THE UNITED KINGDOM OFFSHORE AGGREGATE INDUSTRY: A REVIEW OF MANAGEMENT PRACTICES AND ISSUES

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Canada Oil & Gas Lands Administration

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ABSTRACT

Over a period of three decades, the U.K. offshore aggregate mining industry has grown significantly and now produces a major share of the country's sand and gravel. Regulatory mechanisms have also evolved in order to deal, in part, with concerns expressed by the fishing industry and with respect to coastal erosion. The U.K. experience and regulatory practice provides valuable lessons and approaches that may be adopted to design a sound regulatory system for Canada's offshore non-fuel mineral resources.

RESUME

Au cours des trente dernières années l'industrie minière des agrégats marins s'est développée de façon significative en Grande-Bretagne. Elle produit maintenant une partie importante du sable et du gravier en demande au pays. Les mécanismes de régulation ont été révisés en réponse, d'une part, aux inquiétudes de l'industrie de la pêche et, d'autre part, pour tenir compte des problèmes d'érosion littorale.

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L'exemple de la Grande-Bretagne, et plus particulièrement ses méthodes de régulation, nous offre d'excellentes leçons et points de vue qui méritent d'être considérés lors de la conception d'un système régulatoire canadien valable en matière d'exploitation des ressources marines en minéraux non combustibles au Canada.

1.0 INTRODUCTION

With the exception of sand and gravel used in the construction of artificial islands for oil and gas exploration in the Beaufort Sea, offshore aggregate mining in Canada has been limited to a few small sporadic operations. However, preliminary assessments of offshore non-fuel mineral resources (Hale and McLaren, 1984) and development potential (Hale, 1984) suggests production could reach several million or possibly several tens of millions of tonnes of aggregates per year within the next decade or so. In most cases, mining will take place in water depths of less than 100 metres and in areas relatively near coastal markets (Figures 1.1 and 1.2).

It is recognized that offshore mineral development is but one of a number of potential land uses that might include fishing, hunting (seals, whales, etc.), recreation, cables and pipelines, archeological sites and military and defense uses (Pasho, 1983). At this early stage of offshore non-fuel mineral development, there is considerable flexibility to develop and implement management practices that minimize the possibilities for conflict with such uses and increase the possibilities for multiple and compatible land uses. One potentially valuable tool in this regard is to take full advantage of the practical experience of other countries in designing sound planning mechanisms and resource management practices for Canadian offshore non-fuel mineral development.

Over the past several decades, offshore aggregate dredging has become a major industry in the United Kingdom. Early modest rates of U.K. offshore aggregate production increased from less than 1 million tonnes per year in the mid 1950s to almost 30 million tonnes per year in the early 1970s. Although production has since decreased to approximately 15 million tonnes per year, offshore mining now accounts for approximately 15 percent of total U.K. sand and gravel production and involves over 20 companies that operate on the order of 60 vessels (Miles, 1985).

As the U.K. industry has grown, resource management practices have changed in response to industry requirements and the concerns of other ocean users. This study reviews the growth of the U.K. aggregate industry and their management system and attempts to identify some of the types of management and regulatory issues that have arisen. The results of this preliminary review will be used to structure more detailed studies that may be warranted. FIGURE 1.1 POTENTIAL ECONOMIC RECOVERY ZONES FOR AGGREGATES OFF THE EAST COAST OF CANADA

(from Hale and McLaren, 1984)

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FIGURE 1.2 POTENTIAL ECONOMIC RECOVERY ZONES FOR AGGREGATES OFF THE WEST COAST OF CANADA (from Hale and McLaren, 1984)



2.0 DEVELOPMENT OF THE MARINE AGGREGATE INDUSTRY

2.1 Approach

For purpose of organization, a review of the industry is presented in four sections that correspond to the time periods: (1) prior to 1963; (2) 1963 to late 1969; (3) 1969 to late 1979; and (4), 1980 to the present. Although somewhat arbitrary, these intervals are distinguished from one another by differences in the growth of marine aggregate production (Figures 2.1 and 2.2; Table 2.1*) and the evolution of marine aggregate dredges, operations and practices.

2.2 Pre-1963

Offshore sand and gravel dredging began during the mid 1920s in the shallow, protected waters of the Bristol Channel (Figure 2.3). Such nearshore operations were, in the 1940s and 1950s, extended to the south coast around Southampton, Portsmouth and Liverpool on the west coast and the outer Thames Estuary on the east coast (Hess, 1971). Dredging operations, done with grab cranes mounted on barges, supplied aggregates to local markets. The majority of gravel dredges were conversions that, by current standards, were relatively small. Generally ranging from 300 to 700 tonnes cargo capacity, the few vessels over 1 000 tonnes were considered large (Webb, 1979 and 1982).

As operations moved seaward during the late 1950s, the limited efficiency and performance of the dredges coupled with more difficult weather conditions made many operations uneconomical. As a result, grab dredges were superceded by hopper dredges that used pumping equipment (Hess, 1971) and operated as stationary or trailing suction dredges. These, although similar in size to their predecessors, were the first purpose-built gravel dredges.

During the late 1950s and early 1960s, U.K. marine aggregate production remained relatively constant and in the order of 3.5 to 4.5 million tonnes per year. Marine aggregates amounted to approximately 5 percent of total U.K. sand and gravel production.

2.3 1963 to 1969

Between 1963 and 1969, U.K. marine aggregate production increased from slightly over 4 million tonnes per year to 13.5 million tonnes per year, an average annual increase of 1.5 million tonnes. As a percentage of total U.K. production, marine production went from 5 percent to slightly over 11 percent and accounted for approximately 20 percent of the cumulative increase in production over 1963 levels (e.g. land-based production met 80 percent of the cumulative increase in demand between 1963 and 1969).

Note: Production statistics in Table 1 excluded Scotland.

Figure 2.1 Marine Production of Sand and Gravel (based on United Kingdom Mineral Statistics, 1983)



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Figure 2.2 Exports of Marine Sand and Gravel (based on United Kingdom Mineral Statistics, 1983)



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REGION	DREDGE SITES	PRINCIPLE MARKETS	MATERIAL	PRODUCTION (<u>1969</u>) ⁴	(<u>1980</u>) ⁵
East Coast: Berwick to Great Yarmouth	Humber Estuary	Huil, Grimsby and North Lincolnshire; Continent (Rotterdam area)	sand and gravel	1.9	1.4 ¹
Thames Estuary: Great Yarmouth to Margate	East Anglia and North Outer Thames	London, North Kent; Continent	sand and gravel	4.3	9.2 ²
South Coast: Margate to Land's End	Isle of Wright	Southampton, Portsmouth Bournemouth also markets east to Dover and West to Falmouth	sand and gravel	2.8	3.3
Bristol Channel: Land's End to Fishguard	Bristol Channel	Bristol area, Cardiff Sevansea	concrete sand	2.2	2.2
West Coast: Fishguard to Carlisle	Liverpool Bay	Liverpool and Manchester area	concrete sand	1.5	.7 ³
				12.2	16.8
Table 2.1 SUMMARY	OF INFORMATION ON PR	INCIPAL MARINE AGGREGATE DR	EDGING AREAS (EX	CLUDES SCOTLAND)	
(1) "Humber and (Central", and, "North	Sea"		(4) Hess (1971)	
(2) "Southern Nor	(5) Webb (1982)				

(3) "Liverpool and Mersey"

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Figure 2.3 United Kingdom Location Map

During the late 1960s, UK marine aggregates became a significant source of sand and gravel for nearby mainland markets in Europe. Over the two-year period between 1967 and 1969, exports increased from virtually nil to slightly over 3 million tonnes per year. In 1969, sand and gravel exports accounted for approximately 25 percent of the U.K.'s marine aggregate production.

Several factors contributed to the rapid growth of marine aggregate production during this period. Initial doubts concerning the suitability of marine aggregates for concrete were being affectively addressed (Anon, 1975) and resulted in greater acceptability of the product. Marine producers also became more competitive due to the economies of scale resulting from the advent of the stationary hopper dredge. In addition to the existing dredging companies that were expanding production, a number of new companies entered the field and contributed to marine aggregate supply (Whiteside, 1972). Finally, there was the increasing cost and scarcity of onland sources that resulted from problems associated with urbanization around market centres, increased land costs, land use conflicts and a variety of associated political, social and environmental constraints (Hess, 1971).

2.4 Late 1969 to 1979

Although marine aggregate production, both in absolute terms and as a percentage of total U.K. production, levelled off between 1969 and 1971, the trend of production was upwards for the remainder of the decade. From 1971 to 1979 marine aggregate production increased from 13.5 million tonnes to 18 million tonnes. This corresponded to an increase from approximately 11.5 percent to 16 percent of total U.K. aggregate production.

The strength of marine aggregate production can, to some extent, be related to export markets. Following a short decline in the early 1970s, the export of marine aggregate production increased from approximately 2 million tonnes per year to slightly over 4 million tonnes per year or from approximately 15 percent to 26 percent of marine aggregate production.

The principal increases from deposits in the southern North Sea and Thames Estuary resulted from increased use of marine aggregates in the London area and the strength of foreign markets in nearby Europe. In London, increasing demand for sand and gravel, the high cost of haulage through highly congested urban areas and load restrictions, and the construction of favourably located facilities for discharging and processing marine materials allowed marine aggregates to increase their market share (Whiteside, 1972). The proximity of European markets and the abundance of gravel, as opposed to sand, on the English side of the southern North Sea resulted in increased shipments to European ports such as Dunkirk and Rotterdam. British dredging experience, coupled with currency devaluations and corporate associations, (Anglo-Dutch) contributed to this trend (Hess, 1971). Increased production of marine sand and gravel throughout the late 1960s and growing uncertainty as to the extent of marine aggregate resources prompted the British Geological Survey (then the Institute of Geological Sciences) to undertake geological and geophysical reconnaissance investigations of the UK continental shelf. By the mid 1970s, there were indications that sand deposits were extensive, but, in general, coarse material within dredging depth was much more limited (Archer, 1972 and Anon, 1975).

The next generation of dredging vessels was dramatically influenced by expanding markets, the need to extend dredging operations into deeper waters to find reserves, the related need to contend with adverse sea and weather conditions, and the advantages of economies of scale. The commonly used stationary suction dredge continued to give way to the trailing suction hopper dredge which had substantially increased capacities. Although several smaller nearshore operations still used power barges with capacities of only 200 tonnes, few vessels built after the early 1970s were less than 1 000 tonnes capacity and most were on the order of 2 000 to 3 500 tonnes. The average of all ships on order in 1970-71 was around 2 700 tonnes, the largest being 5 000 to 7 000 tonnes (Archer, 1973; Whiteside, 1972; and SAGA, 1978).

Accompanying the growth in carrying capacity was an increase in the sophistication of dredging systems, particularly with respect to instrumentation and heave compensation equipment. This, coupled with the larger size vessels that provided a more stable platform, permitted better utilization with less down-time due to weather conditions. While some vessels cease dredging at wind force 4, some newer vessels are able to operate up to force 7 (Hess, 1971; Whiteside, 1972; Webb, 1979 and 1981). These new dredges were capable of routine operations in depths of 20-30 metres, although, in many cases, their pumps were adequate to allow operations at depths up to 40-45 metres (Whiteside, 1972; Webb, 1982). In addition, the trailing suction technique allowed exploitation of thinner deposits, in the range of 1-3 metres thick (Hess, 1971), without degrading the cargo by penetrating and recovering undesirable material (clay) that commonly underlies the deposits.

One of the main competitive advantages enjoyed by marine aggregate producers was the ability to land aggregates at wharfs situated near the centre of large markets. This advantage was tempered to some extent by the high cost of wharf facilities, space limitations that restricted the accumulation of large stockpiles and shallow water depths at discharge points (Whiteside, 1972).

The high cost of dock dues encouraged unloading at tidal wharfs that were commonly in shallow waters and had limited unloading facilities. Although the dredges were, in many cases, specially built to carry maximum tonnage at minimum draft, it was still necessary to plan operations to fit either a 12 or 24-hour tidal cycle (Archer, 1973). The need for rapid unloading and the desire to serve a variety of markets where unloading facilities were not readily available led to the development of onboard offloading systems. While several alternatives were tried, most dredges eventually employed drag scrapers and elevator systems capable of unloading at rates of approximately 1 000 to 2 500 tonnes per hour (Whiteside, 1972; Ironman, 1978; Anon, 1983).

Although the major portion of aggregate processing was done shoreside, there was a trend towards shipboard concentration. In earlier years, the quality of material being dredged was such that there was little need for screening equipment on the vessel other than the grid fitted to the dredgehead to stop large stones from passing up the pipe (Whiteside, 1972). As markets increased, customer requirements changed and the nature of the dredged material varied, it became necessary to install some onboard grading equipment. Onboard screens were used to reject oversize material where only sand was required, or, alternatively, to reject fines and sand where the market required gravel.

While most onboard grading equipment was limited to relatively simple screening, one ship, the <u>El Flamingo</u>, was equipped with a highlyautomated shipboard treatment plant capable of producing a wide range of washed and sized aggregate products at sea and unloading a desired sized product or a special mix. Although the ship was, in the early 1970s, said to characterize the U.K. sand and gravel dredging fleet of the future (Hess, 1971), it was laid up by the end of the decade and subsequently scrapped (P.C. ARC).

Onshore treatment typically involved washing and screening. Recirculating systems are common and generally use mains/town water for both the initial and top up water. Settling tanks were used to separate silt prior to discharging the water.

Beginning in the mid 1960s, there was an increasing trend to tie ready-mix concrete plants to onshore aggregate processing facilities (Hill, 1970, Hess, 1971 and Whiteside, 1972).

During the 1970s, the cost of producing marine aggregates increased rapidly; more rapidly than the cost of producing on land aggregates. This was attributed to the very high cost of fuel oil bunkers and the cost of maintaining and repairing the vessels (SAGA, 1979). Despite this and the post 1973 decline in total sand and gravel production, production of marine aggregates remained relatively steady and, because of the decline in total production, expanded its share of U.K. production until 1979.

It is widely felt that the marine sector may have gained in the London market as a result of greater competitiveness. It has also been suggested that maintenance or expansion of the marine aggregate market share may reflect a deliberate policy on the part of the companies with interests in both land and marine production whereby these organizations conserve land-based resources which are an appreciating asset while ensuring maximum utilization of shipping fleets which were costly, depreciating assets (Tinsley, 1983).

2.5 1980 to Present

Since 1980, both the absolute level of marine production and the percentage of U.K. production have declined. It would appear that a significant portion of this decrease was the result of declining exports. While U.K. production was, in the past, very competitive in foreign markets, the situation has changed in recent years due to relative rates of escalation and inflation and changing values in currencies (Webb, 1982).

The structure of the industry has changed substantially since the early 1970s. Mergers and take overs, led by onshore producers wanting to protect their long term supply by ensuring access to marine sources, has resulted in fewer companies and vessels but roughly the same or slighty higher production rates. The companies are, to a greater extent, vertically integrated as a result of investment in value added concrete, concrete products and asphalt markets (Wheeler, 1984).

One factor likely to have a long-term effect on the marine aggregate industry is the rapid increase in shipbuilding prices since the early 1970s. The cost per cubic metre of carrying capacity of a self-discharging dredge has tripled during this time. It is significant that the U.K. and Dutch owned companies, which account for the majority of vessels, had not, in the space of the 8 years prior to 1983, placed one contract for a new ship. Although a significant portion of the fleet consists of high-grade vessels built during the first half of the 1970s, it is, even assuming the average life of 15-20 years, notable that investment in new construction had not taken place until recently when ARC Marine ordered two new vessels (Artz, 1976; Tinsley, 1983; P.C. ARC Marine). In fact, of the major producers, only two have fleets exclusively less than 12 years old (Webb, 1982). This will affect the future of marine aggregate production as the aging ships become increasingly expensive to repair and maintain. Companies in the industry are, however, discussing major modifications and new building with shipbuilders (P.C. ARC Marine).

A further problem facing the industry is the availability of quality reserves. While it is known that substantial reserves exist in depths in excess of 50 metres, the existing method of centrifugal pumping technically limits the depth to which material can be dredged to 40-45 metres and economical dredging is restricted to around 30-35 metres. If deeper deposits are to be exploited, changes in pumping systems will be necessary. Alternatively, shallower water reserves exist, but, it would be necessary to deal with overburden (Webb, 1982).

It was, in the early 1980s, generally anticipated that there would not be any large-scale growth in the U.K. marine aggregate industry in the forseeable future (Webb, 1979). More recently, however, the Department of the Environment is looking for a significant increase in marine aggregate production to make up for expected shortfalls from reduced land production of sand and gravel (P.C. ARC Marine).

3.0 MANAGEMENT

3.1 Crown Estates Commissioners

Proprietary rights in the foreshore and Territorial Sea are held by the Crown. The <u>Continental Shelf Act</u>, 1964 provides that rights with respect to the exploration and exploitation of all minerals on the continental shelf outside the Territorial Sea are, with the exception of oil, gas and coal, also vested with Her Majesty. The Crown Estates Commissioners are responsible for managing the Crown's proprietary interests, including offshore non-fuel minerals. The Crown Estates Office is, however, not a government department and the Commissioners, therefore, have no overall jurisdiction, control or statutory powers related to other interests that may be affected by aggregate exploration.

3.2 Regulatory Mechanisms

Pursuant to its authority under the <u>Crown Estates Act</u>, <u>1961</u> and the <u>Continental Shelf Act</u>, <u>1964</u>, the Commissioners issue prospecting and dradging licences (Appendix I and II) for offshore aggregates in accordance with a Code of Practice (Appendix III) agreed to by the Crown Estates Commissioners and the Marine Section of the Sand and Gravel Association in March, <u>1977</u>. The most recent general review of the basic licencing system was made in the mid 1970s. Although it concluded that no changes in the basic system were necessary, some modifications were incorporated in the Code of Practice (Anon, <u>1975</u>).

A <u>prospecting</u> licence is issued to "competent" companies of proven capability and allows the holder to prospect for and sample sand and gravel (up to 1000 tonnes) in a specified area that is usually in the order of 2 600 km². The licence is for a term of 2 years, and is not transferable. A fee, varying with the size of the area, is levied. Terms and conditions include: restrictions on drilling and sampling near cables; a prohibition on "unjustifiable interference" with navigation, fishing or "the conservation of the living resources of the sea"; indemnification of the Crown against all actions, proceedings, costs, etc., brought by any third party; and reasonable access by authorized persons to examine installations and equipment. Provision is made for revocation and dispute settlement through arbitration.

The licence includes a requirement to provide the Commissioners with a report on operations in a form approved by the Commissioners and is to include a copy of all geophysical profiles produced during the operation. The holder is also required to furnish "such other information... as the Commissioners may from time to time require". The information is considered confidential for 4 years (Anon, 1975) and is not released without the written consent of the licencee "which shall not be reasonably withheld".

Applications for <u>production</u> licences are considered only if the applicant has first held a prospecting licence covering the area in question and full prospecting details have been submitted. The licence covers a much smaller area than the prospecting licence and provides the holder with the right to dredge and carry away sand and gravel from the licenced area. The licence specifies terms and conditions relating to: the maximum annual quantity of material that may be recovered and the term of the licence; the keeping of accounts and deck logs; prohibitions on activities that would cause any damage, loss, or injury to any company, person, or property; and a requirement for compensation in such an event. Additional provisions relate to revocation and the non-transferable nature of the licence.

Pursuant to the 1977 Code of Practice, production licences are considered only if the applicant has the necessary vessels, facilities, etc. required to undertake the work. The Code also indicates that production licences will be on an annual basis, and that the Commissioners will normally grant only one licence for any one area. To allow for a review of any concerns with respect to coastal protection and fishing, the Code also indicates that six months prior notice is required for a production licence.

The holder of a licence is charged a " dead rent" on the approved annual tonnage and a royalty on the actual quantity of production. The rates are variable and are assessed for new licences at the time of application. They are then in effect for at least three years and are established after consultation with individual operators taking into account market prices, operating costs or other significant factors (Web, 1979). Overall, the levies amount to something in the order of 8 to 10 percent of the landed price (P.C. Crown Estates Commissioners, 1978).*

3.3 Agency Responsibilities

A number of government departments and agencies have statutory and advisory responsibilities:

- The Department of Trade's (formerly Board of Trade) Marine Navigational Aids Branch administers navigational regulations (pursuant to the <u>Coast Protection Act, 1949</u>) that establish dredging practices and restrictions with respect to shipping lanes, cables, oil and gas pipelines, navigational buoys and shipwrecks.
- 2. The Ministry of Post and Telecommunications reviews applications from the standpoint of underwater cables (Whiteside, 1972).
- 3. The Natural Environmental Research Council's Unit of Coastal Sedimentation, established in 1969, undertakes investigations and provides advice on offshore dredging as it relates to sediment transport (Hess, 1971).
- 4. The Ministry of Technology's Coastal Engineering Division of the Hydraulics Research Station at Wallingford investigates specific problems and conducts field research on coastal hydraulics and coastal erosion problems (Hess, 1971).

^{*} This has changed: the adjustments are negotiable and rates are currently linked to the U.K. Retail Price Index.

- 5. The Fisheries Research Group of the Ministry of Agriculture, Fisheries and Food (MAFF) (particularly the Fisheries Laboratory at Lowestoft) reviews applications and undertakes research and investigations of problems associated with the commercial fishing industry including basic environmental and ecological studies related to offshore aggregate dredging (Hess, 1971).
- The Department of Energy and the Ministry of Defence also review applications.

3.4 Coordination and Review of Applications

Prior to 1971, the Crown Estates Commission review of a production licence application involved direct consultation with the previously noted agencies in order to identify possible concerns. In addition, the Crown Estates Commissioners also participated in an Advisory Committee, formed in 1969, to review and make recommendations on policy matters related to sea dredging and preservation of the ocean environment. In addition to the previously noted groups, representatives on the Committee included the National Institute of Oceanography, the Institute of Coastal Oceanography and Tides, the Institute of Geological Sciences (now the British Geological Survey), the National Ports Authority and university representatives (Hess, 1971).

Since the early 1970s, applications for production licences are first forwarded by the Commissioners to the Hydraulics Research Station to determine if the proposed activities raise any concerns with respect to coastal erosion. If no difficulties are raised in this regard, the application is referred to the Minerals Planning Division of the Department of the Environment which coordinates the "government view process". This process involves consultation with local coastal protection authorities, fisheries interests, navigational authorities, oil and gas production departments and other interested parties. On the basis of their consultations, the Department makes recommendations as to whether or not the application should be granted by the Crown Estate Commissioner's office (Anon, 1975).

Experience has shown that modern prospecting operations cause little disturbance to the marine environment or interfere with other activities at sea. As a result, there is no formal government consultation procedure for a prospecting licence and MAFF cannot, and does not, object to granting licences. Until issued, prospecting licences are regarded as confidential and MAFF does not consult organizations outside the Ministry. Once the licence has been granted, MAFF will provide details to the Sea Fisheries Committees and the appropriate national fishermen's organizations. (Code of Practice for the Extraction of Marine Aggregate, December, 1981: Appendix III).

Since the mid 1970s, the Crown Estates Commission does, however, inform MAFF before issuing a prospecting licence. MAFF, after consultation with its regional officials, informs the company concerned of any readily identifiable areas where there may be fisheries objections to subsequent extraction operations. This advice does not prevent the company from prospecting in those areas nor does it automatically imply that there would be no subsequent objection to proposed mining operations in other areas.

Bulk sampling is provided for under a prospecting licence but must be specifically authorized by the Crown Estates Commissioners, who consult with MAFF in advance. MAFF, on the basis of advice from its regional officials, may propose modifications that it considers necessary to protect important fisheries resources (e.g. time and place of the operation, method of extraction). These suggestions relate only to bulk sampling. There are also local consultations to ensure that bulk sampling operations do not interfere unnecessarily with fishing activity or fixed gear.

4.0 MANAGEMENT AND REGULATORY ISSUES

4.1 Navigational Concerns

The principal navigational problems presented by aggregate dredging relate to operations in or near shipping lanes. The Department of Trade Navigational Regulations at one time stipulated that dredging must be done with the vessel stationary and at anchor. This, however, precluded trailing suction dredging that, for operational, cost and environmental reasons became increasingly popular in the late 1960s. By 1970, the regulations requiring stationary dredging had been rescinded in certain areas (Hill, 1970), and in some areas, the Board of Trade required that dredging be done on the move for navigational reasons (Hess, 1971).

A section on compulsory pilotage recently included in the <u>Merchant</u> <u>Shipping Act, 1979</u>, has given rise to industry concerns that resulting port authority by laws could add costs in the order of 10 percent of the average selling price of aggregate (Webb, 1982). The industry contends that dredge captains are familiar with the unloading ports because of their frequent landings, that aggregate dredges do not represent a safety problem and should therefore be excluded from application of the regulations.

The Board of Trade Navigational Regulations also restrict dredging within one nautical mile of oil and gas pipelines and one-half nautical mile of submarine cables and navigational buoys or shipwrecks. No difficulties have been expressed with respect to this restriction.

A final concern, noted in the early 1970s (Hess, 1971), was the possibility that the discharge of fine sediments from a dredging operation may result in filling of some navigational channels. There has, subsequently, been no indication of any problems in this regard.

4.2 Coastal Erosion

Prior to 1970, coastal erosion in a number of areas led to suggestions that it might have been caused by offshore dredging. The inability to determine whether dredging or other factors were responsible brought to light the inadequacy of available information and led, in 1969, to the establishment of the Unit of Coastal Sedimentation to provide basic oceanographic and environmental data for such purposes. In addition, studies on sediment transport were funded by the Crown Estates Commission (Appendix IV).

Concerns over coastal erosion led the Crown Estates Commissioners to establish a policy that generally precluded the issuance of prospecting and dredging licences within three miles of the coastline or shallower than the 18-metre "stopline" which was considered by the Hydraulic Research Station as being the minimum water depth that could be safely dredged without fear of coastal erosion. There have been suggestions that this guideline is not absolute (Anon, 1975). As of the early 1970s, existing nearshore licencees were resisting this policy and apparently adopting the attitude that the Crown Estate Commissioners would eventually have to change the restriction. Most operators, however, accepted the restriction and extended their exploration efforts further offshore (Hess, 1971).

4.3 Tenure

By the early 1970s, the industry was expressing concerns that they could not obtain exclusive rights or title to aggregate deposits and therefore could not be expected to invest in prospecting and development. It was also pointed out that the non-exclusive approach to licencing virtually prohibited properly planned dredging programs and that good quality deposits were being haphazardly dredged with a large proportion of the material being downgraded and left behind (Hill, 1970, Anon, 1975).

Although the licence provisions have not been changed, the 1977 Code of Practice sets out the principle that only one licence would normally be granted for any one area. This has apparently provided operators with a greater measure of certainty with respect to the continuation of their licences over the long-term (Webb, 1979).

4.4 Fishing

Government departments, including MAFF, agree that both the fishing and aggregate industries legitimately exploit offshore resources and that no one industry or activity can have an absolute priority. MAFF, for example, does not oppose extraction licences simply on the grounds that the area is fished commercially. Objections are limited to those cases where extraction could seriously damage fisheries resources or interfere to an unacceptable extent with an important commercial fishery (Code of Practice, December, 1981).

However, the Crown Estates Commissioners have, at least in the early 1970s, followed a general policy of turning down requests for dredging in areas which are known to be important spawning or commercial fishing grounds. Noteable examples include Galloper Bank, a principal herring spawning ground located off the coast of Harwich, which has been closed to all dredging although it is composed of good quality gravel (Hess, 1971). Another area of concern is the Outer Dowsing Shoal (southeast of Humber Estuary), which, beginning in the mid 1970s, came under pressure from dredging interests and as of 1975 had been the subject of no less than 5 separate surveys and 4 production licence applications, all of which were refused. Also, only seasonal dredging is permitted offshore of Southwold in order to safeguard a winter longline fishery for cod (Milner et al, 1977). Although both the aggregate and fishing industries had, for many years, co-existed in relatively nearshore waters and in areas where there was little commercial fishery activity, tensions arose as the result of the rapid increase in offshore sand and gravel production in the late 1960s and the expansion of sizeable dredging operations into areas that supported large commercial fisheries. Expansion of operations off the south coast in the Southampton/Portsmouth area, the west coast in the vicinity of Liverpool and off the east coast in Outer Dowsing Shoal were areas of particular concern. Fishermen were understandably interested in protecting their fishing grounds and their livelihood from the perceived threat of the impact of seabed dredging while the dredging industry felt that fisheries interests were unreasonably obstructing their access to dredging grounds.

Over the years the fishing industry has expressed concern with respect to the following (see Hess, 1972; Dickson, 1975): changes in bottom topography that result from dredging and, in turn, may present a hazard to fishing gear; and direct and indirect effects on fish stocks such as those that may result from altering the suitability of spawning grounds or that may be related to the effects of siltation on fish, shellfish, spawning grounds and egg development. As might be expected, there were strong and increasingly antagonistic exchanges between the aggregate and fishing industries as to whether or not these concerns could be confirmed and, if not, whether this reflected a lack of information or indicated that the claims were unjustified and/or exaggerated.

In 1973, the International Council for Exploration of the Sea (ICES) established a Working Group that attempted to identify the effects and implications of sand and gravel dredging on fisheries, to review techniques for studying these effects and to compare national codes of practice for the control of dredging activities. The ICES reports provided a summary of fisheries' concerns, relevant research, regulatory initiatives and activities (ICES 1975a, 1975b and 1979)*. In 1979, the Sand and Gravel Dredging Association (SAGA) published a paper suggesting that the first ICES report had a serious fisheries bias, contained numerous inaccuracies, and that it did not substantiate the Working Groups' "foregone conclusion that the dredging industry is harmful to the fishing industry" (SAGA, 1979).

Although it had been recognized for quite some time that a communication gap existed between the commercial fisheries and dredging industries (Hess, 1971; ICES, 1975a, 1979b and 1979; SAGA, 1978), it appears that the ICES/SAGA exchange and government prompting were necessary to bring together representatives of the two industries in order to identify areas of potential conflict and how they could be overcome (Webb, 1982). This latter effort resulted in the December 1981 Code of Practice that outlines specific mechanisms for promoting exchange of information and coordinating activities.

^{*} The ICES Working Group on Effects on Fisheries of Marine Sand and Gravel Extraction was disbanded in 1981 but has recently been replaced by a new ICES Working Group on the Effects of Extraction of Marine Sediments.

As stated by the Minister of State, Ministry of Agriculture Fisheries and Food, "both the fisheries and the marine sections of the sand and gravel industries are engaged in winning valuable resources from the sea. It is in the interest of these two industries and therefore in the national interest that the activities of each affect, as little as possible, the operations and potential resources of the other" (Code of Practice for the Extraction of Marine Aggregates, December 1981: Appendix III).

4.5 Environmental Effects

The concerns expressed by the fishing industry appear to be commercial/ socio-economic effects as opposed to significant environmental effects involving the broader ecosystem. Similarly, in the case of coastal erosion, it is not apparent that concerns extend beyond beach depletion to include any ramifications that erosion might have on coastal zone ecology. By way of observation, as opposed to a conclusion, the published literature reviewed during the course of this study made no mention of significant environmental effects from dredging during its thirty-year history.

4.6 Other Issues

Additional comments on some of the policies of the Crown Estates Commission and other regulatory agencies from the literature gleaned are briefly noted below:

- Demonstration of Competence: To counteract the rapidly increasing number of applications for dredging licences during the late 1960s, the Crown Estates Commissioners took steps to make it more difficult to obtain a licence by limiting the number of applications. One such mechanism was to require applicants to demonstrate "competence" in the form of sufficient capital, proven capability or detailed schemes of operations. It has been suggested that this practice is restrictive and, in essence, could only be fulfilled by an applicant already in the business (Hess, 1971).
- 2. Foreign Dredging Licences: During the late 1960s, a frequently voiced criticism was the "leniency" in granting dredging licences to foreigners and permitting the export of aggregates. It was argued that this constituted an unwise use of a valuable domestic resource and that allowing the use of good quality aggregate for channel linings, for example, was imprudent (Hess, 1971).
- 3. Duplication of Prospecting Work: In the early 1970s, it was noted that there was a tendency for prospecting to be carried out within the same or largely similar areas by competing organizations. It was suggested that this was a misuse of both financial resources and the equipment available (Whiteside, 1972).
- 4. Unlicenced Dredging Operations: Bottom surveys in unleased areas suggested, by the early 1970s, that considerable amounts of material had, at some time, been illegally removed. This concerns both

companies that have spent considerable amounts of money on exploration and the fisheries industry. The Crown Estates Commissioners, however, have no surveillance or enforcement capabilities (Hess, 1971).

- 5. Environmental Monitoring: As of the early 1970s, industry was not required to, nor did they, conduct environmental monitoring programs. The responsibility fell to the Government but was problematic because there were no legal mechanisms whereby Crown agents had the authority to transfer offshore lease funds paid to the Crown for such environmental monitoring work (Hess, 1971).
- 6. Information Release: There was criticism that the Crown Estates Commissioners' office was under no statutory obligation to release information to Parliament or the public because it is responsible only to the Crown (Hess, 1971).
- 7. Delay: Procedures and consultations related to issuance of dredging licences can "...take years..." (Anon., 1974).
- 8. Review Process: The interests of the many organizations involved in the government view process, the lack of an overriding authority or independent appeals procedure, and the lack of industry opportunity to explain their case has lead to unjustified refusals or unnecessary restrictions being placed on industry (Anon, 1975).

5.0 DISCUSSION

5.1 Resource Availability and Land Use Concerns

Management practices have a substantial effect on both the short and long-term availability of high-quality aggregate materials that are in shallow water and are relatively close to markets. Availability, in turn, has significant implications with respect to cost, environmental effects and land use conflicts. Increased costs of production result from the increased transit time to and from dredge sites and the need for larger, more sophisticated equipment that is necessary in order to operate in deep water and under difficult weather conditions. Onboard size classification of lower quality deposits results in increased loading time and costs, and raises fisheries concerns with respect to discharged material. Finally, scarcity results in pressure to allow dredging in areas where it may cause concerns because of coastal erosion, fishing and navigation routes.

Obviously, depletion is a natural consequence of mining. However, some factors that unnecessarily reduce the availability of low-cost, high-quality material may be dealt with by the resource manager. One example would be the degradation of existing reserves and wasteful mining practices that result from the lack of exclusive mining rights. Tenure and approval of a development plan should provide the means for encouraging and ensuring good mining practice. Another example would be the inappropriate use and export of high quality, scarce material that could be dealt with by regulations that establish terms and conditions with respect to conservation of resources. Finally, information on the quantity and distribution quality of offshore sand and gravel resources could be developed in order to guide development into areas where mining would not raise concerns related to fishing or coastal erosion.

While restrictions such as prohibitions related to concerns with coastal erosion, spawning grounds and navigation routes may be effective mechanisms to minimize conflicts when resources are abundant, in time, and in the face of scarcity, the rational for such restrictions may be challenged. For example, some have suggested that the stop lines are arbitrary and that dredging might not, depending on specific circumstances, result in coastal erosion. Similarly, the sand and gravel industry claims that dredging in fishing and spawning areas does not, given certain restrictions with respect to timing and substrate removal, have any effect on commercial fish stocks. It has also been proposed that navigation routes should be changed or modified to allow aggregate dredging.

Blanket restrictions are not necessarily unreasonable when there is a lack of information demonstrating that dredging could be undertaken without endangering other interests. Although the U.K. aggregate industry contends that there is no evidence of damage where dredging has taken place, others respond that there is insufficient information and/or that dredging is causing long-term or unknown difficulties. This classic chicken and egg exchange may ultimately be decided on the basis of economic considerations and/or public opinion. The obvious danger is that a wrong decision could have detrimental effects on fisheries' interests or other land users or, alternatively, inhibit the realization of the benefits of mineral development (Anon, 1975). Thus, while it may be both realistic and expedient to establish restricted areas at the outset when resources are abundant, it is also prudent to begin to examine the basis of possible concerns and to begin to collect the types of information that are needed to evaluate the situation when there is pressure to justify or modify such restrictions.

Over the past year or so, the Department of the Environment has been reviewing offshore sand and gravel dredging practices as well as the constraints that the industry faces. The report is due for completion sometime in 1986 (P.C. Dept. of Environment).

5.2 Relationship with Fisheries

A potentially productive basis for cooperation between the fishing and aggregate industries appears to have been established by the ICES Working Group when they decided to identify and concentrate on the most important grounds for concern and to consider how research might best be organized to fill in the main gaps in our knowledge. They noted that this approach was based on the realization that, although there will be some environmental effects, dredging must nevertheless be permitted, and that it was important to distinguish all serious grounds for concern from those of relatively minor importance so that the best yield from both fisheries and offshore mining could be realized. Although the Sand and Gravel Association responded by indicating that grounds for fisheries concerns had, so far, not been established, they did indicate that this basic approach was not unreasonable (SAGA, 1979).

Most workers apparently feel that the main threat to the UK fisheries industry is to herring spawning grounds (Fisheries Research Group as cited in Hess, 1971, and ICES, 1975a). More specifically, it has been suggested that the main concern is the alteration of the seabed either grossly by removing the entire gravel bed or, more subtly, by altering the suitability of the ground for spawning (Dixon, 1975). This, in turn, has led to suggestions that more research is required (Anon 1975) and that the principal research requirement lies in establishing better methods for delineating spawning grounds (Dixon, 1975) and producing maps that can be considered alongside charts of the most valuable gravel deposits (Anon, 1975; ICES, 1975b and 1979). The latter information results from the continuing efforts of the Institute of Geological Sciences to produce sediment maps based on surficial and shallow borehole samples in the offshore (Institute of Geological Sciences, 1983).

The Sand and Gravel Association has also suggested that it is worthwhile carrying out practical research in cooperation with the fishing industry in order to identify spawning grounds (Sand and Gravel Association, 1979). Members of the aggregate industry have, for some time, expressed and demonstrated their willingness to cooperate with Fisheries Research officials by studying the potential effects of dredging on spawning grounds. Cooperative studies on the effects of dredging have been undertaken in the early 1970s offshore of Hastings on the south coast (Hess, 1971 and Dickson and Lee, 1973) and off Southwold on the east coast (Millner et al, 1977 and ICES, 1979) (Appendix IV).

6.0 CONCLUSIONS

It would appear that UK experience is particularly instructive with respect to resource management concerns related to the availability of sand and gravel, fisheries and coastal erosion. A number of the approaches and ideas stemming from the U.K. experience are worth adopting and applying to the Canadian offshore in order to avoid similar difficulties. These would include:

1. Identification of significant concerns and associated research requirements.

A more detailed investigation to identify and evaluate the validity of reported concerns expressed by the fishing industry and with respect to the coastal zone could serve as an initial basis for identifying possible Canadian concerns. It would also be helpful to obtain suggestions on management practices that might be adopted in Canada and on what types of research would need to be carried out in order to address these concerns.

2. Delineate areas of aggregate potential relative to areas that are sensitive from the standpoint of fisheries and coastal erosion.

A natural tendency to avoid difficulties, delays and costs suggests that baseline maps showing the distribution of sand and gravel resources and the identification of sensitive areas would help guide industry into regions where conflicts would not be expected to arise. Timely compilation of available information on the distribution of aggregate resources, sensitive fisheries resource areas, fishing grounds, and areas likely to experience coastal erosion, would be a useful planning tool for both the industry and the resource manager. Identification of aggregate resources should take into account such factors as exploitability, off loading sites, market locations and market specifications. The federal/provincial Mineral Development or Fisheries Subagreements might be appropriate mechanisms for undertaking such work.

3. Communication between interested industries.

Although the UK aggregate and fisheries industries ultimately established a mechanism for coordination and information exchange, considerable anomosity had built up prior to that time. The atmosphere created by this type of a situation is not conducive to good management. It is not difficult to envision circumstances where management decisions are detrimentally influenced by emotions, unfounded speculation and lack of information. Every effort should, therefore, be made to provide accurate information and to encourage early and meaningful communication between interest groups.

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8.0 APPENDICES

APPENDIX I: PROSPECTING LICENCE

(Crown Estate Commission, 1985)

THIS LICENCE dated the

19 made B E T W E E N THE QUEEN'S MOST EXCELLENT MAJESTY of the first part THE CROWN ESTATE COMMISSIONERS on behalf of Her Majesty acting in exercise of the powers of the Crown Estate Act 1961 (hereinafter called "the Commissioners") of the second part and

day of

whose registered office is at

(hereinafter called "the Licensee") of the third part

WITNESSETH as follows :-

IN consideration of the payment of the sum of £ (the receipt whereof the Commissioners hereby acknowledge) and the performance and observance by the Licensee of all the terms and conditions hereof the Commissioners HEREEY GIVE to the Licensee in common with all others similarly authorised LICENCE AND PERMISSION during the continuance of this Licence and subject to the provisions hereof to prospect and search for and to remove and carry away samples of sand shingle gravel and other like minerals (hereinafter called "the said materials") within the area (hereinafter called "the licensed area ") shown by pink colour on the plan annexed hereto forming part of or lying on the seabed <u>Junder the territorial waters</u> of Great Britain J and within the areas in which by virtue of the provisions of the Continental Shelf Act 1964 rights are exercisable by the United Kingdom outside territorial waters with respect to the seabed and sub-soil and their natural resources J

THIS Licence unless sooner determined under any of the provisions herein shall be and continue in force for the term of $\underline{two}/\underline{four}$ years next after the date hereof

3.

2.

1.

WITHOUT prejudice to any obligation or liability imposed by or incurred under the terms and conditions hereof this Licence may be determined :-

(a) At any time during the said term of $\underline{two}/\underline{four}$ years by the Licensee's giving to the Commissioners or the Commissioners' giving to the Licensee not less than three months' previous notice in writing to that effect whether as to the whole or any part of the licensed area or

(b) If any part of the licensed area shall be required for any works of a permanent nature (including but without prejudice to the generality of the foregoing pipelines and floating pontoons or jetties secured to the foreshore or seabed) or if any rights over any part of the licensed area shall be required in connection with works of such a nature by not less than one month's written notice given by the Commissioners to the Licensee to that effect as to such part of the licensed area as shall be affected by such works or rights

4.

5.

THE Licensee shall not by reason of the determination of this Licence or of any reduction in the licensed area be entitled to be repaid or allowed any part of the consideration paid for this Licence

The right to search for the said materials conferred by this Licence shall include the use of geological geochemical or geophysical surveys and examinations or the drilling of test boreholes (provided that no structure shall be constructed on the said seabed for such drilling purposes) and (in the case of alluvial deposits) taking samples of the said materials not exceeding tonnes in extent in the said period of two/four years PROVIDED (1) that no bulk sampling exceeding tonnes shall be landed at a port without the Commissioners being advised of the date and quantity landed within 14 days of such landing and PROVIDED ALSO $\sqrt{2}$ that no drilling or removal of samples shall take place within one mile of the cables shown by black lines on the said plan without the consent in writing of the Post Office and (3) that no commercial dredging vessels shall be used for the purpose of prospecting except with the previous consent in writing of the Commissioners and subject to such conditions concerning the use of such vessels as the Commissioners may impose

- 6. THE Licensee shall not carry out any operation authorised by this Licence in or on the licensed area in such manner as to interfere unjustifiably with navigation or fishing in the waters above the licensed area or with the conservation of the living resources of the sea and the Licensee shall at all times during this Licence comply with the Code of Practice (in force for the time being) for the Extraction of Marine Aggregates agreed between the Ministry of Agriculture Fisheries and Food and the Sand and Gravel Association (Marine Section)
- 7. (a) WITHIN two months after the expiration or determination of this Licence (or in the event of the Licensee applying to the Commissioners before such expiration or determination for a licence for commercial dredging in any part of the licensed area then at the time of such application) the Licensee shall furnish to the Commissioners in a form from time to time approved by the Commissioners a report of all operations conducted by the Licensee in the licensed area during the period of this Licence and of the information obtained from such operations together with one copy of all geophysical profiles produced during the operations and one copy of boreholes logs and details of all bulk sampling and sieve analyses of material sampled The report shall cover all areas searched and not be restricted to areas where sand and gravel has been found (b) The Licensee shall furnish to the Commissioners such other information including information in the form of maps and plans as to progress of the Licensee's operations in the licensed area — as the Commissioners may from time to time require

8.

ALL records returns plans maps and information which the Licensee is or may be from time to time required to furnish under the provisions

of this Licence shall be supplied at the expense of the Licensee and shall become the property of the Commissioners but shall not (except with the consent in writing of the Licensee which shall not be unreasonably withheld) be disclosed to any person not in the service or employment of the Crown or in the service of any other responsible national body whose expenses are wholly or partially defrayed out of moneys voted by Parliament

9.

10.

ANY person or persons authorised by the Commissioners shall be entitled at all reasonable times to enter into and upon any of the installations and equipment used by or to be used in connection with the operations in the licensed area in order to examine the installations plant appliances and works made or executed by the Licensee in pursuance of this Licence and the state of repair and condition thereof

THE Licensee shall at all times keep the Commissioners and Her Majesty effectually indemnified against all actions proceedings costs charges claims and demands whatsoever which may be made or brought against the Commissioners or Her Majesty by any third party in relation to or in connection with this Licence or any matter or thing done or purported to be done in pursuance thereof

11. THE Licensee shall not assign or part with any of the rights granted by this Licence in relation to the whole or any part of the licensed area or grant any sub-licence in respect of any such rights
12. (a) IF any of the events specified in the following paragraph shall occur then and in any such case the Commissioners may revoke this Licence and thereupon the same and all the rights hereby granted shall cease and be determined but subject nevertheless and without prejudice to any obligation or liability incurred by or imposed upon the Licensee by and

under the terms and conditions hereof

(b) The events referred to in the foregoing paragraph are :- -

(i) any breach or non-observance by the Licensee of any of the terms and conditions of this Licence

(ii) the making by the Licensee of any arrangement or composition with creditors

(iii) the appointment of a Receiver or any liquidation of the Licensee whether compulsory or voluntary

(iv) the Licensee ceasing to have its central management and control in the United Kingdom

13.

NOTHING contained in this Licence shall be deemed to impose any obligation upon the Commissioners to grant the Licensee a Licence for commercial dredging in any part of the licensed area

IN WITNESS whereof the Official Seal of the Commissioners and the Common Seal of the Licensee have been hereunto affixed the day and year first above written

THE OFFICIAL SEAL of THE CROWN) ESTATE COMMISSIONERS hereunto) affixed was authenticated by:-)

THE COMMON SEAL of was hereunto affixed in the presence of:-

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- and -

DRAFT

LICENCE

to prospect for offshore deposits of sand and gravel

Consideration : £

Term : Two years from the date hereof

THE SOLICITOR Crown Estate Commissioner Crown Estate Office 13/15 Carlton House Terrace London SW1Y 5AH

Ref: C. / /Foreshores

1984

APPENDIX II: DREDGING LICENCE

(Crown Estate Commission, 1985)

Master Disk 2/08 Dredging Licence (England & Wales) L(5)(Lic)(a)

THIS LICENCE made the

day of

One thousand nine hundred and eighty B E T W E E N THE QUEEN'S MOST EXCELLENT MAJESTY of the first part THE CROWN ESTATE COMMISSIONERS on behalf of Her Majesty acting in exercise of the powers of the Crown Estate Act 1961 (hereinafter called "the Commissioners") of the second part and

LIMITED having its registered office

at

(hereinafter called "the Licensee") of the third part W I T N E S S E T H as follows:-

1. In consideration of the annual sums and royalties hereinafter made payable and of the covenants by the Licensee and conditions hereinafter contained the Commissioners HEREBY GIVE to the Licensee in common with all others similarly authorised LICENCE AND PERMISSION in accordance with such directions as may from time to time be issued by the Commissioners to dredge dig get and carry away sand gravel shingle and other like materials (such sand gravel shingle and other like materials being hereinafter together called "material") from ALL THAT part of the bed of the

forming part of or lying on the seabed <u>under the</u> territorial waters of Great Britain and within the areas in which by virtue of the provisions of the Continental Shelf Act 1964 rights are exercisable by the United Kingdom outside territorial waters with respect to the seabed and sub-soil and their natural resources which is shown by pink colour and defined by co-ordinates and numbered on the plan annexed hereto and is hereinafter called "the said area" PAYING THEREFOR to Her Majesty and Her

Successors

(1) in the first year commencing on the day of
198 during the continuance of this Licence an annual sum of f.
(hereinafter called "the basic annual sum") to be paid by two
equal payments the first of such payments to be made on the
execution hereof and the second payment to be made in advance on
the day of 198 and

(2) in each of the subsequent years during the continuance of this Licence such an annual sum (rounded to the nearest Ten Pounds) as shall be equal to the basic annual sum multiplied by the variable factor (as hereinafter defined) applicable to the year in relation to which the calculation is being made such annual sum to be paid in advance by two equal payments on the day of and the day of in every year AND ALSO PAYING to Her Majesty and Her Successors

(1) in the first year commencing on the day of 198 during the continuance of this Licence a royalty of £ (hereinafter called "the basic royalty") for every tonne of material dredged dug got or carried away from the said area and

(2) (a) in each of the subsequent years during the continuance of this Licence such a royalty (rounded to the mearest fourth decimal place of One Pound) as shall be equal to the basic royalty multiplied by the said variable factor applicable to the year in relation to which the calculation is being made such royalties to

be paid in arrear by half-yearly payments on the day of

and the day of in every year PROVIDED THAT:-

(1) the royalties payable for any half year shall be deemed to have been paid to the extent of the half of the annual sum already paid in advance for that half year

(2) the total sum to be paid in respect of any year shall not exceed the total amount of the royalties payable for the year or the annual sum whichever is the greater the said annual sums and royalties to be paid to the Commissioners at their Office for the time being

(b) The variable factor in relation to any one year during the continuance of this Licence shall be the numerical fraction which shall have as its denominator the figure of and as its numerator the figure which shall have been officially published by the Department of Employment (or any other Ministry or Government Department upon which the duties in connection with the Index of Retail Prices shall have devolved) as the figure representing the monthly Index of Retail Prices for the month of

immediately preceding the commencement of such year
In consideration of the Licence and Permission hereby given the Licensee hereby covenants with Her Majesty and Her Successors and as a separate covenant with the Commissioners as follows:
(1) To pay the said annual sums and royalties on the days and in manner aforesaid and in addition thereto to pay to Her Majesty and Her Successors on the day of
19 the basic royalty in respect of the

period from the day of 19 to the date hereof during which period the Licensee has with the consent of the Commissioners exercised the Licence and Permission hereby given and if the said annual sums and royalties or other sums becoming payable hereunder by the Licensee to the Commissioners or any part thereof respectively shall remain unpaid for more than twenty-one days after becoming due and payable (whether formally demanded or not) then the Licensee shall (if demanded) (without prejudice to the Commissioners' right of determination hereinafter contained or any other right or remedy of the Commissioners) as from the date on which the same became due until the date of actual payment pay interest thereon (as well after as before any judgment) at the rate of 3 per cent per annum above the lowest of the bank base rates of the members of the Committee of London Clearing Bankers prevailing from time to time during the relevant period and the amount of such interest from time to time payable shall be deemed to be part of the sums hereby recoverable in like manner as a debt due to Her Majesty but shall not itself bear interest (2) To pay all present and future rates taxes assessments and outgoings whatsoever payable in respect of the Licence and Permission hereby given

(3) (a) To deliver to the Commissioners at their Office for the time being within ten days after the day of and the day of in every year and at such other times as the Commissioners shall by notice in writing require an accurate detailed and legible account in writing in such form as the Commissioners may from time to time direct of the

quantity of material which during the preceding half-year or such period as shall be required by such notice as aforesaid shall have been dredged dug got or carried away by the Licensee from the said area or if the circumstances shall so require a statement that no material has during the preceding half-year or such period as aforesaid been dredged dug got or carried away from the said area such account or statement being if required by the Commissioners first certified by an Auditor or verified by a Statutory Declaration made by the Secretary of the Licensee

(b) To keep accurate detailed and legible accounts and records in writing with correct entries of the matters aforesaid and at all times when required to produce explain or verify such accounts and records with all relevant receipts vouchers and documents to the Commissioners' agent and permit him to take extracts therefrom or copies thereof

(c) To keep a deck log on all dredgers operated by the Licensee in exercise of the Licence and Permission hereby given recording the date time and position of each dredging operation carried out and to produce all such logs to the Commissioners for inspection if requested to do so

(d) After reasonable notice being given by the Commissioners to the Licensee to permit the Commissioners' representative at the risk of the Commissioners to go to sea on any dredger or vessel operated by or on behalf of the Licensee under the terms of this Licence Provided that nothing herein contained shall absolve the Licensee from any claim arising out of the negligence of its employees or agents

(e) To comply at all times during this Licence with the Code of Practice (in force for the time being) for the Extraction of Marine Aggregates agreed between the Ministry of Agriculture Fisheries and Food and the Sand and Gravel Association (Marine Section) (4) Not to dredge dig get or carry away material from the said area so as to cause any damage loss or injury to any corporation company body firm or person or to any property whatsoever in the neighbourhood of the said area and to pay compensation for any damage loss or injury which may be caused to any corporation company body firm or person in consequence of such dredging digging getting or carrying away and to indemnify Her Majesty and Her Successors and the Commissioners against all actions suits claims demands and costs on account of any such damage loss or injury as aforesaid which may be caused by the Licensee in breach of the terms of this Licence

(5) Not to interfere with the dredging digging getting or carrying away of material from the said area by any corporation company body firm or person acting under a Licence from or with the permission of the Commissioners Provided that if any dispute or question shall arise between the Licensee and such corporation company body firm or person regarding their representative rights to dredge dig or carry away material from the said area then every such dispute or question shall be referred to the Commissioners whose decision shall be final

(6) Not to dredge dig get or carry away any material in excess of tonnes in any one year under the terms of this Licence or otherwise without the written consent from time to time

of the Commissioners Provided that the amount (if any) by which the said maximum permitted annual tonnage exceeds the tonnage actually dredged dug got or carried away in any one year (hereinafter called "the shortfall") may be carried forward to the next succeeding year Provided also that in subsequent years the shortfall carried forward shall at no time exceed tonnes (7) Not to assign or dispose of this Licence or to part with any benefit arising therefrom or to grant any sub-licence thereunder or to give permission to any corporation company body firm or person (except employees or agents of the Licensee) to dredge dig get or carry away material from the said area

3. IT IS HEREBY AGREED AND DECLARED that:-

(1) If the said annual sums or royalties or any part thereof respectively shall remain unpaid for twenty-one days next after any day on which the same ought to be paid or if there shall be any breach non-performance or non-observance of any of the covenants or conditions on the Licensee's part herein contained then this Licence may be determined at any time by the Commissioners on giving written notice to the Licensee in which event the Licensee shall not be entitled to a refund of any part of the said annual sums

(2) The Licence may be determined at any time either by the Commissioners by giving months' written notice to the Licensee or by the Licensee by giving similar notice to the Commissioners

(3) If this Licence shall be determined as mentioned in sub-clause(2) hereof by notice expiring on a day other than the

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in any year the Commissioners shall refund of to the Licensee such proportion of the said annual sums or such part thereof respectively as shall have been actually paid and as shall be apportionable to the unexpired portion of the year or half-year (as the case may be) and as shall not already have merged into royalty

(4) In whatever manner this Licence shall be determined such determination shall be without prejudice to the right of the Commissioners to recover from the Licensee any sum or sums then remaining due up to the date when this Licence shall be determined and without prejudice to and so as not in any manner to affect any liability hereunder on the part of the Licensee which may then be subsisting or have accrued

(5) Section 196 of the Law of Property Act 1925 as amended by the Recorded Delivery Service Act 1962 shall apply to any notice required or authorised to be given hereunder in the same manner as if the parties hereto were respectively lessor and lessee within the meaning of that Section Provided that any notice given by the Licensee shall be sent by post to or delivered at the Office for the time being of the Commissioners

IN WITNESS whereof the Official Seal of the Commissioners and the Common Seal of the Licensee have been hereanto affixed the day and year first above written

THE OFFICIAL SEAL of THE) CROWN ESTATE COMMISSIONERS) hereunto affixed was) authenticated by:-)

THE COMMON SEAL of) LIMITED) was hereunto affixed in) the presence of:-)

Director

Secretary

DATED 198

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THE CROWN ESTATE COMMISSIONERS

- to -

LIMITED

LICENCE

- to -

remove material from the bed of the

The Solicitor Crown Estate Commissioners Crown Estate Office 13/15 Carlton House Terrace LONDON SWIY 5AH

Ref: C / /Foreshores

APPENDIX III: CODE OF PRACTICE FOR THE

EXTRACTION OF MARINE AGGREGATES



Code of Practice for the Extraction of Marine Aggregates

December 1981



Further copies of this Code are available free of charge from:

Room 275 Ministry of Agriculture, Fisheries and Food Great Westminster House Horseferry Road London SW1P 2AE

(01-216 7514)

Room 521 Department of Agriculture and Fisheries for Scotland Chesser House 500 Gorgie Road Edinburgh EH11 3AW (031-443 4020, Exts 2202 or 2206) MESSAGE FROM THE RT HON ALICK BUCHANAN-SMITH MP MINISTER OF STATE, MINISTRY OF AGRICULTURE, FISHERIES AND FOOD

Both the fishing and the marine section of the sand and gravel industries are engaged in winning valuable resources from the sea. It is in the interests of these two industries, and therefore in the national interest, that the activities of each affect as little as possible the operations and the potential resources of the other. Therefore I warmly welcome the important opportunity this Code of Practice provides for the two industries to work more closely together, in a spirit of co-operation and mutual understanding of each other's problems.

It would indeed be surprising if the difficulties, the misunderstandings and the suspicions that have sometimes existed in the past were to disappear overnight when the Code comes into force on 1 January 1982. But I believe that implementation of the Code should create an atmosphere in which difficulties can be overcome at working level, in which misunderstandings can be avoided and in which mutual suspicions can be allayed by personal contacts.

I welcome the initiative of the Marine Section of the Sand and Gravel Association in promoting such a Code; I thank the Association of Sea Fisheries Committees for agreeing that the Committees they represent should undertake the donkey work of providing local contact points with the fishing industry in England and Wales; and I recognise also the encouragement provided by the Crown Estate Commissioners in the establishment of the Code. I wish the arrangements well.

FOREWORD

The sand and gravel industry welcomes the opportunity presented by this Code of Practice to improve the understanding of the problems and the system of communication between the fishing and marine aggregate dredging industries.

The winning of sand and gravel from the sea forms an important part of the total national production of such material and features significantly in the structure plans of various regions of the country which are in the process of being approved by the Department of the Environment.

We are aware of the problems and changes being forced on the fishing industry and that proper account must be taken by our members of their legitimate interests and we hope that our willingness to enter into this Code of Practice will be a contributory factor, albeit a small one, to the easing of the pressures on fishermen and their industry.

> The Marine Section Sand and Gravel Association

CODE OF FRACTICE FOR THE EXTRACTION OF MARINE AGGREGATES

INTRODUCTION

1.1 The purpose of this Code of Practice is to provide a basis for close liaison at working level between the fishing and dredging industries in order to promote mutual cooperation and to reduce to a minimum potential interference with each other's activities and damage to each other's resources. It is a voluntary Code which will only be effective if it receives the active support of those directly involved.

1.2 The Code is essentially aimed at establishing practical working communications at local level. Marine extraction is necessary from the national point of view and there will be a need to consider the grant of new dredging licences in areas where there is commercial fishing in order to meet the existing and foreseeable demands for marine aggregates. The object of the Code, therefore, is to assist the development of working relationships between the fishing and dredging industries which minimise interference with fishing while facilitating dredging operations. Modern extraction methods have come a long way from earlier practices and, when properly applied, have a minimum of effect on the seabed.

1.3 It should be emphasised that the establishment of the Code will not affect the formal Government consultation arrangements which are described in the Appendix prepared by the Ministry of Agriculture, Fisheries and Food (MAFF) in consultation with the Department of the Environment (DOE) and the Crown Estate Commissioners (CEC). The Marine Section of the Sand and Gravel Association (SAGA) will continue to have direct access to DOE and CEC on all matters concerning the winning of marine aggregates; liaison with the appropriate fishermen's organisations at national level will continue to be the responsibility of MAFF HQ, which will keep the organisations informed about applications for extraction licences, bulk sampling proposals and prospecting and extraction licences issued for England and Wales.

1.4 The development of liaison between the two industries at working level requires, so far as the fishing industry is concerned, an organised regional network which can offer the dredging companies clear-cut points of contact. In England and Wales, the Association of Sea Fisheries Committees has agreed that this task should be undertaken by Sea Fisheries Committees (SFCs). The Association and the members of the Marine Section of SAGA have undertaken to introduce the procedures set out in the Code on 1 January 1982.

1.5 Most dredging activity takes place off the English and Welsh coasts. However, clear lines of communication are also necessary for operations in Scottish waters. In the absence of SFCs in Scotland, the Department of Agriculture and Fisheries for Scotland (DAFS) will supply individual dredging companies with details of appropriate local contact points for the fishing industry. DAFS will also be responsible for liaising with national fishing organisations. For reasons of clarity the Code contains a separate section for Scotland but the procedures themselves will be essentially the same as those applying to England and Wales.

CODE OF FRACTICE FOR ENGLAND AND WALES

I: PROSPECTING

2.1 The CEC will inform MAFF HQ in confidence when they intend to grant a prospecting licence, with the name of an appropriate company contact.

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2.2 MAFF HQ will consult its Fisheries Research Laboratory at Burnham-on-Crouch and the District Inspector of Fisheries, but no outside interests.

2.3 Based on advice from Burnham and the District Inspector, MAFF HQ will notify the CEC (with a copy to the company) of any readily identifiable areas where there might be objections to subsequent extraction. This will be for information only.

2.4 When a prospecting licence is issued, the CEC will inform MAFF HQ, which will send details to Burnham, the District Inspector and SFC. MAFF HQ will provide the company (with a copy to the CEC) with the names and addresses of the District Inspector and SFC (in some cases more than one District Inspector and SFC will be involved).

2.5 Before prospecting starts the company will approach the SFC to discuss working contacts. The SFC will invite the company to provide information on its proposed operations, will supply the company with information about local fishing activity and will discuss any potential difficulties.

2.6 The SFC will inform local fishermen of the issue of a licence and of the company's proposed work schedule and will act as the contact point for any further queries fishermen may have.

2.7 The CEC will inform MAFF HQ of any proposal to take samples by dredging, including the planned area, time and method of working.

2.8 MAFF HQ will inform Burnham, the District Inspector and SFC. If the proposals as they stand would involve a significant risk to fisheries resources MAFF HQ will notify the CEC (with a copy to the company). Such objections will be discussed informally with the company on request.

2.9 If MAFF HQ is satisfied that the proposed operation poses no substantial risk to fisheries resources it will inform the CEC (with a copy to the company), the District Inspector and SFC.

2.10 The SFC will inform local fishermen as appropriate.

II: EXTRACTION

2.11 Under the Government View procedure DOE will consult MAFF HQ on an application for an extraction licence. MAFF HQ will consult Burnham and the District Inspector. This is an inter-Departmental procedure and does not represent a basis for public consultation.

2.12 Unlike prospecting applications, extraction applications are not subject to commercial confidentiality once they have been notified through the Government View procedure. MAFF HQ will therefore also inform the SFC, which will have the opportunity to put views to MAFF HQ.

2.13 MAFF HQ will formulate a Departmental view. If MAFF HQ has in mind to object it will first notify the company informally, through the CEC, giving the reasons. Where possible MAFF HQ and the company will attempt to resolve the objections. involving the SFC where appropriate.

2.14 MAFF HQ will then put its formal comments to DOE under the Government View procedure.

2.15 When an extraction licence is issued, the CEC will inform MAFF HQ, which will send details to Burnham, the District Inspector and SFC. The SFC will inform local fishermen. Wherever possible the working methods listed in Annex A will be used.

III: TIMETABLE

2.16 The timetable for the consultations set out in this Code is at Annex B.

Code of Practice for England and Wales

WORKING METHODS TO BE USED BY THE DREDGING INDUSTRY WHEREVER POSSIBLE

In response to paragraph 1.2 of the Code of Practice, the dredging and fishing industries will take all reasonable steps to ensure that their activities cause the minimum of interference or damage to each other. In particular, the dredging industry will:-

- (a) provide the District Inspector and SFC with as much advance notice as possible of the areas to be worked;
- (b) inform the District Inspector and SFC of any areas not being worked for the time being;
- (c) work each licensed area in as systematic a manner as is practicable, giving advance information to the District Inspector and SFC of any changes in plan;
- (d) wherever possible, work up and down the tidal streams.

Code of Practice for England and Wales

TIMETABLE FOR CONSULTATIONS

(NB. These are maximum periods and consultations should be completed sooner wherever possible.)

ANNEX B

Notification to MAFF HQ of intention to issue prospecting licence

2 weeks to comment to CEC

Notification to MAFF HQ of issue of prospecting licence

1 week to notify Burnham, District Inspector and SFC 1 week to agree working contacts and arrange meeting if needed

Notification to MAFF HQ of proposal to take samples by dredging

1 week to notify Burnham, District Inspector and SFC 3 weeks to comment to CEC

Government View procedure

1 week to notify Burnham, District Inspector and SFC 4 weeks to comment to MAFF HQ 2 weeks to formulate MAFF view, arrange meeting with company if necessary, and send final view to DOE

CODE OF PRACTICE FOR SCOTLAND

I: PROSPECTING

3.1 The CEC will inform DAFS HQ in confidence when they intend to grant a prospecting licence, with the name of an appropriate company contact.

3.2 DAFS HQ will consult its Marine Laboratory at Aberdéen, the Sea Fisheries Inspectorate and Inspector of Salmon and Freshwater Fisheries, but no outside interests.

3.3 Based on advice from Aberdeen and the Inspectorate, DAFS HQ will notify the CEC (with a copy to the company) of any readily identifiable areas where there might be objections to subsequent extraction. This will be for information only.

3.4 When a prospecting licence is issued, the CEC will inform DAFS HQ, which will send details to Aberdeen, the Inspectorate and the appropriate fishing organisation or organisations. DAFS HQ will provide the company (with a copy to the CEC) with the names and addresses of the Area Inspector and fishing organisations.

3.5 Before prospecting starts the company will approach the appropriate fishing organisations to discuss working contacts. The organisations will invite the company to provide information on its proposed operations, will supply the company with information about local fishing activity and will discuss any potential difficulties.

3.6 The fishing organisations will inform their local members of the issue of a licence and of the company's proposed work schedule and will act as the contact point for any further queries fishermen may have.

3.7 The CEC will inform DAFS HQ of any proposal to take samples by dredging, including the planned area, time and method of working.

3.8 DAFS HQ will inform Aberdeen, the Inspectorate and appropriate fishing organisations. If the proposals as they stand would involve a significant risk to fisheries resources DAFS HQ will notify the CEC (with a copy to the company). Such objections will be discussed informally with the company on request.

3.9 If DAFS HQ is satisfied that the proposed operation poses no substantial risk to fisheries resources it will inform the CEC (with a copy to the company), the Inspectorate and appropriate fishing organisations.

3.10 The fishing organisations will inform their members as appropriate.

II: EXTRACTION

3.11 Under the Government View procedure DOE will consult DAFS HQ on an application for an extraction licence. DAFS HQ will consult Aberdeen and the Inspectorate. This is an inter-Departmental procedure and does not represent a basis for public consultation.

3.12 Unlike prospecting applications, extraction applications are not subject to commercial confidentiality once they have been notified through the Government View procedure. DAFS HQ will therefore also inform the appropriate fishing organisations, which will have the opportunity to put views to DAFS HQ.

3.13 DAFS HQ will formulate a Departmental view. If DAFS HQ has in mind to object it will first notify the company informally, through the CEC, giving the reasons. Where possible DAFS HQ and the company will attempt to resolve the objections, involving fishing organisations where appropriate.

3.14 DAFS HQ will then put its formal comments to DOE under the Government View procedure.

3.15 When an extraction licence is issued, the CEC will inform DAFS HQ, which will send details to Aberdeen, the Inspectorate and appropriate fishing organisations. The fishing organisations will inform their members. Wherever possible the working methods listed in Annex A will be used.

III: TIMETABLE

3.16 The timetable for the consultations set out in this Code is at Annex B.

Code of Practice for Scotland

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WORKING METHODS TO BE USED BY THE DREDGING INDUSTRY WHEREVER POSSIBLE

In response to paragraph 1.2 of the Code of Practice, the dredging and fishing industries will take all reasonable steps to ensure that their activities cause the minimum of interference or damage to each other. In particular, the dredging industry will:-

- (a) provide the Area Inspector and fishing organisations with as much advance notice as possible of the areas to be worked;
- (b) inform the Area Inspector and fishing organisations of any areas not being worked for the time being;
- (c) work each licensed area in as systematic a manner as is practicable, giving advance information to the Area Inspector and fishing organisations of any changes in plan;
- (d) wherever possible, work up and down the tidal streams.

TIMETABLE FOR CONSULTATIONS

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(NB. These are maximum periods and consultations should be completed sooner wherever possible.)

Notification to DAFS HQ of intention to issue prospecting licence

2 weeks to comment to CEC

Notification to DAFS HQ of issue of prospecting licence

1 week to notify Aberdeen, Inspectorate and fishing organisations

1 week to agree working contacts and arrange meeting if needed

Notification to DAFS HQ of proposal to take samples by dredging

1 week to notify Aberdeen, Inspectorate and fishing organisations

3 weeks to comment to CEC

Government View procedure

1 week to notify Aberdeen, Inspectorate and fishing organisations

4 weeks to comment to DAFS HQ

2 weeks to formulate DAFS views, arrange meeting with company if necessary, and send final view to DOE

PROCEDURES FOR LICENSING PROSPECTING AND EXTRACTION OF MARINE AGGREGATES

Introduction

1. Most mineral rights in UK waters are vested in the Crown and companies cannot prospect for, or extract, marine aggregates without a licence from the CEC. In addition, under Section 34 of the Coast Protection Act 1949 operations at sea which may interfere with navigation require the consent of the Secretary of State for Trade. This Appendix describes the formal inter-Departmental consultation arrangements which apply to the issue of prospecting and extraction licences; for convenience it refers only to the arrangements as they relate to MAFF, but DAFS apply very similar procedures in respect of Scottish waters.

Prospecting licences

Modern prospecting operations, properly conducted, 2. cause little disturbance to the marine environment or interference with other activities at sea. There is therefore no formal Government consultation procedure and MAFF cannot and does not object to the grant of prospecting licences. The CEC do, however, inform MAFF before issuing any prospecting licence. Having consulted Burnham and the District Inspector, MAFF informs the company concerned of any readily identifiable areas where there may be fisheries objections to subsequent extraction operations. This advice does not prevent the company prospecting in those areas, nor does it automatically imply that there would be no objection to later extraction in other areas. Until they are issued, prospecting licences are regarded as commercially in confidence and MAFF does not consult organisations outside the Ministry. Once a licence has been granted MAFF will provide details to the SFC and the appropriate national fishermen's organisations.

3. Commercial dredgers are commonly used for prospecting operations; however, any bulk sampling must be separately authorised by the CEC, who have agreed to consult MAFF in advance. In the light of advice from Burnham and the District Inspector, MAFF may propose any modifications which it considers necessary to protect important fisheries resources (eg to the time or place of the operation or the method of extraction). Such modifications would be solely concerned with the likely effect of the sampling operation. MAFF would not object to sampling simply on the grounds that there would be objections to full-scale extraction later, although the company would be alerted if there clearly would be such objections. Under the arrangements proposed in the Code there would also be local consultation to ensure that bulk sampling operations did not interfere unnecessarily with fishing activity or fixed gear.

Extraction licences

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4. Applications for extraction licences are subject to formal inter-Departmental consultation under what is generally known as the Government View procedure. This is coordinated by DOE, which consults all interested Departments including MAFF. MAFF comments are invariably based on advice from Burnham and the appropriate District Inspector. In addition, the CEC have now agreed that outside interests may be consulted at this stage. If MAFF expects to object to a proposal it will offer the company concerned an opportunity to resolve difficulties through informal discussions before putting comments to DOE. DOE, having considered comments from all Departments, puts a formal Government View to the CEC.

5. The Government View procedure is designed to provide a mechanism for considering licence applications and, if necessary, resolving substantial objections to them wherever possible. Both the fishing and extraction industries are legitimately exploiting the sea's resources; no one industry or activity can have an absolute priority and MAFF does not oppose extraction licences simply on the grounds that the area is fished commercially. Objections are limited to those cases where extraction could seriously damage fisheries resources or interfere to an unacceptable extent with an important commercial fishery.
APPENDIX IV: STUDIES ON THE IMPACT OF AGGREGATE DREDGING ON FISHERIES AND COASTAL EROSION

Fisheries Studies

1. Hastings

In the late 1960s, the Unit of Coastal Sedimentation and the Fisheries Research Group (Lowestaft and Burnham-on-Crouch) began a joint study to monitor a proposed dredging site off Hastings before, during and after dredging (Hess, 1971). The area was of particular interest because an application to dredge this location had been opposed by local fishing interests on the grounds that dredging would destroy feeding grounds and render the area permanently untrawlable (Jolliffe, 1974). The specific aims of the research were to study the effects of dredging on bottom topography to determine whether it renders an area unsuitable for trawling, to estimate the recovery time of a dredged seabed area and to monitor the faunal changes that result from dredging. Following baseline surveys undertaken in December, 1970 and in February, 1971, Civil and Marine Limited dredged an experimental pit during July, 1971. Subsequent surveys, July, 1971, May, 1972 and April, 1973, used scanning sonar and current meters to study the fate of the pit (Dickson and Lee, 1973).

2. Southwold

A second study to ascertain the direct and indirect effects of dredging on a variety of benthic communities was undertaken during the mid-1970s in dredging grounds some 5 to 12 km offshore of Southwold in Sussex. Specific work included topographical surveys, bottom current measurements, benthic surveys before dredging and after trailing suction hopper dredging (Dickson, 1975; Milner, 1977).

Coastal Erosion

2+

1. Isle of Wight

The unit of Coastal Sedimentation and Hydraulics Research Station, Wallingford, carried out sediment transport studies offshore of the Isle of Wight on the south coast. The study, funded by the Crown Estates Commissioners, involved the release and monitoring of the redistribution of radio-active silver impregnated pebbles at various depths (Hess, 1971).

2. Worthing

In 1969 a second radio-active tracer study was undertaken off Worthing, east of the Isle of Wight (Anon, 1972).