit to extract 5 x 10⁶ m³, but the final permit issued covered 2.1 x 10⁶ m³ to be extracted between 1990 and 1994. In 1990 approximately 0.5 x 10⁶ m³ was dredged and used for a landfill project.

The city of Kotka has continued its routine marine sand extraction programme to cover part of its demand on aggregate for various uses.

8.5 France

The extraction of siliceous sands and gravel remained at the same level in 1990 as in the previous year: about 3 x 10⁶ t. Imports from the UK to four French harbours (Dunkerque, Calais, Boulogne and Roscoff) provided a further 1 x 10⁶ t.

Off Dieppe in the eastern Channel average annual production of aggregates is around 4×10^5 t.

The production of calcareous aggregates (mainly *Lithothamnion*) is about 6×10^5 t. Such material is only dredged off Brittany.

In 1990 a significant number of new licences were requested along the French coasts, mainly in the Channel. In the Bay of Seine several companies are planning to extract aggregate in the coming years. An extraction licence was granted here in 1989 to Jean Lefebvre (JL) for a site approximately 8 km^2 in size and with an expected average annual production of 2×10^5 t. However this project is currently awaiting local Government authorization to extract because of strong opposition by local fishermen. A further licence application for a site in this area from Morillon-Corvol (MC) is also being considered at present. Both these sites are located approximately 25 km offshore. A third project, closer to the coastline, which is also being reviewed at present concerns the widening of the entrance channel to Le Havre harbour.

8.6 Ireland

No commercial gravel and sand operations have been conducted. 900 tons of *Lithothamnion* have been dredged.

8.7 Netherlands

Data on extraction activities in recent years in the Netherlands are presented in Figures 7-14.

8.8 Sweden

The extraction of marine aggregate in Sweden is very limited due to the large deposits of sand and gravel on land in eskers. In 1990 a total of $171,700 \text{ m}^3$ was extracted from the seabed in three areas off the west coast, as follows:

$138,700 \text{ m}^3$ - Stora Middelgrund

$31,300 \text{ m}^3$ - Vastra Haken

$1,600 \text{ m}^3$ - Sandflyttan

There are two Swedish (Ahlseil Mineral AB and Glassand AB) and four Danish companies who have licences in these areas.

The fee to the State for the extracted volume of sand and gravel is approximately 6 SEK/ m^3 . This is equivalent to approximately 10% of the value of the sand and totals about 0.5 M SEK.

The amount of marine aggregate dredged per annum from the Swedish continental shelf during the period 1980-1990 is shown in Figure 15.

8.9 United Kingdom

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

The 1990 production figures (tonnes) are as follows:-

Total production (construction and fill) 25,281,729 t

Construction	23,026,729 t
Contract Fill	2,255,000 t

This represents an 11% drop in production compared with 1989. Marine production contributes about 10% to total primary aggregate production and 15-16% sand and gravel. Exports have increased from 10% to 15%, broken down as follows by country: Netherlands 32%; Belgium 35%; France 25%; and Germany 7%.

In the UK there are about 100 production licences covering 5 main dredging areas: East Coast, Thames, South Coast, Bristol Channel and the North West. There are four major dredging companies producing more than 90% of the total UK output of marine aggregate. No new production licences have been issued over the last 12 months and no licences have been terminated. About 12 production licence applications have been received and are presently being dealt with under the "Government View Procedure". Further results from the very active prospecting programme over the last two years will be likely to result in new production licence applications over the next twelve months. The fisheries, conservation and archaeological interest in our marine aggregate production continues as pressure on the UK coastal zone increases. Maërl and waste coal continue to be dredged in south-west England but in small quantities.

Investment by the marine aggregate industry has continued with 6 purpose built sand and gravel dredgers commissioned at a cost of £35,000,000. At the same time new receiving facilities have been built both in the UK and near continent.

Further data on extraction activities in the UK in recent years are presented in Figures 16-22.

8.10 The United States

The extent of marine sand and gravel mining along the U.S. Atlantic coast is essentially the same as last year. One company continues to mine sand from the main shipping channel into New York Harbour for use as fill and construction aggregate at a rate of between 4×10^5 and $8 \times 10^5 \text{ m}^3$ per year. Elsewhere marine sand is used for beach renourishment, but this is almost entirely sand dredged from inlets to maintain navigation. The U.S. Army Corps of Engineers is responsible for these projects but as the Corps does not yet keep a centralized data base to keep track of them, the total volume of sand applied in 1990 is uncertain. The general level of activity was reported in last year's meeting report of the Working Group.

The state of New York is interested in establishing a sand mining program in New York Harbour and is in the process of preparing an environmental impact statement required before such a program could be implemented.

9. ENVIRONMENTAL RESEARCH RELATING TO MARINE AGGREGATE EXTRACTION ACTIVITIES

9.1 Belgium

Two geological studies are presently being carried out by Ghent University:-

- project Westbank - phase II (started in late 1989 or early 1990)
- project Gottebank

It was on the basis of the first results of the Westbank study (phase I) that the northern part of the Kwintebank was closed for extraction. Both projects will last for 5 years. More information on results should be available next year, especially on the northern part of the Kwintebank.

A general monitoring programme of marine aggregate extraction sites is executed by the Ministry of Agriculture but no results are available to the Working Group as the data has not yet been released by the Fisheries Station, Oostende.

9.2 Canada

A proposed experimental extraction with effects monitoring off Prince Edward Island in connection with the Prince Edward Island to New Brunswick land bridge has been delayed. Although exploratory surveys have been adequate to identify vast quantities of recoverable sand, further work is required to confirm the existence of suitable gravel deposits.

9.3 Denmark

Monitoring of dredging activities is routinely carried out in a number of localities; both trailing suction areas and stationary suction areas are investigated. The programme includes hydrographic surveys, side scanning, benthos investigations, salinity and oxygen profiles.

A mapping programme on stone reefs at a number of locations was started in 1990 including side scanning and flora investigations using divers and video cameras.

In the Great Belt, the Great Belt Company is running a very intensive monitoring program including hydrography, sediment spreading, nutrient release, oxygen, eelgrass and *Laminaria* growth, herring spawning grounds, mussel beds and Eider ducks.

9.4 Finland

A report by P. Oulasvirta and J. Leinikki on the effects of sand extraction on fisheries in the sea area west of the island of Eestiluoto is in press. The following is a summary of this work.

Herring spawning areas and salmon and sea trout fishing areas were mapped in spring 1990 before and during dredging operations in the sea area off Helsinki which lasted from July 20th to August 28th. Herring spawned mainly on algae (*Fucus vesiculosus*, *Cladophora glomerata* and *Cladophora rupestris*) and at depths between 2 and 8 m. Siltation together with disturbance decreased salmon and trout catches. It was estimated that extra cleaning of fishing gear during the dredging operations, due to siltation, caused a total of 3 to 4 additional manwork days. Effects on Baltic herring trap net catches were difficult to interpret because reference data was not yet available.

9.5 France

IFREMER achieved an exhaustive study on maerl deposits around Brittany with the cooperation of dredging companies and of the Regional Council of Brittany. A confidential report was produced but two documents also were published:

- a surficial sediments map showing the limits of *Lithothamnion* beds (Augris et al. 1988, in Annex III of this Report)
- a study on the annual growth rate of *Lithothamnion* (Potin et al. 1990, in Annex III of this Report)

The bio-sedimentary survey off Dieppe continued in 1991 with sampling in March following the previous survey in October, 1988.

Additional stations were also sampled on this occasion to form a baseline survey for another company planning to dredge on a nearby site. All these results will be ready for the next meeting of the Working Group.

In the Bay of Seine:

- a pre-dredging survey was conducted in April 1990 on the site licensed to J. Lefebvre, to actualize and refine a previous survey conducted there in 1986 on a larger scale. The objective of this most recent survey was to fix the limits of the extraction site on the basis of sedimentological and biological data. Having been conducted soon after the exceptional storms of February 1990 the survey allowed the intensity of natural fluctuations at the site, from a sedimentological and biological point of view, to be observed (eg faunal density and specific richness were 50% lower in 1990 than in 1986). The delay in giving local Government authorization to extract from this site will probably lead to the performance of a second pre-dredging survey.
- a pre-dredging survey was conducted in March 1991 on a new site licensed to Morillon Corvol; initial results show a greater infaunal richness than in the site licensed to J. Lefebvre, but this may be a consequence of the relative lack of stormy weather in the winter of 1990-91.

9.6 Ireland

No relevant environmental research has been reported.

9.7 Netherlands

In April 1991 a report was published which deals with the geomorphology and macrobenthic community of the Klaverbank and evaluates the short-term effects about 9 to 15 months after gravel extraction there ceased. The purpose of the investigation was to document the extent of recovery of the Klaverbank seabed on and near the 1989 dredge sites, stressing:

- recovery or semi-permanent changes in bottom characteristics
- appearance and disappearance of macrozoobenthic species
- changes in density and biomass of macrozoobenthic species
- to increase the present knowledge of geological dynamics of the area and the presence of macrozoobenthos.

9.8 Sweden

No studies have been carried out in Sweden dealing with the effects of marine sediment extraction except the control programme of the V. Halken area in the southernmost part of the country. Here extraction has been taking place since 1971. The silica rich sand is used in the glass manufacturing industries. Extraction takes place close to the shore, but is not permitted inside the 3 m isobath. Operational activities have been followed by the Geological Survey of Sweden in a programme in which the changes of the sand volume between the 1 m and 6 m isobaths within the area in question is being studied. The total amount of extraction has been about 69,000 m³ sand, on average, per year. This may be compared to the natural variation of the sand volume within the area which, including the extraction volume, may reach close to 500,000 m³ in one year. During the period of extraction (1971-1990) the sand volume within the area has increased from 10.5 x 10⁶ m³ to 11.7 x 10⁶ m³. On average about 66% of the inflowing sand has been extracted annually.

The effects of shipping traffic on seabed sediments along shipping lanes has been studied by Cato (1986, 1990) for the Gothenburg area (1965-1984) and the Brofjaden area (1972-1989). A strong positive correlation was found between decreasing clay fraction and organic matter content of the topmost sediment (0-2 cm) and increasing vessel size using the various lanes in the Gothenburg area. Similar changes in the sediment in the Brofjaden area show a strong positive correlation with increasing numbers of vessels using the harbours in the shipping lanes there. The changes have been interpreted as a consequence of sediment resuspension due to propwash and movement along the seabed of the pressure wave created by each vessel's movement. The magnitude of these resuspension events increases with the size of the vessel, and their frequency with the number of vessel passages. The changes in the clay fraction and organic matter content were around 15% and 10% respectively.

9.9 United Kingdom

Results of the 1989 survey by the Ministry of Agriculture, Fisheries and Food of licensed extraction areas to the east of the Isle of Wight in the English Channel have become available since the previous meeting of the Working Group. The benthic fauna and sediments of two newly licensed extraction areas, 340 and 351, were characterized and this data will be used for comparison with data generated during future surveys of these areas. In addition an existing licence area, 213, was found to have been heavily impacted due to suction trailer dredging, resulting in the formation of a 1 km broad, 3 m deep, furrowed depression in the

north-eastern corner of the site. Despite the manifest evidence of extraction activity no clear variations in the benthic communities were discovered which could be related to this impact. This may have been partly due to the limited areal extent of the impacted ground in comparison to the broadly based grid of stations surveyed.

Detailed studies of the Hastings Shingle Bank licence area (English Channel) are presently underway. A side scan sonar survey of this recently licensed area was conducted in December 1990, which permitted identification of the most heavily impacted locations within it. On the basis of this survey, 24 stations are to be sampled in and around these locations later this year which, when compared with data generated at this site in 1986, will provide valuable information on the effects which extraction has had there. Results should be available by the end of the year.

Studies of plankton distributions within the English Channel, also conducted by the Ministry of Agriculture, Fisheries and Food, have shown there to be a concentration of *Cancer pagurus* (edible crab) larvae in the eastern end of the English Channel in the general vicinity of the Hastings Shingle Bank and surrounding areas supporting earlier contentions that this region may support overwintering populations of egg-bearing females of the species.

Tenure of a research studentship into the benthic ecology of gravel substrates around the English coast commenced in October 1990. This project is being jointly funded by MAFF and CEC, with support from the dredging industry and will include a project to monitor recolonization of an experimentally dredged area of seabed.

9.10 United States

No relevant environmental research was reported.

10. OVERVIEW OF NATIONAL SEABED SEDIMENT MAPPING PROGRAMMES

10.1 Belgium

The Belgian part of the seabed sediment map (Ostend sheet 51°N-52°N and 2°E-4°E) of the 1:250,000 series of the British Geological Survey was completed by the Belgian Geological Survey in 1990.

The map incorporates data generated by HAECON and the University of Ghent as well as information made available by the Fisheries Research Station in Ostend in previously published maps. It will be available in late 1991 at the Belgian Geological Survey, Jennesstraat 13, Brussels.

10.2 Denmark

A map at a scale of 1:1,000,000 of the surface sediments in the Sound between Denmark and Sweden was published in 1991. A similar map at a scale of 1:500,000 of the Inner Danish Waters and the western part of the Baltic will be published at the end of 1991.

10.3 Finland

During 1990 additional work was conducted within the Helsinki offshore area to finalize a set of 12 map sheets (ca. 10 x 10 km at a scale of 1:20,000). These are presently available in digital form. A compilation of this data for a generalized map at a scale of 1:100,000 is being finalized for printing in 1991.

A further 48 map sheets (ca. 10 x 10 km at a scale of 1:100,000) of a larger area in the southwestern archipelago are presently in preparation. These will be accompanied by a comprehensive explanatory text.

A regional survey for aggregates was conducted at the request of the South Western Regional Planning Office in Turku, although conflicting interests with a planned marine national park area were apparent.

10.4 France

In mid-1991 a report of marine sand deposits off Guadeloupe and ten maps at a scale of 1:25,000 of the surficial sediments of the shelf in this area are due to be published. A new survey off Martinique has recently commenced.

A book entitled "Le domaine marin du Nord-Pas de Calais", was published by IFREMER in December. This is the synthesis of 5 years of sedimentological studies in the north of France. The nature and morphology of the seabed were mainly identified by side scan sonar. The results are essentially concerned with the morphology of variously-sized bedforms. The sedimentary processes controlling the evolution of sandy bedforms are identified by morphological, sedimentological and marine current data, and quantified by radioactive tracing. The data obtained represents useful basic information for various types of human activity at sea and along the coast.

10.5 Ireland

Mapping of the Irish Sea and South coast at a scale of 1:250,000, in association with the British Geological Survey, has been completed to 8°W. Some areas to the west of this have been partially mapped but map production will probably be rather slow due to limited resources.

10.6 Netherlands

The seabed sediment mapping programme to map the Netherlands sector of the North Sea on a scale of 1:250,000 continued. All five maps west of 4°E are either published (4) or in press (1). The latter map (Ostend sheet) forms the southern tip of the Dutch sector. These maps have been prepared in cooperation with the Ministry of Transport and Public Works and the British Geological Survey. Data acquisition is taking place in the areas 54-55°N, 4-6°E (Oyster Grounds sheet). This is in cooperation with the German organizations: Niedersächsisches Landesamt für Bodenforschung, Hannover and Bundesamt für Seeschifffahrt und Hydrographie, Hamburg.

The 1:100,000 mapping programme for the nearshore areas continues. The first map will be published in the second half of 1991 (Rabsbank sheet, licence blocks 57, 58, 510 and 511). Data collection is taking place in blocks 53, 56, Q16.

Exploration for gravel deposits has continued. Environmental impact studies were carried out in the Klaverbank area and have been reported in 1991.

Another study in a potential gravel bearing area northwest of Den Helder port has been finished and reported. The results point to gravel bearing sand with maximum percentages of gravel of 70% in small areas. Most of the investigated area contains <2% of gravel.

10.7 Sweden

Marine geological maps of Sweden are published by the Geological Survey of Sweden at a Scale of 1:100,000. They show the distribution of the topmost sediments (0.5m) of the seabed as well as the stratigraphy down to the bedrock surface. The most recent map deals with the geology of southern Kattegat. The central part of Kattegat will be published by the end of 1991. Presently field investigations are being carried out in the northern part of Kattegat.

An overview map at a scale of 1:3,000,000 covering the seabed sediment of the Baltic, Kattegat and Skagerrak will be published in the New Atlas of Sweden. The map is based on data compiled from different maps and investigations published in the literature by the countries surrounding these sea areas.

10.8 United Kingdom

The systematic reconnaissance geological survey of the UK Continental Shelf by the British Geological Survey (BGS) which began in 1969, is nearing completion. Currently about 94% of the 1:250,000 scale maps are published including some 55 seabed sediment maps with the complete suite of maps being scheduled for publication in 1992. Summary maps at the 1:1,000,000 scale are also being prepared. Separate maps show seabed sediments (published), Quaternary geology and solid geology. A series of offshore regional geological reports accompany the map series and currently two reports covering the Moray Firth area and South West Approaches are published. The series, which will comprise 10 reports, is to be completed by 1993.

A recent initiative of BGS has been to proceed with the strategic geological survey of the UK coastal zone, filling a gap of geological knowledge by surveying the seabed between the foreshore and the inshore limit of the previous BGS offshore survey.

The current status with publication dates of the marine aggregates mapping programme is outlined below:

<u>Desk Studies</u>		<u>Resource Surveys</u>	
Phase 1	Southern North Sea	1986	Great Yarmouth-Southwold 1988
Phase 2	South Coast	1988	Isle of Wight-Beachy Head 1989
Phase 3	East Coast	1990	Humber 1992
Phase 4	Irish Sea (commencing 1991?)		

BGS Desk Study reports are available from the Crown Estate and the BGS Resource Survey reports are available from the Minerals and Land Reclamation Division of the Department of the Environment.

10.9 United States

There continues to be interest in offshore mining. Nationally, the U.S. Geological Survey and the National Oceanic and Atmospheric Administration (NOAA) have a joint office for mapping mineral resources on the shelf in the Exclusive Economic Zone (Joint Office for Mapping and Research, 915 National Center, Reston, Virginia 22092, USA, Telephone: 703-648-6525). They also publish a quarterly newsletter.

Only a small part of their activity has been on the U.S. Atlantic coast however. Further details are given on the CONMAP program in the 1990 meeting report of the Working Group. Two sediment maps have been produced at a scale of 1:1,000,000 covering the shelf area from Maine to North Carolina. These are now available from the U.S. Geological Survey Map Distribution Section, Box 25286, Federal Center, Denver, Colorado 80225, USA (\$3.10 each plus \$1.00 shipping). Ten new bathymetric maps for the shelf and slope from Connecticut to Virginia are available from NOAA's National Ocean Service. These are at a scale of 1:100,000 with one meter contour intervals to 200 m (\$4.00 each; Distribution Branch N/CG 33, National ocean Service, 6501 Lafayette Avenue, Riverdale, Maryland 20737, USA, Telephone: 301-436-6990).

11. BLACK BOXES

11.1 Belgium

In 1990, fishermen informed the Ministry of Economic Affairs that a lot of aggregate extraction was taking place out of the extraction zones. Two dredging vessels were subsequently "caught" by the police and received an official reprimand.

The Ministry of Economic Affairs, or more specifically the Mining Department, which is the authorising and controlling authority, has recently decided that all new licence holders should arrange for black boxes to be installed on board extraction vessels. This requirement will be made formal by publication of a Royal Decree in the course of 1991.

One new licence was granted in April 1991, and 2 other new licences are expected to be granted within a few months. For existing licences the installation of black boxes will be obligatory when the licences come up for renewal (4 in 1992; 1 in 1993 and 1 in 1994).

Specifications of the black box (provisional requirements only).

The requirements of the system have yet to be finalized but will probably take the following form:

Parameters Registered:

- identification of dredging vessel
- identification of permit holder
- trip number or specification
- date, time
- ship's position (GPS) to an accuracy of 0.01'
- status of the pumps (on/off)
- status of operation (extracting/not extracting)
- technical data (yet to be specified but may include: status of cables, pressure sensors etc)

Recording Interval:

1. In harbour - every 60 mins
2. At sea - every 15 mins
3. With pumps switched on - every 5 mins

The black box will be sealed and the tape on disc will probably be changed every 2 months. Decoding will be carried out by the Ministry of the Environment who have considerable experience in such matters as a result of the use of black boxes on board dumping vessels for industrial waste.

11.2 Netherlands

Black boxes are presently used by the maintenance dredging industry to assist in the calculation of quantities of material which have been dredged. These have been developed by the Government in cooperation with the dredging contractors. No information regarding the use of black boxes by the aggregate extraction industry was reported.

11.3 United Kingdom

The Crown Estate Office and the Marine Aggregate Companies have been progressing the introduction of Electronic Monitoring Systems (EMS) on all marine aggregate dredging vessels since the last meeting of the Working Group in Canada.

The intention is to have EMS installed on all marine aggregate dredging vessels by the end of 1992. The main features of the EMS will be the position of the vessel and the status of the dredging equipment. Dredging status will cover the position of the dredge pipe and draghead in the water column and the operation of the dredging pumps.

A flexible approach has been taken with the specification for the EMS. There are navigation systems such as satellite position fixing which are readily available, reasonably priced and of suitable accuracy in the UK. Security options range from fully open to totally secure. A fully open system would not be acceptable because of the strong 'control' element in the EMS. A totally secure system such as the Ministry of Agriculture, Fisheries and Food's (MAFF) Marine Position Recorder for dumping vessels is not considered to be appropriate for the marine aggregate industry. The installation, maintenance and management costs of such a system do not reflect the relatively small number of incidents of unlicensed dredging.

The Crown Estate is considering a 'scrambler' system which will provide good protection against tampering with the information stored on the computer disc. Security will be further enhanced by regular audit visits to the dredging vessels and random spot checks. Records of all dredging voyages will be checked by the Crown Estate and any discrepancies rigorously followed up, and if appropriate, suitable action taken.

12. COOPERATIVE RESEARCH REPORT

12.1 The Working Group reviewed progress in the writing and preparation of the 'Cooperative Research Report on the Effects of Marine Aggregate Extraction on Fisheries'. Since the previous year's meeting all sections of the Report had been completed. On the basis of recommendations made to the Working Group by ACMP, its own members and others further sections were written and added to the Report as follows:

- Executive Summary
- Recommendations for Future Research
- Uses of Marine Aggregate - Construction Aggregates
- Uses of Marine Aggregate - Coastal Protection and Breakwater Construction

Text on the process of "stone-fishing", as practiced in some Scandinavian countries, was also written and added where appropriate.

In addition the following sections were substantially updated:

- 2.2 Uses of Marine Aggregate
- 4.1.1 Legislation and Review Procedures - Belgium
- Annex 3. Details of National Seabed Sediment Mapping Programmes -
Netherlands
Sweden

Minor edits throughout the Report and the "Code of Practice for the Commercial Extraction of Marine Minerals" were then implemented.

13. ANY OTHER BUSINESS

13.1 To assist in the completion of recommendations (a)-(g) below, it was agreed that the following documents would be prepared by members of the Working Group in advance of next year's meeting and submitted to the Chairman, Dr S J de Groot, by 28 February 1992:-

- a. reviews of electronic surveillance equipment as used on dredging and/or disposal vessels in the UK and Belgium (Dr Murray and Ms Lauwaert respectively);
- b. reviews of requirements and contents of Environmental Impact Assessments (EIA) for marine aggregate extraction schemes as adopted by Belgium (Ms Lauwaert), Denmark (Dr Nielsen), Finland (Drs Lehtonen and Winterhalter), the Netherlands (Dr Davis), Sweden (Dr Cato) and the UK (Mr Bide). A review of the EEC directive for formulation of EIA's will also be prepared (Dr Side);
- c. a summary of the relative environmental effects of gravel extraction activities at Dieppe and the Klaverbank (Dr Desprez).

d. a review of the effectiveness of physical and biological sampling equipment available for sampling coarse sediments (Mr Laban). Members of the Working Group should submit appropriate information regarding such sampling equipment to Mr Laban well in advance of 28 February 1992 to enable this document to be prepared and submitted on time.

In addition it was agreed that Mr Lees and Mr Pearson (UK) would arrange for sampling of the outwash flow of a working dredger to be conducted to determine the condition of benthic life within it.

14. RECOMMENDATIONS

14.1 The Working Group adopted the recommendations listed below.

The Working Group on the Effects of Extraction of Marine Sediments on Fisheries (Chairman, Dr S J de Groot) will meet from 12-15 May, 1992 in St Valery-sur-Somme, France to carry out the following tasks.

- a. to make recommendations regarding the content of Environmental Impact Assessments which, according to the "Code of Practice for the Commercial Exploitation of Marine Minerals", it may be necessary to carry out prior to extraction of such deposits;
- b. to evaluate the results of Environmental Impact Assessments relevant to the Working Group especially those related to major extraction projects;
- c. to review the effectiveness of physical and biological sampling equipment available for sampling coarse sediments and compare the degree to which the physical and biological samples obtained reflect the original environment and productivity of the area;
- d. to study the relationship between benthos and fish stocks and catches in areas of aggregate extraction;
- e. to review the status of marine aggregate extraction activities in ICES member countries and related environmental research;
- f. to review the development of seabed resource mapping in ICES member countries;
- g. to review the development and implementation of electronic surveillance systems ("black boxes") for monitoring the operation of dredging vessels;

In addition the attendance of the Chairman of the Benthic Ecology Working Group at future meetings of the Working Group on the Effects of Extraction of Marine Sediments on Fisheries was recommended to provide an exchange of information in overlapping fields of interest.

15. CLOSE OF MEETING

15.1 Dr de Groot thanked the host, Dr J Side for his hospitality and for the hard work of his staff and colleagues. The attendees were thanked for their contributions to the meeting, which was then declared closed.

ANNEX I

ICES Council Resolution 1990/2:33

The Working Group on the Effects of Extraction of Marine Sediments on Fisheries (Chairman: Dr S J de Groot, Netherlands) will meet at Stromness, Orkney, Scotland from 14-17 May, 1991 to:

- a) finalize the report on the Effects of Extraction of Marine Sediments on Fisheries (Doc. C.M. 1990/E:35);
- b) finalize the Code of Practice on the Effects of Extraction of Marine Minerals and Aggregates on Fisheries [sic];
- c) report progress on the development and implementation of electronic surveillance systems ("black boxes") for recording the movement and monitoring the operation of sediment dredging vessels;
- d) review a draft environmental effects monitoring plan related to trial aggregate extraction in the Gulf of St Lawrence (prepared by Canadian scientists) and make recommendations based on Member Country experience.

ANNEX II

DRAFT AGENDA

of the meeting of the ICES WG on the Effects of Extraction of Marine Sediments on Fisheries, International Centre for Island Technology, Stromness, Orkney, UK, 14-17 May, 1991.

May 14:

1. Welcome by hosts and chairman.
2. Opening of the meeting.
3. Terms of reference.
4. Nomination of a rapporteur.
5. Adoption of agenda.
6. Introduction of those present.
7. Review of comments received of past activities of the group and how to act on them.
8. Short overview per country of developments related to sand and gravel extraction and related environmental research.
9. Report on blackboxes.

May 15:

10. Splitting into small groups to work on the various sections of the code, overview, WG - report.

May 16:

11. Continue to work on code, overview, WG - report.
12. Convene as group to discuss work done.

May 17:

13. Recommendations.

ANNEX III

PAPERS AND REPORTS MADE AVAILABLE AT MEETING FOR DISCUSSION BY THE WORKING GROUP

- ANON., 1987. Marine minerals: exploring our new ocean frontier. Congress of the United States, Office of Technology Assessment, Washington DC, 1987.
- ANON., 1989. Maintenance dredging in North Europe. The Dock and Harbour Authority, vol 70, July/August 1989, pp 61-72.
- AUGRIS, C., HOULGATTE, E. and ROLET, J., 1988. Surficial sediments map of Baie de Douarnenez (France), northern part. 1:15,000 . Plus explanatory notes. IFREMER, Département du Finistère.
- AUGRIS, C., CLABAUT, P. and VICAIRE, O., 1990. Le domaine marin du Nord-Pas de Calais. Nature, morphologie et mobilité des fonds. Ed. IFREMER, Région Nord-Pas de Calais.
- BURTON, R., 1991. EC invites suggestions for fishing vessel monitoring. Lloyds List, London, 21/1/1991.
- DESPREZ, M. & LAFITE, R., 1990. Impact biologique de l'extraction de graves marines en Baie de Seine. Association G.E.M.E.L. Mont-Saint Aignan, France.
- HALL, S. J., BASFORD, D. J. & ROBERTSEN, M. R., 1990. The impact of hydraulic dredging for razor clams *Ensis* sp. on an infaunal community. Netherlands Journal of Sea Research 27(1): 119-125 (1990).
- LEES, R. G., REES, H. R., LAMBERT, M. A., ROWLATT, S. M. and LIMPENNY, D. S., 1990. Benthic studies in relation to dredging activity off the Isle of Wight, Southern England. ICES Marine Environmental Quality Committee. CM 1990/E:15.
- PENNEKAMP, J. G. S. & QUAACK, M. P., 1990. Impact on the environment of turbidity caused by dredging. Terra et Aqua, number 42, April 1990.
- POTIN, P., FLOC'H, J. Y., AUGRIS, C. and CABIOCH, J., 1990. Annual growth rate of the calcareous red alga *Lithothamnion corallioides* (Corallinales, Rhodophyta) in the Bay of Brest, France. Hydrobiologia 204/205: 263-267. 13th International Seaweed Symposium, Canada.
- 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 BV, AJ Culemborg, Netherlands.
- STEVENS, P. M., 1987. Response of excised gill tissue from the New Zealand scallop *Pecten novaezelandiae* to suspended silt. New Zealand Journal of Marine and Freshwater Research, 1987, vol 21:60.

SYDOW, J. S., 1990. Cruise report experiments on the interaction of fishing gear (beam trawl) vs benthos with the R.V. Mitra. Report NZ-N-91.01. North Sea Directorate, Rijswijk, Netherlands.

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 1989. Bureau Waardenburg BV, AJ Culemborg, Netherlands, July 1990.

VAN MOORSEL, G.W.N.M. & WAARDENBURG, H.W., 1991. Short term recovery of geomorphology and macrobenthos of the Klaverbank (North Sea) after gravel extraction. Bureau Waardenburg BV, AJ Culemborg, Netherlands, April 1991.

ANNEX IV

ATTENDANCE LIST

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Fax: + 35 80462205

ANNEX V

ANNUAL REPORTS ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

Reports on extraction of marine sediments and excavations were submitted to the Working Group as follows:

<u>Country</u>	<u>Reporting Period(s)</u>
Belgium	1990
Denmark	1989
Federal Republic of Germany	1989
Ireland	1990
United Kingdom	1989, 1990
United States of America	1990

These are copied below.

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR 1990 REPORTING PERIOD 1990
 COUNTRY BELGIUM REGION OR SUB-AREA (a) IV c
 REPORTER NAME FISHERIES RESEARCH STATION INSTITUTION
 Address ANKERSTRAAT 1 8400 OOSTENDE

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach replenishment, Coast Protection	Dredge spoils which are disposed of at sea.	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m ³
Silt Mud Clay							
Sand		1					
Gravely Sand							
Sandy Gravel							
Gravel							
Larger material (specify)							
Calcareous materials (specify)							
Other deposits (specify)							

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

J: Nr. SN 866/99-0023

REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR1989..... REPORTING PERIOD 1. jan - 31. dec
 COUNTRYDenmark..... REGION OR SUB-AREA (a)
 REPORTER NAME Erik B. Aksig..... INSTITUTION Miljøministeriet, Skov- og Naturstyrelsen
 Address Slotsmarken 13 - DK 2970 Hørsholm.....

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach Replenishment, Coast Protection	Dredge spoils which are disposed of at sea.	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m ³
Silt Mud Clay							
Sand		1,38	5.06	1.0			
Gravelly Sand							
Sandy Gravel		0,70					
Gravel		0,54					
Larger material (specify)			Boulders 22000 ton				
Calcareous materials (specify)							
Other deposits (specify)			Till 0.03				

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR1989..... REPORTING PERIOD1989.....
 COUNTRY ...FR...GERMANY... REGION OR SUB-AREA (a) ...3,3 nm. W. of WESTERLAND/SYLT
 REPORTER NAME WEICHAERT/BAUMGARTH INSTITUTION
 AddressDT. HYDROGR. INST. HAMBURG.....

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach Replenishment, Coast Protection	Dredge spoils which are disposed of at sea.	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m ³
Silt Mud Clay							
Sand				1,97			
Gravely Sand							
Sandy Gravel							
Gravel							
Larger material (specify)							
Calcareous materials (specify)							
Other Deposits (specify)							

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR1990..... REPORTING PERIOD1.1.90 - 31.12.90.....
 COUNTRYIreland..... REGION OR SUB-AREA (a) ...VIIj., Brehave Sound, Castletownbere...
 REPORTER NAMEDan Minchin..... INSTITUTIONFisheries Research Centre.....
 AddressFisheries Research Centre, Abbotstown, Dublin 15.....

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach Replenishment, Coast Protection	Dredge spoils which are disposed of at sea.	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m ³
Silt Mud Clay							
Sand							
Gravely Sand							
Sandy Gravel							
Gravel							
Larger material (specify)							
Calcareous materials (specify)	Lithothamnion (dead) 1.3				(for land use as a fertiliser) →		690 i.e. 900 tonnes
Other Deposits (specify)							

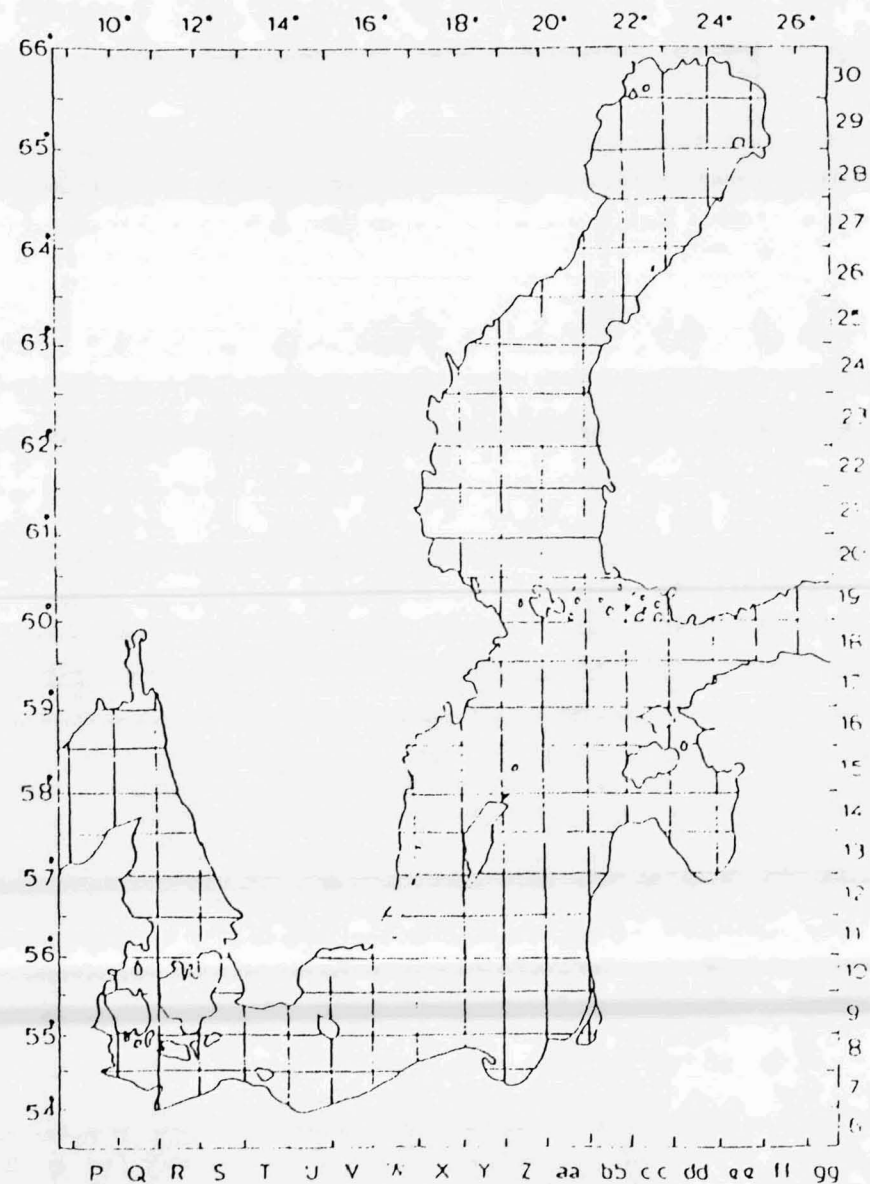
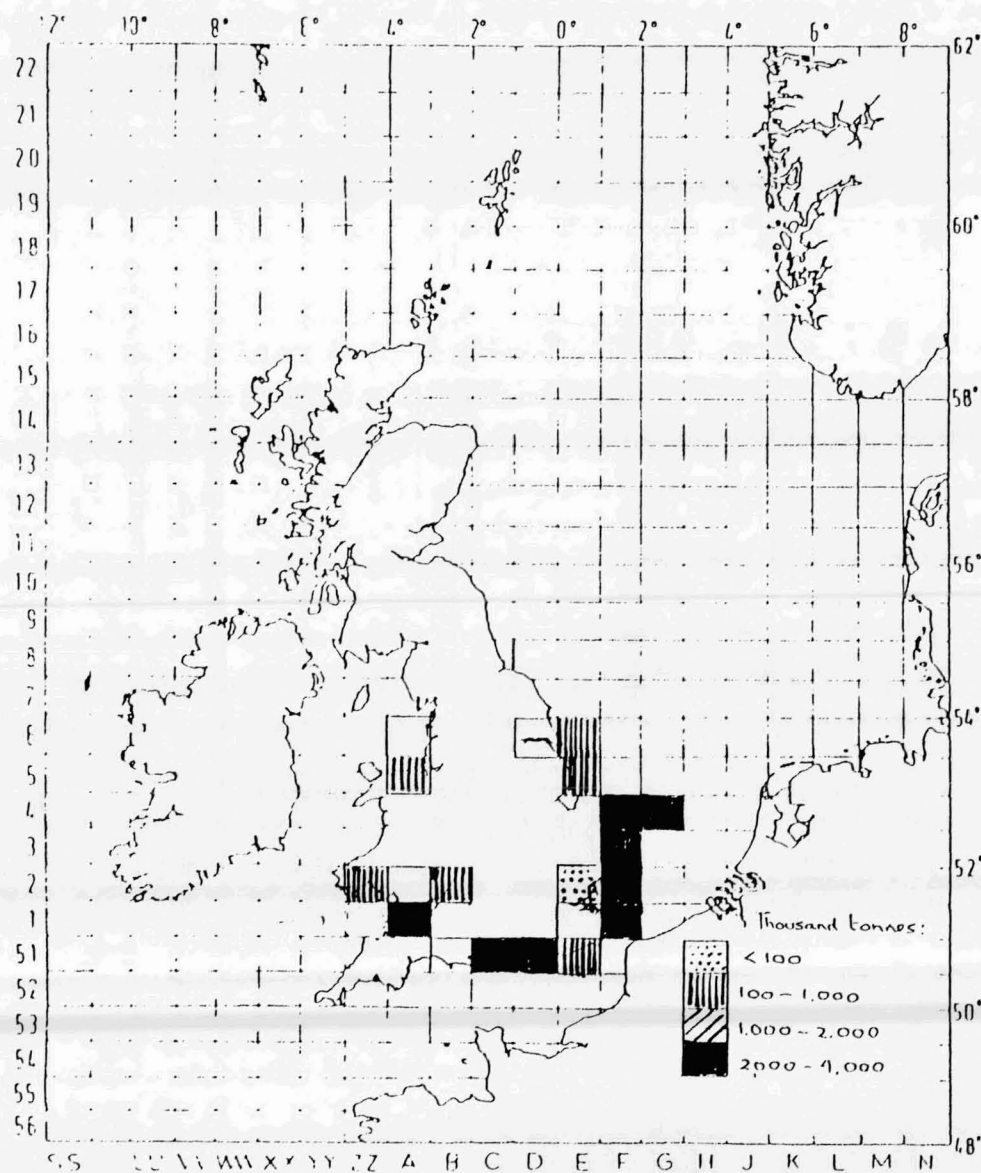
ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR 1989 REPORTING PERIOD JANUARY-DECEMBER
 COUNTRY UNITED KINGDOM REGION OR SUB-AREA (a) UK COASTAL WATERS
 REPORTER NAME FISHERIES LABORATORY INSTITUTION MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
 Address REMEMBRANCE AVENUE, BURNHAM-ON-CROUCH, ESSEX CM0 8HA

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach Replenishment, Coast Protection	Dredge spoils which are disposed of at sea.	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m ³
Silt Mud Clay							
Sand	1.57	15.1	2.2	0.6			
Gravely Sand							
Sandy Gravel							
Gravel							
Larger material (specify)							
Calcareous materials (specify)	Litho-thamnion					Soil conditioner	16,000 tonnes
Other Deposits (specify)							

Aggregate extraction for land use, reclamation and beach nourishment.



ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

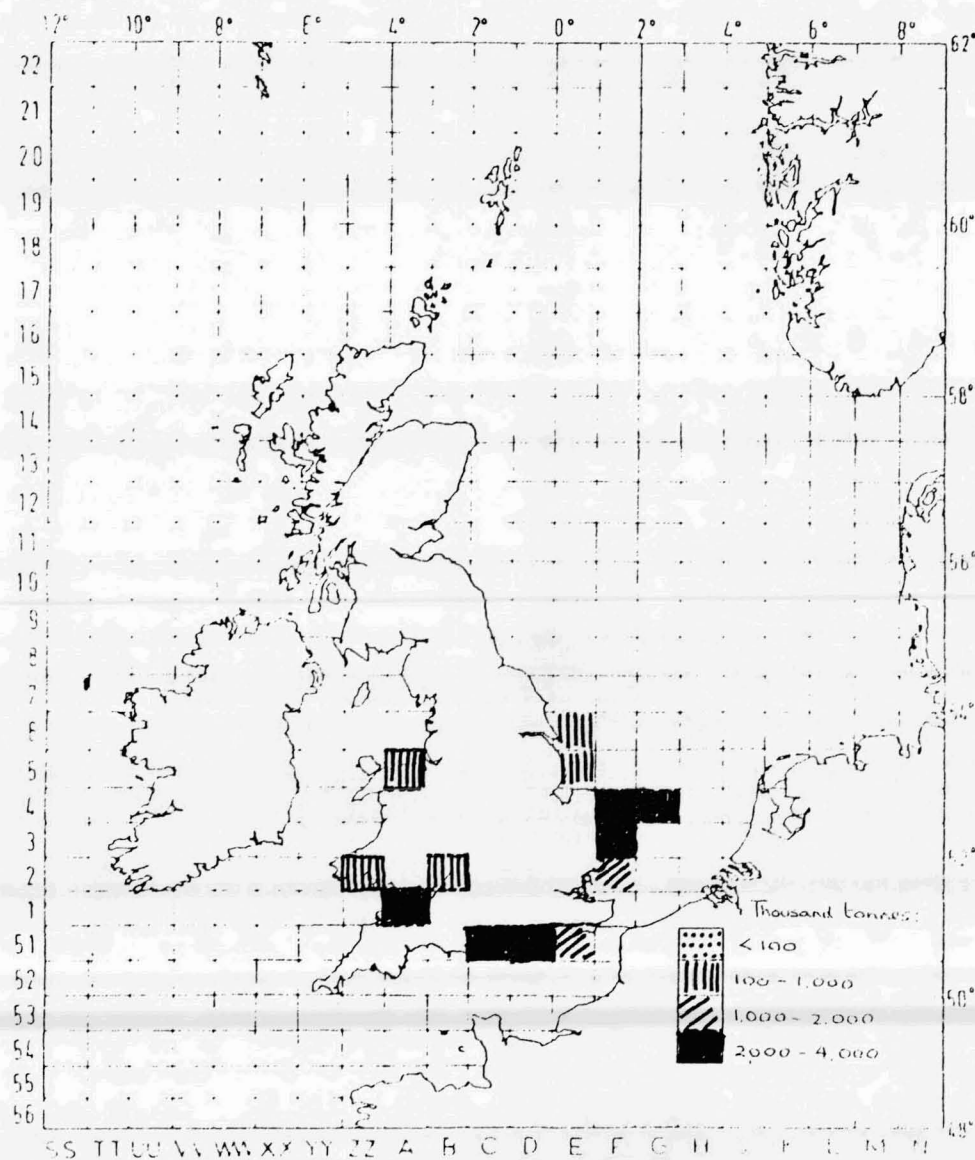
REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR 1990 REPORTING PERIOD JANUARY - DECEMBER
 COUNTRY UK REGION OR SUB-AREA (a) UK COASTAL WATERS
 REPORTER NAME FISHERIES LABORATORY INSTITUTION MINISTRY OF AGRICULTURE, FISHERIES AND FOOD
 Address REMEMBRANCE AVENUE, BURNHAM-ON-CROUCH, ESSEX CM0 8HA

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach Replenishment, Coast Protection	Dredge spoils which are disposed of at sea,	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m ³
Silt Mud Clay							
Sand	1.57	14.8	1.3	0.1			
Gravely Sand							
Sandy Gravel							
Gravel							
Larger material (specify)							
Calcareous materials (specify)							
Other Deposits (specify)							

MARINE AGGREGATE EXTRACTED FOR BUILDING, FILL, COAST PROTECTION AND BEACH NOURISHMENT

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ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR 1990 REPORTING PERIOD January 1 - December 31, 1990
 COUNTRY U.S.A. REGION OR SUB-AREA (a) New England District
 REPORTER NAME H. Mustafa/J. Pearce INSTITUTION U.S. Army Corps of Engineers
 Address Northeast Fisheries Center, Woods Hole, MA 02543

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach Replenishment, Coast Protection	Dredge spoils which are disposed of at sea.	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m
Silt Mud Clay							
Sand					0.6 m ³		
Gravely Sand							
Sandy Gravel							
Gravel							
Larger material (specify)							
Calcareous materials (specify)							
Other Deposits (specify)							

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR1990.....

REPORTING PERIOD JANUARY 1 - DECEMBER 31, 1990

COUNTRY U.S.A.

REGION OR SUB-AREA (a) New York District

REPORTER NAME H. Mustafa/J. Pearce

INSTITUTION U.S. Army Corps of Engineers

Address NE Fisheries Ctr., Woods Hole, MA

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach Replenishment, Coast Protection	Dredge spoils which are disposed of at sea.	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m
Silt Mud Clay					3.4 m ³		
Sand							
Gravelly Sand							
Sandy Gravel							
Gravel							
Larger material (specify)							
Calcareous materials (specify)							
Other Deposits (specify)							

ICES - MARINE ENVIRONMENTAL QUALITY COMMITTEE

REPORT ON EXTRACTION OF MARINE SEDIMENTS AND EXCAVATIONS

YEAR 1990 REPORTING PERIOD January 1 - December 31, 1990
 COUNTRY U.S.A. REGION OR SUB-AREA (a) Philadelphia, District,
 REPORTER NAME H. Mustafa/J. Pearce INSTITUTION U.S. Army Corps of Engineers
 Address NE Fisheries Ctr., Woods Hole, MA

TYPE OF MATERIAL (b)	Conversion Factor	Removed for use on land (eg construction materials, roads etc.)	Artificial land or island construction	Beach Replenishment, Coast Protection	Dredge spoils which are disposed of at sea.	Other	
	Tonnes/m ³	million m ³	million m ³	million m ³		Specify use (c)	m
Silt Mud Clay							
Sand					0.18 m ³		
Gravelly Sand							
Sandy Gravel							
Gravel							
Larger material (specify)							
Calcareous materials (specify)							
Other Deposits (specify)							

BELGIUM

	CONVERSION	REMOVED FOR USE ON LAND	BEACH REPLENISHMENT	DREDGE SPOILS WHICH ARE DISPOSED OF AT SEA
1988				
SAND	1.6T/ m ³	616,872 m ³	2.5 million m ³	22,539,174 m ³
1989				
SAND	1.6T/ m ³	969,723 m ³	2.2 million m ³	23,581,705 m ³
1990				
SAND	1.6T/ m ³	947,215 m ³	Information not yet available	Information not yet available

Figure 1. Belgium. Marine aggregate removed for use on land and for beach replenishment, 1988-1990.

MARINE EXTRACTION IN DENMARK

Time period 1980 - 1989

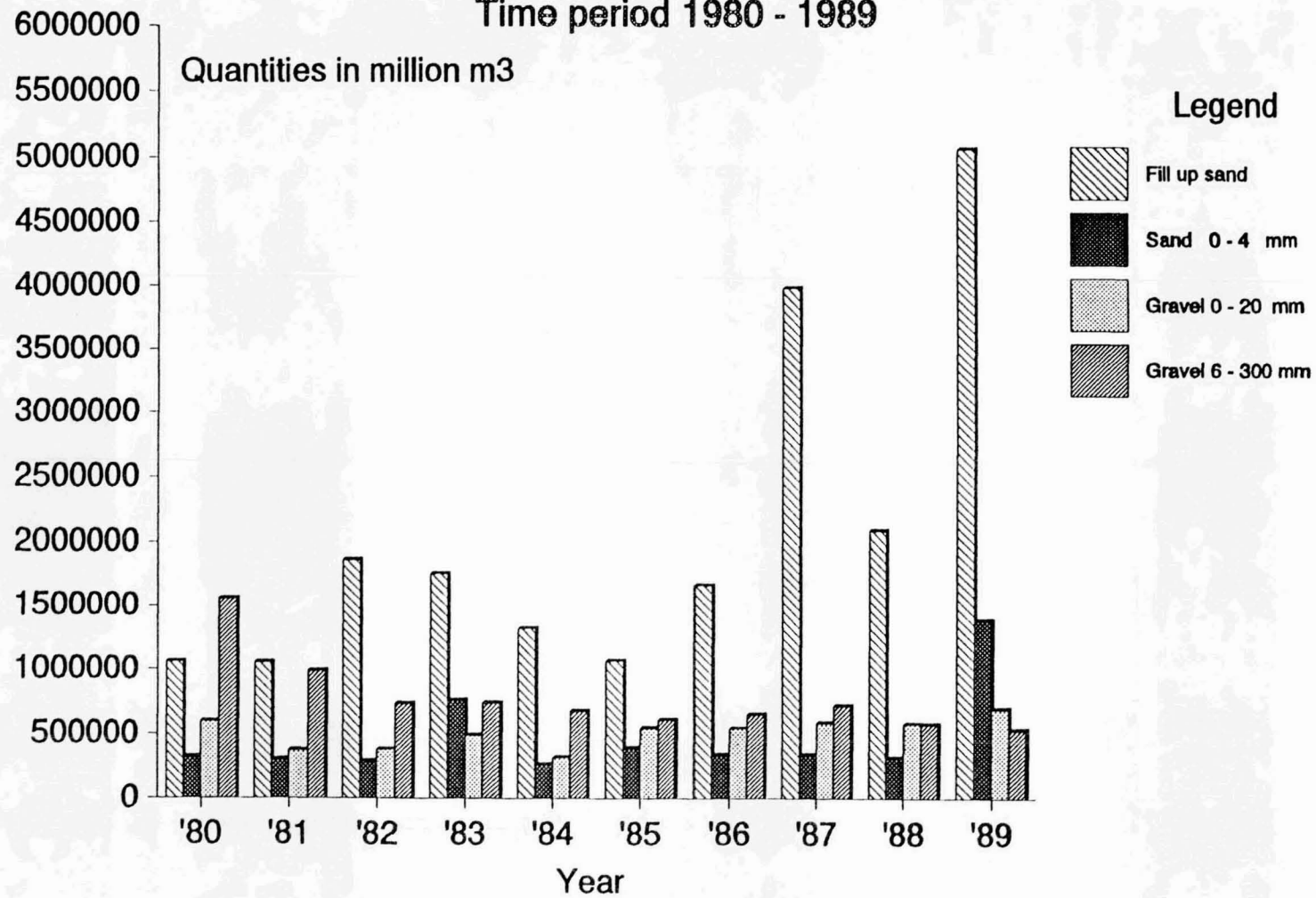


Figure 2. Denmark. Extraction of marine sand and gravel, 1980-1989.

CONSUMPTION OF MARINE SAND AND GRAVEL IN DENMARK

Timeperiod 1980 - 1989

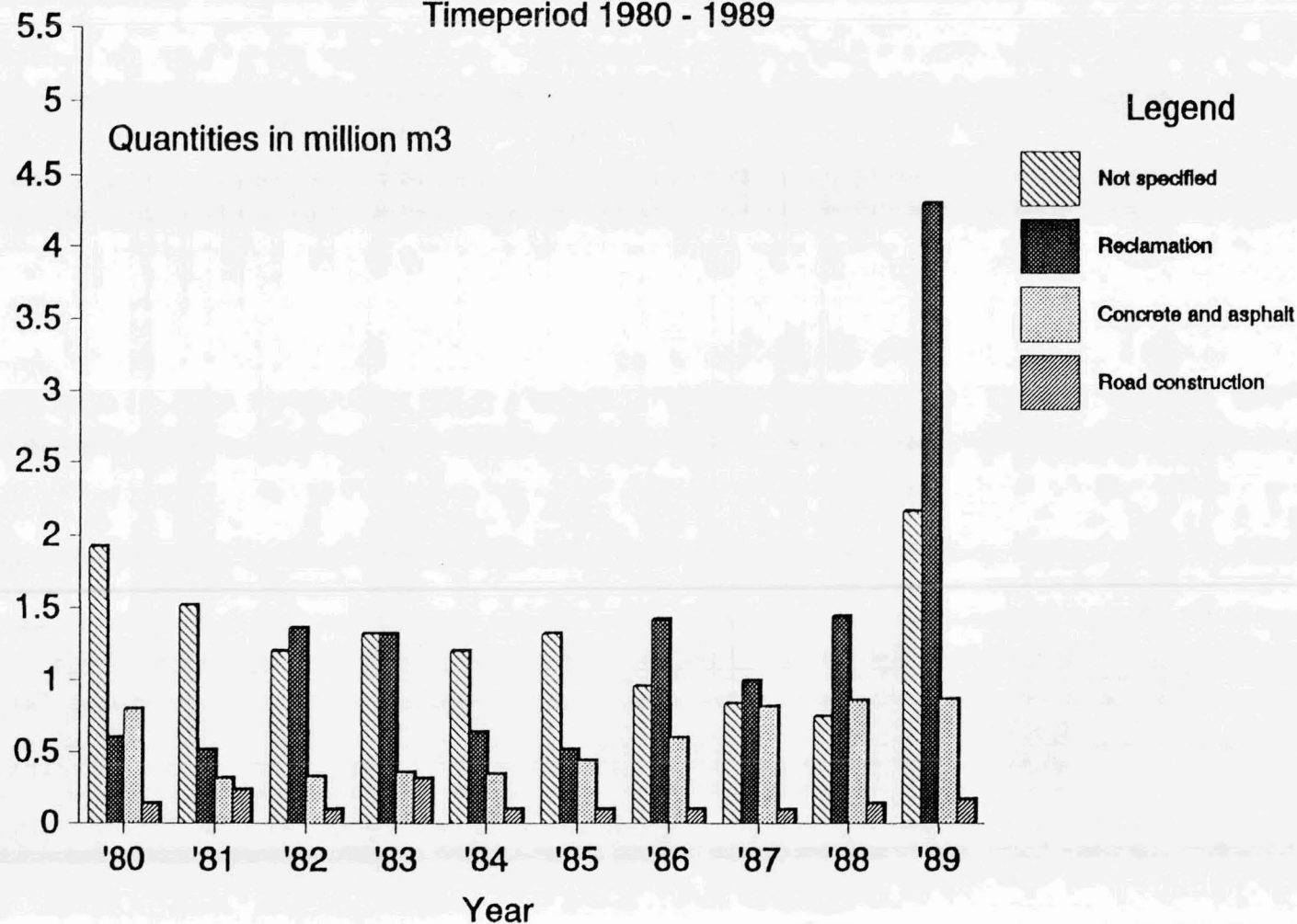


Figure 3. Denmark. Uses of marine won sand and gravel, 1980-1989.

LAND EXTRACTION IN DENMARK

Time period 1980 - 1988

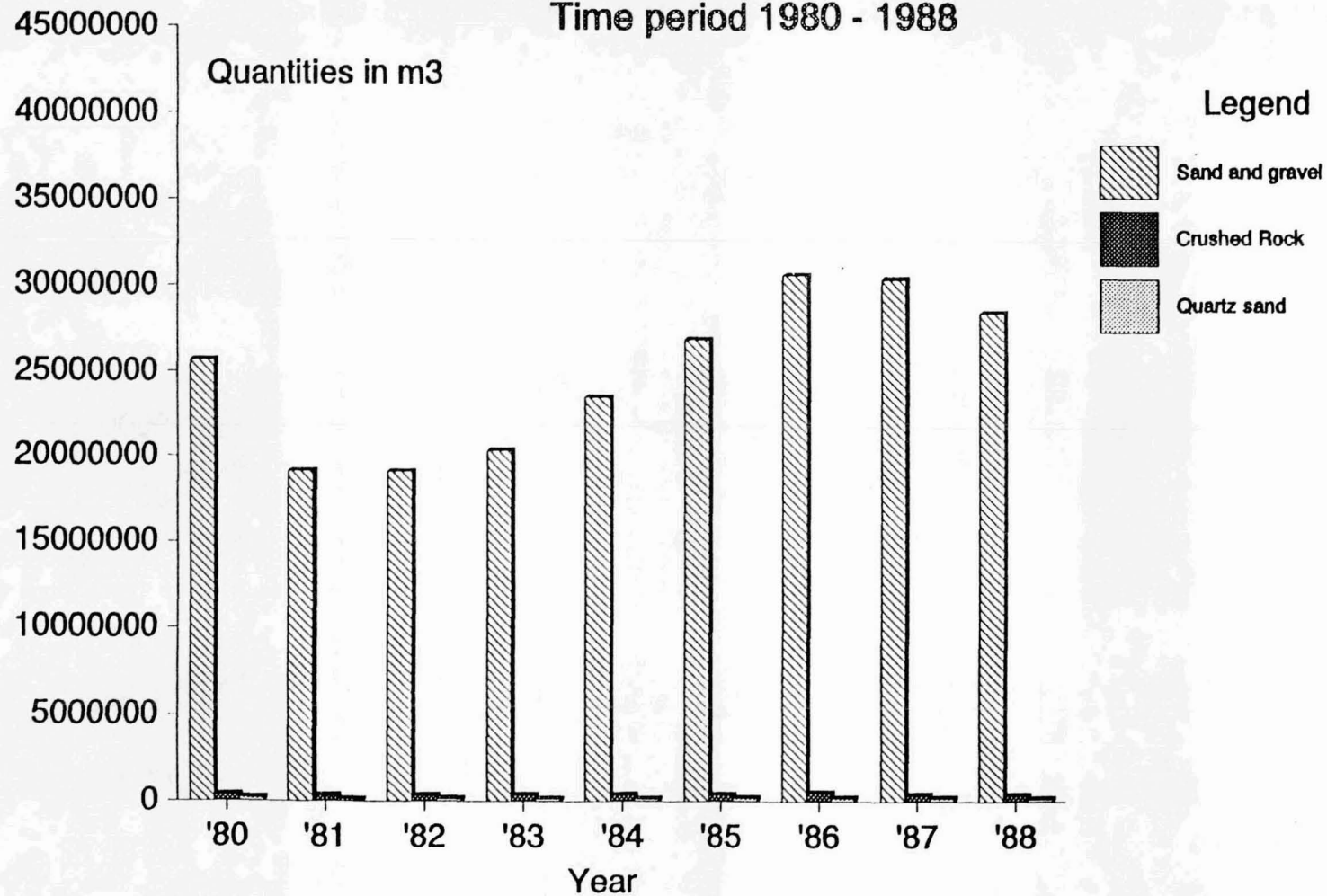


Figure 4. Denmark. Aggregate extraction on land, 1980-1988.

LAND EXTRACTION IN DENMARK

Time period 1980 - 1988

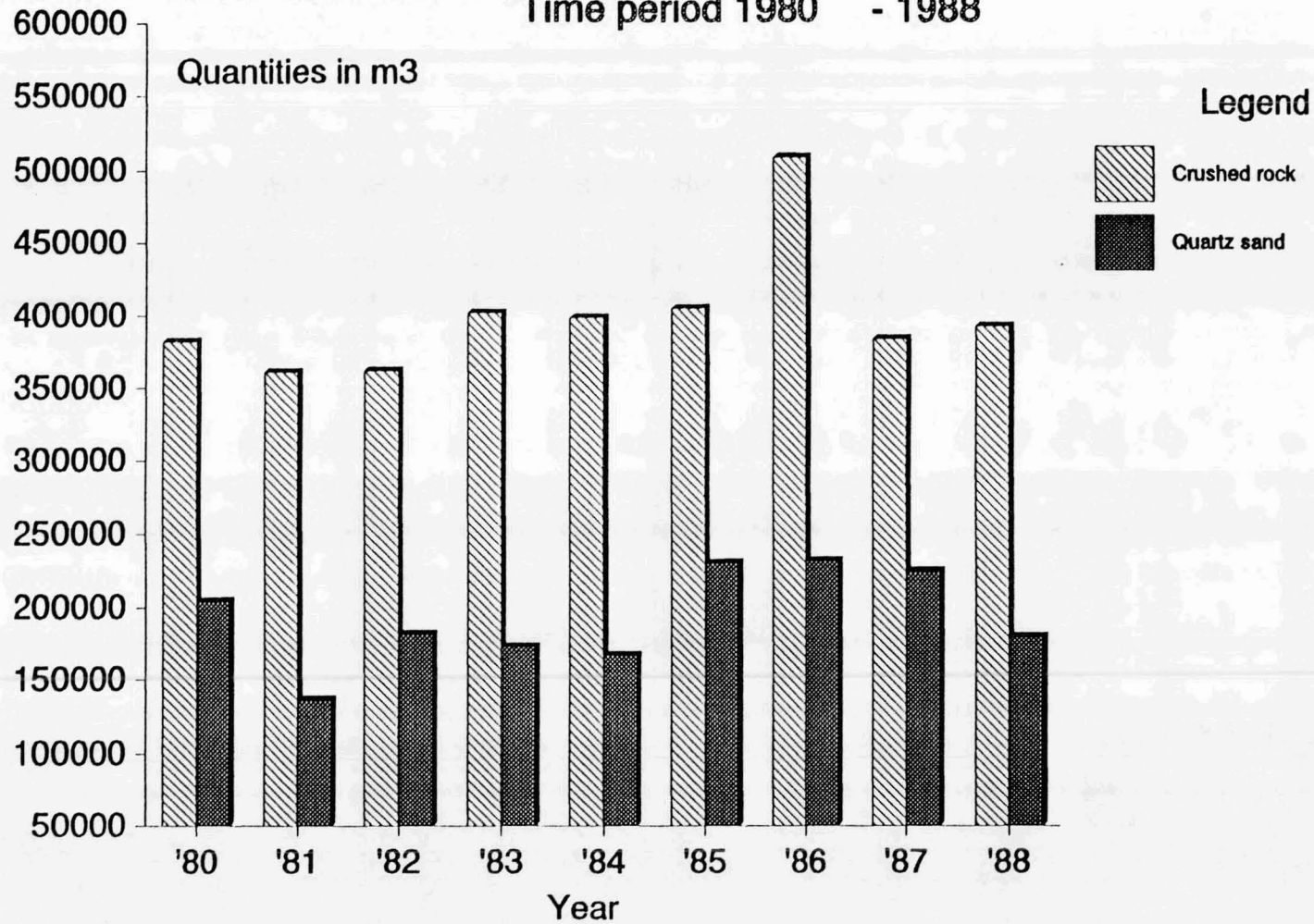


Figure 5. Denmark. Aggregate extraction on land, 1980-1988. Detail of figures for crushed rock and quartz sand.

SANDEXTRACTION IN DENMARK

Timeperiod 1980 - 1988

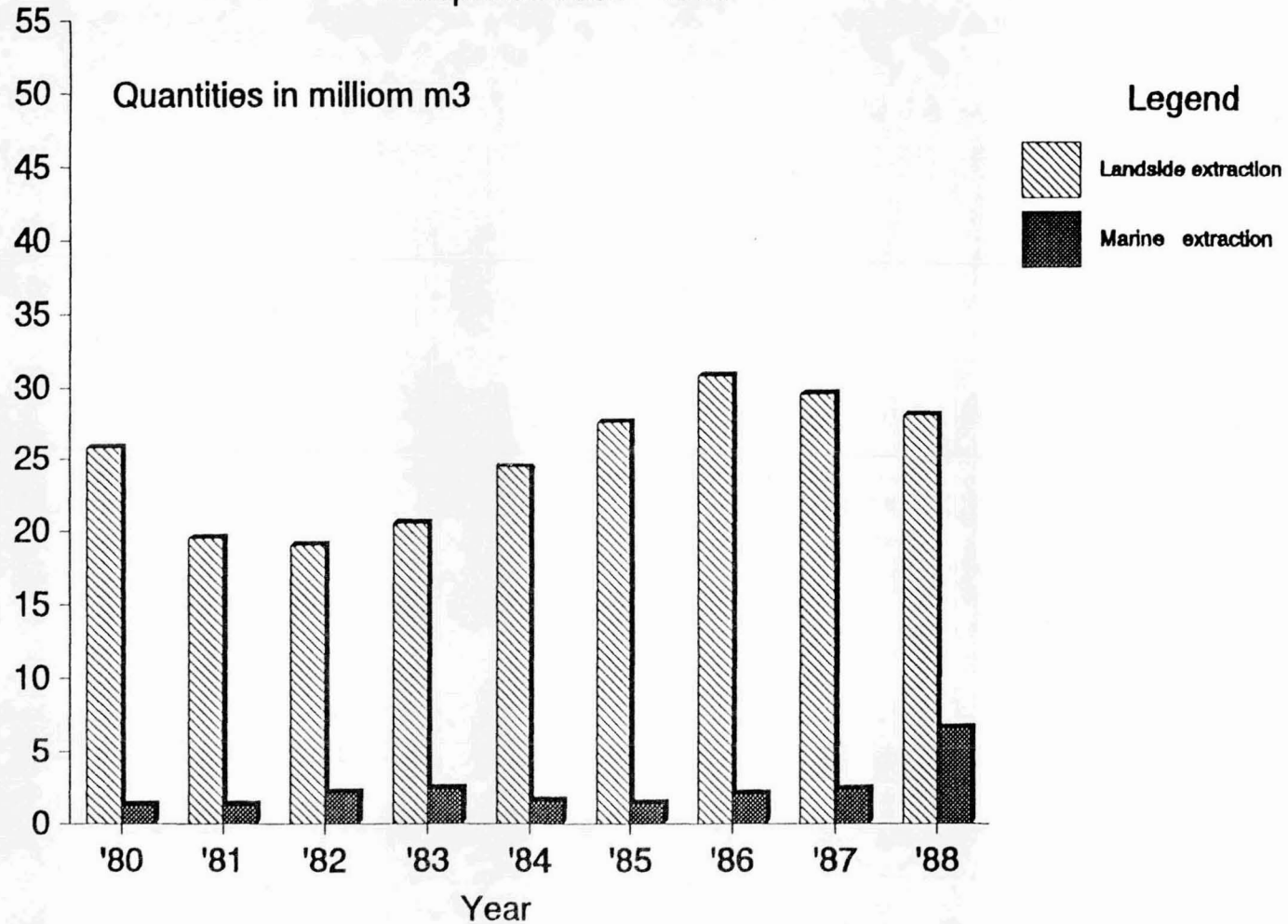


Figure 6. Denmark. Comparison of volumes of sand won from marine and from land based deposits, 1980-1988.

Winning of seasand (supply and fill up sand) in the Netherlands

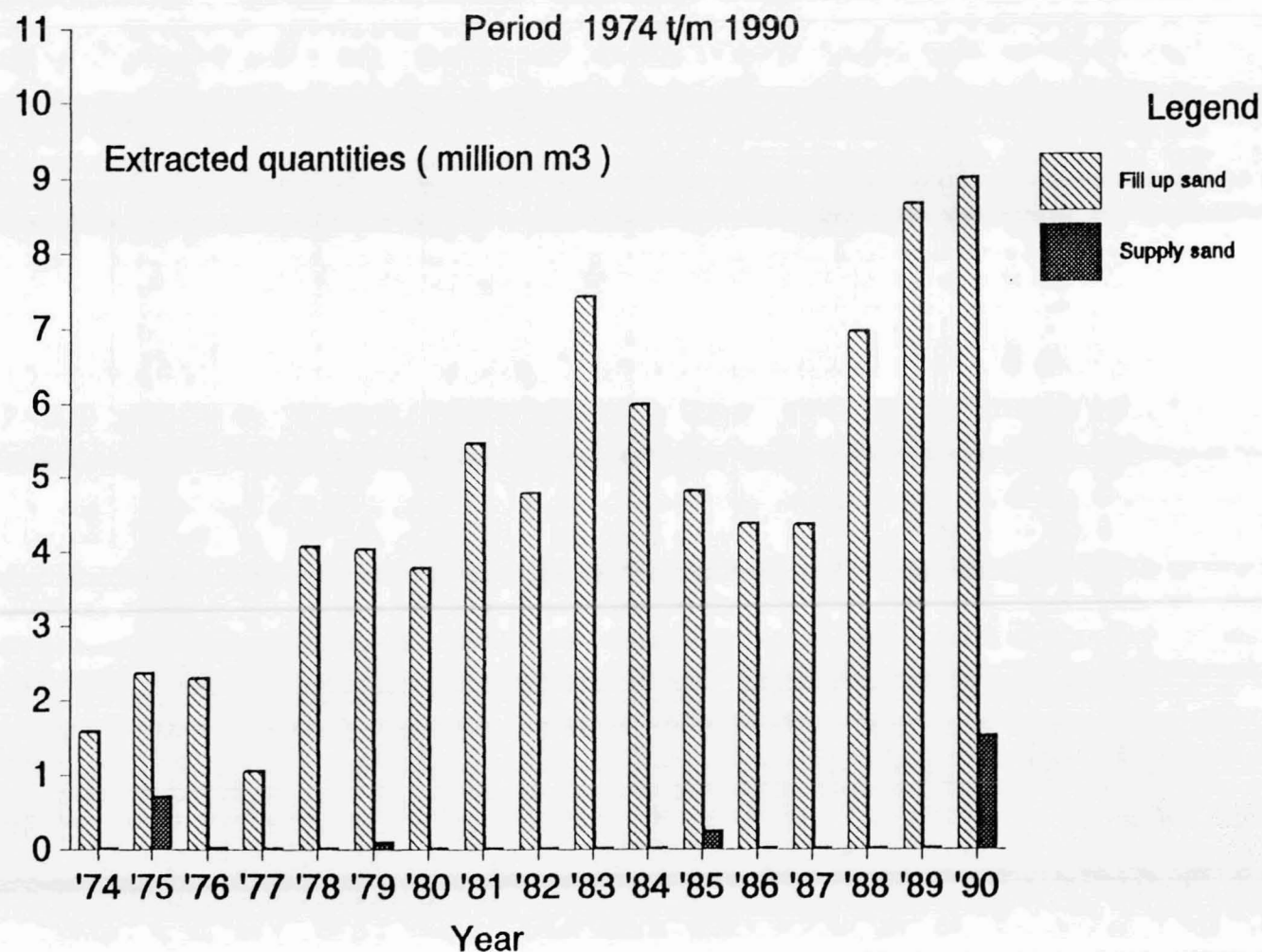


Figure 7. Netherlands. Extraction of marine sand for fill and supply, 1974-1990.

Forecast of winning of seasand (supply and fill up sand) in the Netherlands

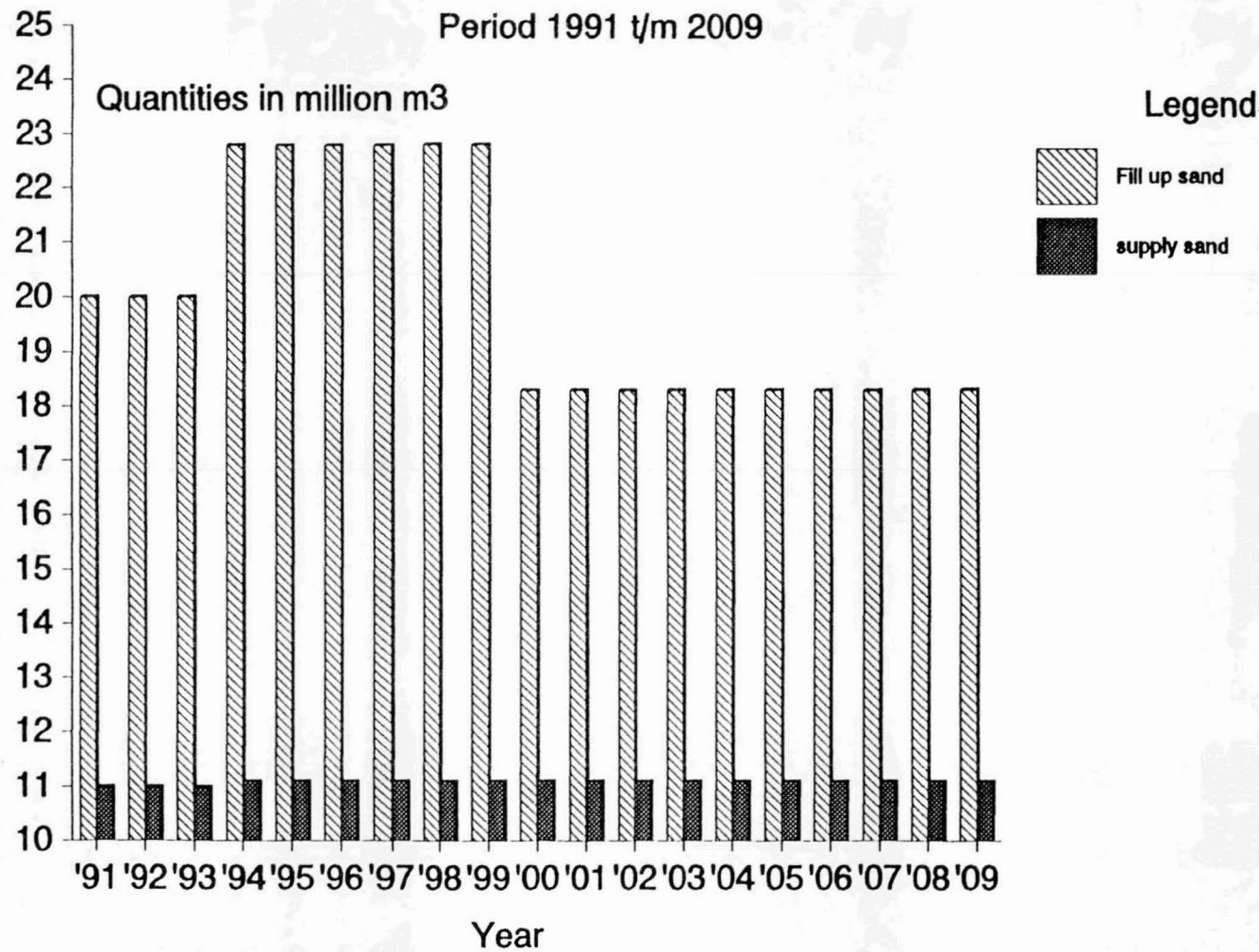


Figure 8. Netherlands. Forecast of demand for marine sand for fill and supply, 1991-2009.

Demand/supply of fill up sand in the Netherlands (in million m³)

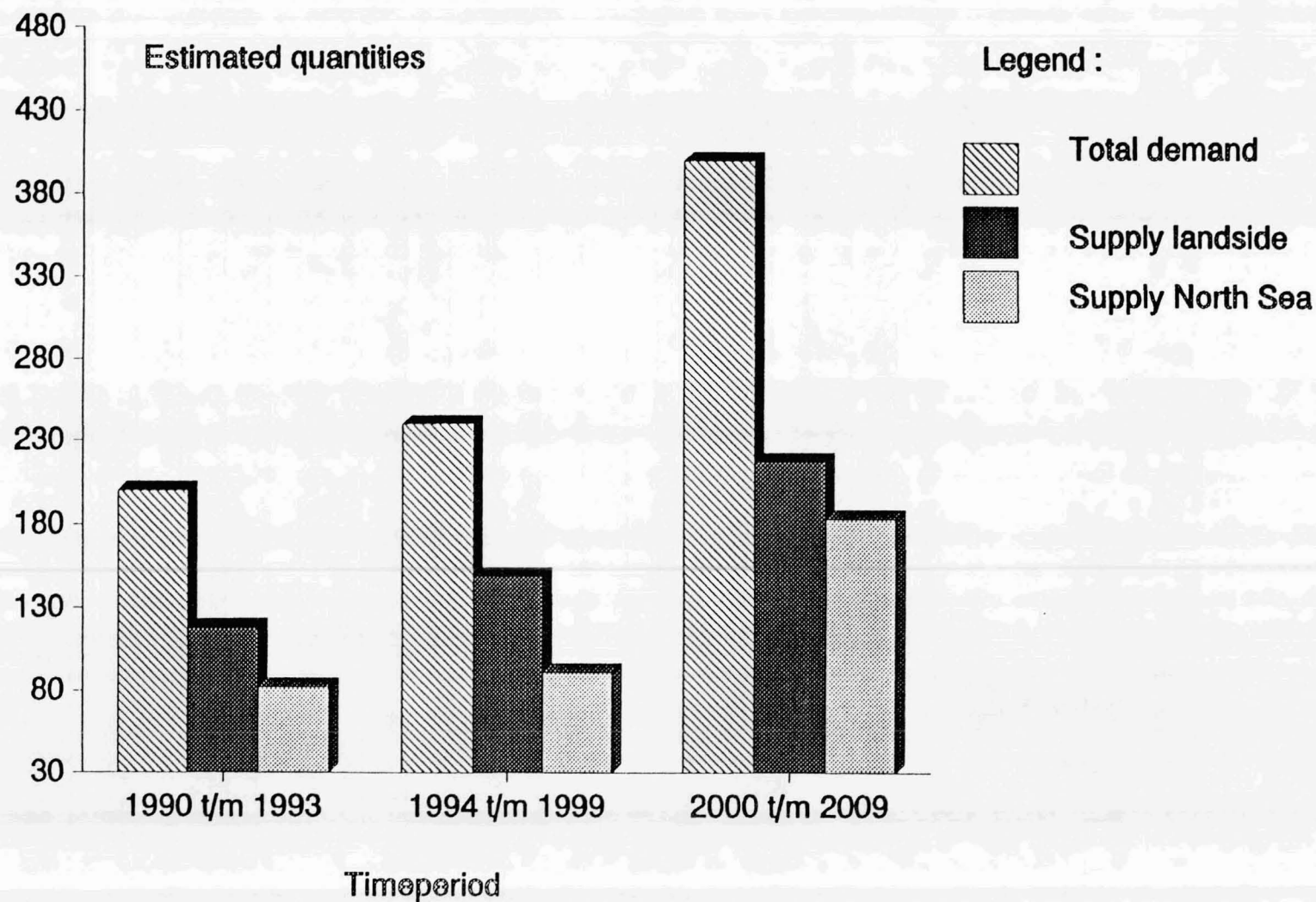


Figure 9. Netherlands. Forecast of demand and supply of sand for fill, 1990-2009.

Demand/supply of supply sand in the Netherlands

(at maximum rising of the sealevel)

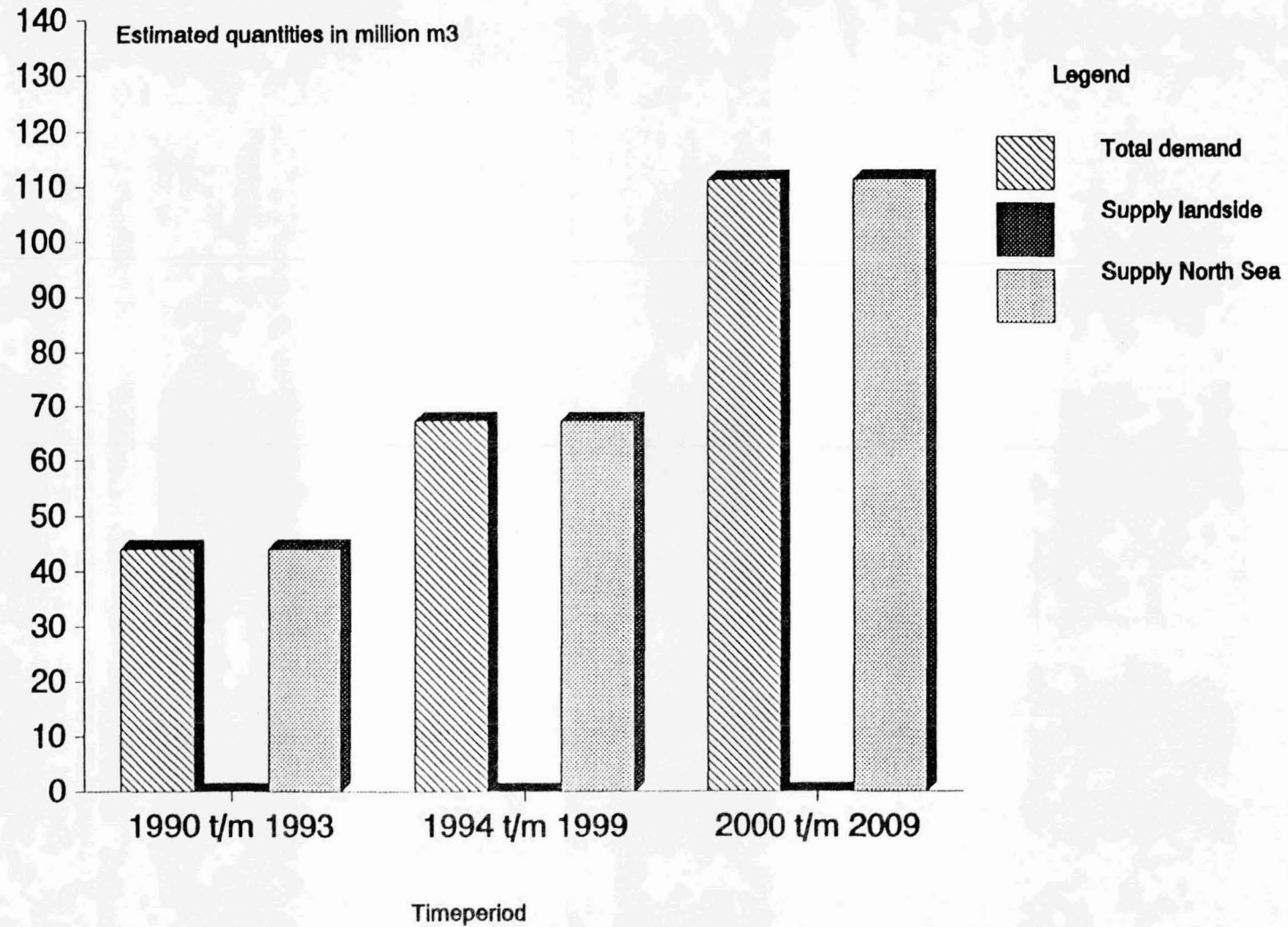


Figure 10. Netherlands. Forecast of demand and supply of sand for supply, 1990-2009.

DEMAND\SUPPLY OF GRAVEL IN THE NETHERLANDS

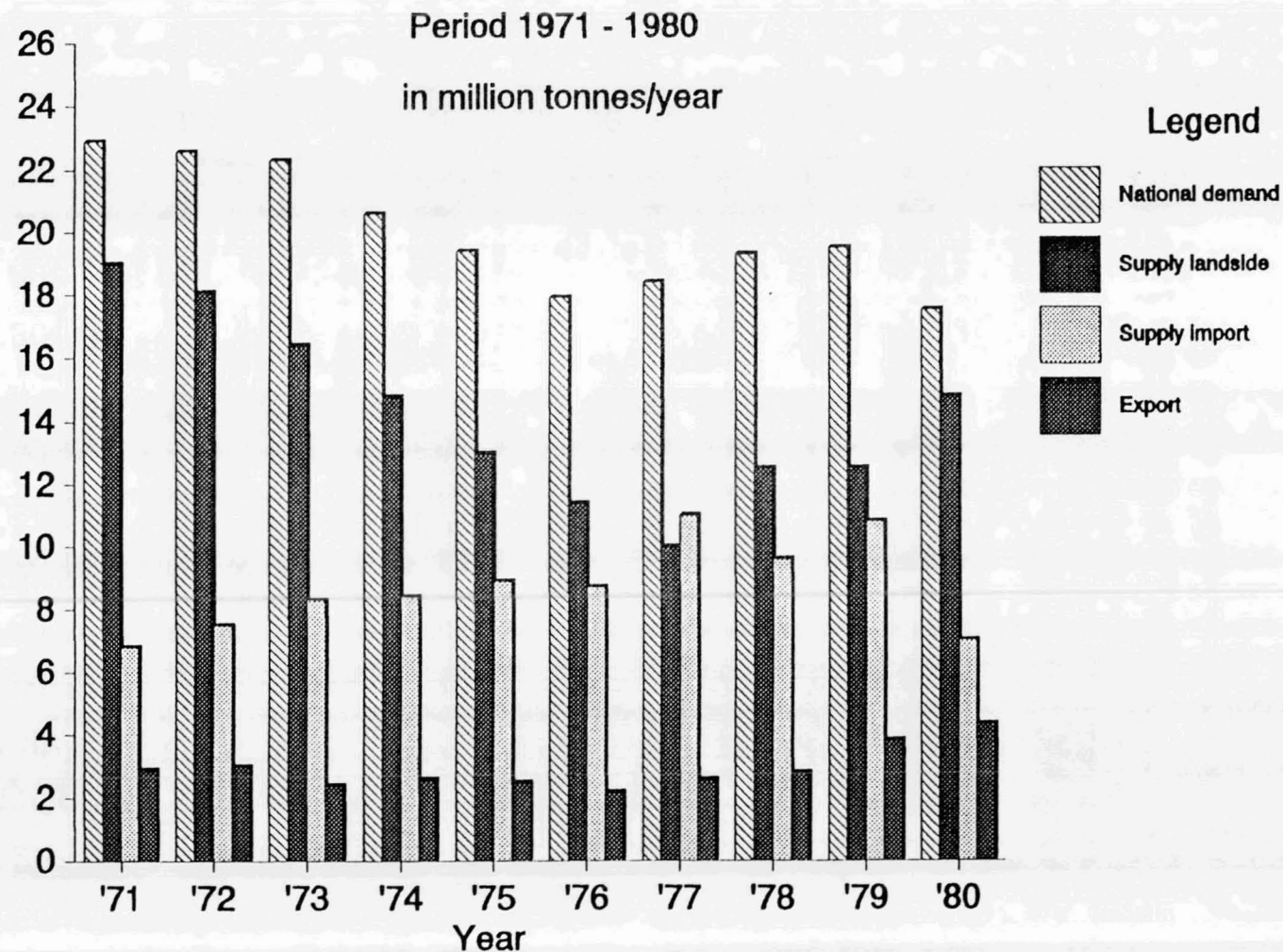


Figure 11. Netherlands. Demand and supply of gravel, 1971-1980.

DEMAND/SUPPLY OF GRAVEL IN THE NETHERLANDS

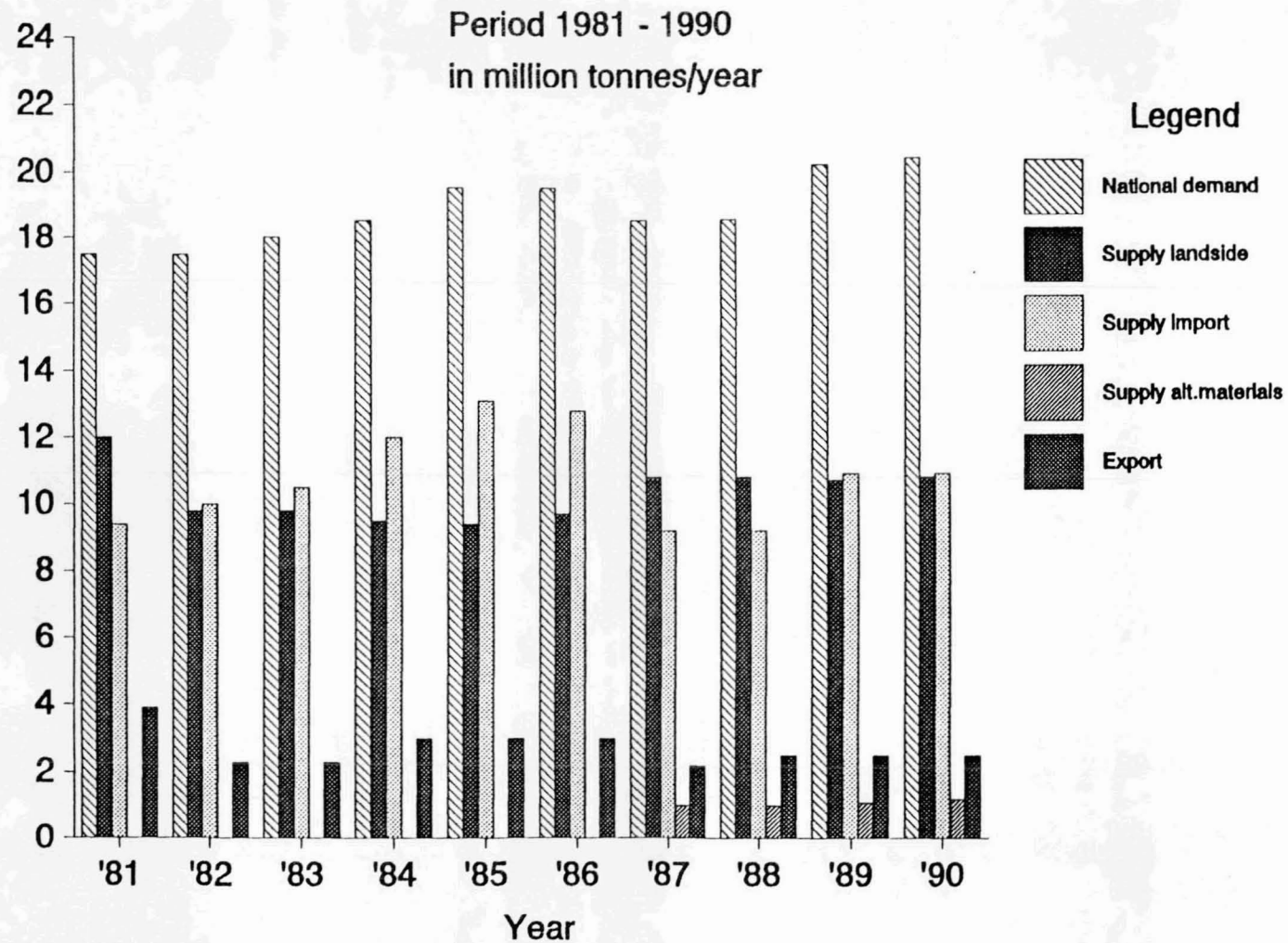


Figure 12. Netherlands. Demand and supply of gravel, 1981-1990.

DEMAND \ SUPPLY OF GRAVEL IN THE NETHERLANDS

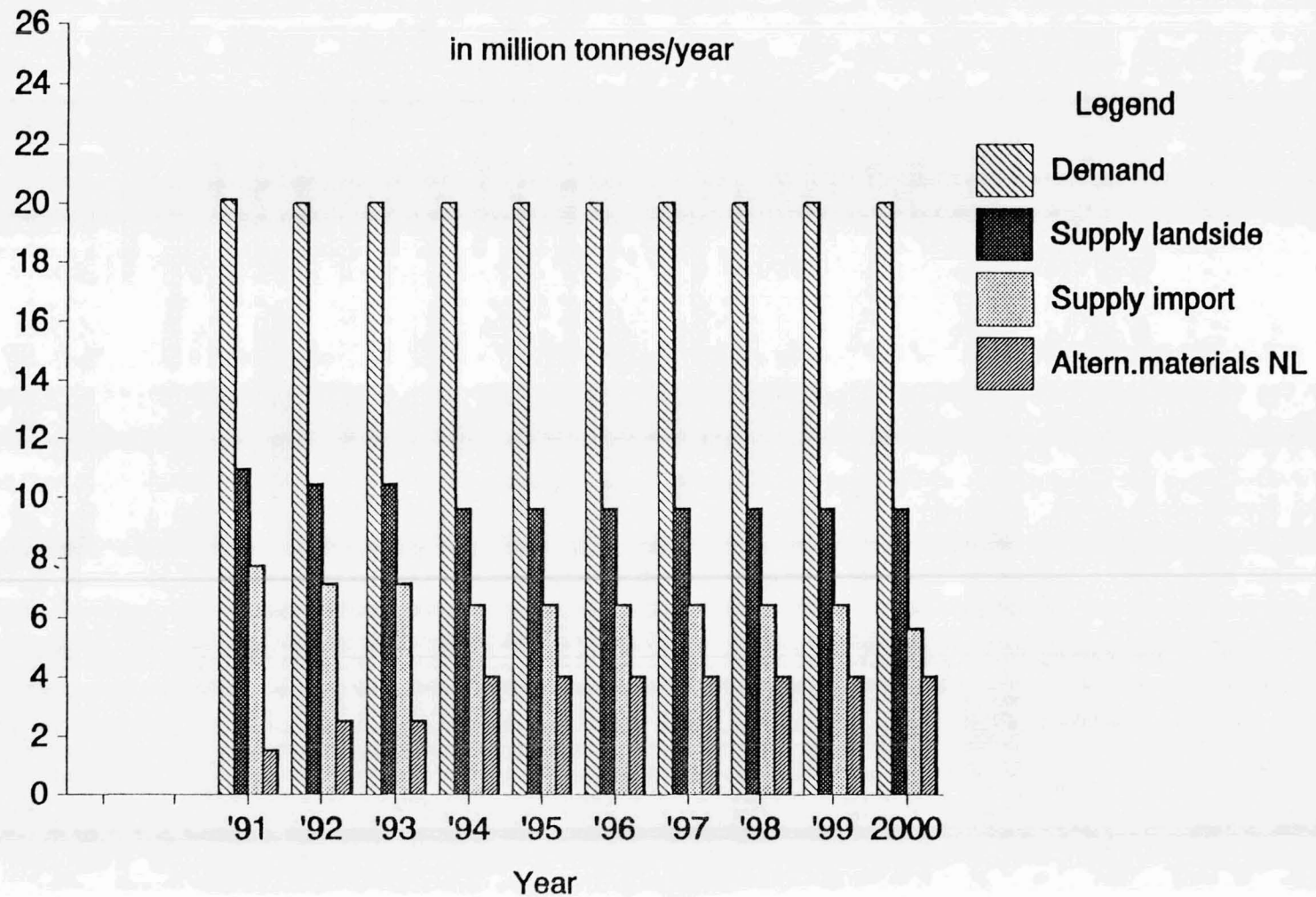
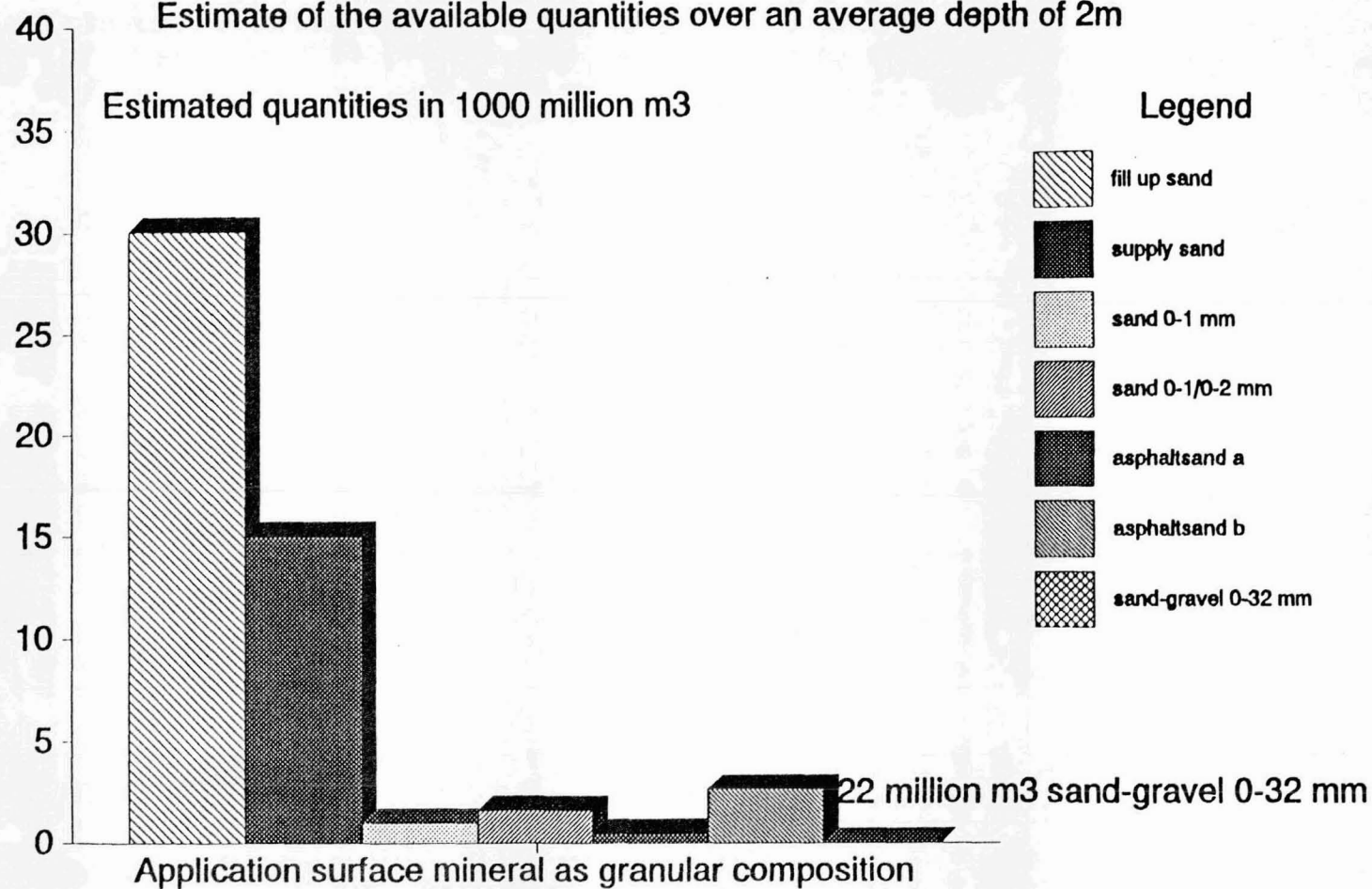


Figure 13. Netherlands. Demand and supply of gravel, forecast for 1991-2000.

Surface minerals in the Dutch part of the North Sea

Estimate of the available quantities over an average depth of 2m



asphaltsand a = sand for open- and gravel asphalt-concrete

asphaltsand b = sand for dense asphalt-concrete

Figure 14. Netherlands. Estimate of quantities of minerals available in the upper 2m of the seabed in the Dutch sector of the North Sea.

EXTRACTION OF MARINE AGGREGATE (m³) IN SWEDEN 1980-1990

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1980-90
DISKEN		525,499	104,415	2,995	38,500							671,409
SANDFLYTTAN	111,798	18,645	28,518	3,400	11,503	5,377	6,205	8,037	4,653	1,692	1,692	201,520
VASTRA HAKEN	22,556	3,190	11,650	45,580	61,094	61,117	38,170	34,263	35,484	35,509	31,302	379,915
LILLA MIDDELGRUND							785					785
STORA MIDDELGRUND								25,380	24,534	30,768	138,776	219,448
FARO								2,720		2,400		5,120
TOTAL	134,354	547,334	144,583	51,975	111,097	66,494	45,160	70,400	64,671	70,359	171,770	1,478,197

Figure 15. Sweden. Extraction of marine aggregates, 1980-1990.

EXPORT OF MARINE AGGREGATES FROM THE UK

Timeperiod 1979 - 1989

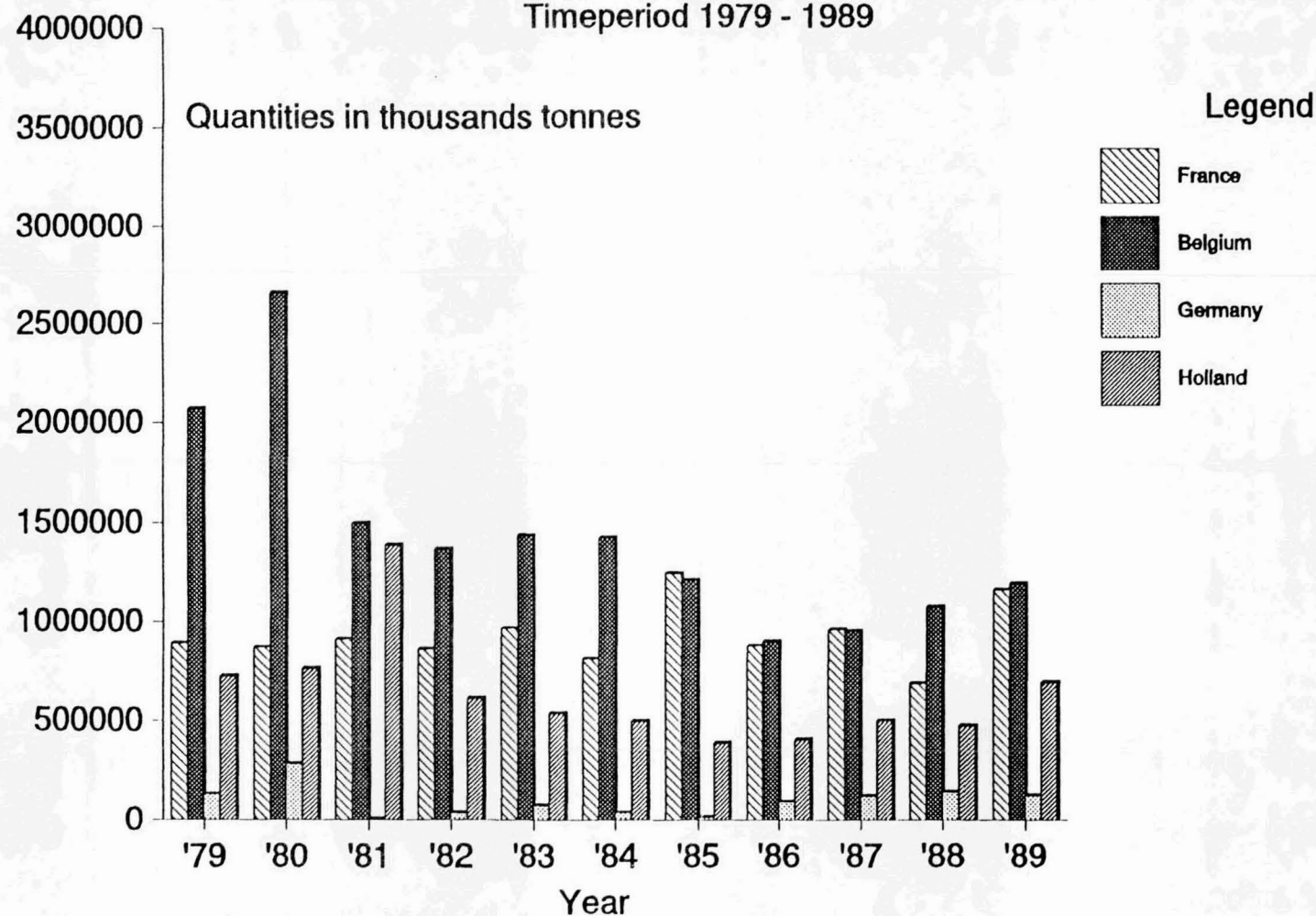


Figure 16. United Kingdom. Export of marine aggregates from the UK, 1979-1989.

LAND VERSUS MARINE AGGREGATES IN ENGLAND

Time period 1979 - 1989

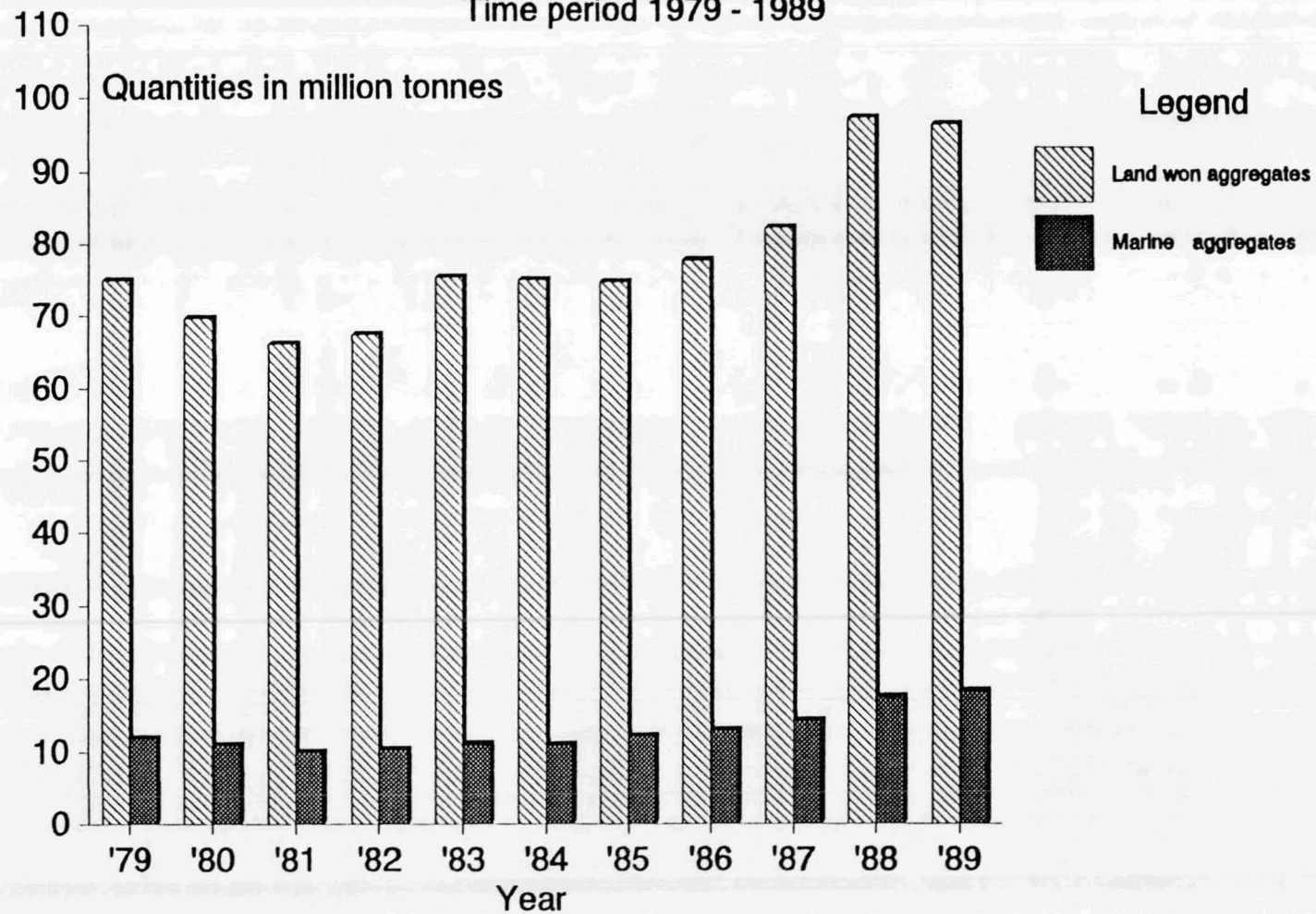


Figure 17. United Kingdom. Comparison of aggregate quantities won from marine and land based deposits in England, 1979-1989.

PRODUCTION OF PRIMARY AGGREGATES IN ENGLAND

Time period 1979 - 1989

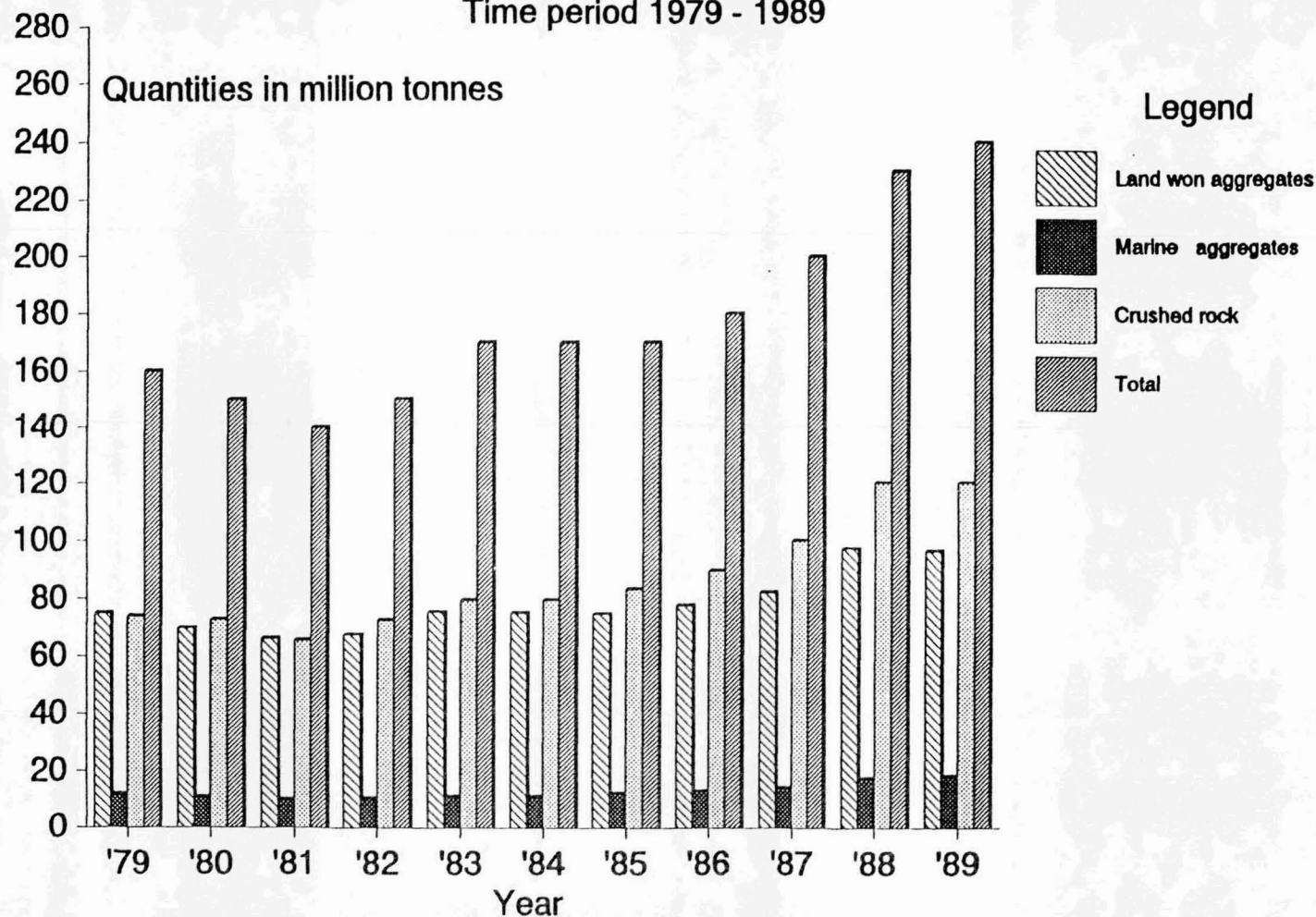


Figure 18. United Kingdom. Production of primary aggregates in England, 1979-1989.

LAND VERSUS MARINE AGGREGATES IN WALES

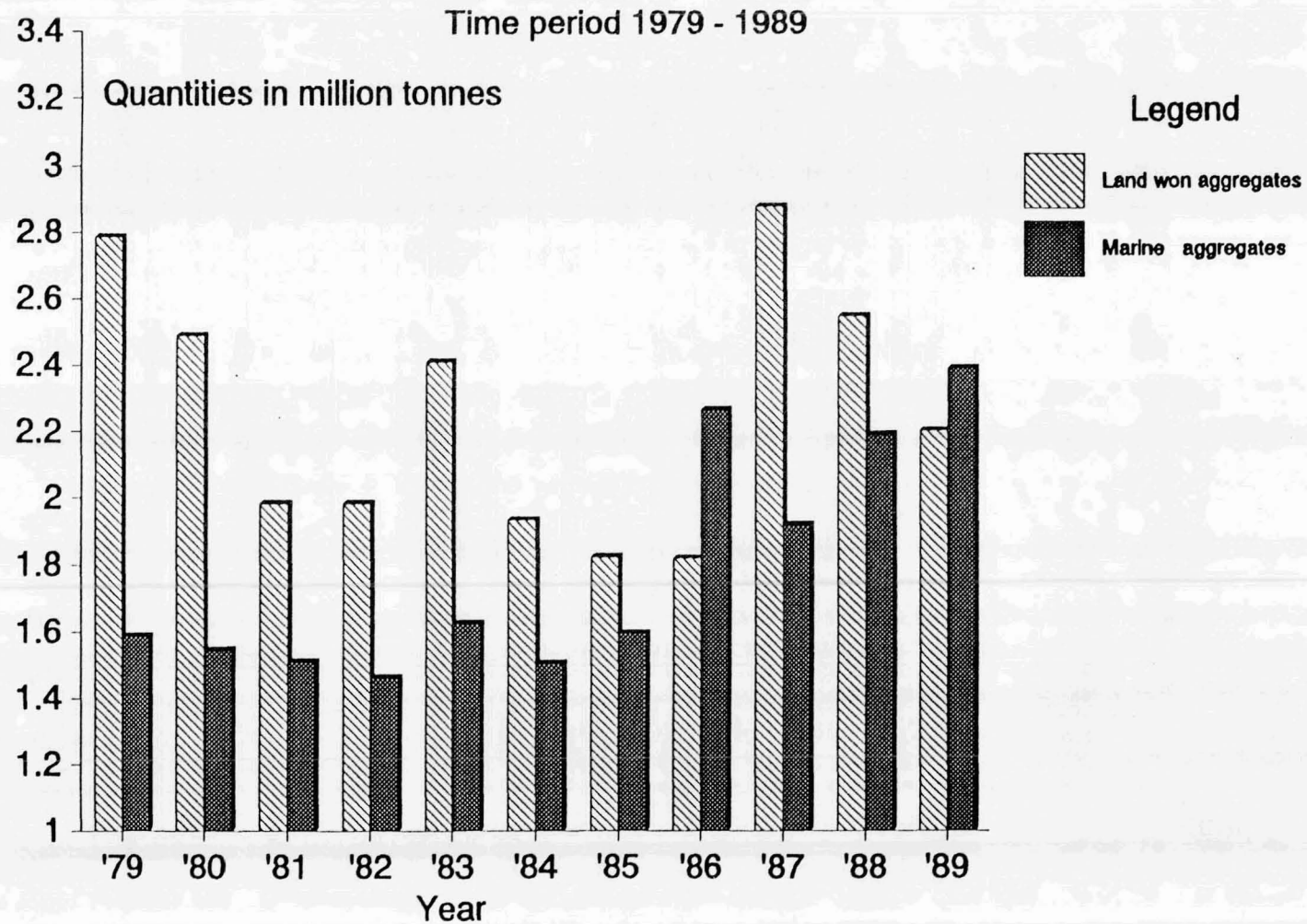


Figure 19. United Kingdom. Comparison of aggregate quantities won from marine and land based deposits in Wales, 1979-1989.

PRODUCTION OF PRIMARY AGGREGATES IN WALES

Time period 1979 - 1989

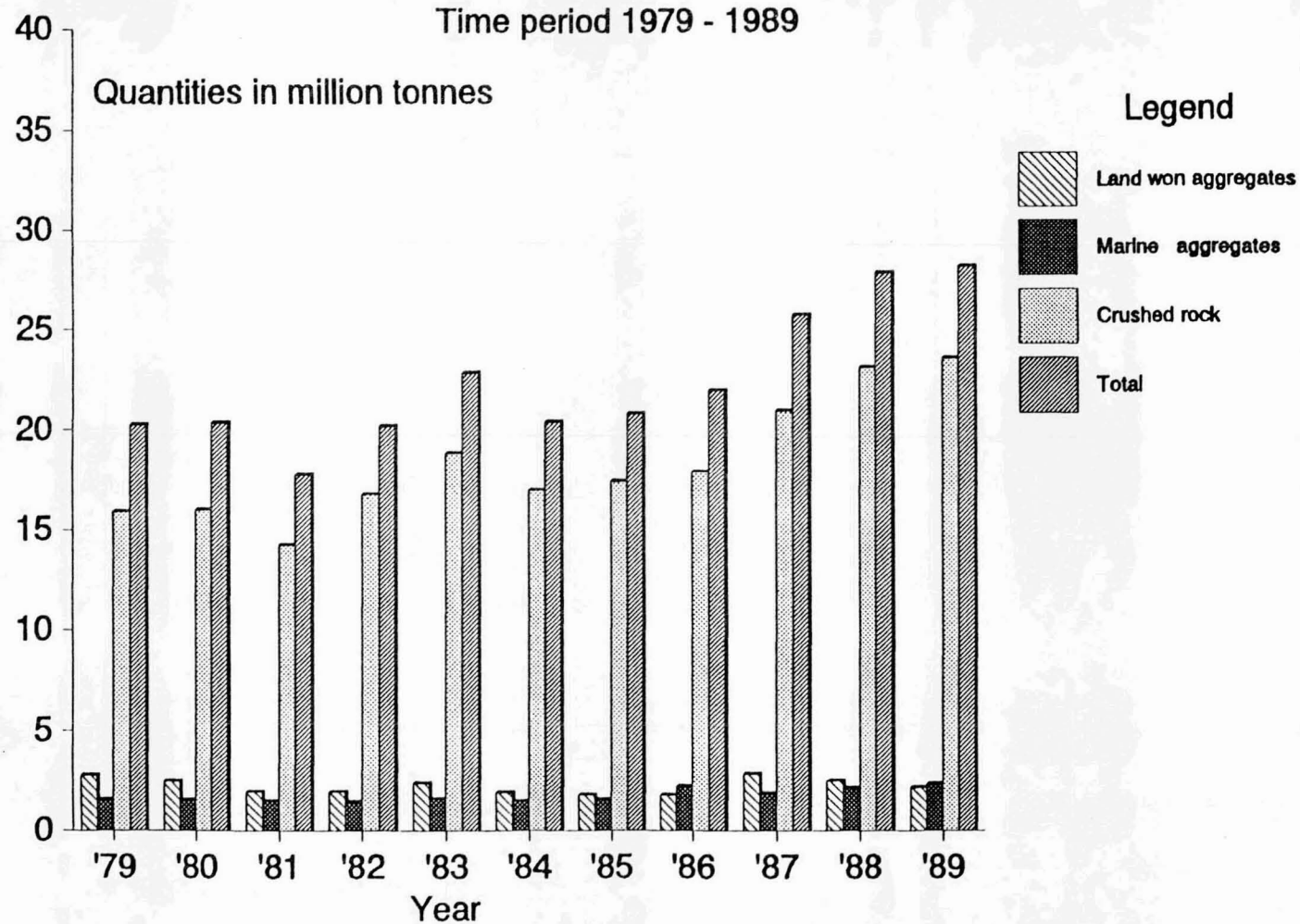


Figure 20. United Kingdom. Production of primary aggregates in Wales, 1979-1989.

LAND VERSUS MARINE AGGREGATES IN SCOTLAND

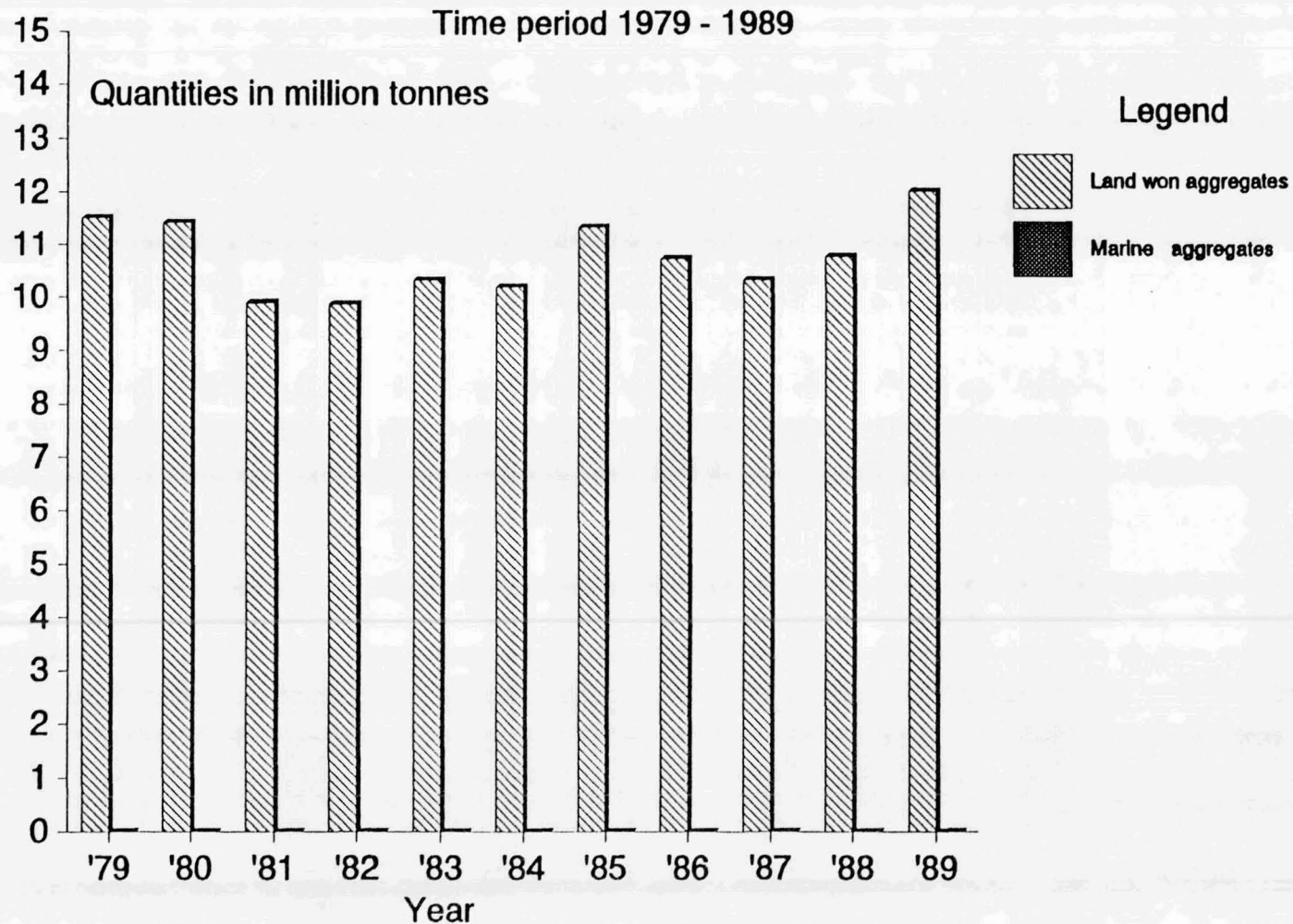


Figure 21. United Kingdom. Comparison of aggregate quantities won from marine and land based deposits in Scotland, 1979-1989.

PRODUCTION OF PRIMARY AGGREGATES IN SCOTLAND

Time period 1979 - 1989

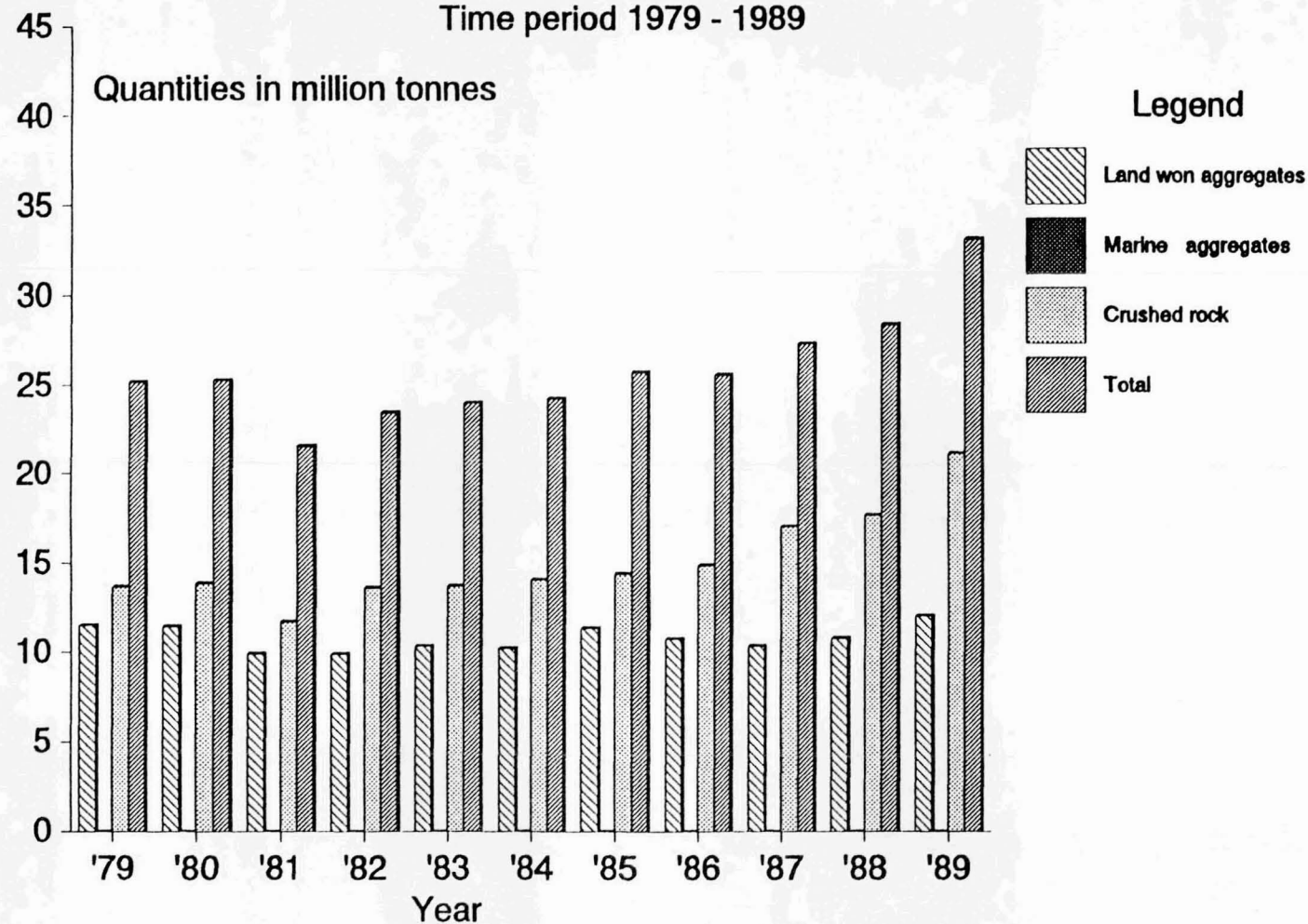


Figure 22. United Kingdom. Production of primary aggregates in Scotland, 1979-1989.