East Channel
association

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regional environmental assessment

December 2002

ROYAL HASKONING
POSFORD HASKONING

contents

Glossary & abbreviations

Abundance The number of animals present per unit area

ADCP Acoustic Doppler Current Profiler, a specialist acoustics instrument for measuring current speed and direction

Added Value The enhancement added to a product before it is offered to end users or customers

Aggregate Sand and gravel suitable for use in the construction industry

Algal / Planktonic Bloom A massive reproduction and growth of algae, often free-floating, in response to the presence of higher than normal levels of nutrients; a seasonal increase in the abundance of plankton

Aphotic An area in a depth of water where light cannot reach

Applicant A company making an application to dredge to ODPM, in this case companies of the ECA

Bathymetry Depth of the seabed, analogous to topography

Bedform Features on the seabed resulting from the movement of sediment over it (e.g. ripples and sandwaves)

Bedload Mechanism of sediment transport where sediment moves across a carpet close to the seabed, rather than in suspension in the water column

Benthic Organisms / Benthos All plants and invertebrate animals that live in or on seabed habitats, including the intertidal zone; organisms associated with the bottom of substratum of aquatic systems

Biomass The total quantity of living organisms in a given area, expressed in terms of living or dry weight of animal flesh, excluding shells, or energy value per unit area

Biodiversity The variability among living organisms from all sources including, among others, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species and ecosystems (UN Convention on Biological Diversity 1992)

Biotopes The physical habitat with its associated, distinctive biological communities; the smallest unit of a habitat that can be delineated conveniently and is characterised by the community of plants and animals living there

Bryozoans A phylum of aquatic, mainly marine invertebrates

BSAC British Sub-Aqua Club

CEFAS The Centre for Environment, Fisheries and Aquaculture Science

Circalittoral Depths greater than the intertidal zone

CNIS Channel Navigation Information Service

Coastal Zone The space in which terrestrial environments influence marine environments and vice versa

Coast Protection Structures used in protection of the coast from erosion against the sea

Community A collection of animals which are persistently associated with a particular habitat type, e.g. fine sand

Crustacea A class of arthropods (invertebrate animals)

Cumulative Representing the sum of many factors. In this case, the combined influence of multi-licence dredging activities on the environmental resource (e.g. the benthic resource)

Cycling The movement of dredging equipment from dredging site to discharge point on a cyclical basis

DEFRA Department for Environment, Food and Rural Affairs

Demersal Seabed dwelling

Density Flow The settling momentum of the descending sediment plume from the dredger's reject chutes and spillways, which is largely dependent on the grain size composition

Depth-averaged An average value taken over the entire water column (e.g. sediment concentration)

DfT Department for Transport

Dispersion The gradual spreading of the sediment plume

Disturbance A change in the system (either biological, e.g. predation) or physical (e.g. storms, human activity) which alters the nature of the biological community

Diversity The variety of animals (usually species) inhabiting a locality

Draw-down Transport of beach sediment offshore (particularly fine sediment) and trapped by depressions, then being unlikely to return to the shore

Drag Head The end unit of a suction pipe which makes contact with the seabed

Dynamic Phase The jet of sediment-laden water that initially (after release from the dredger as overflow or screened material) moves rapidly downwards towards the bed

ECA East Channel Association

Ecological Succession A predictable ordering of a dominance of a species or groups of species following the opening of an environment to biological colonisation

ECR East Channel Region

EIA/ES Environmental Impact Assessment/Environmental Statement

EMS Electronic Monitoring System

EN English Nature

Epibenthos / Epifauna Animals that live on the surface of the seabed or other substratum

Euphotic Zone The area of a mass of water that is less than one hundred metres in depth, where light can still be found and photosynthesis can occur

Fish Stocks A population of a species of fish that is isolated from other stocks of the same species and does not interbreed with them and can, therefore, be managed independently of other stocks; in EU legislation the term 'stock' is used to mean a species of fish living in a defined sea area, the two are not always synonymous

Government View The Interim Government View Procedures require the applicant to undertake a Scoping Study, an Environmental Impact Assessment and Coastal Impact Study of the proposal. A favourable Government View is required before a production licence can be issued

Hydrodynamic Processes The causes and effects of liquid (water) motion, e.g. tides, currents and wave action

ICES International Council for the Exploration of the Sea, an independent scientific advisory body founded in 1902

IFREMER French Fisheries Research Institute

In-combination The interactive influences of different activities on the resource (e.g. dredging in combination with trawling)

Infauna Animals that live buried in the seabed, e.g. cockles and lugworm

Interstitial Of or in a crevice or gap

Invertebrates Animals without backbones; In this report, invertebrates relates to marine species (e.g. polychaete and oligochaete worms, molluscs, etc.) living on or within the sediment

Juveniles An immature fish, i.e. one that has not reached sexual maturity (but could still be larger than the minimum landing size)

Larval A discrete stage in many species, beginning with zygote formation and ending in metamorphosis

Larval recruitment The addition of individuals to a population via settlement of larvae from the plankton, and subsequent metamorphosis to juveniles

Licence Authority or liberty given to do or forbear any act. The Crown Estate issues licences to developers who wish to extract marine aggregate resources. The licence is only issued following permission received from the regulating body, currently the ODPM

Littoral / Intertidal The area of the shore that is occupied by marine organisms which are adapted to or need alternating exposure to air and wetting

Macrofauna Animals that are large enough to be retained by a 1 millimetre sieve

Macrophytes Plants and seaweeds large enough to be seen by the naked eye

MCA Maritime and Coastguard Agency

Mesolithic The cultural period of the Stone Age between the Paleolithic and Neolithic periods, marked by the appearance of microlithic tools and weapons and by changes in the nature of settlements

MMG1 Marine Mineral Guidance Note 1. Guidance on the extraction by dredging of sand, gravel and other minerals from the English seabed issued by the Office of the Deputy Prime Minister

Molluscs A phylum of soft-bodied invertebrates, usually living in shells

MPA Marine Protected Area

Navtex broadcasts The NAVTEX system is used for the automatic broadcast of localised Maritime Safety Information (MSI)

Nearshore The seabed from the beach crest to the start of the offshore zone, typically extending from the coast to water depths of around 20m

Notices to Mariners Weekly published corrections, alterations and amendments to admiralty charts and publications

NGDF National Geospatial Data Framework

Occupancy The amount of time that dredging equipment will be in use at the dredging site over a 24 hour period

ODPM Office of the Deputy Prime Minister

Overflow Excess water draining through spillways on each side of the dredger hopper or through the keel

Palaeolithic The second period of the Stone Age (following the Eolithic)

Paleo-geographical The study of the geography of ancient times or ancient epochs

Paleovalley A preserved valley that has been excavated by processes no longer active, and which may be filled by sediment

Phytoplankton Microscopic plants floating in the water column that drift to-and-fro with the tides

Planktivorous Feeding on plankton

Plankton Organisms suspended in the water column and incapable of moving against water currents

Plume (sediment plume) In this case a body of water containing sediment particles

Polychaete A class of marine annelid worm

Production Licence A production licence is the legal vehicle which transfers government permission with its associated conditions into the commercial agreement between landlord and tenant

Prospecting Licence A prospect licence allows a developer to carry out the necessary studies (geological and geophysical) to inform an assessment of the nature of the seabed and resources. If this survey information indicates that the resource is suitable aggregate, then the company will apply for an exclusive production licence

Pseudofaeces Excretions produced by scallops to remove sediment from gills and vital organs

REA Regional Environmental Assessment

Rectilinear Moving in, consisting of, bounded by, or characterised by a straight line or lines

Residual The quantity left over at the end of a process; a remainder

Resuspension The erosion of deposited sediment

RYA Royal Yachting Association

Screening The process by which the proportion of gravel to sand in the cargo is adjusted to meet customer requirements. Varying quantities of sand are rejected overboard into the water column by screens located either in the vessel towers or over the hold as dredging is occurring

Sedentary/Sessile Remaining or living in one area and not migratory, or attached to a surface and not moving freely

Semi-pelagic Pelagic refers to living in the mid water column

Settling velocity The speed at which the sediment settles under the combined forces of friction, gravity and buoyancy

SOLAS International Convention for the Safety of Life at Sea

Source term Any of three aspects of marine aggregate dredging operations that release sediment into the water column, including 1) sediment forced into suspension by dredging at the seabed, 2) sediment returned to the water column within excess water (overflow), and 3) sediment rejected as a consequence of screening out unwanted grain size fractions

Spawning The production of eggs, often in large numbers, by aquatic animals such as bivalve molluscs, fishes, and amphibians

Stand on Under the Collision Regulations (Rule 17), the stand-on vessel (i.e. a ship that is dredging) is required to keep her course and speed

Sublittoral/Subtidal The zone of the shore below low water exposed to air only at its upper limit by the lowest spring tides

Synergistic effects The interaction of two or more agents or forces so that their combined effect is greater than the sum of their individual effects

Tidal current The movement of water associated with the rise and fall of the tides

Tows Areas traditionally fished using towed gear such as a beam trawl

Turbidity A measure of the attenuation of light in the water column; can be caused by the light adsorption properties of the water, plankton, suspended particulate organic and inorganic matter and dissolved colour

UKHO United Kingdom Hydrographic Office

Vibrocore Core of sediment taken from the seabed surface to a designated depth e.g. 3m through the use of a vibrating tube

Wave period The time taken for two successive wave crests to pass the same point

Winnowing The effects of tides and currents in separating fine sediments from coarser sediments

XML Extendible Mark-up Language

Industry statement

Foreword

Over the past three or four decades the marine aggregates dredging industry has grown to become a vital and integral part of the materials supply chain for the construction industry. The business has been built upon the supply of good quality aggregate resources used mainly for construction of our buildings and infrastructure, as well as the protection of our coastal regions through beach replenishment.

This report originates directly from the new discovery of substantial volumes of aggregate resources in the Eastern English Channel, which will permit the dredging industry to maintain its social and economic contribution for many decades to come.

As responsible developers, the East Channel Association of dredging companies have funded the preparation of this independent report to brief stakeholders about the potential cumulative and in-combination regional impacts of the proposed development, together with an outline of possible mitigation and monitoring strategies.

An Industry Statement precedes the independent Regional Environmental Assessment report prepared by Posford Haskoning.

www.eastchannel.info

Beach nourishment, Sussex

Canary Wharf, London

Southampton Football Stadium

Millennium Bridge, Gateshead

The Industry Statement consists of two sections;

Section 1

The first section comprises an introduction to marine aggregates and their importance, the Eastern English Channel Region, the Regional Environmental Assessment, the companies involved in the East Channel Association (ECA) and the aggregate resources. A commitment, by ECA members, to a charter forms the conclusion.

Section 2

The second section outlines the proposed activity of each individual company, with each dredging proposal described in detail. This section summarises the current proposed dredging plans, some of which are described in Environmental Statements already published. However Environmental Statements have not been completed for all applications to date, therefore some of the proposals remain informal at this stage. Marine aggregate production forecasts for the East Channel Region are also outlined.

1 Introduction to marine aggregates and the dredging proposals

The first section comprises an introduction to marine aggregates and their importance, the Eastern English Channel Region, the Regional Environmental Assessment, the companies involved in the East Channel Association (ECA) and the aggregate resources. A commitment, by ECA members, to a charter forms the conclusion.

1.1

Why we need marine aggregates

Government recognises that marine aggregates play a key role both in servicing the requirements of society and the built environment, as well as maintaining coast and flood protection defences. This is particularly important for London and South-East England, where around 32-36% of demand (Figure 1) for construction aggregates is supplied from marine sources, or around 8-10 million tonnes every year. In addition, demand for marine aggregates for coastal protection schemes in SE England is commonly up to 1-2 million tonnes every year and is predicted to increase. It is therefore vital to ensure continuity of supply if future construction and coastal protection demands are to be met.

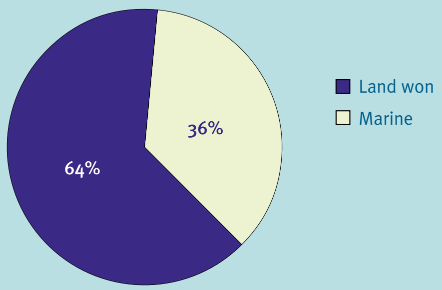

Figure 1. Sources of construction aggregates for London and SE England (1999). Note that typically the marine aggregate contribution is equivalent to around 8-10 million tonnes per annum.

Government also recognises that the contribution of marine aggregate is important through relieving pressure on constrained and declining land-based aggregate sources.

Marine sands and gravels are essential materials. They are widely used in the construction industry to build our homes, hospitals, schools, offices, bridges, drains, roads and improving our infrastructure, which underpins the economic and social development of our society.

'Over the past 25 years, land-based sand and gravel production in SE England has declined by 60%'

1.2

Supply and quality of marine aggregates

The construction industry requires a continuous supply of consistent quality aggregates throughout the year. Marine aggregates are delivered to wharves, which are commonly integrated with concrete and block plants, and lie close to the markets. Aggregates for use in construction, particularly concrete, must be delivered as a mix of around 55% gravel and 45% sand. In order to satisfy this quality objective and to maintain continuity of supply, industry has to continually replace resources as they become steadily depleted. In the past, London and SE England have been supplied with a combination of local land-based sand and gravel and with marine sand and gravel from licences lying mainly offshore Norfolk. Over the past 25 years, land-based sand and gravel production in SE England has declined by 60% (see Figure 2) and will continue to decline as the resources become increasingly constrained.

During this time the marine aggregate contribution has increased. However the existing offshore sand and gravel licences have now been dredged for over 30 years. While they still contain substantial sand resources, the gravel contents of the Norfolk licences have declined, forcing industry to increasingly substitute supply from more distant, less economic licences (Figure 3).

Alternative resources must therefore be found to replace the essential materials necessary for the construction industry, to satisfy existing and future demand and to sustain and develop the regional economy. In addition, securing alternative, long-term resources will provide the confidence within the aggregate supply industry to continue to make the necessary investment in ships, jobs and wharves.

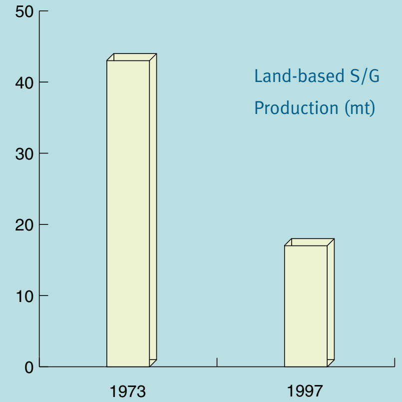

Figure 2. Decline in land-based sand and gravel production in SE England.

1.3

New marine aggregate resources – the East Channel Region

In the last five years, independent surveying by several companies has led to the discovery of significant marine aggregate reserves in the eastern English Channel. The area is referred to as the East Channel Region (ECR) and lies in the centre of the eastern English Channel, around 30km offshore Beachy Head (Figure 4). The ECR has not previously been a source of marine aggregates. Water depths in the area are between 30-60m. The aggregate resources of the area are critical to the marine aggregates industry and have the potential to form the major long-term source of marine aggregates for many decades to come.

1.4

Development of the resources in the East Channel Region

Whilst the importance of the ECR resources to the construction and marine aggregate dredging industry, as well as the regional economy and society are indisputable, the ECA understands that permissions will not be given if environmental impacts are unacceptable. As responsible developers, the ECA recognises that environmental impacts must be assessed and mitigated in accordance with Government policy (Marine Minerals Guidance 1, 2002). Furthermore, the ECA recognises the Government's aim for sustainable development and attaches importance to the prudent use of resources, maximising efficiency and minimising impacts associated with aggregate recovery.

'The aggregate resources of the area are critical to the marine aggregates industry and have the potential to form the major long-term source of marine aggregates for many decades to come.'

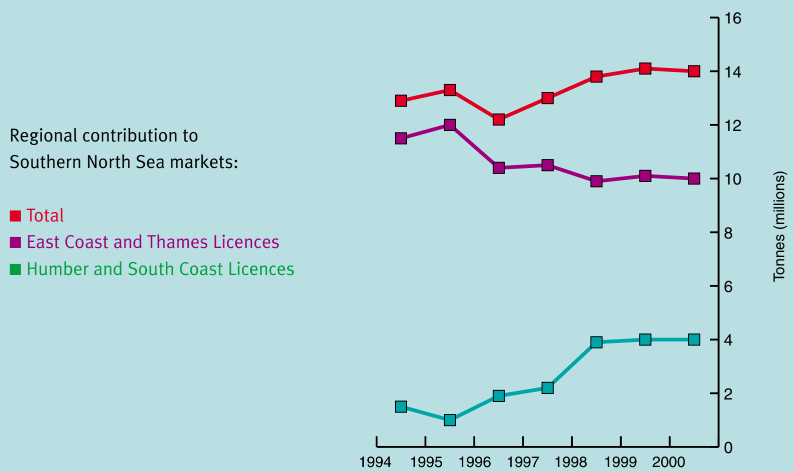

Figure 3a. Sources of marine aggregate delivered to southern North Sea markets. Note the decline in the contribution of East Coast and Thames licences as a result of decreasing gravel contents in these areas leading to increased cycle times (Figure 3.b).

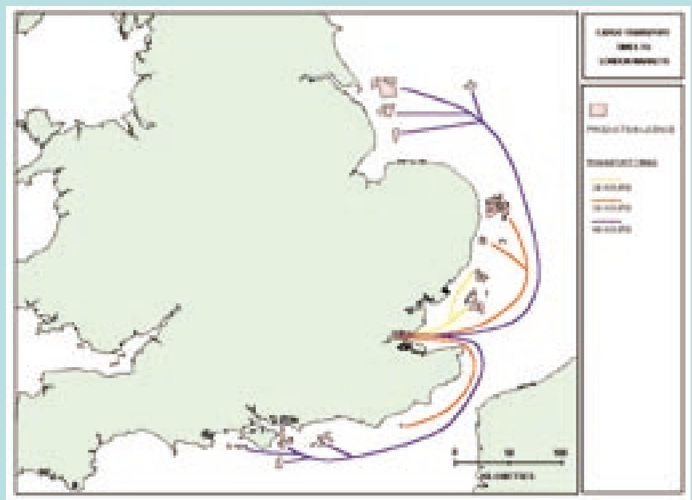

Figure 3b. Cargo Transport times to London Markets

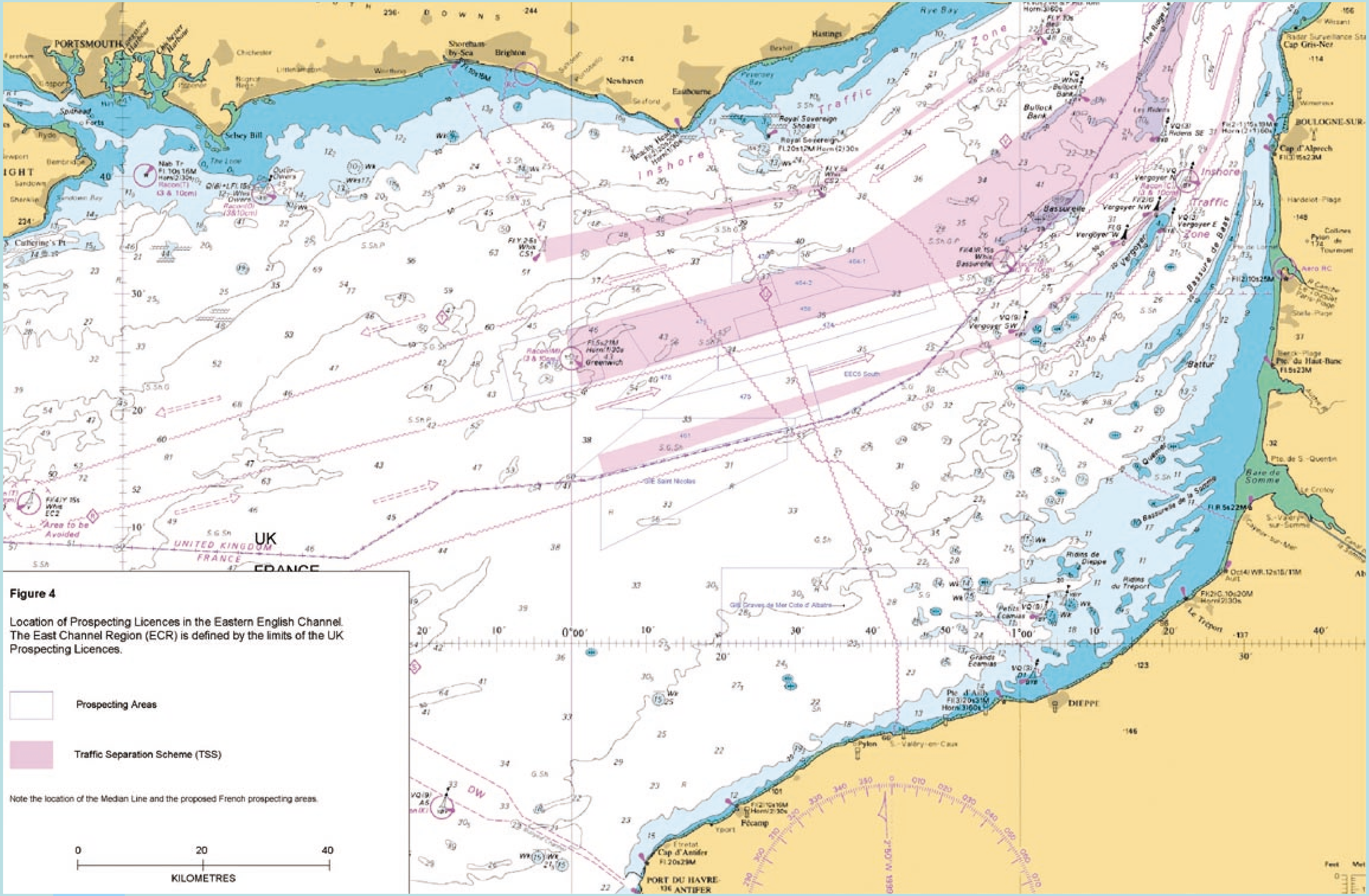

Figure 4

Location of Prospecting Licences in the Eastern English Channel. The East Channel Region (ECR) is defined by the limits of the UK Prospecting Licences.

Prospecting Areas

Traffic Separation Scheme (TSS)

Note the location of the Median Line and the proposed French prospecting areas.

0 20 40

KILOMETRES

1.5

The East Channel Association (ECA)

The East Channel Association (ECA) is an association of aggregate dredging companies with prospecting and application areas in the ECR. The ECA is neither a trade association nor a commercial organisation, but was formed to research, analyse and promote aggregates dredging in the Eastern English Channel. ECA members are:

Britannia Aggregates Ltd
a joint venture between Canterbury-based Robert Brett & Sons and Redland Westminster Aggregates Ltd of Fareham

Dredging International UK Ltd
one of the world's leading dredging operators with a UK base at East Grinstead in Sussex

Hanson Aggregates Marine Ltd
the Southampton-based marine aggregate operation of Hanson's world-wide construction materials group

RMC Marine Ltd
the Southampton-based marine aggregate operation of the international construction materials group RMC

United Marine Aggregates Ltd
a Chichester-based joint venture between two of Britain's major construction materials companies Tarmac and Hanson

Volker Dredging Ltd

Volker Dredging Ltd

The ECA was formed following the 'New Agenda' workshop attended by a wide range of stakeholders at the Crown Estate in June 2001. This meeting examined the options for assessing several dredging applications from companies in a new region of the UK Continental Shelf. It is envisaged that if the development of the ECR is permitted, the role of the ECA will continue to provide a focus for co-ordinating and managing regional dredging activity and issues.

At the workshop the industry outlined the vision for the development of the ECR with a strategic objective;

'To develop an industry wide plan for the East Channel Region which will allow new reserves to be released to meet all companies' reasonable needs as soon as practicable within a framework acceptable to DTLR (now ODPM) and DEFRA'.

The ECA members, (the companies who have carried out their own independent prospecting in the eastern English Channel) that have submitted (or intend to submit) Environmental Impact Assessments in support of their applications for Production Licences, have recognised 3 key principles;

- no single application can be considered in isolation,
- cumulative impacts should be minimised, and
- no additional areas in the ECR should be tendered until current interests are clarified.

The plan outlined at the New Agenda meeting also identified other important considerations including;

- agreed timescales, with permissions to be issued as soon as practicable,
- the importance of a Regional Environmental Assessment (REA),
- linkages with other dredging regions (ie. return and adjustment of existing licenced area and tonnage, combined with a review of the status of applications not in the ECR – particularly off the East Coast and around the Isle of Wight),
- a commitment to resource management (eg. a maximum of $10km^2$ of active dredging area available for dredging at any given time in each licence),
- a commitment to dredging management (based on a risk assessment, co-ordinated reporting/operating procedures and a Code of Practice),
- the creation of a review board and adoption of a rolling assessment of impacts, and
- an undertaking to work with regulators, wider industry and stakeholders throughout the development of the ECR.

Having established that there is a regional perspective to issues associated with potential dredging activities in the ECR, as a first step towards addressing these concerns the ECA has commissioned a Regional Environmental Assessment (REA). The REA addresses regional issues associated with resource and dredging management arising from the proposed developments. However, as a result of competition, individual applicants remain responsible for translation of REA recommendations into individual applications, as well as the development of linkages between existing and proposed licences. It is also anticipated that the REA will guide future management and monitoring requirements.

The primary objective of the REA is to provide information to assist regulators in assessing the regional implications of several dredging permissions being granted and identifying potential mitigation options.

1.6 The Regional Environmental Assessment (REA)

As a first principle the ECA recognised that the development of the area should be undertaken in an environmentally acceptable and safe manner. To address broad, emerging regional issues, which are not easily considered by individual environmental statements, the ECA commissioned consultants to produce an independent study investigating the combined influence of all the individual dredging proposals and report on all relevant environmental issues and potential mitigation measures. This study is called 'The East Channel Regional Environmental Assessment' (REA) and is based on a strategic environmental assessment approach. The REA is based on all existing available data and a series of specialist studies commissioned by the ECA.

The REA is an independent study, which lies outside the current Government View procedure. Although formal consultation has not been undertaken, stakeholder participation has occurred through a scoping Technical Workshop on 1 November 2001. A briefing is planned to accompany the final report.

The primary objective of the REA is to provide information to assist regulators in assessing the regional implications of several dredging permissions being granted and identifying potential mitigation options. In summary, the REA;

- lies outside the current formal application procedures,
- is a responsible initiative funded by industry,
- is undertaken by independent consultants, and
- functions as a reference study providing stakeholders with regional data, interpretation, an assessment of cumulative and in-combination effects and mitigation proposals on a regional scale.

Individual dredging applications will still need to be accompanied by site-specific Environmental Impact Assessments (EIA), and applicants will need to undertake consultation and resolve concerns as required by the existing permission procedures.

Applications in the region are at various stages of development and several of the applicants have already provided environmental statements to the ODPM.

1.7 The ECA Charter

The Charter is a development of the best practice approach outlined by the industry at the New Agenda Workshop and has been established as an initial response to the recognition of issues and concerns surrounding the proposed dredging in the ECR. The Charter provides a platform to develop bespoke mitigation strategies.

As a basic premise, the ECA companies will minimise dredging impacts through responsible practice and the Charter consists of a series of broad aims setting a common standard for all ECA companies. The ECA recognises the benefits of a regional approach, however each ECA member is entitled to an individual interpretation of any results and recommendations of the REA and ensuing studies.

The ECA Charter

The ECA Charter is a commitment by each company to;

- implement the results and recommendations of the REA and ensuing studies as appropriate to individual applications,
- co-operate and fund future regional environmental studies and research,
- recognise the results of further environmental studies and respond to recommendations,
- monitor, mitigate and manage environmental impacts and operational activity on a regional basis,
- careful management of dredged area, with an aim of reducing dredged area to a minimum,
- zoning permission areas to restrict operational dredging areas,
- only dredging resources >2m thick on average,
- minimise screening,
- transparency – make all relevant dredging and environmental data publicly available through regular company reporting, and
- audit – all relevant data will be made available for analysis by independent experts.

2 Individual company dredging proposals

Section 2 provides a background to the dredging applications in the ECR, reviews the dredging areas proposed by each company and the likely marine aggregate production rates.

2.1

Prospecting and Proposed Dredging Permission Areas in the ECR

Details of the ten Prospecting[1] Licences are listed in Table 1 and their locations are shown in Figure 4. At present, there are two applications for exploration licences lying in French waters, although it is understood no exploration has taken place to date.

Table 1. Prospecting Licences, proposed maximum offtake tonnages and status of applications in the ECR

Licence Area	Applicant	Maximum Tonnage million tonnes p/a	Application Status
458 464/1-2	United Marine Dredging Ltd /RMC Marine Ltd	10	Consultation report complete, awaiting ODPM decision
461	Volker Dredging Ltd	5	Consultation report complete, awaiting ODPM decision
473	Hanson Aggregates Marine Ltd /RMC Marine Ltd	9	Environmental Statements submitted April 2002, consultation complete.
474/475	Hanson Aggregates Marine Ltd		
477	Britannia Aggregates Ltd	5	Environmental Statement in preparation
478	Dredging International UK	2	Environmental Statement in preparation
479	Dredging International UK	2	Environmental Statement in preparation
EEC 5 (South)	Hanson Aggregates Marine Ltd	1	Environmental Statement in preparation

[1] Exclusive area available to a company permitting exploration for sand and gravel and awarding a company the commercial rights to develop an application to dredge.

2.2

Dredging Proposals in the ECR

2.1.1

Consenting Procedures

The government (ODPM; Office of the Deputy Prime Minister) regulates marine aggregate dredging in English waters. Permission to dredge will only be given by the ODPM pending the successful conclusion of the non-statutory Government View Interim Procedures (DETR Government View: New Arrangements for the Licencing of Minerals Dredging, 1998). Application procedures consist of a scoping study, preparation and assessment of an Environmental Statement, several phases of consultation and resolution of concerns by the applicant. The ODPM will consider all information submitted as part of the application process before reaching a decision and receives technical advice from CEFAS, DEFRA, English Nature and other agencies.

The Crown Estate (for details see www.crownestate.co.uk) holds the sea bed mineral rights around England and issues licences for the extraction of marine aggregates. The licences permit companies to extract defined tonnages, subject to conditions imposed by government. Individual companies tender competitively for Prospecting Licences which permit exploration of the sea bed under exclusive rights and commit the tenderer to develop a dredging application within an agreed timescale.

2.1.2

Prospecting Licences in the ECR

The ECA Prospecting Licences, tendered by separate companies to the Crown Estate prior to detailed survey, form a combined area of 1132km^2 of the Eastern English Channel and were tendered between 1995 and 2000. The Prospecting Licences lie >120km to the south west of the Dover Straits and largely lie within the shipping Traffic Separation Scheme (TSS) (Figure 4). Subsequent evaluation of survey data has revealed that substantial areas of seabed within the Prospecting Licences contain significant volumes of viable aggregate reserves. Consequently each tenderer in the ECR has decided to pursue an application to dredge.

Companies of the ECA have recognised that the ECR offers the opportunity to develop resources in a responsible manner, in line with government policy (see REA). As a result, all of the ECA companies are proposing at this stage to only develop small areas of sea bed lying within each Prospecting Licence, in accordance with the ECA Charter. Each company's approach to resource and dredging management is detailed in their individual environmental statements, and proposed dredging plans are the culmination of balancing resource, economic and environmental issues.

In order to be aware of the potential cumulative effects of the combined applications, it is necessary to understand the dredging plans proposed by each company in the region. Although there is no common approach recommended by government or established through precedent, the ECA companies have attempted to minimise the size of their applications and to limit proposed dredged area to a minimum (Table 2, Figure 5). It is important to note that;

- the Proposed total ODPM Dredging Permission Area for all applications is **231km²** (compared with a Prospecting Licence area of 1132km²). This is the combined total area of the companies' applications for permission to dredge. This total area is exceedingly unlikely to be dredged, as the permission includes a factor to allow for variable resource qualities. This compares favourably with the existing dredging licence block lying off the East Coast (Figure 6).

- the target (ie. it is a company environmental performance objective as outlined in individual environmental statements) Proposed Maximum Dredging Area for the 15 year Government Permission term totals **117km²**, or about 10% of the Prospecting Licence area. If resource predictions are realistic, companies believe that dredging can be constrained to an area substantially less than 117km².

- in response to Government policy (MMG 1, 2002), and other stakeholder interests, the ECA companies have also proposed that dredging will be restricted to highly localised, delineated zones lying within the Government Permission areas (Figure 5). These zones are defined as Proposed Areas Available for Dredging at any One Time and will range in size between **2-10km²** depending on each application. The total zoned area is **43km²**.

- based on existing dredging experience and expected production levels from the ECR, the typical area dredged over 1 year in the entire ECR is likely to be around **10km²**.

In conclusion, compared with existing licences, the ECR applications will reduce impacts through limiting permission, dredged and zoned areas, as well as isolating individual dredging areas across the wider region.

2.3 Marine Aggregate Production Forecasts in the ECR

The long-term total annual production of marine aggregates from the ECR is difficult to predict, however three production forecasts outlining possible extraction rates within the ECR are described below. These form a background to the REA

Scenario 1; Dredging offtake of 34 million tonnes per annum

The theoretical maximum annual permissible offtake from the ECR is 34 million tonnes per annum (Mtpa). This tonnage is the combined tender application total of six separate, competing companies operating within the same regional European market. The market in the UK stretches from Ipswich to the Isle of Wight and on the continent from Honfleur (Northern France) to Harlingen (North Holland). Inevitably, there is an element of double counting of tonnage within this combined application total because the individual companies are competing for the same market tonnage demand. In 2000, the tonnage dredged and supplied within the market region described above was 13.6 million tonnes, just 40% of the total under application in the ECR. The disparity between licenced volume and dredged tonnage also exists on current licences and is a function of the tendering process. Experience proves that it is highly unlikely this level of offtake will be dredged during the proposed licence terms and as a result consideration of this level of offtake is unrealistic.

Scenario 2; Dredging offtake of 17 million tonnes per annum

This tonnage equates to 50% of the maximum permissible offtake. It represents an offtake that may be achieved in the future from the ECR, should demand increase significantly for marine aggregates in SE England and the near Continent. This level of production cannot be achieved with the existing aggregate dredging fleet, although may be dredgable in the future with further investment.

Scenario 3; Dredging offtake of 8.5 million tonnes per annum

This tonnage equates to 25% of the maximum permissible offtake and represents the realistic aggregate market requirements today. It is the average annual tonnage that will be dredged in the coming five years if regional marine aggregate demand remains constant. Assessment of the effects potentially associated with this offtake would therefore represent the most likely and realistic impact of the proposed operations given current demand forecasts.

After the initial five year period of extraction, the offtake is anticipated to increase by up to 50% (3 to 5Mtpa), to total around 11.5 to 13.5Mtpa, as reserves elsewhere continue to decline. Production is not expected to reach 17mtpa.

Table 2. Applications and proposed dredging areas in the ECR (see Figure 5).

Applicant	Application number	Prospecting Area km²	Proposed ODPM Govt View/ Dredging Permission Area km²		Proposed Maximum Total Dredging Area km²		Proposed Area available for Dredging at any one time km²	Typical Area Dredging over One Year km²	NOTES
UMD/RMC	458 464/1-2	139	26		26		4.8		>3m dredging depths planned
VDL	461	148	90		30		10		Crown Estate licence will restrict dredging activity to 30km²
HAML/RMC	473	153	12		9		4		473, 474 and 475 form part of a regional extraction plan and whilst minor details on individual licences may be modified, total areas will not amended
HAML	474	140	12	40	6	25	2		
HAML	475	140	16		10		6	10	
DI	478	84	25		10		5		Extraction Plan in preparation
DI	479	54	10		10		5		
BA	477	131	30		10		5		Extraction plan in preparation
HAML	EEC5 South	144	10		6		2		Extraction Plan in preparation
TOTAL		1132	231		117		43	10	

Prospecting Area – exclusive exploration area available for development into a Dredging Permission.

Dredging Licence – the commercial agreement with the Crown Estate for extracting aggregate from the seabed and the legal vehicle for applying Government conditions to the dredging operations.

Dredging Permission/Government View – Government judgement on the environmental acceptability and need for the application, given by Secretary of State, the ODPM being the competent authority. A Permission normally extends for 15 years with 5-year reviews.

Dredging Permission/Government View Area – area permitted for dredging by the Government.

Proposed Maximum Total Dredging Area – the estimated maximum dredged area over the 15 year term based on company performance targets = estimated worst-case dredging impact area. (Note this area is less than the Dredging Permission Area, but reflects potential, unforeseen resource variability).

Proposed Area Available for Dredging at Any Time – the estimated area available for dredging at any one time based on company production plans and zones = typical active operational area, planned to be 43km².

Typical Area Dredged over One Year – area actually likely to be being dredged over one year based on current practice.

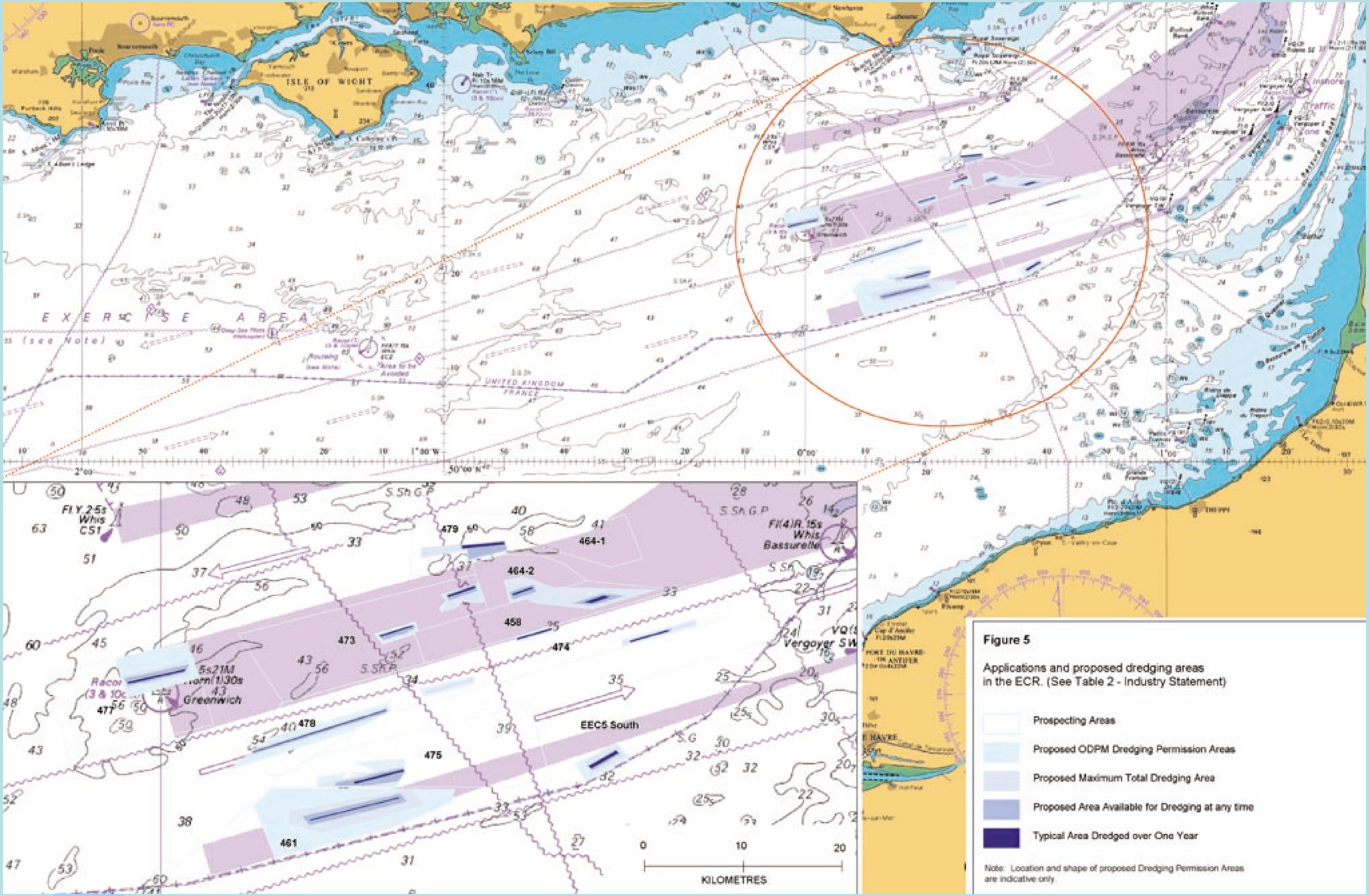

Figure 5

Applications and proposed dredging areas in the ECR. (See Table 2 - Industry Statement)

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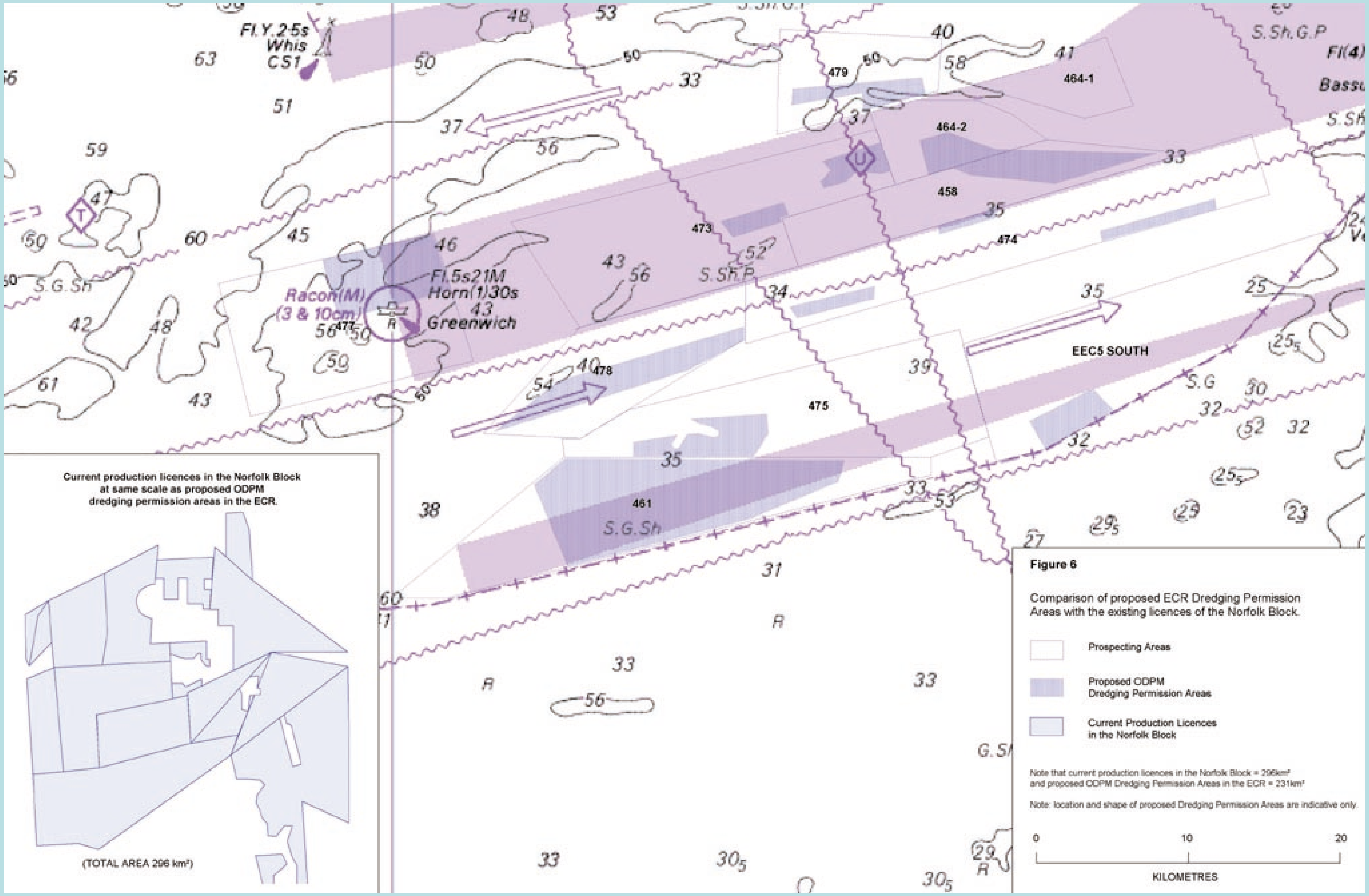


Note reduction in size of proposed ECR Dredging Permission Areas compared to the existing production licences off Gt Yarmouth.

1 Introduction and background

1.1 Introduction

Proposals for development within the marine environment require an Environmental Impact Assessment (EIA) to be undertaken as part of the application process. Environmental Impact Assessments have been undertaken as part of the permission process for commercial marine aggregate extraction on an individual application basis since the early 1990s.

In the last five years, six separate companies have prospected the east English Channel for commercially exploitable marine sand and gravel and discovered significant marine aggregate reserves. Prospecting licences were obtained through competitive tender from the Crown Estate to allow the companies to explore the reserves in the region. Production applications have subsequently been made to the newly created Office of the Deputy Prime Minister (ODPM), the Government's Regulatory body. The preceding Industry Statement describes the background to these applications, which are at various stages in the process, and the Applicant companies.

The area defined as the East Channel Region (ECR), lying in the centre of the eastern English Channel around 30km off Beachy Head, has not been previously licensed for marine aggregate dredging (see Figure 4 in the Industry Statement). In order to encourage discussion on the means to progress potential exploitation in an undeveloped region, a workshop was held by the Crown Estate in June 2001 to examine the options for assessing several, proximate dredging applications; the New Agenda Workshop. Further to this meeting of the industry, relevant stakeholders and regulators, it was agreed that a regional assessment of potential environmental impacts associated with the licensing of a number of dredging areas in the ECR should be undertaken. The East Channel Region – Regional Environmental Assessment (REA) was then initiated by the Applicant companies. The East Channel Association (ECA) was formed to commission and inform the REA process.

1.2 Regional Environmental Assessment

An important consideration of the EIA process is the evaluation of the impact of a proposed development in conjunction with existing and planned projects in the study area.

The East Channel Region – Regional Environmental Assessment was initiated to evaluate the potential cumulative and in-combination effects of all the proposed dredging operations in the ECR; where, for the purposes of this assessment, cumulative effects are taken to be the combined influence of multi-licence dredging activities on the environmental resource (e.g. the benthic resource), while in-combination effects are taken to be the interactive influences of different activities on the resource (e.g. dredging in combination with trawling). The REA forms a comprehensive approach to the investigation and evaluation of the proposed multi-licence dredging activities within a defined geographical area. The REA makes recommendations for management of the proposed dredging activities as well as for mitigation and monitoring based on the results of the assessment.

The ECR Regional Environmental Assessment was commissioned following discussions between the dredging industry and its regulators, who have endorsed the approach. There is no statutory requirement for the REA, however, it is intended to be a document that will inform the determination of a number of licence applications for extraction within a single region and provide a strategic overview of the cumulative effects that individual environmental impact assessments are unable to address. As a voluntary undertaking by applicant dredging companies, the REA for the East Channel Region aims to attain a number of specific objectives. These are described in Chapter 2.

The REA will be widely distributed to stakeholders for information. The primary objective of the REA is to provide information to assist the regulators in assessing the regional implications of several dredging permissions being granted. The data contained in the REA will therefore be used by applicant companies, where appropriate, to provide a regional context in support of individual dredging applications. Consultation will be carried out within the Government View process for individual application areas.

1.3 Context of the REA

1.3.1 SEA Directive

The East Channel Region REA has been undertaken adopting the principles of Strategic Environmental Assessment. This is the first independent applicant-funded REA to be undertaken for marine developments in the UK. The SEA initiative currently being undertaken by the DTI in relation to the licensing for Oil and Gas extraction, has been closely considered throughout the REA process.

Directive 2001/42/EC on the assessment of the effects of certain plans and programmes on the environment, the Strategic Environmental Assessment (SEA) Directive, entered into force on 21 July 2001. The main objective of the Directive is to 'contribute to the integration of environmental considerations into the preparation and adoption of plans and programmes with a view to promoting sustainable development'.

SEA contributes to transparent planning through integrating environmental considerations and public consultation, with an overarching goal of achieving sustainable development. SEA is a process of predicting and evaluating the environmental implications of a policy, plan or programme at a strategic level, thereby inputting into the decision making process. The responsibility for undertaking Strategic Environmental Assessment lies with the Government regulator and not with the developer.

The Regional Environmental Assessment is not an SEA. However, the main objectives of the REA have been set in line with the concept of SEA.

1.3.2
UK Licensing Procedure for Marine Aggregate Extraction

The Crown Estate owns the seabed out to the 12 mile territorial limit and is responsible for the right to explore and exploit the non-energy minerals of the UK Continental Shelf. The Crown Estate issues licences to developers who wish to extract marine aggregate resources. These are essentially commercial agreements between the licensees and the Crown Estate. The licence is only issued following permission received from the regulating body, currently the ODPM. For marine aggregate extraction, two types of licence issued by the Crown Estate are currently required, namely a 'prospecting licence' which subsequently may be followed by a 'production licence'. The Crown Estate plays no role in the assessment and determination of dredging applications.

A prospecting licence allows a developer to carry out the necessary studies (geological and geophysical) to inform an assessment of the nature of the seabed and resources. If this survey information indicates that the resource is suitable aggregate, then the company will apply for an exclusive production licence.

A production licence is only issued following a favourable Government View (otherwise known as Dredging Permission) from the Minerals and Waste Planning Division of the ODPM. A production licence is the legal vehicle which transfers government permission with its associated conditions into the commercial agreement between landlord and tenant.

A Government View is considered according to the Interim Procedures set out in 'Government View: New Arrangements for the Licensing of Minerals Dredging' published by the DETR (now the ODPM, formerly DTLR) in 1998. The Interim Government View Procedures require the applicant to undertake a Scoping Study, an Environmental Impact Assessment and Coastal Impact Study of the proposal. Extensive consultation is undertaken throughout the process and concerns are addressed at each stage, with the onus on the applicant to resolve issues. A decision is made on the application by the First Secretary of State.

1.3.3
Statutory Procedures

The existing Government View procedure will shortly be replaced by a statutory system of 'Dredging Permissions'. New regulations will incorporate the provisions of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999 and the Conservation (Natural Habitats, & C.) Regulations 1994 ("The Habitats Regulations").

1.3.4
Marine Minerals Guidance Note 1 - 2002

The ODPM has recently published Marine Minerals Guidance Note 1 (ODPM, 2002), which sets out Government policy on the extraction of marine sand and gravel and other minerals from the English seabed. Government recognises that although marine aggregate makes an important contribution to the UK construction industry, extraction must be undertaken without unacceptable adverse impacts.

The Government wishes to see continued use of marine aggregates for construction and beach nourishment work in keeping with the principles of sustainable development.

"To achieve this, the dredging industry requires sufficient access to suitable long-term resources to meet its varied and fluctuating markets and to provide it with sufficient confidence to invest in new ships and wharves. At the same time, it is important that dredging activities do not significantly harm the environment or fisheries or unacceptably affect other legitimate users of the sea."

The Government believes that the policy aims described above can be achieved through several measures, including:

- Minimising the total area licensed/permitted for dredging;
- The careful location of new dredging areas;
- Considering all new applications in relation to the findings of an Environmental Impact Assessment (EIA) where such an assessment is required;
- Adopting dredging practices that minimise the impact of dredging;
- Requiring operators to monitor, as appropriate, the environmental impacts of their activities during, and on completion of, dredging; and
- Controlling dredging operations through the use of conditions attached to the dredging licence or dredging permission.

These policy objectives have been taken into account throughout this Regional Environmental Assessment, particularly when developing recommendations for mitigation, monitoring and management.

2 The Regional Environmental Assessment: Purpose and process

2.1

Introduction

The East Channel Region - Regional Environmental Assessment was commissioned as a result of discussions between the Dredging Industry and its Regulators, confirming the advantage in adopting a collective approach to studying and managing dredging activities in the ECR and encouraging a unified approach to the assessment of regional effects. The scope and purpose of the REA was developed following a review of the Environmental Statements already prepared or in preparation (see the Industry Statement) and refined in discussions with the Centre for Environment Fisheries and Aquaculture Science (CEFAS) and other relevant stakeholders.

2.2

Aims and objectives

The REA is a study of the potential cumulative impacts associated with the proposed multiple dredging activities occurring within the defined region of the ECR. The study aim is to provide cumulative and in-combination assessment information to individual Applicant companies for use, where appropriate, in project-specific EIAs. In addition, the REA provides information to the relevant regulators for assessing the cumulative impacts of the operations. Its underpinning objectives are as follows:

1. To assess the potential cumulative, in-combination and transboundary effects of a number of proposed dredging operations in a previously undredged region on the environment and operational practices.
2. To identify areas of sensitivity within the identified study area.
3. To make recommendations for regional mitigation, monitoring and dredging management plans.
4. To provide a basis for informed and reasoned decision-making, through the provision of both quantitative and qualitative regional information and predictions.
5. To recommend options for facilitating a co-ordinated regional and long-term approach to dredging activities in the East Channel Region.

Two further objectives of the REA reflect its dynamic nature:

6. The REA is intended to be a living document. It is anticipated that new data and approaches will be progressively incorporated into the REA over time. This should include further data gathered as part of the individual application (as described in the Industry Statement), as well as monitoring data should licences be issued. Conclusions and recommendations made as part of the REA should be reviewed in light of new information.
7. A dedicated Geographical Information System (GIS) has been developed as part of this work. The REA objectives also include updating the database as new information is gathered.

2.3

The REA Process

Posford Haskoning was commissioned by the East Channel Association to undertake the Regional Environmental Assessment for the East Channel Region. The key environmental issues associated with the proposed developments were identified principally based on the scoping studies undertaken for individual production licence applications. A team of specialists was appointed to address each key subject area and produce subject specific technical reports. The REA itself is a compilation, interpretation, summary and assimilation of these technical reports, as well as a review of existing information on other regional issues.

The project team adopted an open and transparent approach to the REA process, which was endorsed by regulators and consultees. The key features of this process have included data gathering, consultation, extensive literature review, a Technical Workshop with stakeholders and specialist assessment, analysis and recommendations.

The key stages of the REA were as follows:

- Task 1: Data collation and consultation;
- Task 2: Description of the existing environment – including the identification of data gaps and validation;
- Task 3: Assessment of potential regional cumulative impacts;
- Task 4: Assessment of potential regional in-combination impacts; and
- Task 5: Recommendations for mitigation, regional monitoring and dredging management.

Figure 2.1 illustrates the process undertaken as part of the REA.

Ideally, the REA would have been based upon the data and conclusions contained within Environmental Statements specific to each permission area application. Each application, however, is at a different stage in the process. When the REA was initiated, two Environmental Statements had been completed (detailed in the Industry Statement) and baseline data gathered for most of the ECR. This site-specific information is supported by regional research studies and literature reviews.

Some original work was undertaken specifically for the REA, including additional wave modelling in order to predict the cumulative effects of dredging in the ECR on the wave climate and, therefore, the English and French coastlines. In addition, individual permission area baseline benthic information was re-analysed at a regional scale, a regional fisheries study was commissioned, and further modelling was undertaken to assess the risk to shipping of all the ECR applications.

Table 2.1 REA Subject Areas and Specialists

REA Subject	Specialists	Technical Report
Coastal Processes	Dr A. Brampton - HR Wallingford	✔
Biological Environment	Prof R. Newell – Marine Ecological Surveys	✔
Fisheries Activity and Resource	Mr T. Huntingdon and Mr R. Banks – Poseidon Aquatic Resource Management Mr B Caillart – Oceanic Development	✔
Geological Resources	Dr C. Evans – Independent Consultant	With coastal processes
Navigational Risk	Mr A. MacDonald – Anatec	✔
Archaeology	Dr A. Firth - Wessex Archaeology	✔
Other Activities	Posford Haskoning	Within the REA

Table 2.1 identifies the specialist organisations and/or individuals responsible for these key issues.

2.4

Key features of the Regional Environmental Assessment

2.4.1

Consultation

Consultation was carried out as part of a scoping exercise prior to the production of the REA. It involved more than 80 organisations, including Government regulators (both English and French), local authorities, conservation groups, representatives of the fishing industry, those with navigation interests and other interested groups. Introductory letters were sent to interested parties, setting out details of the proposed applications, the goals of and approach to the REA and inviting comment. Many of the consultees had been contacted previously as part of the consultation process for the individual EIAs and an emphasis was placed on avoiding the duplication of effort. Although responses were only received from 20 consultees, there was general support for the REA concept. The key points raised by consultees are summarised in Appendix 1.

2.4.2

Consideration of Transboundary Effects

Due to the location of the proposed dredging areas on the Median line between French and English waters, the REA has examined the potential implications of the proposals for the activities of other potentially affected nations. Information has been collated from France, Belgium, Holland and Denmark, mostly through literature review but also through consultation. Requests for data on commercial fishing activity have also been made.

2.4.3

Technical Workshop

An interim Technical Workshop was held in November 2001 as part of the REA process. The workshop brought together technical specialists, stakeholders and regulators to discuss the background, progress and initial findings of the REA. The workshop was vital to providing direction for the remainder of the regional assessment.

Figure 2.1 The REA process

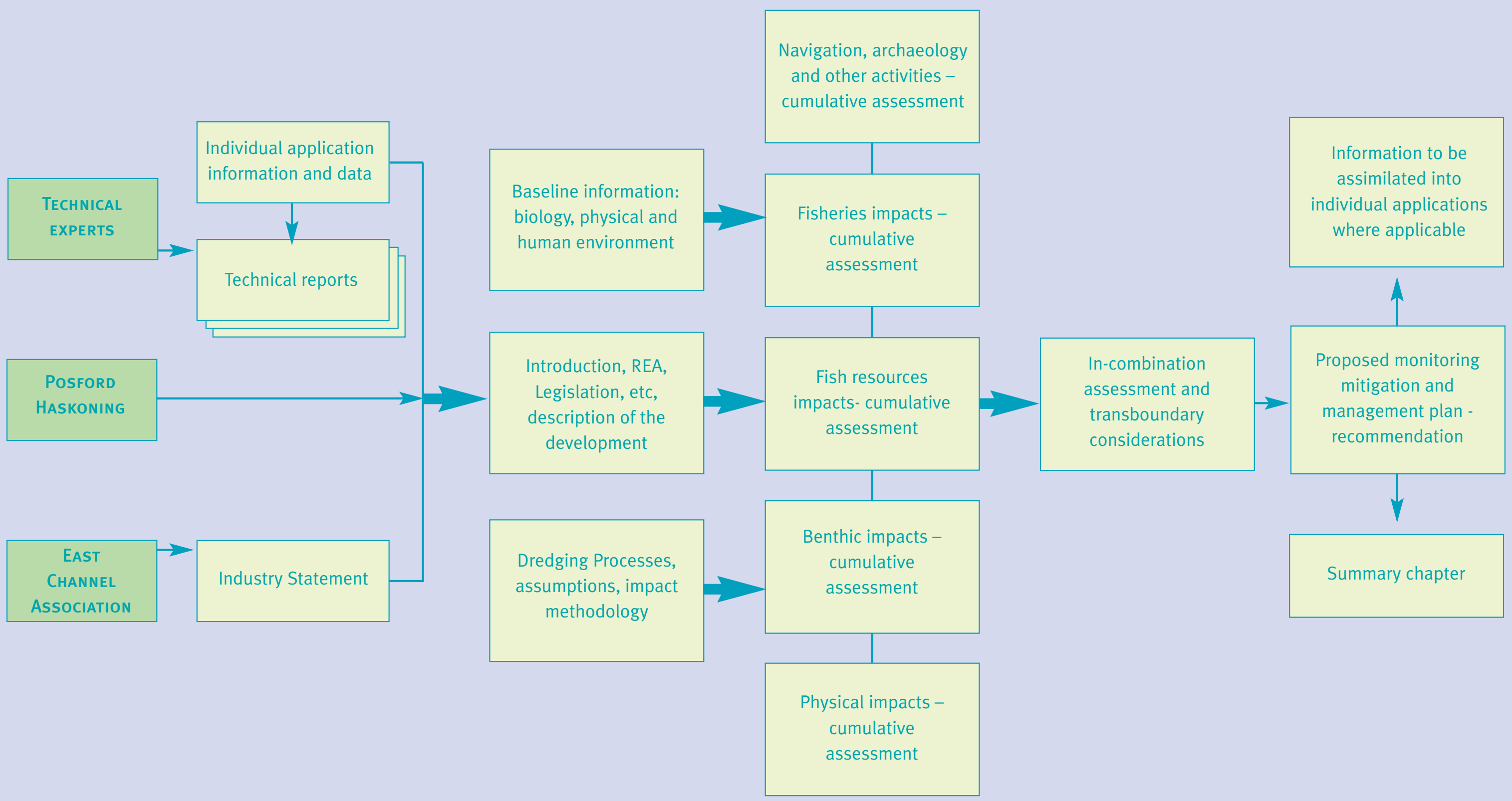
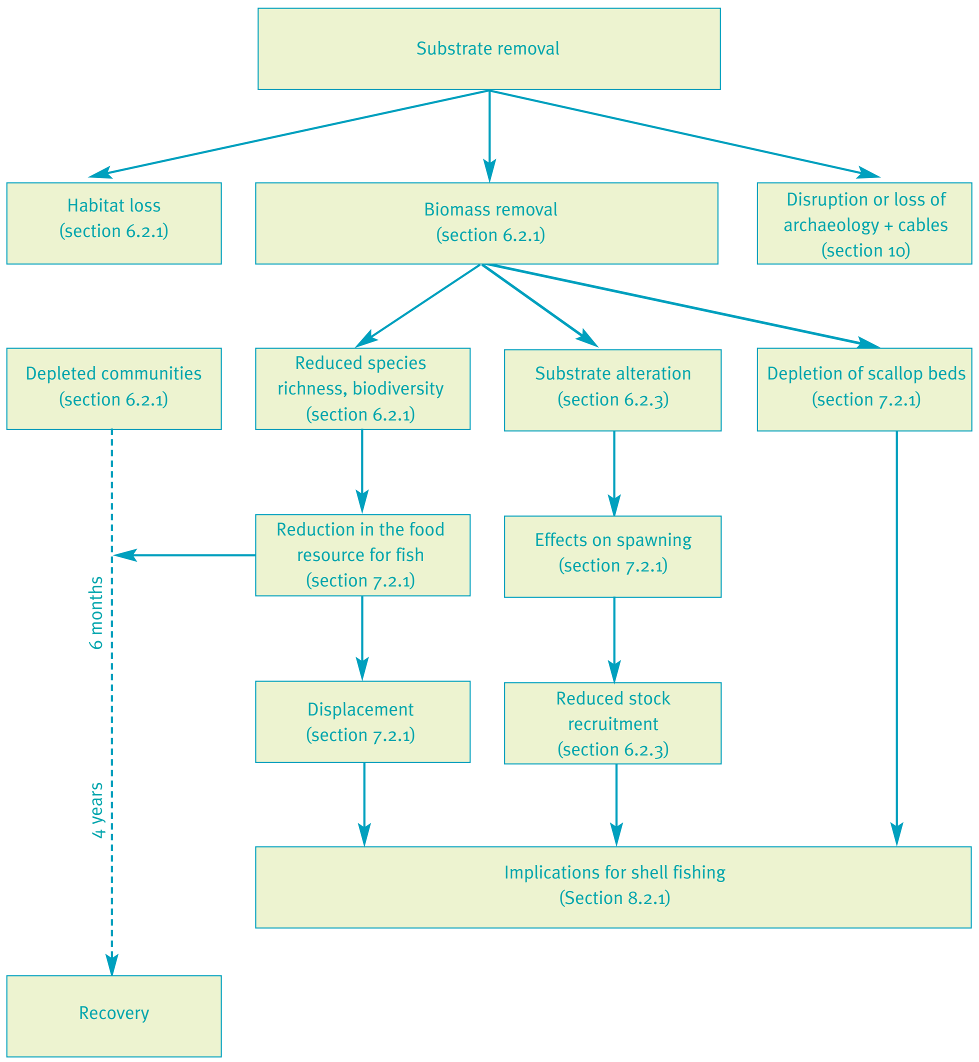


Figure 2.2 Implications of substrate removal



The workshop consisted of a series of presentations from the ECA, Posford Haskoning and the specialist team, followed by breakout groups, which discussed the following subject areas:

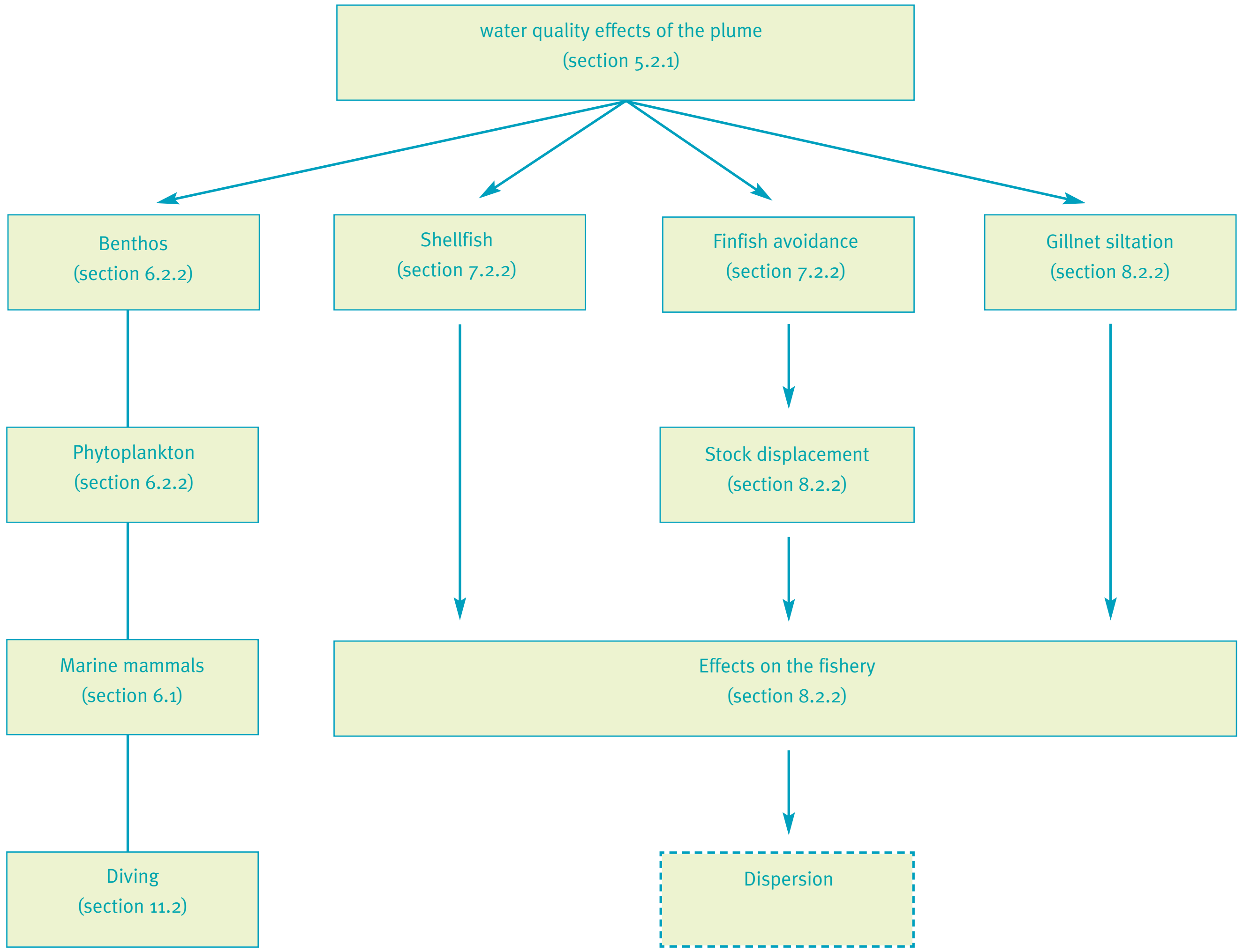
- REA objectives and process;
- Benthic biological resources;
- Fishery resources and fishing activity;
- Geology, sediment transport and coastal processes; and
- Shipping and navigation.

The key conclusions of the Technical Workshop are included in Appendix 2. A series of objectives were suggested at the workshop which are listed in Appendix 2, these have been revised and summarised to provide the five key objectives listed in Section 2.2.

2.4.4
GIS Database

The MapInfo GIS database has been set up as part of the REA to store, update, analyse and integrate the data collated on the physical, human and biological environment. A catalogue of metadata ('data about data') has also been created. This includes information on the owner; format; date of creation; copyright; availability; accuracy; errors; contact person and source of the data.

Figure 2.3 Influences of the plume on water quality



2.5 Structure of this Report

The REA, as set out below, provides the background to the proposed developments, the proposed dredging plans and describes the existing environment. The potential regional/cumulative and transboundary effects of the plans on the existing environment are discussed, and the proposed mitigation and monitoring proposals identified.

Chapter 1
Introduction and Background
Introduces the concept and context of the REA

Chapter 2
The Regional Environmental Assessment:
Purpose and Process
Provides information on the REA objectives and approach

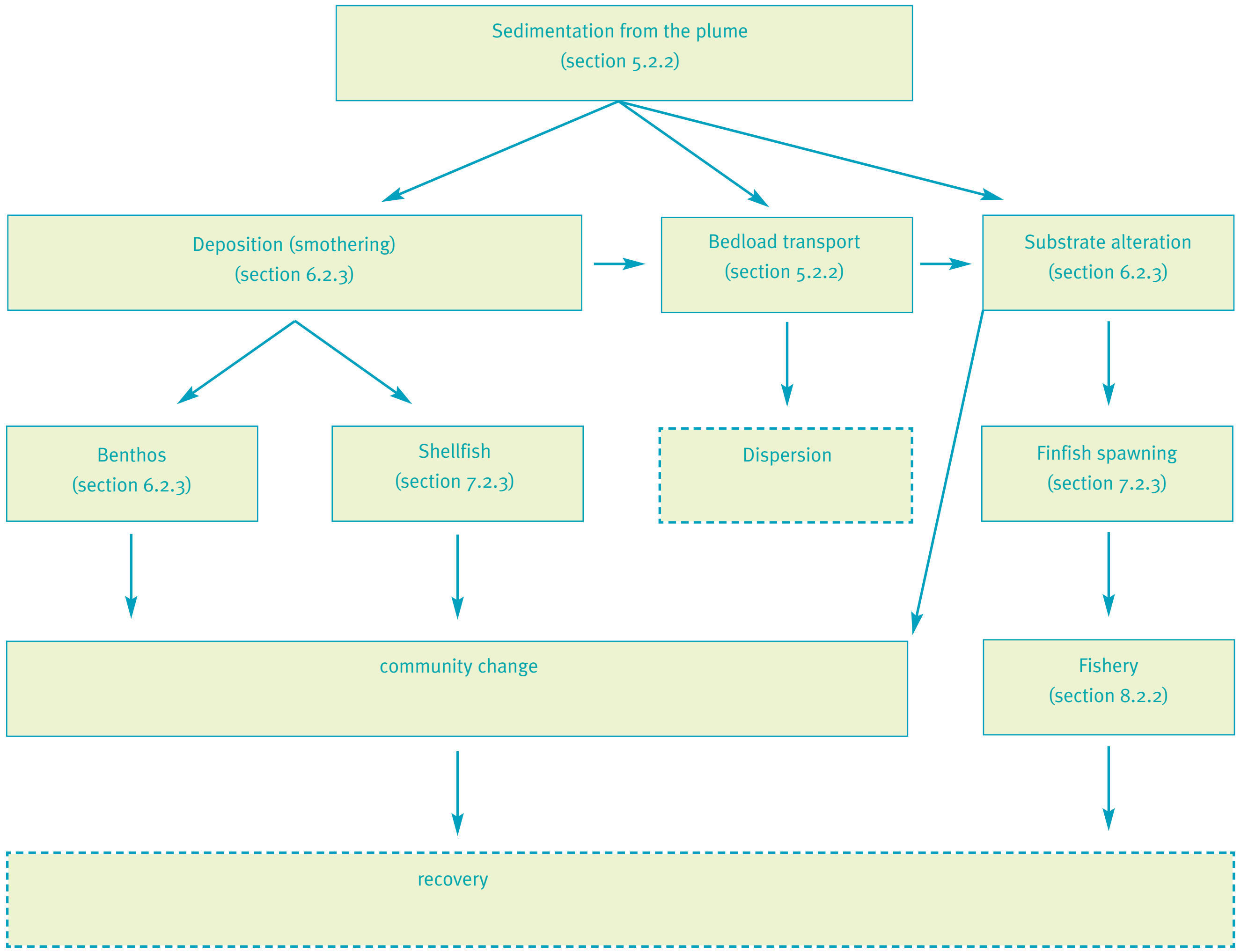
Chapter 3
Basis for the Assessment
Sets out the impact assessment assumptions and assessment methodology

Chapter 4
Overview of the East Channel Region
Provides a regional overview of the existing physical, biological and human environment (i.e. the baseline environment) in the ECR

Chapter 5
Effects of Dredging on the Physical Environment
Considers the cumulative implications of dredging in the ECR on the geological resource and coastal processes, potentially affecting suspended sediment levels in the water column, the seabed and waves and currents.

Chapters 6-7
Potential Regional Effects on Biological Resources
Given the predicted influence at the works on the physical environment, potential impacts on the regional biological resource are considered (particularly benthic ecology, fish and shellfish).

Figure 2.4 Implications of sedimentation



Chapters 8-11
Potential Regional Effects on
Human Activities
Setting out the potential cumulative implications of the works on fishing, navigation, archaeology and other activities.

Chapter 12
In-combination and Transboundary Effects
Assessment of the potential in-combination effects of the proposed dredging activities with other activities and uses in the region on biological and human resources.

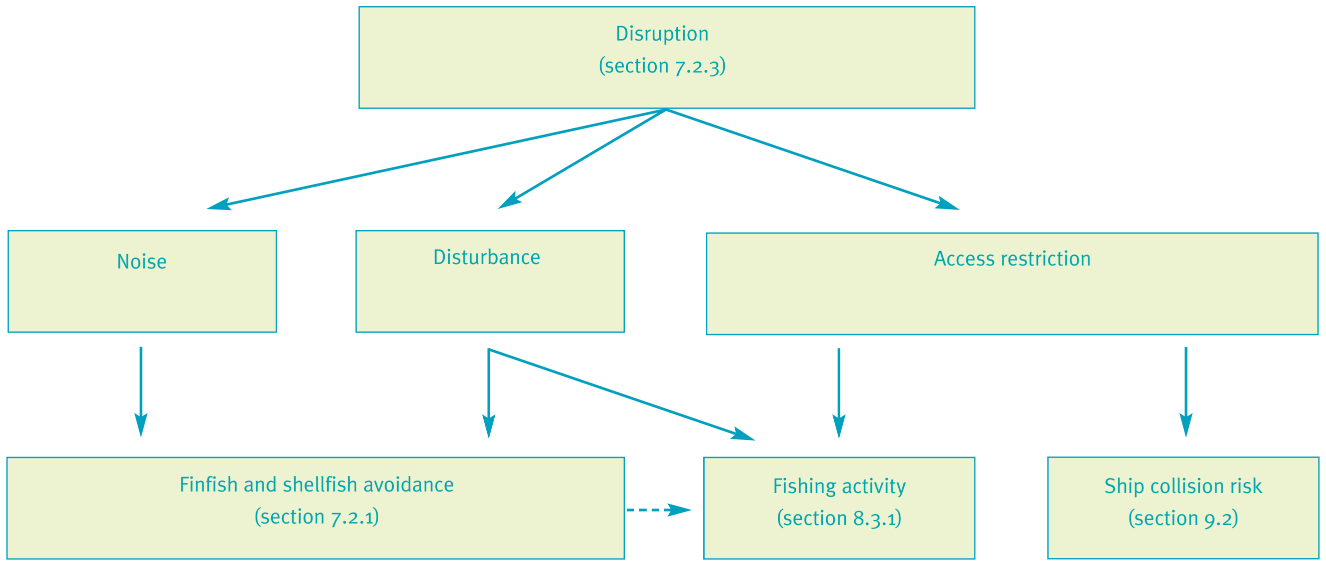
Chapter 13
Conclusion: Mitigation, Monitoring and Regional Management
Providing a summary of impacts and proposed mitigation, in conjunction with a monitoring and management plan.

The key effects arising from dredging activity and its influence on the physical environment considered in the REA include:

- substrate removal;
- the influence of the plume on water quality;
- sedimentation from the plume (deposition and transport); and
- noise, disturbance and disruption to other activities.

Each of these effects (described in Chapters 3 and 5) has the potential to influence a number of biological and human activities that characterise the ECR (see Chapter 4). Figures 2.2 to 2.5 illustrate some of the possible implications considered in Chapters 6 to 11 with a view to demonstrating their likely significance given aggregate extraction at a number of sites in the ECR.

Figure 2.5 Consequences of disruption



3 Basis for the Assessment

3.1 Introduction

This chapter sets out the basis for the assessment of impacts. A number of assumptions have been made in order to establish the assessment methodology for the extraction of aggregates across the region. Key considerations in determining the potential influence of the dredging on the biological resources and human activity within the ECR (discussed below) include dredging processes, proposed dredging activity (time and space) and production levels. A summary of key assessment assumptions is provided at the end of the chapter.

3.2 The East Channel Region – Geographical Boundaries

For the purposes of this study, the ECR is defined as the area of the eastern Channel encompassing the prospecting areas and including all intervening areas (1132km^2), as shown on Figure 3.1. The ECR is situated within the Channel Traffic Separation Scheme (TSS), a system of navigational lanes and separation zones which manages the high volume of shipping traffic through the Dover Straits. The TSS consists of a southwest-bound shipping lane, a northeast-bound shipping lane and a separation zone in between. The application areas are situated within both the shipping lanes and the separation zone.

In order to make the assessment process manageable, within this study area, the potential effect of the proposed dredging on the resources and activities in the region have been separated based on parameters pertaining to the physical, biological and human environment. To that end, tides, waves and currents, benthos, fish and fishing activities, archaeology, shipping and navigation are all considered individually. Given this context and the dynamic nature of the marine environment, for the purposes of this assessment, the geographic study boundary for each parameter/activity has been separately defined and is discussed in the relevant sub-section of Chapter 4 (e.g. 4.2.1, 4.3.1, 4.4.1 etc.)

3.3 Dredging Processes

This section briefly describes the dredging process and proposed methods of marine aggregate extraction within the ECR.

Dredging is the process by which seabed sediments are extracted from the seabed and deposited into the vessel hold. A draghead, approximately 2 to 3m wide, is attached at the end of the dredging pipe, which is lowered to the seabed within a licensed dredging area. The dredging pipes are typically between 0.70 and 1m in diameter and vary in length up to approximately 85m. Aggregate dredgers use a centrifugal pump to lift sand and gravel from the seabed, together with seawater, which is deposited in a hopper of 5000 to 8000 tonnes capacity.

As the pump lifts sand, gravel and water from the seabed, the material is brought into the vessel's hopper, which is already full of seawater. A process of settling occurs in the hopper, with the larger particles sinking to the bottom and some fine sediment remaining in suspension. Excess water and fine sediments are decanted from the hopper as overflow back into the sea.

Generally there are two techniques used by the Applicants' fleets for sand and gravel extraction; trailer and static dredging.

3.3.1 Trailer Dredging

The Applicants intend to use trailer-suction hopper dredgers to extract the majority of aggregate from the ECR. This method of dredging involves the deployment of a suction pipe from a slowly moving vessel (trailing at approximately 1.5 knots). A drag head is trailed over the seabed and water and sediment is pumped up from the bed via the suction pipe.

This process is used for deposits forming extensive sheets and results in a series of 2 to 3m wide drag head tracks on the seabed. Each pass of the drag head typically removes 30 to 50cm of material which, after repeated passes, gradually deepens the seabed. It is anticipated that a range of resource thicknesses will be exploited in the ECR, ranging from 2m and potentially exceeding 6m locally.

3.3.2 Static Dredging

There may be limited opportunity for static dredging in the ECR by some companies. During static dredging, the vessel anchors or is dynamically positioned over a deposit and extracts material while stationary. This method is effective for working thick, localised reserves. Over time, a depression is created as the deposit is extracted, resulting in shallow seabed slopes. The same extraction equipment is used for static as for trailer dredging.

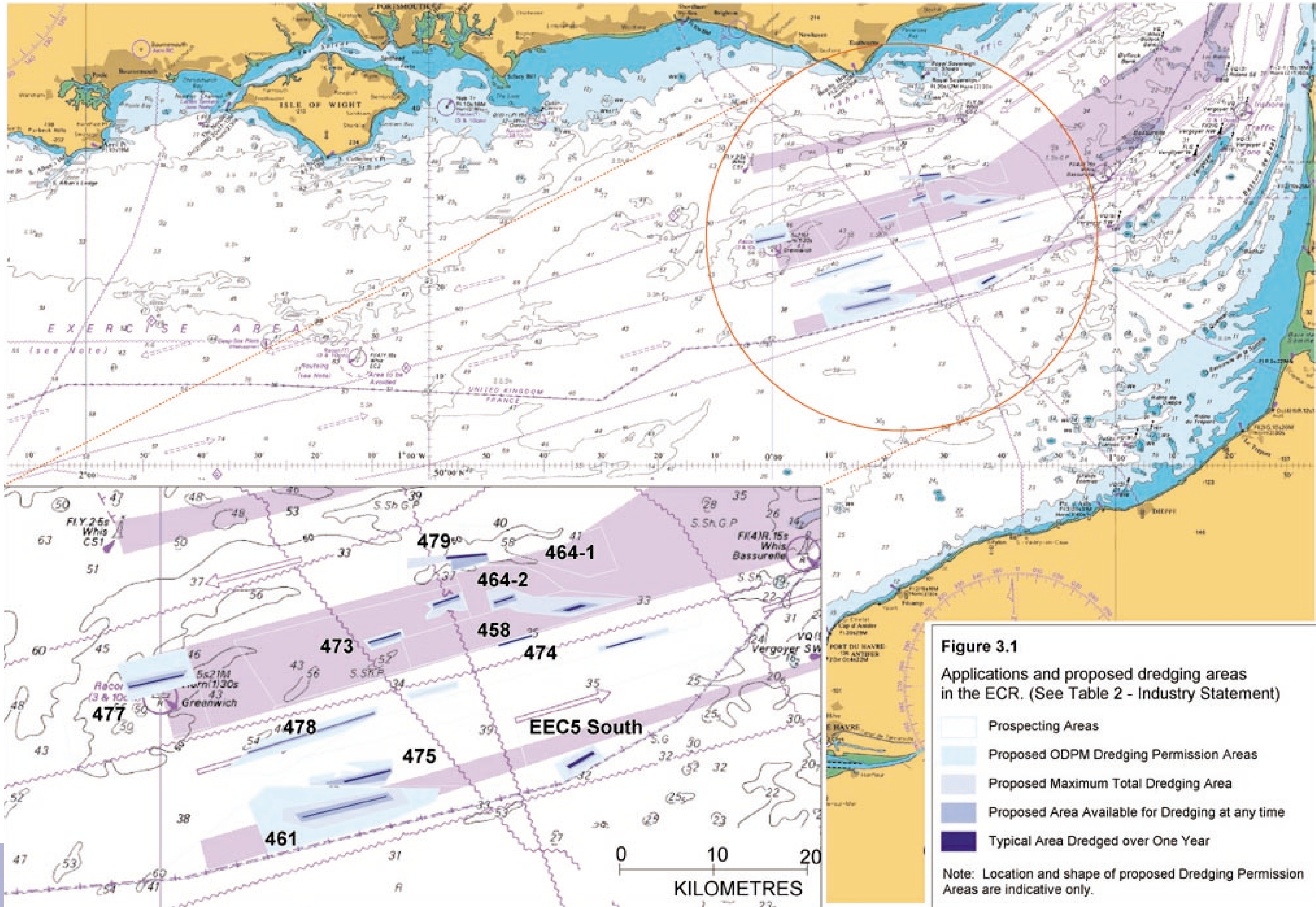


Figure 3.1

Applications and proposed dredging areas in the ECR. (See Table 2 - Industry Statement)

- Prospecting Areas
- Proposed ODPM Dredging Permission Areas
- Proposed Maximum Total Dredging Area
- Proposed Area Available for Dredging at any time
- Typical Area Dredged over One Year

Note: Location and shape of proposed Dredging Permission Areas are indicative only.

All proposed dredging areas in the ECR lie within the Channel Traffic Separation Scheme. It is envisaged that whilst trailer dredging would be permitted within the shipping lanes, should licences be issued, static dredging would only be permitted within the separation zone.

3.3.3
Screening

Screening, or the selective loading of sand or gravel by the dredger, will be required should dredging be permitted in the ECR. Screening is the process by which the proportion of gravel to sand in the cargo is adjusted to meet customer requirements. Varying quantities of sand are rejected overboard into the water column by screens located either in towers mounted on the vessel's side decks or over the hold as dredging is occurring. The required gravel to sand ratio for construction aggregates is typically between 50:50 and 60:40.

In the ECR, the proportion of sand in the resource varies, but is typically 55%. As a result, limited screening will be necessary. The amount of sand rejected back to the seabed to obtain customer material specifications compliant with market demand will average between 25 to 33% of the total volume of sand and gravel pumped per load.

3.3.4
Production Cycle

Should dredging be licensed in the East Channel, dredgers will normally be operating between the dredging areas and ports in South-East England and the near Continent. Daily extraction programmes will be determined to meet individual market and customer demand. Typically dredgers will load on the licensed dredging area, steam to the customer wharf, discharge the cargo and steam out again. Loading times are discussed in Section 3.4.1.

3.3.5
Dredging Zones

Companies generally manage licensed areas by creating operational dredging zones. For the purposes of this assessment, a typical operational dredging zone in the ECR will be 3km long by 250m wide (see Figure 6.2). The actual size may vary between dredging companies.

3.4
Defining Impact Criteria for the ECR

3.4.1
Dredging Activity and Production Levels

Assessment of the potential effects associated with the dredging proposals in the ECR requires a clear understanding of the scale of the development. Three key elements of the activity of dredging need to be considered:

1. production levels, i.e. tonnage to be extracted;
2. the time element, i.e. individual cargo loading time;
3. the spatial element, i.e. area actively being dredged.

Table 3.1 Predicted Production Levels in the ECR

Production Level	Tonnage Dredged (Mtpa)	Tonnage Dredged (Mt over 15 years)
Estimated Level	8.5	127.5
Upper Level	17	255

1. Production levels - the proposed tonnage to be dredged

The Industry Statement considers three theoretical levels of production. A realistic level of extraction has been estimated to be 8.5 million tonnes per annum (Mtpa) from the ECR, consistent with current market requirements. The Regional Environmental Assessment has been undertaken for this proposed level of production. In addition, consideration has been given to a higher level of production, 17Mtpa which is 50% of the total application tonnage. Annual extraction in the ECR is anticipated to build rapidly in the first 2 to 4 years to around 8.5Mt. It is envisaged that after the initial five year period of extraction, the offtake could increase by up to 50% (3 to 5Mtpa) to total 11.5 to 13.5Mtpa, as reserves in existing licence areas continue to decline (Table 3.1).

2. Temporal Extent of Dredging Activities – total time/occupancy of dredgers in the ECR

Aggregate extraction production levels are directly related to licence occupancy (time spent on the licences by dredgers) and influence the dredged area.

Applications for dredging permissions are being developed by individual companies. Daily operations by individual companies creates the potential for several possible occupancy scenarios over the region. Scheduling may result in dredging taking place on more than one licence across the region at the same time; alternatively dredging may only occur on a single licence in the region at any one time or dredging may not be taking place in the region at all. Furthermore, production levels and dredging areas will potentially change from year to year.

Consequently, if dredging effects are to be understood and mitigated, it is necessary to define the proposed activity in the ECR in terms of the assumed levels of production and the assumed temporal and spatial extent of the activities, as follows.

Table 3.2 Dredging activity in the ECR at differing annual production rates

Dredging Activity	8.5Mtpa	17Mtpa
Average dredger capacity	5000 t	5000 t
Average loading time	6 hrs	6 hrs
Average number of cargoes	1700 p.a.	3400 p.a.
Total loading time	10200 hrs	20400 hrs
Total dredging time per day	27.9 hrs	55.9 hrs
Number of dredging licences	10	10
Cargoes per day	4.7	9.3
Total dredging time per week	196.2 hrs	392.3 hrs
Cargoes per week	32.7	65.4

Note: this table is based on use of the smallest dredgers likely to operate in the ECR. At 17Mtpa using larger vessels (i.e. 8000t), for example, occupancy will be reduced by approximately 40%

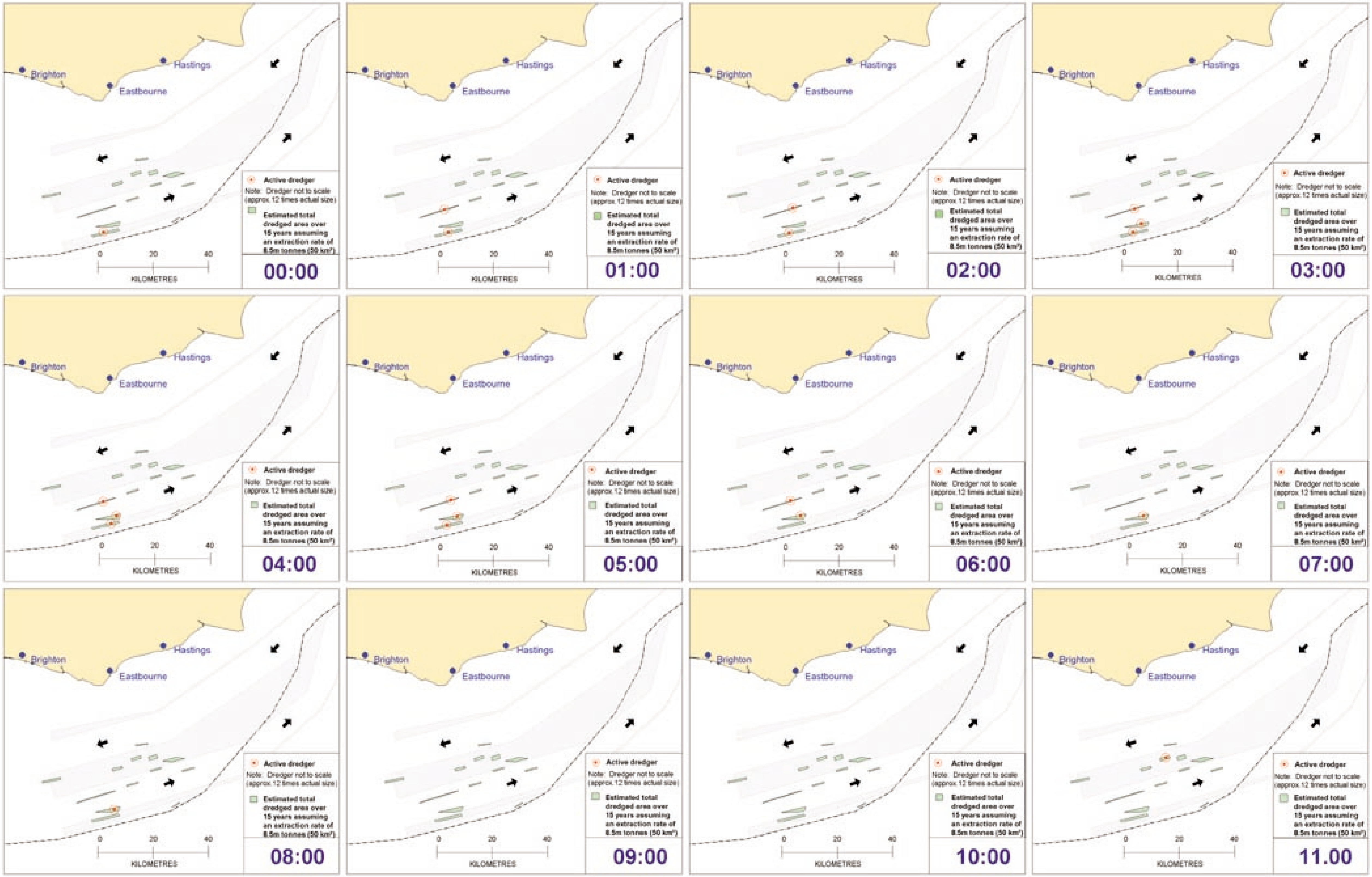
Table 3.3 Predicted dredger occupancy across the ECR at differing production rates

PREDICTED OCCUPANCY LEVELS IN THE ECR

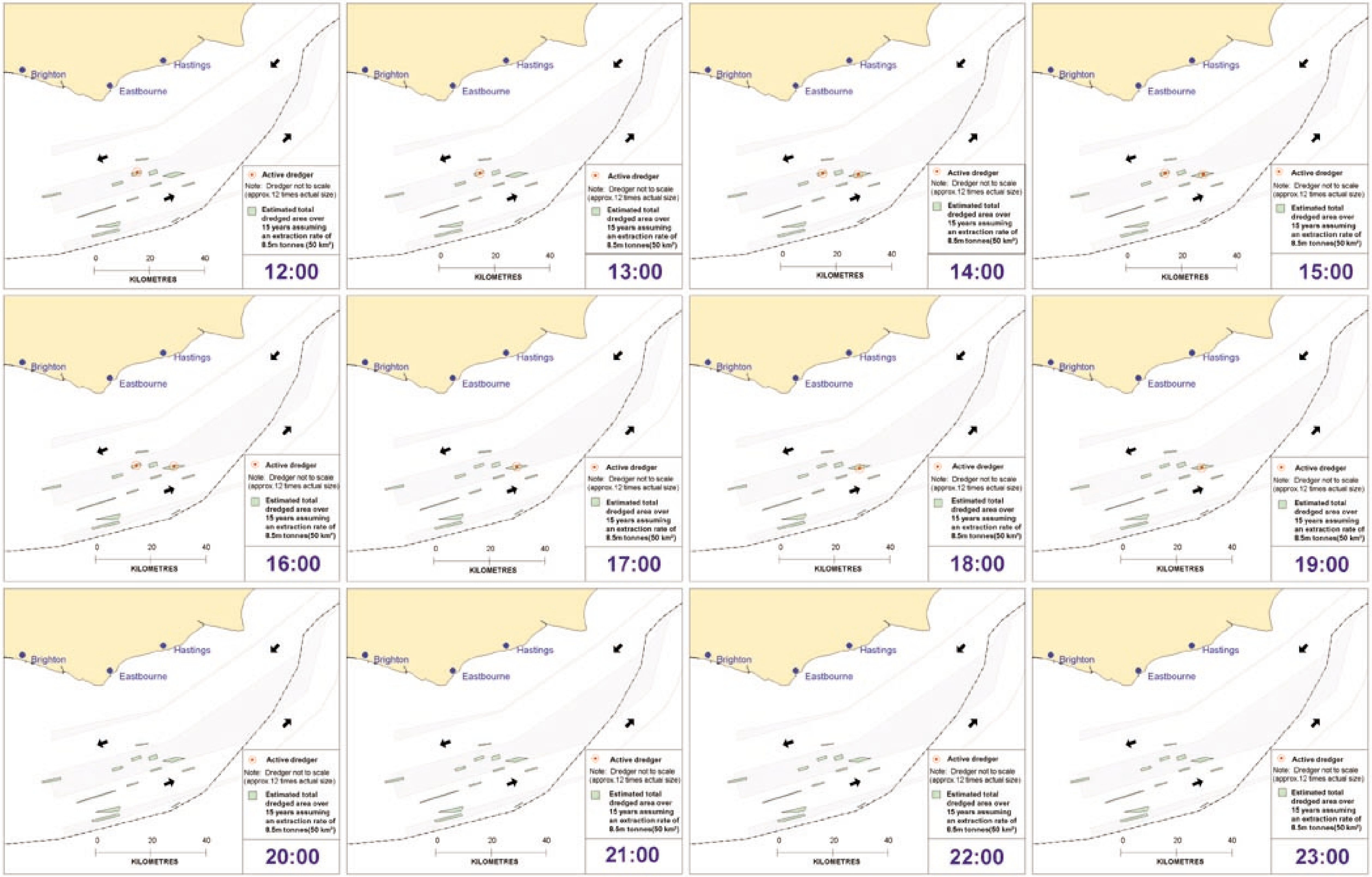
Production level	Licence occupancy across the region per day			
	Number of dredgers	Concurrently	Typically	Consecutively
Estimated (8.5Mtpa)	5 per day	6hrs	18hrs	24hrs
Upper (17Mtpa)	10 per day	6hrs	22hrs	24hrs

To calculate occupancy of dredgers in the ECR, two assumptions have been made: firstly, each cargo takes about 6 hrs to load and, secondly, the average capacity of a dredger is assumed to be 5000 tonnes. The average time and likely licence occupancy of the dredgers in the ECR has therefore been calculated for each production scenario, as shown in Table 3.2.

Dredging at 8.5Mtpa therefore equates to an average of 4 to 5 cargoes per day from areas across the region that may be dredged concurrently (6 hours of dredging), consecutively (24 hours of dredging) or, more likely, in any overlapping combination (between 6 and 24 hours). Production at 17Mtpa will result in 9 to 10 cargoes per day (on average) from areas across the region, which also may be dredged concurrently, consecutively or in any overlapping combination between (Table 3.3).
A typical day of dredging operations in the ECR is depicted in Figure 3.2a and b for an estimated annual production scenario of 8.5Mt. The 24-hour period has been divided into hourly snapshots to give an indication of



3.2a Dredger occupancy in the proposed dredging areas (50km²) of the ECR during a typical day (24hrs). This assumes production at 8.5Mtpa. Note that there is a dredger in the ECR for 18 hours of the day and up to 3 dredgers are present in the ECR (an area of around 1000km²) concurrently. When dredging concurrently, dredgers are often >5-10km apart. Note: Estimated total dredged area is explained in 3.4.1, No.3.



3.2b Dredger occupancy in the proposed dredging areas ($50km^2$) of the ECR during a typical day (24hrs). This assumes production at 8.5Mtpa. Note that there is a dredger in the ECR for 18 hours of the day and up to 3 dredgers are present in the ECR (an area of around $1000km^2$) concurrently. When dredging concurrently, dredgers are often >5-10km apart. Note: Estimated total dredged area is explained in 3.4.1, No.3.

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likely dredger occupancy in the ECR. Based on the assumptions in Table 3.3, this figure indicates that:

- an average of 5 dredgers will operate each day in the ECR;
- each dredger will load for 6 hours;
- a 6-hour interval will occur without any dredging activity;
- dredgers operating simultaneously could be separated by more than 10km;
- where dredging areas are in close proximity, it is still likely that dredgers will be separated by 5km;
- within the separation zone of the Traffic Separation Scheme, there will periods when no dredging activity is occurring; and
- within the total area of the ECR (1,132km²), on average 3 dredgers could operate simultaneously.

At an annual extraction rate of 17Mt, it is likely that there will be activity in the ECR for most of the time (approximately 22 hours per day). However, dredgers will still operate at greater than 5km apart and, typically, at a distance of 10km. It is predicted that 10 dredgers will operate daily in the ECR at a production level of 17Mtpa. However, in the future dredgers may be larger, reducing occupancy significantly.

3. Spatial extent of the extraction – total area and location of dredged seabed

The positions of the proposed Dredging Permission Areas within the original Prospecting Areas are indicated on Figure 3.3. Dredging is planned to occur in an area that is substantially smaller in size than the proposed ODPM Permission Areas (as set out in the Industry Statement); the proposed ODPM Permission Areas allow for variability within the sand and gravel deposits.

In order to undertake the regional impact assessment, a realistic area of impact has been determined. Table 3.4 illustrates the assumptions made in defining the impact area. Assuming a production level of 8.5Mtpa, that resources averaging 2m thick are dredged and that companies follow agreed practice, the total dredged area is estimated to be 50km² over 15 years (see Figure 3.4). Production of 17Mtpa from resources 2m thick will result in a dredged area of 100km² over the same period (see Figure 3.5). However, if thicker resources are dredged then the area dredged will be reduced.

Direct sea bed impacts will arise within the dredged areas detailed above. Indirect impacts, that is areas subjected to sedimentation arising from discharges from dredging vessels and subsequent seabed sediment transport (see Chapter 5), will also arise and are therefore considered in the REA.

3.4.2 Impact Assumptions for the REA

Both the temporal and spatial elements of the proposed dredging operations in the ECR have been incorporated into the assessment of likely cumulative impacts as follows.

Area

Taking into account the proposed spatial element of the dredging activity and customer quality requirements, based on the extraction of 8.5Mtpa, the realistic area of direct dredging impact is predicted to be **50km²** over 15 years (see Figure 3.4).

Consideration is also given to the larger figure of 100km², which is assumed to be the predicted area to be directly impacted by dredging should demand increase significantly to 17Mtpa. It should be reiterated that 8.5 million tonnes per annum is the current annual extraction level expected by the ECA (full details are provided in the Industry Statement).

Table 3.4 Relationship between production rates, volumes to be dredged, thickness of reserves and area dredged in the ECR

Tonnage Dredged p.a. (Mt)	Total Tonnage dredged over 15 years (Mt)	Total Volume (Mm³)	Total Volume + 33% for screening (Mm³)	Area Dredged over 15 years: 1m thick reserves	2m thick reserves	3m thick reserves	4m thick reserves
8.5	127.5	75	100	100km²	50km²	33.3km²	25km²
17.0	255	150	200	200km²	100km²	66.6km²	50km²

Assumptions

- 50km² over 15 years
- 18 hours occupancy
- 8.5 Mtpa

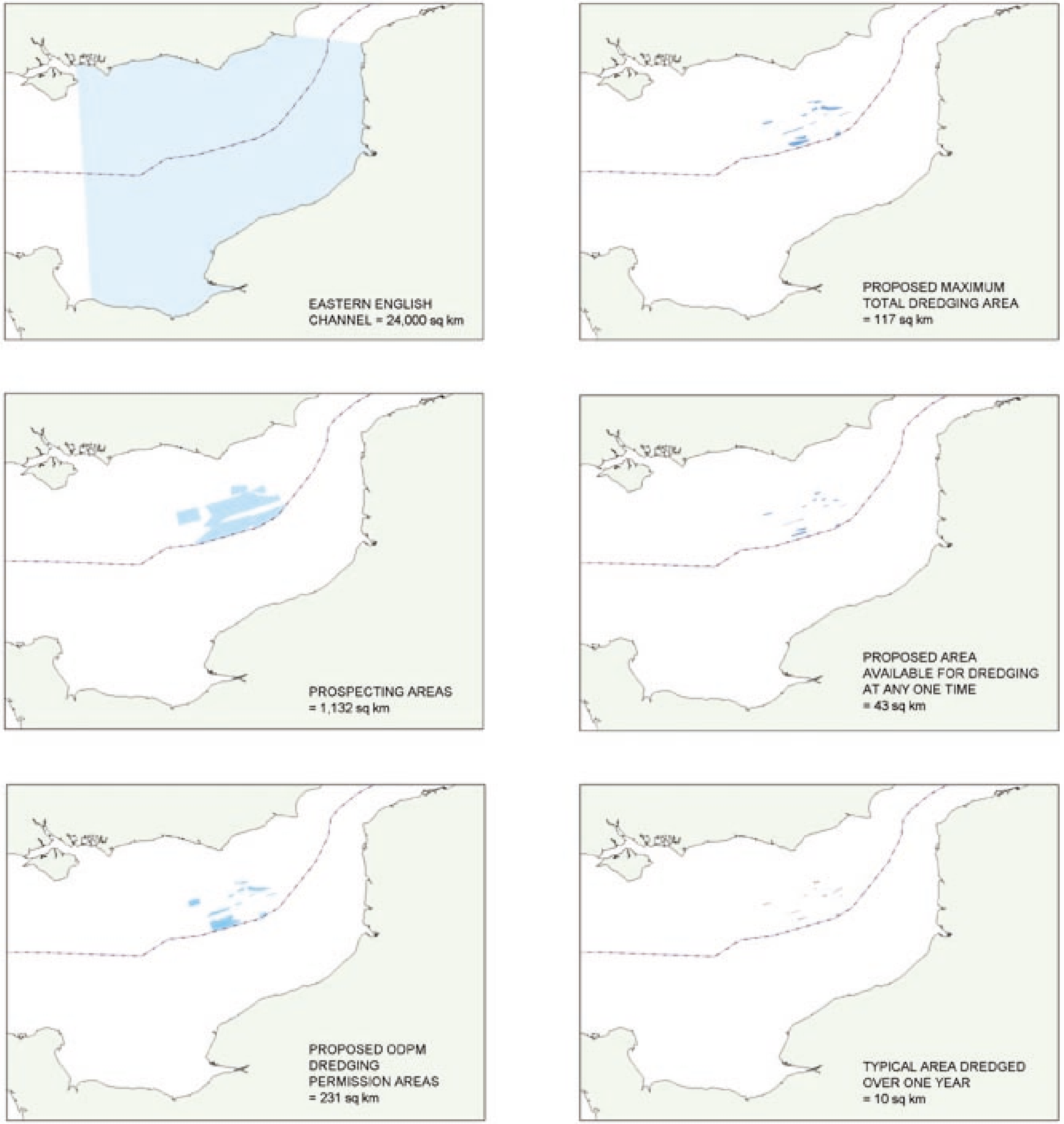
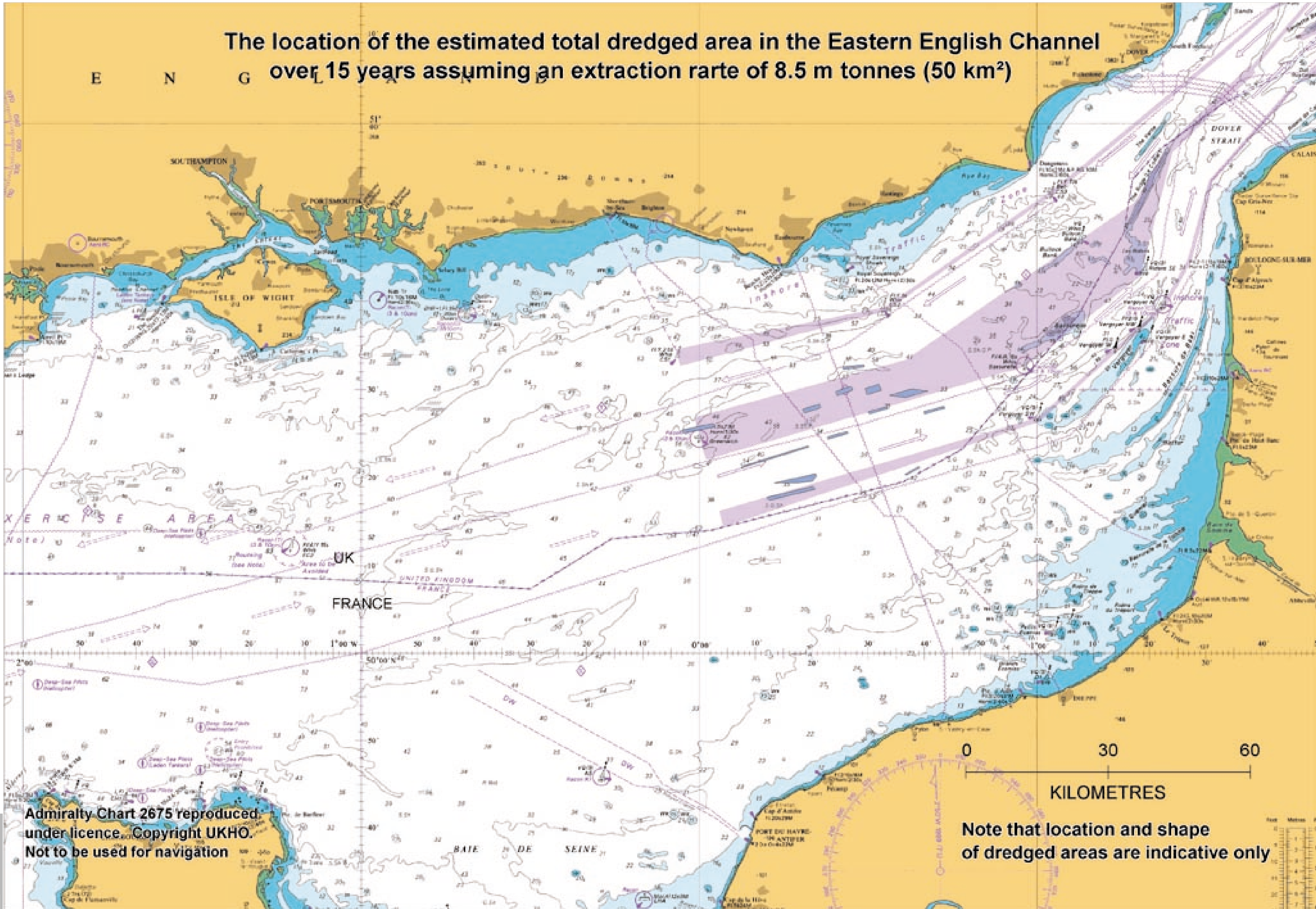


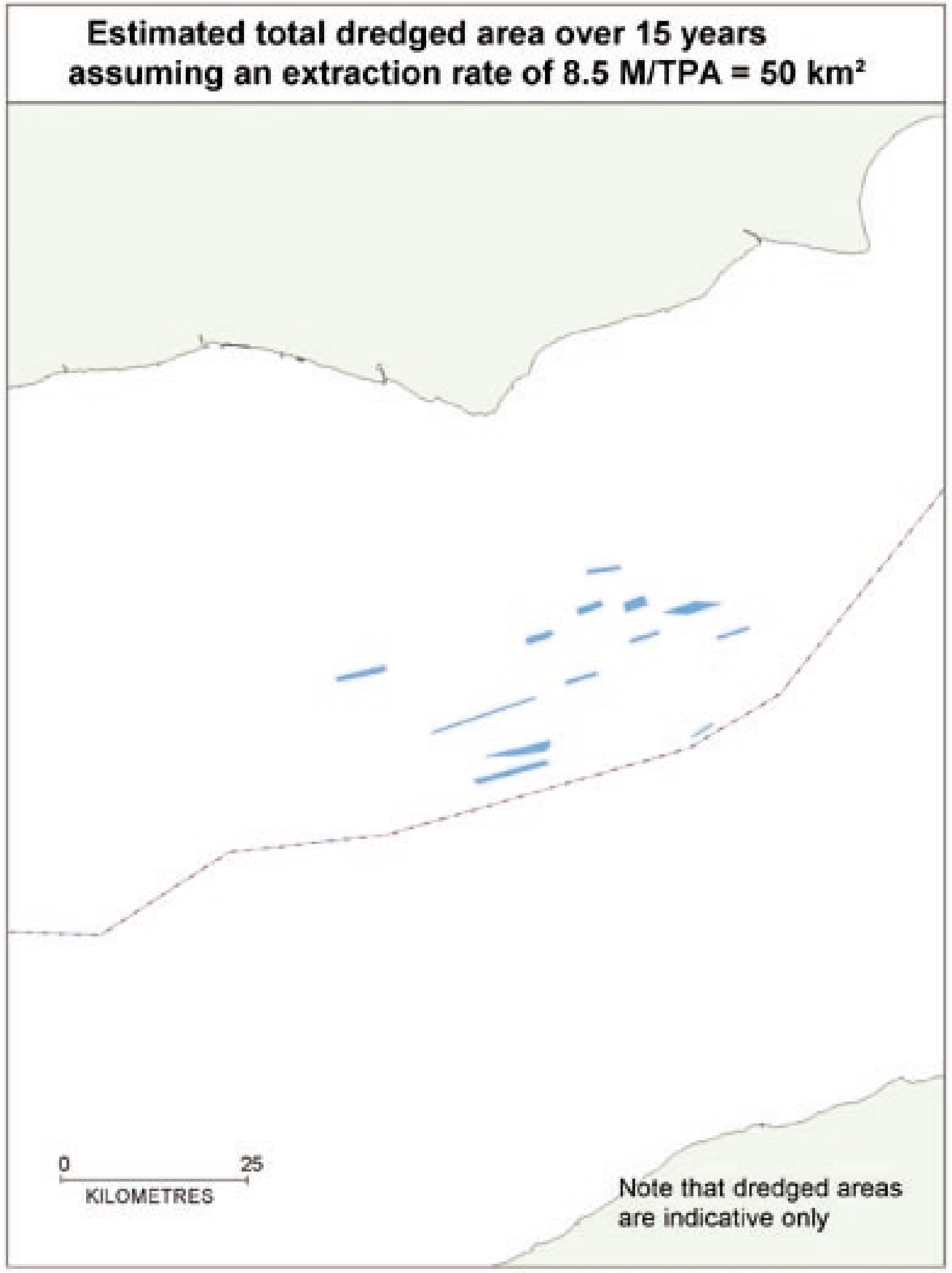
Figure 3.3

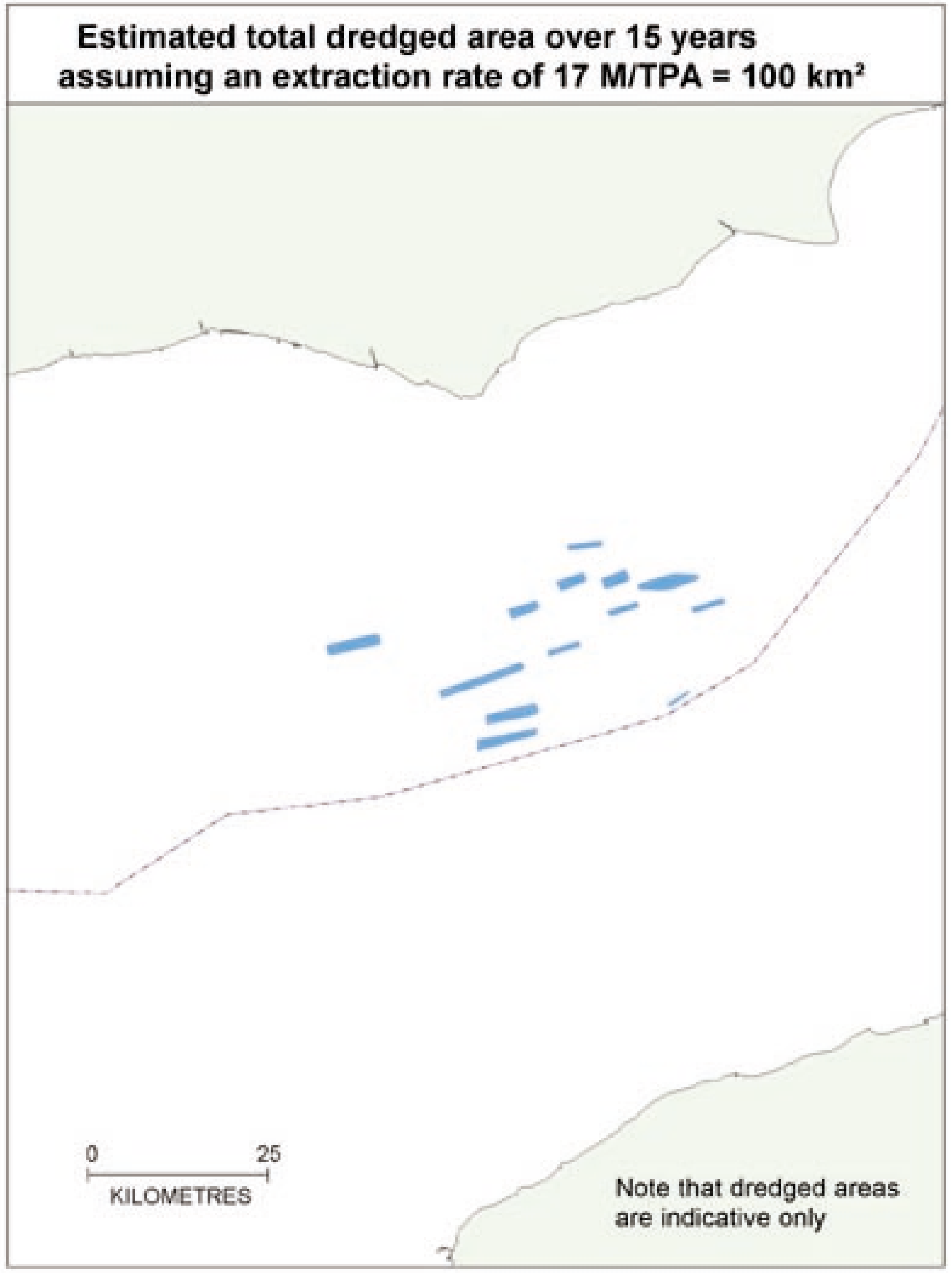
Applications and proposed dredging areas in the ECR (see industry statement)

Note: Locations and shape of proposed Dredging Permission Areas are indicative only.



3.4 Location of estimated total dredged area over 15 years assuming an extraction rate of 8.5Mtpa (see Industry Statement).





3.5 Estimated total dredged area over 15 years as considered in the REA (a) 8.5Mtpa = 50km², (b) 17Mtpa = 100km².

Occupancy

A predicted average daily occupancy has been estimated based on annual tonnage requirements and cycling times for dredgers between ports and the ECR. This is based on the assumption that there will be some overlap of dredger occupancy in the ECR and that at times there will be no dredgers present in the ECR. The predicted likely temporal component of the dredging operations has been predicted to be 18 hours of occupation per 24-hour period. For the higher extraction rate of 17 million tonnes per annum, 22 hour occupation is predicted per 24-hour period.

The proposed dredging permission areas are on average 10km apart. Therefore, although dredgers may be operating simultaneously within the ECR, an average distance between dredgers of 10km has been assumed.

3.5 Assessing Regional Impacts

3.5.1 Significance Criteria

As far as possible, an attempt has been made to define the significance of each potential effect identified. A number of criteria have been incorporated into the determination of the significance of impacts. These criteria have been utilised in the REA to assess the significance of the potential effects and are defined as follows:

- Magnitude (scale);
- Spatial extent (local/regional, km^2);
- Duration (short/long term);
- Value (of conservation significance or rare);
- Sensitivity/Recoverability (level of tolerance/likelihood of recoverability);
- Probability of the occurrence of the effect;
- Confidence in the prediction (the level of uncertainty); and
- The margins by which set values are exceeded where appropriate (e.g. water quality standards).

Table 3.5 Impact significance levels and criteria

Significance level	Major	Moderate	Minor	Negligible
Relevant factor				
Scale (magnitude)	Large	Medium	Small	Local
Extent	English Channel	Local to Regional (from 5km away from a dredging zone to the ECR)[1]	Highly localised (within 5km of a dredging zone)	At source (i.e. point of impact only)
Duration	Long term (over 10 years)	Medium term (5 to 10 years)	Temporary (less than 1 year)	One off or a few days/hours
Conservation	Of conservation significance/ nationally rare	Of conservation significance/ regionally rare	No conservation significance/ common	No conservation significance
Tolerance	Low tolerance to change	Medium tolerance/ Adaptable to change over time	High tolerance/ Adaptable to change	Opportunistic species
Standards	Exceeds accepted standards	May be above accepted standards	Within accepted standards	Within accepted standards
Recoverability	Low recovery rate	Partial recovery likely or medium recovery rate	Rapid recovery to accepted standards	Rapid recovery

[1] An impact of 'moderate significance' could potentially cover a wide range of spatial extents, that is, from 5km to 1000km^2. Therefore, where an impact is determined to be of moderate significance its extent could range from local to the whole ECR but could be influenced by the significance of other factors (e.g. tolerance).

For the purposes of the REA the levels of impact significance (and corresponding significance criteria) set out in Table 3.5 have been identified (the examples provided are indicative rather than absolute):

This approach is used to assess the potential effects of the combined dredging proposals on the baseline environment. Where adverse impacts are identified, mitigation measures are proposed and relevant monitoring requirements discussed. Where possible, residual effects are then quantified.

3.5.2
Data Gaps and Uncertainty

A substantial amount of survey data has been gathered from the ECR for individual dredging applications. This includes data on the geophysical, biological and human environments. The consistency of the data across the region is of particular significance to this assessment. The ECR is possibly the most intensively surveyed area of the English continental shelf.

Despite the volume and quality of the data obtained, as with all EIAs, an element of uncertainty is associated with this assessment. No region with a similar environment to the ECR has ever been subject to marine aggregate extraction.

Although both the nature of the resource and the 'typical' response of the marine environment to dredging is known (in terms of the likely duration of recovery etc.) the response of the habitat in this circumstance cannot be predicted with absolute certainty. For example, the exact nature of the interaction of the plume with the benthic resource is unknown.

This assessment, however, is based on extensive experience of dredging elsewhere, up to date scientific knowledge and reasoned assumptions. Where present, any uncertainty or data gaps are clearly outlined. Recommendations for monitoring set out within the REA are therefore crucial to validate and quantify the assumptions made in this assessment.

3.6
Summary of Impact Assumptions

Based on the description of the dredging process described in the Industry Statement and discussed above, the assumptions used in this impact assessment are set out in the box below.

Estimated production level:	8.5Mtpa (to 17Mtpa)
Dredging to a depth of:	2m (to > 4m) below the seabed
Area dredged after 15 years:	50km² (to 100km²)
Maximum Active dredging area in each licence at any one time:	2 to 10km²
Typical area dredged across the ECR over one year:	10km²
Typical operational dredging zone:	3km long by 250m wide
Typical duration of activity within one dredging zone:	1 to 3 years
Screening:	25 to 33% of the total pumped volume
Average cargos/occupancy in the ECR per day:	4 to 5 dredgers
Dredger occupancy In ECR per day:	6 to 24 hours (18 assumed)
Typical simultaneous operation:	3 dredgers

(Note that individual dredging zones may vary in shape).

4 Overview of The East Channel Region

4.1

Introduction

This section provides a regional overview of the existing conditions in the ECR relating to the physical, biological and human environment. Detailed descriptions of the baseline environment of the ECR are contained within the Technical Reports that support this REA.

4.2

Geology, Resources and Seabed Sediments

4.2.1

Introduction

The geological study (HR Wallingford & Evans Technical Report, 2002) describes the formation and character of the deposits of sand and gravel within the ECR, both on and below the surface of the seabed. This information has been used to provide a description of the potential marine aggregate resource in the ECR. The bedforms and grain-size of the surface sediments provide information on sediment transport through the region.

4.2.2

Geology

The majority of the ECR is underlain by very gently dipping lower Tertiary rocks, mostly clays, sandy clays and silts, which occupy the core of the Hampshire-Dieppe Basin (Hamblin *et al.* 1992). These rocks rarely crop out at seabed but where the overlying Quaternary sediments are thin, mud may be incorporated into them from the underlying bedrock. The bedrock is incised by a network of partly or wholly infilled channels of mid-Quaternary age. These channels, including the Northern Palaeovalley, were incised by rivers during Pleistocene cold stages when sea level fell to expose much of the English Channel as land (Hamblin *et al.* 1992).

The sediments infilling the channels display a complex seismic geometry that consists of multiple channel infills and sheet-like deposits. The red-brown colour associated with some of the gravelly deposits is an indication that the sediment experienced subaerial exposure during a period of lowered sea level. This implies that some if not all of the resource deposits were exposed during the last glacial maximum (about 18,000 years ago), and thus laid down before it. The compact and dense nature of some of the gravels may also be explained by the subaerial exposure.

4.2.3

Resources

Within the ECR, the main resource is the extensive sheet-like deposits formed predominantly of flint gravel locally interbedded with sand. The channel infills themselves are usually too deep to be an accessible resource. They have not been sampled by vibrocoring but their characteristics based on the seismic data suggest that they are less gravelly than the overlying sheet deposits.

The resource sheet is commonly between 5 to 10m thick and is very extensive. Both vibrocores and seismic profiles show the unit to exhibit vertical and lateral lithological variation. Where the sheet is very gravelly, the vibrocore has penetrated usually no more than about 2m, but where the sheet is sandier penetration may reach 6m. The most common sediment is a poorly sorted sandy gravel, with a gravel (mostly flint) content of 30 to 60% including minor proportions of cobbles. West of Areas 475 and 461, across Area 478 and locally elsewhere, some of these gravels, have a bright red-brown colour. Secondary sediment types include well-sorted fine-grained sand, medium to coarse-grained sand, well sorted gravel, and fine shell gravel. The sands covering much of the gravelly resource sheet in the eastern part of the region have a higher shell content than the underlying sediments. The shelly sands do not represent as important a resource as the underlying sandy gravels.

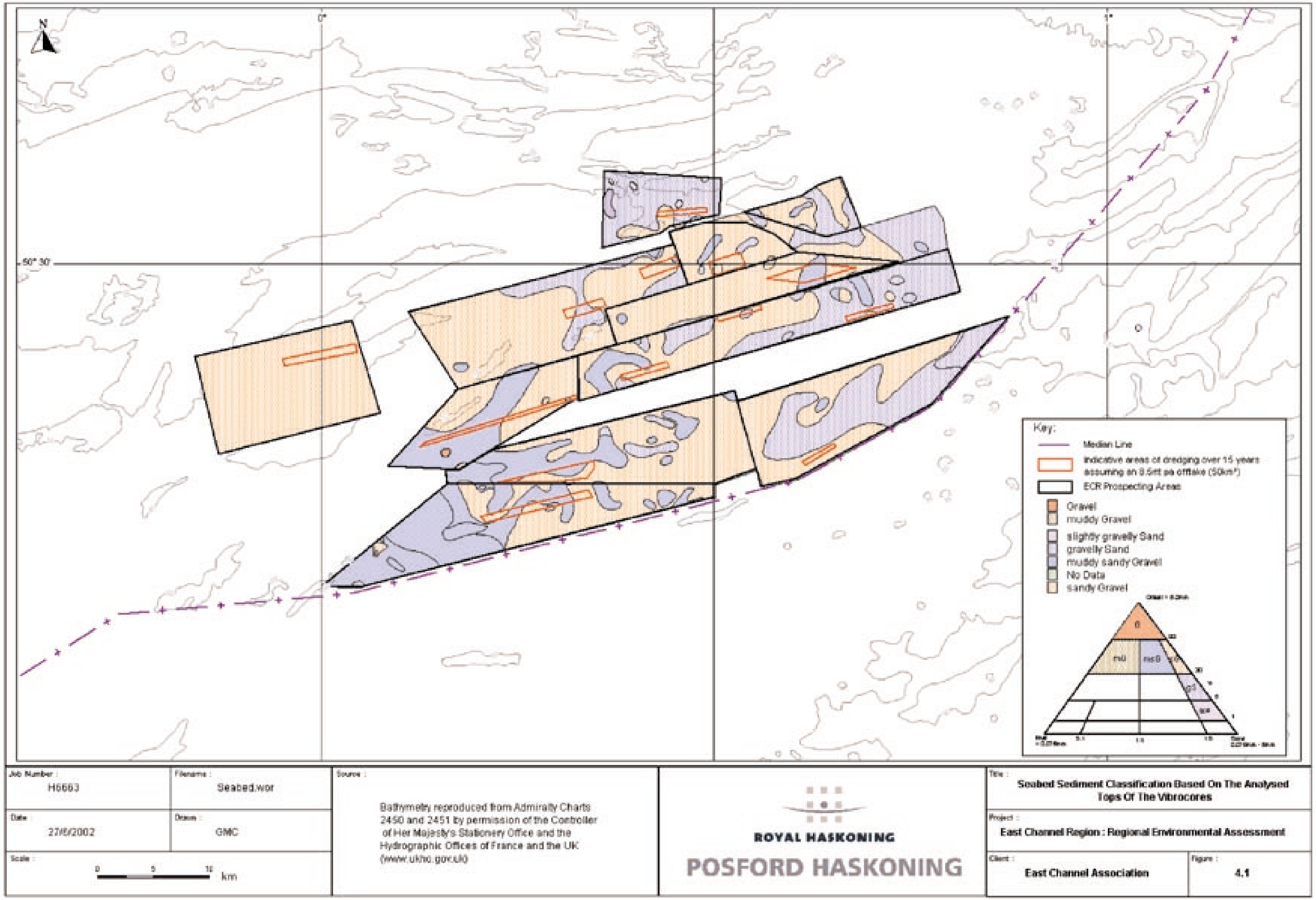
4.2.4

Seabed Sediments and Features

Composition

Figure 4.1 shows seabed sediments across the ECR based on analysed samples from the top of vibrocores (usually 0 to 40cm below seabed) collected during prospecting surveys across the region. In the western part of the ECR, seabed sediments consist primarily of sandy flint gravels, with extensive areas of the seabed covered by a gravel, a few centimetres thick, formed of broken and whole shells (Figure 4.1). The shell content of the sand within these sediments is variable and locally exceeds 40% but elsewhere is less than 5%. At the eastern limit of the ECR, and farther east, the seabed sediments are sandier, with gravelly sand predominating.

Where the seabed sediments (equivalent to marine Holocene sediments) are thin, the analysed vibrocore sample may include a proportion of both seabed sediment and the underlying more gravelly resource unit. Grab samples, which represent the top 10 to 15cm show that the bed sediments are less variable, and slightly sandier, than indicated by the top vibrocore samples (Figure 4.1).



4.1 Sea bed sediments in the ECR

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The d_{50} (median grain size) of the top samples varies across the ECR with values of <1mm common at the eastern limit of the ECR and values of 5 to 10mm common across the western part. This variability reflects the inclusion in the analysed sample of coarser underlying resource sediments with the seabed sediments.

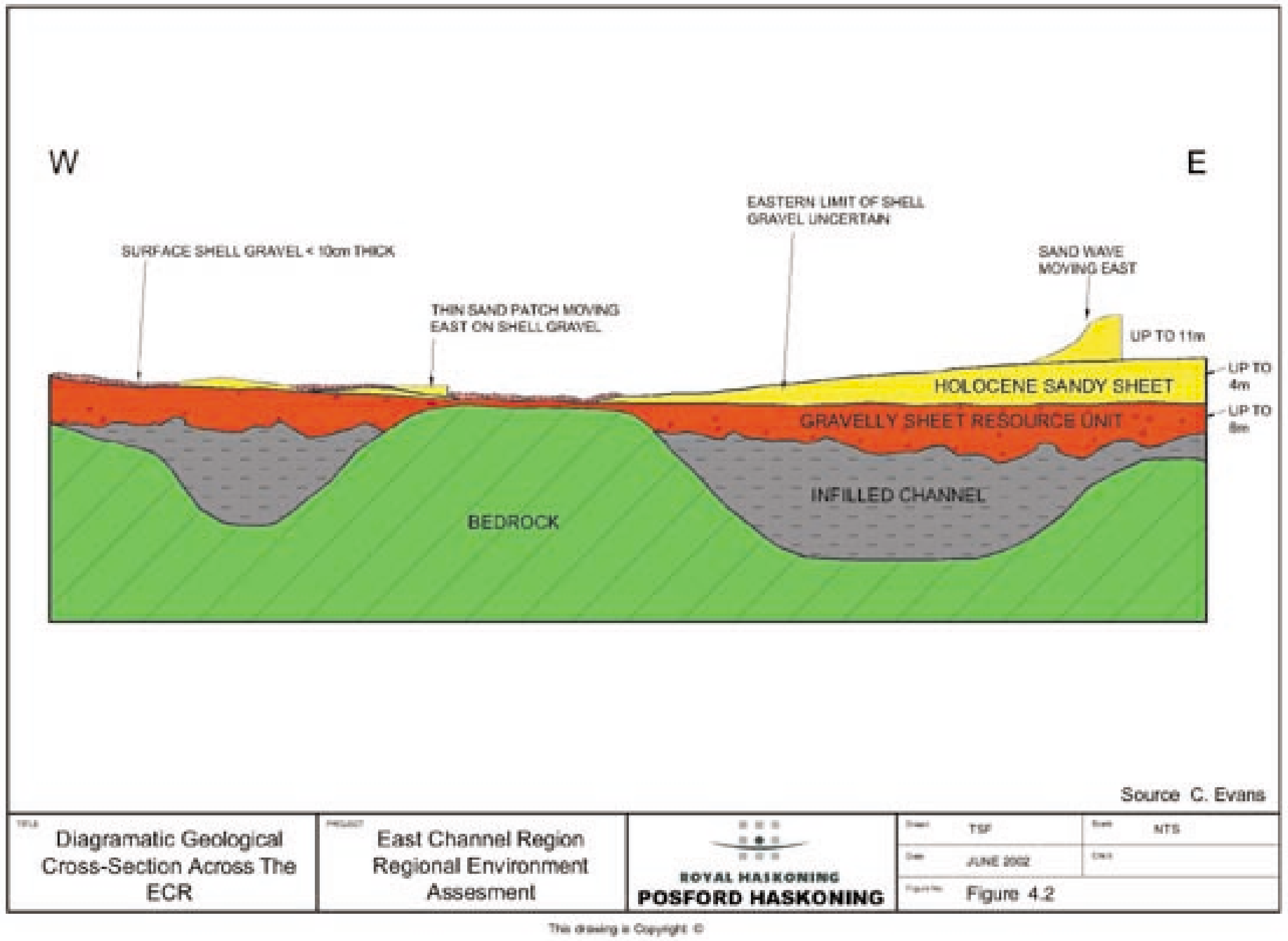
Distribution

Figure 4.2 shows a diagrammatic cross-section of the geology of the ECR. Across most of the central and western part of the ECR the seabed sediments (localised surface sands) are less than about 25cm thick and overlie bedrock or the Quaternary channel infills and sheets. These surface sands thicken eastwards and east of the ECR form a continuous sheet up to a few metres thick. This sheet gradually changes form into a series of sand banks and sand wave fields.

Transient linear sand patches, commonly up to 1km long, cover the more gravelly sediments across the western part of the area. The patches become larger and more common eastwards.

Gravelly seabed sediments typify the ECR and the surrounding eastern English Channel (Hamblin *et al.* 1992).

4.2 Geological cross-section across the ECR



Sediment transport

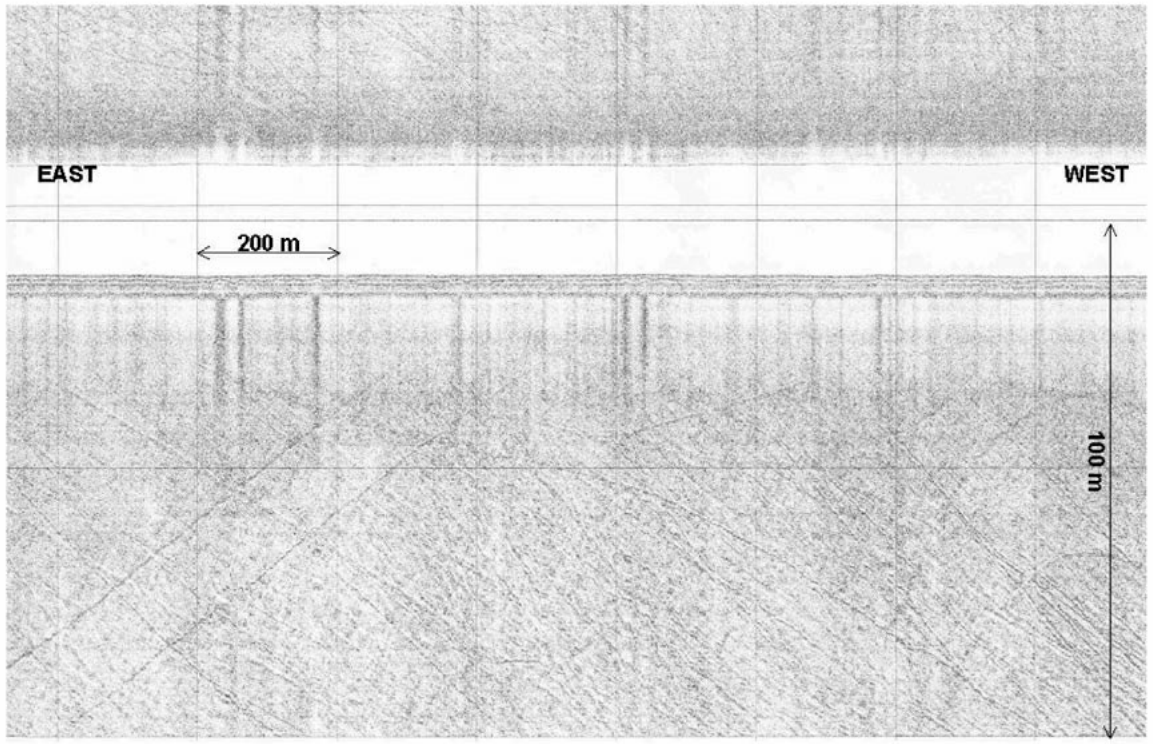
The asymmetry of bedforms in the region and the orientation of the sand patches indicate that sand is moving east-north-east through the area, parallel to the main channel axis, and under the influence of tidal currents. The volume of sand in transit, based on the volume of these bedforms, is small compared to that within the sand sheet east of the ECR. In contrast, the gravelly seabed sediments display no evidence of transport and are considered immobile.

A regional assessment of sand transport in the eastern English Channel suggests a convergence zone of bedload sediment (sand) within an area lying south-east of Hastings. West of this zone, under the influence of tidal currents (see Section 4.3), sand moves eastwards, while to east of the zone it moves westwards. The thicker seabed sediments towards the eastern part and to the east of the ECR are an indication of this convergence in sand transport. The ECR lies to the west of the convergence and thus any sand in transit within it moves east-north-eastwards. Regional sand wave asymmetry, numerical tidal modelling and analysis of tidal residuals all confirm the presence of this convergence zone.

Trawl marks

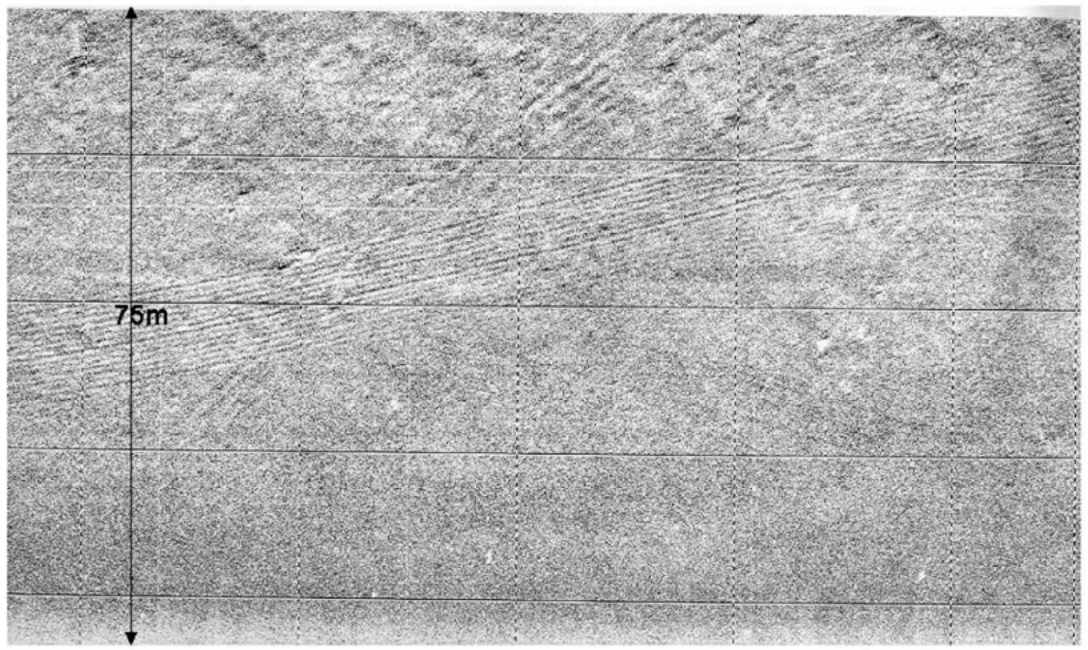
Extensive areas of trawling are recognised on the side-scan sonar records from across the ECR. About 60% of the region is affected, with clarity varying from well defined to barely visible. The marks are locally cross-cutting. Two types of marks are visible (see Figure 4.3), one with parallel tracks about 10 to 15m apart (probably beam trawling) and another comb like track 15m across (probably scallop dredging). The variability in clarity indicates that with time, or subsequent trawling, the trawl marks become less well defined. However, the age of the trawl marks and their rate of disintegration cannot be deduced from the data.

Seabed debris, wrecks and rare boulders have also been identified across the region on the side-scan sonar records. No evidence of sediment transport is apparent around these seabed features.



Example side scan data from Area 458

4.3 Side scan sonar records acquired in the ECR. The arcuate, parallel grooves are widespread and are attributed to fisheries activity; both beam trawling and scallop dredging.



Example side scan data from Area 473

4.3
Hydrography

4.3.1
Introduction

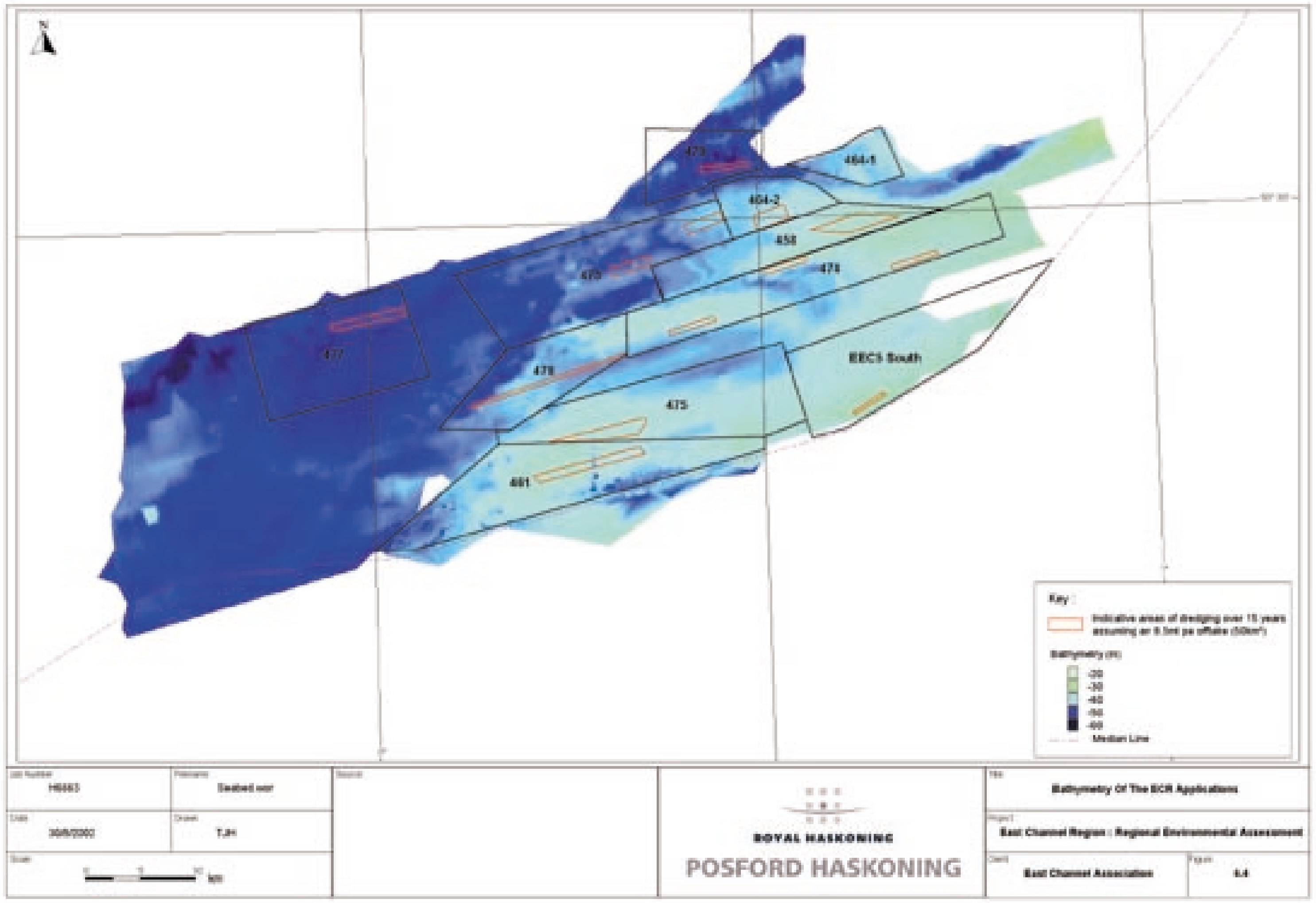
The hydrographic study (HR Wallingford & Evans Technical Report, 2002), considers the waves, tides and coastal processes within an area of the English Channel from a line joining the Isle of Wight and Cherbourg to a line joining Dover and Calais. This study area encompasses the ECR and extends beyond its limits to provide a regional context. The eastern boundary extends into the system of sandbanks lying just off the French coast.

4.3.2
Bathymetry

South of the Isle of Wight, much of the central part of the English Channel lies at depths of between 60 to 70m below chart datum (CD). The seabed shallows eastwards and, south of Dungeness (at about 1° E), the central part of the English Channel has a depth of between 30 to 40m (Figure 4.4). Incised into this broadly planar seabed is a channel system which changes from a simple open form north of the Dover Strait to a complex network between 1°E and 1°W (BGS, 1989 and 1990). The channel system is incised into bedrock of Cretaceous and Tertiary age. Some of the channels can be identified from the modern bathymetry of the area and contain little or no softer sediment infill, while other parts of the system are completely infilled, with no indication at seabed of the filled channel below (Hamblin et al. 1992).

The main, partly infilled channel in the eastern English Channel is known as the Northern Palaeovalley, which extends eastwards from about 45km south of the Isle of Wight to 17km south of Beachy Head where it has a maximum (bedrock) depth of around 90m. This channel continues eastwards to about 44km south of Dungeness (1°E) and then curves gently northwards to run into the Dover Strait. The ECR Region mainly lies immediately south of the Northern Palaeovalley, however, the valley runs through Area 479 and between Areas 464/1 and 464/2 in the north-eastern part of the region (Figure 4.4).

Within the ECR as a whole, water depths range from 30 to 60m and commonly lie in the range 35 to 45m. The seabed is of low relief with few well-defined breaks of slope, gently dipping to the south-west where depths of over 50m mainly occur west of 0 degrees longitude.



4.3.3

Tides

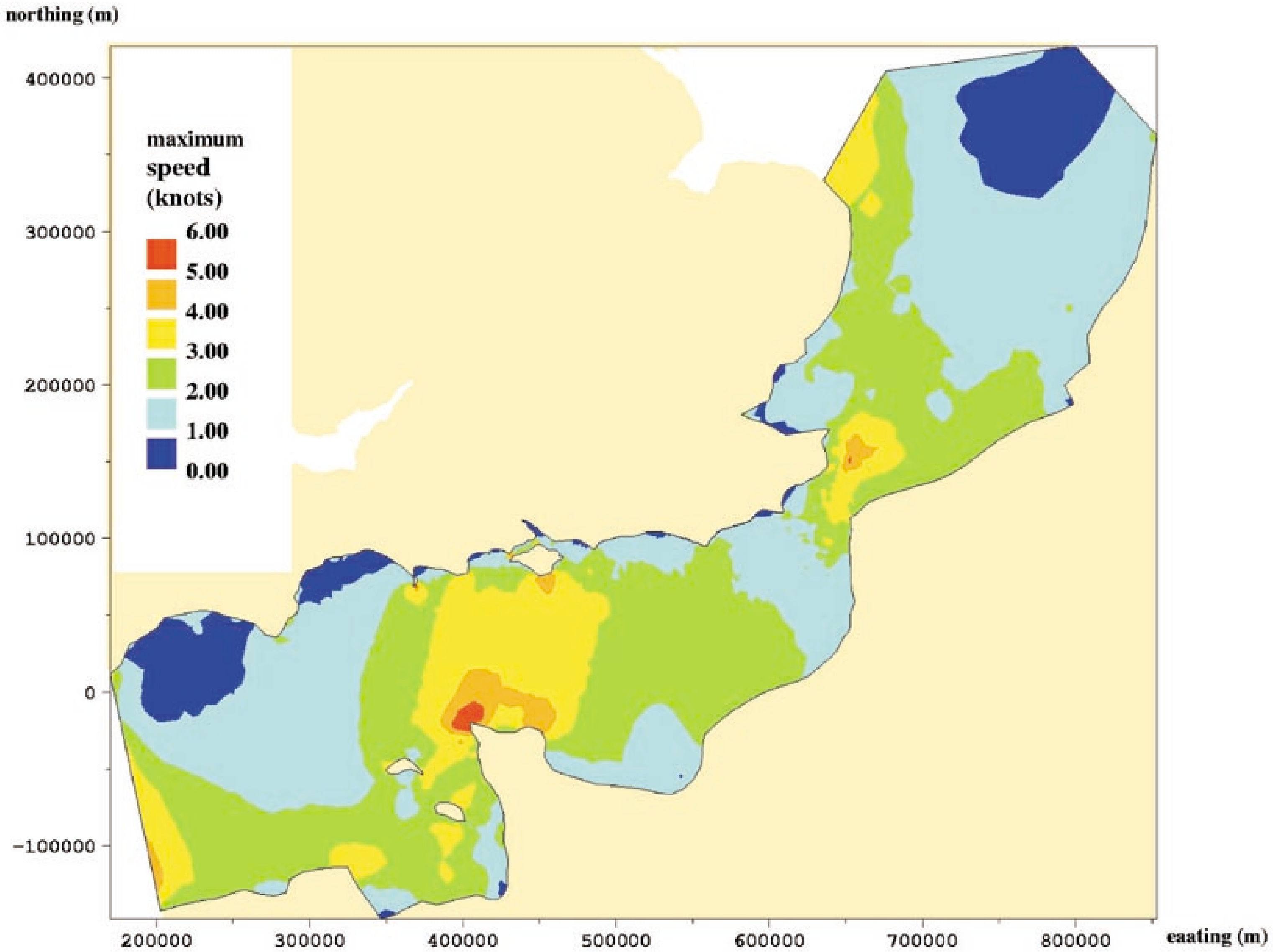
There are strong flows associated with the propagation of the tide into and out of the English Channel. However, these currents change in strength in response to changes in the width and depth of the Channel. In addition, there is interaction between the tide propagating eastwards up the English Channel and southwards down the southern North Sea.

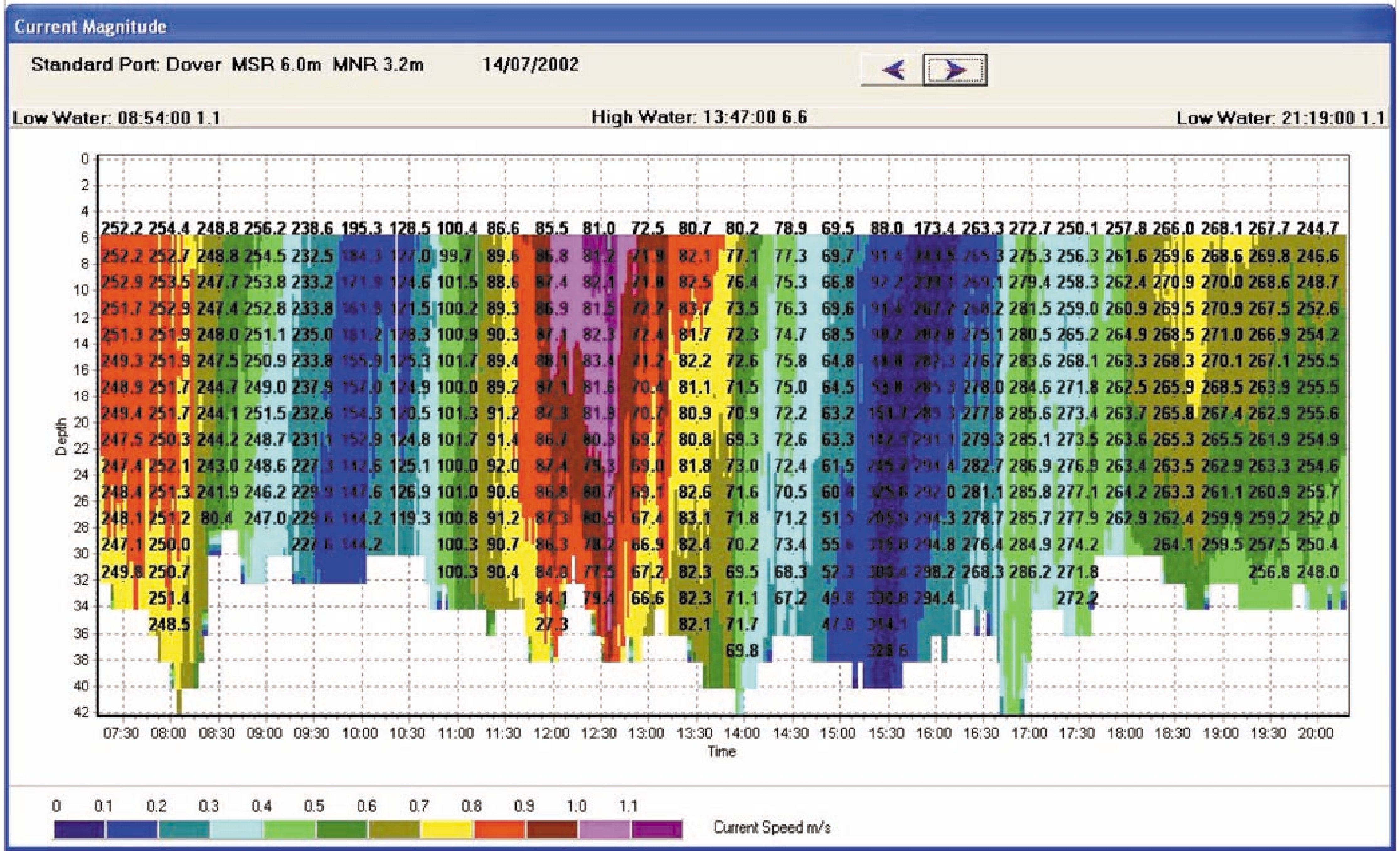
Tidal flows entering the English Channel from the west, initially decrease in strength and then increase towards the Strait of Dover, as shown in Figure 4.5. Tidal currents in the ECR have maximum speeds of around 1 to 2 knots (Figure 4.6), which are considerably less than those to both to the east and west, where current speeds reach up to 4 knots in the Dover Strait and south of the Isle of Wight.

Tidal currents for the peak of the flood and ebb tide in the western part of the ECR are strongly rectilinear, i.e. with the ebb and flood currents being on the same alignment but in opposite directions, flowing along the main axis of the English Channel. Further east within the region, the currents have a slight anti-clockwise rotation either side of slack water.

Within the ECR, the tidal range is 6 to 8m on spring tides and 3 to 5m on neaps.

Figure 4.5 Tidal flows in the English Channel





4.6 ADCP current data for a spring tide in the ECR (Area 473). Current orientation is represented as a compass direction throughout the water column.

4.3.4
Waves

In the ECR, the highest waves approach from the west-south-west (i.e. from around 240° N). These waves occur more frequently than those from other directions and have longer periods. By contrast, waves coming from the north-east, generated in the southern part of the North Sea (centred around 30° N), are both smaller and less frequent. With a smaller wave generation area, these North Sea waves also have a shorter wave period and are less strongly affected by changes in the seabed levels. Waves from the Atlantic or the northern part of the North Sea are greatly reduced in height before they reach the ECR, so that wave heights greater than 4m are only experienced for about 1.8% of the time.

On the English coast, between Beachy Head and Dover, and on the French coast between The Somme estuary and Wissant, the predominant west-south-westerly waves are responsible for generating persistent longshore currents that carry beach sediments along shore to the east and north.

4.3.5
Water quality

Natural suspended sediment concentrations in the eastern English Channel are generally low. In offshore areas, suspended sediment concentrations are typically low, of the order of 1 to 10mg/l (Velegrakis et al. 1999 and ERM, 2000). Values of 3 to 4mg/l have been estimated for the Dover Strait (Van Alphen, 1990). However, closer inshore, storm-induced concentrations can reach 300mg/l, for example in 20m of water off Hastings, compared to background concentrations under calm conditions of around 5 to 10mg/l (South Coast Shipping, 1994).

4.3.6
The Channel Coasts

The following description of the coastlines nearest the proposed dredging Permission Areas sets the scene for the description of the seabed character and sediment transport processes (Section 4.3), and for the assessment of any possible "far field" effects of dredging (Chapter 5).

The English Coast – Beachy Head to Dover

The English Coast from Beachy Head to Dover comprises chalk and sandstone cliffs with predominantly shingle beaches in the intervening embayments. Longshore transport along the Beachy Head to Dover frontage is from south-west to north-east, with some local re-circulation of sand around projections such as harbour mouths and in the "lee" (to the east) of the Dungeness peninsula. Sea level rise, coupled with partial protection of the cliffs further west, has reduced the supply of fresh shingle, causing a long-term problem of beach erosion. This has resulted in the need for beach management schemes, including recharge using marine dredged gravel and sand (e.g. at Seaford near Newhaven and Eastbourne (see Plate 4.1).

Plate 4.1 Eastbourne, east of Beachy Head

French coastline - Cap D'Antifer to Wissant

The solid geology of the French coastline in the study area mirrors that along the English coast. In the west, the chalk cliffs from Cap D'Antifer past Dieppe to Ault erode where they are not defended and provide shingle that is carried eastwards by longshore drift. Along the eastern part of this frontage, and unlike the English coast, increasing amounts of sand produce beaches of mixed sediment, with the shingle forming ridges at the rear of sandy inter-tidal beaches. At the Somme estuary, the shingle disappears and the beaches become sandy with dunes at their crest. Longshore drift is still east and northwards, with some sand accumulating in the estuary of the Somme and the rest moving towards Baie de L'Authe, Berck and Le Touquet (see Plate 4.2). Along this stretch of coastline there are numerous nearshore sandbanks, possibly exchanging sand with the beaches.

The low-lying coastal plain north of the Somme estuary gives way to cliffs of clay and sand at Cap D'Albrech, and from here to Cap Gris Nez the beaches are generally narrower. More substantial beaches form in embayments in the cliffs, or against the updrift side of harbour arms and breakwaters, with corresponding erosion problems to the north and east of such structures. The sand beaches disappear in front of the cliffs at Cap Gris Nez, but it is believed that sand still travels around this headland along sandbanks in the shallow nearshore zone, and collects in the Baie de Wissant to the west of Cap Blanc Nez.

Coastal protection works along the French coastline are largely confined to the frontages of the various towns, and typically consist of seawalls and groynes. Erosion of cliffs and beaches is often a problem on the eastern or northern sides of these defended areas, reflecting the predominant drift direction. Large-scale extraction of sand and gravel from the beaches south of the Baie de Sommme has now apparently ceased. There appears to have been little or no beach management by nourishment or re-cycling, except on the shingle spit just south of the Baie de Somme.

Plate 4.2 Sandy beach at Berck-Plage, Pas de Calais

4.4 Biological Resource

4.4.1 Introduction

There is a considerable amount of data available to characterise the benthic habitats and species within the ECR. This data has been collected as part of wider investigations of the marine life of the English Channel and also for the individual dredging application areas as part of the EIA process (MES Technical Report, 2002). The data is robust in its scientific content and enables a broad scale benthic biological description of the ECR.

The study area for the benthic resources reflects the current level of existing information and is based on the availability of data from individual studies. This data has been collected using a range of broadscale and detailed techniques and provides a wide variety of information on habitat, community and species distribution. Detailed information is available for the individual application sites forming the ECR, while beyond the ECR the data is restricted to a series of samples within projected plume excursions. Data within the study area is therefore comprehensive, but the data is not all to the same level of detail.

4.4.2

Overview

The ECR is, in biological terms, a circalittoral, completely immersed, thermally stable aphotic zone. The conditions in the ECR are stable, thereby allowing for successional development of community types associated with the particular substrate type present. Circalittoral habitats generally occur in water depths between 20m and 200m and are dominated by animal life. Little plant life exists due to the lack of light.

4.4.3

Substrate characteristics

The substrate is one of the key determining factors in the type of community that develops. The seabed in the study area is dominated by sediments ranging from fine sand to gravel. There are also localised areas where bedrock is exposed, although bedrock is not exposed in the ECR. Figure 4.1 shows that sediments in the ECR are gravelly, bordered in the north and east by gravelly sand and to the west by muddy sandy gravel. Interpretation suggests that there could be three biotopes (the habitat together with its recurring associated community of species) that fit with the physical characteristics of the environment in the ECR and indeed over large parts the eastern English Channel. They include two circalittoral gravel and sand biotopes and possibly a circalittoral mixed sediment biotope. Bivalve molluscs or polychaete worms generally dominate these biotopes. The biotope CMX (circalittoral mixed sediment) appears to be ubiquitous to the area and supports a fauna dominated by polychaete worms. Unfortunately, due to the small number of accepted circalittoral biotopes presently available, it is not possible to subdivide the biotope that characterises the ECR further. This concurs with the more detailed work that has been undertaken as part of the EIA process for the individual application areas.

The predominantly immobile seabed sediments in the ECR imply that the community types within the region are widespread and stable. This is supported by the presence of long-lived species. However, other activities are likely to have influenced the distribution of communities and species. A number of the EIAs have identified evidence, from surveys, of trawling or scallop dredging affecting the seabed. It is estimated that about 60% (about 600km^2) of the seabed area surveyed has visible marks on it that suggest fishing activity (see Figure 4.3).

4.4.4

Infaunal Characteristics

Observations of community structure allow the relatively confident prediction of the benthic communities that are likely to be found in the application areas. In general, deposits in the ECR support communities with high biodiversity, population density and evenness (characterised by species such as squat lobsters and brittle stars), compared with deposits towards and beyond the north and north-east of the ECR which are sandier and dominated by polychaete worms and bivalve molluscs.

Polychaete worms, mainly colonising sandy gravel and gravelly sand, dominate species numbers and variety in the majority of the application areas (MES Technical Report, 2002). In the sandy gravel substrate, species diversity, richness and evenness is at its highest (see Figures 4.7 to 4.9). These high diversity heterogeneous habitats are characterised by the presence of species such as the squat lobster *Galathea intermedia*, the serpulid worm *Pomatoceros triqueter*, brittlestars *Ophiura* sp, and the sea urchin *Psammechinus miliaris*. These species are indicative of coarser sediments including rocks and boulders. Such habitats are found in Areas 461, 458/464, 473, 474 and 475 (Figure 3.1).

The ECR's benthic fauna assemblage comprises a wide range of taxa (MES Technical Report, 2002). Mean values for the number of species, number of individuals and biomass of benthic infauna per unit area are similar to those recorded for similar deposits in other areas in the coastal waters of the UK. However, in many cases, the biomass of benthic infauna in coastal sites is higher than that in the ECR. This suggests that whilst biodiversity appears to be high for the ECR as a whole, the significance of benthic infauna for marine food webs is less when compared with coastal deposits.

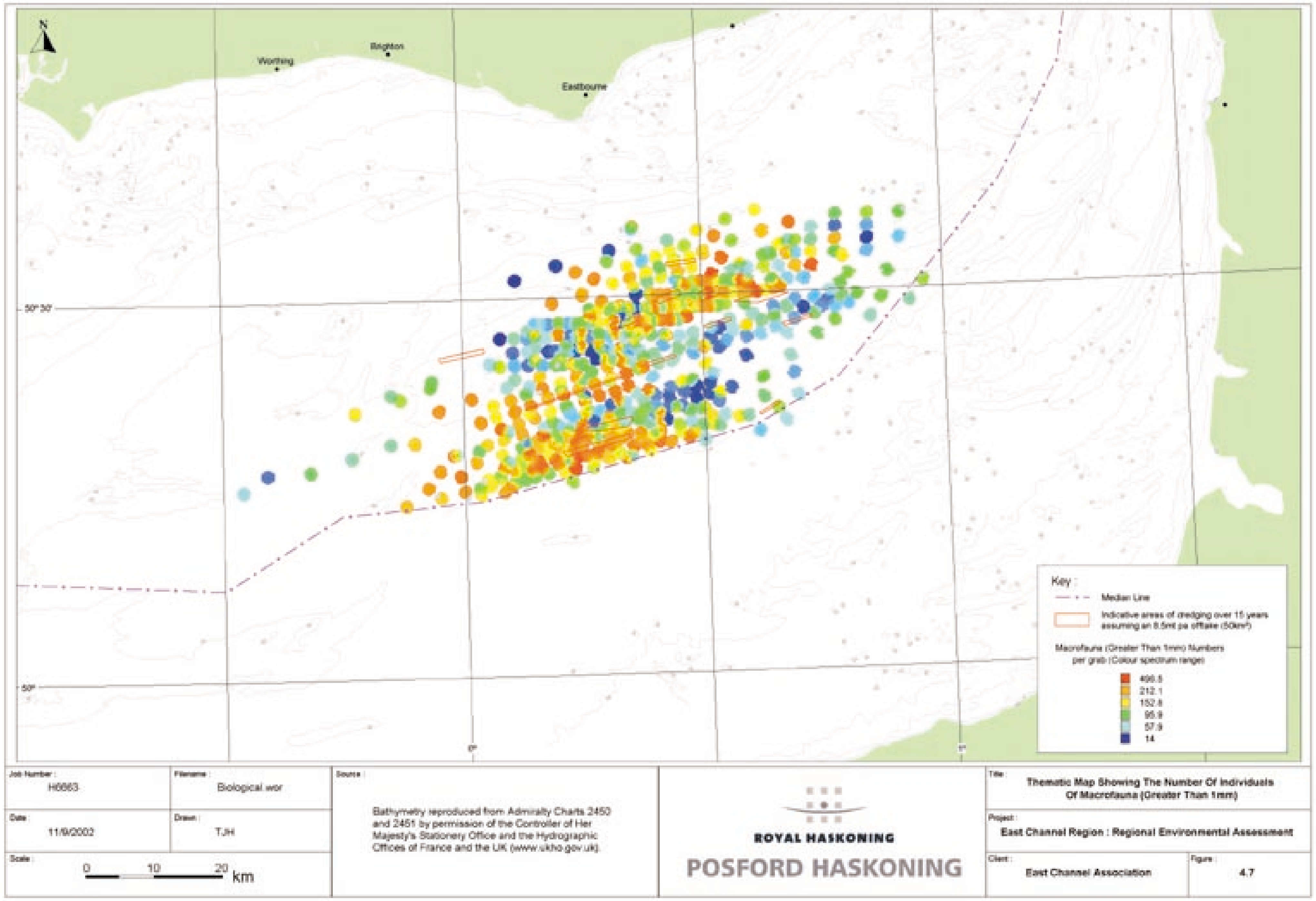
In addition, there are important differences in community composition within the application areas, resulting in patchiness of distribution of species and communities. This increases the biodiversity of the area by enabling a different species dominance to develop to suit the substrate type. In general, the communities that have been recorded within the licence application areas are rich and diverse and, due to the stability of the physical characteristics that prevail, are long-lived stable communities. There is no evidence of species or communities of conservation significance being present that are not well represented and widespread in the eastern English Channel outside the boundaries of the ECR.

A notable feature within the study area is the series of sandbanks that occur to the north-east of the ECR. These banks comprise mainly coarse sands and support a rather sparse fauna. Only one area has been identified that is associated with rich communities (including crustaceans, sponges, soft corals, bryozoans and hydroids), the rocky outcrops at 'Les Ridens', which occurs approximately 80km to the north-east of the proposed extraction areas.

4.4.5

Epifaunal Characteristics

The epifauna within the region has been studied through the individual applications but also to a wider extent through work undertaken by Ellis and Rogers (2001). This work identified five groups of benthic communities for the Southern North Sea and Eastern English Channel. Of particular importance is the dominance of the queen scallop, which is present in a number of the application areas. This is a commercially exploited species and is in an area widely used by the fishing industry. Soft coral and echinoderms, including starfish, brittlestar, sunstar, the shore urchin and the purple heart urchin, dominate the community that represents the deeper waters of the central English Channel.



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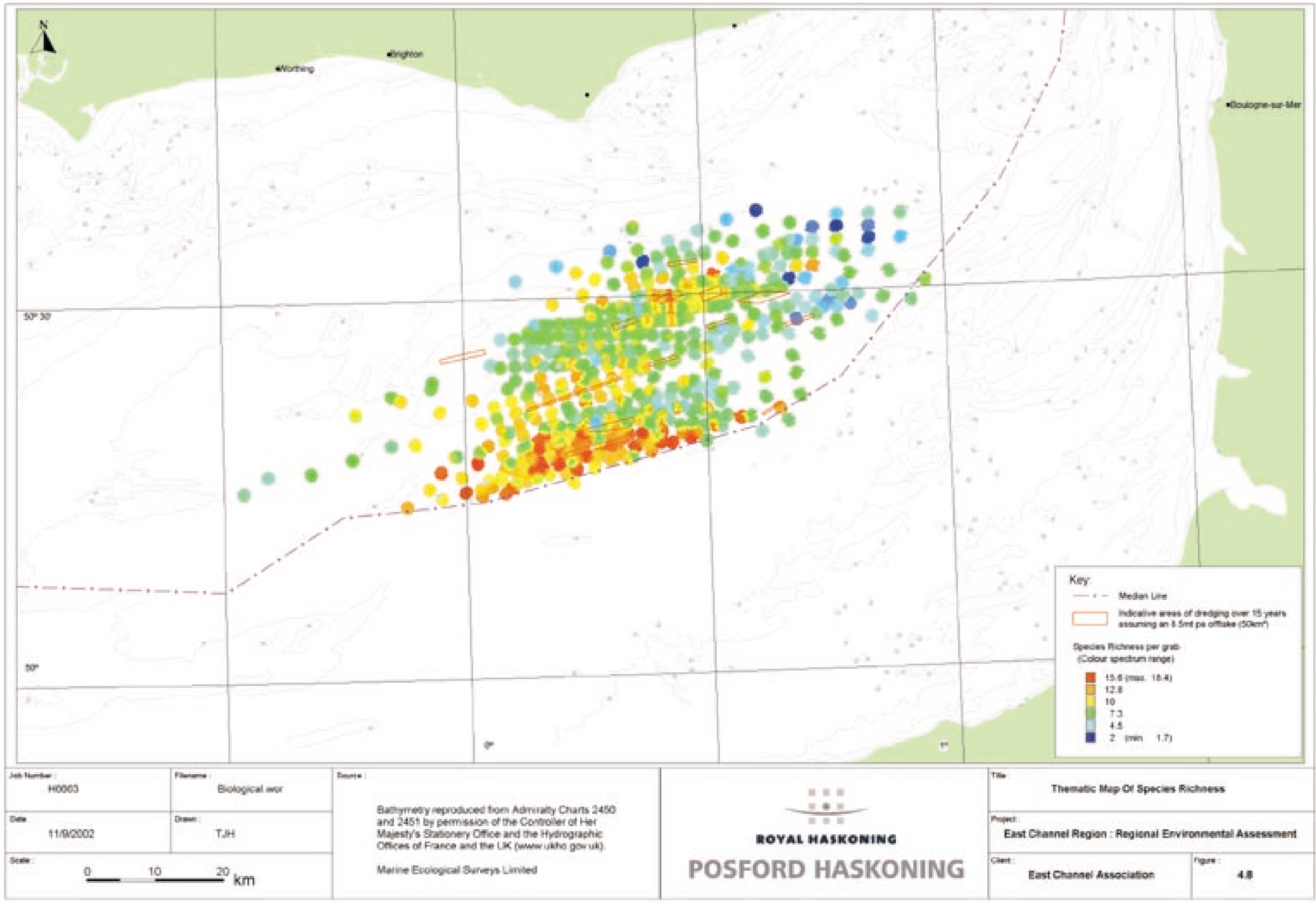

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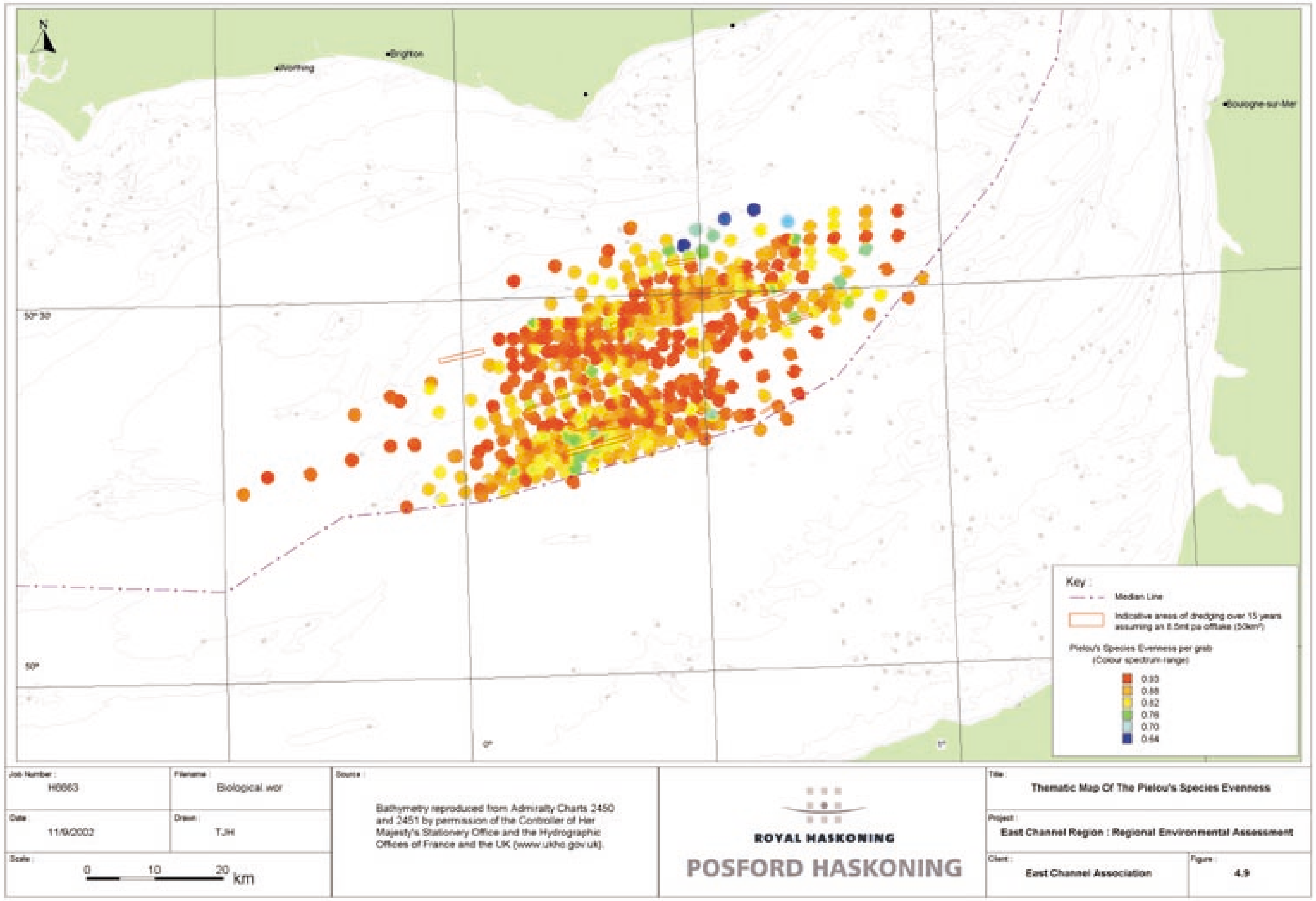


N
Brighton
Worthing
Boulogne-sur-Mer
50° 30'
50°
0°
1°
Key :
Median Line
Indicative areas of dredging over 15 years assuming an 8.5mt pa offtake (50km²)
Pielou's Species Evenness per grab
(Colour spectrum range)
0.93
0.88
0.82
0.76
0.70
0.64
Job Number :
H6863
Filename :
Biological.wor
Date :
11/9/2002
Drawn :
TJH
Scale :
0 10 20 km
Source :
Bathymetry reproduced from Admiralty Charts 2450 and 2451 by permission of the Controller of Her Majesty's Stationery Office and the Hydrographic Offices of France and the UK (www.ukho.gov.uk).
ROYAL HASKONING
POSFORD HASKONING
Title :
Thematic Map Of The Pielou's Species Evenness
Project :
East Channel Region : Regional Environmental Assessment
Client :
East Channel Association
Figure :
4.9

The more detailed studies undertaken for the individual application areas reveal that small-scale variations in the nature of the seabed are important factors that influence the community composition of the epibenthos. They also indicate that the gravel communities of the ECR comprise typical species that are widespread in the English Channel.

4.4.6

Plankton-Benthos Relationships

Circalittoral communities such as those found in the eastern English Channel have very little *in situ* primary production, as macrophyte growth is restricted due to the lack of light penetration in the deeper waters of the English Channel. As a result, the communities of the eastern English Channel rely heavily on a supply of primary production from phytoplankton in the euphotic surface layers, and from marine macrophytes and coastal vegetation. This supply of fragmented material from plankton has a controlling influence on the structure, abundance and diversity of the benthic community. The main constituents of the communities found within the ECR are filter and deposit feeders that are adapted to utilise this kind of primary production.

The planktonic communities of the eastern English Channel are typically less diverse and abundant than those in the west (Newell, 1963). This could be a significant contributory factor to the difference in species diversity in the western as compared to the eastern English Channel.

Fish are considered separately in Section 4.5.

4.4.7

Sensitivity of Benthic Organisms

The benthic communities of the east English Channel are considered to be climax communities that have developed under relatively stable conditions, albeit with intensive fishing activity in some areas. These communities are controlled by biological interactions and are dominated by slow growing, long-lived species. They are characterised by a high species diversity and eveness and, generally, there is no single dominant species. This, however, means that the effects of any significant disturbance will persist. Slow growing, long-lived organisms such as brittlestars are particularly sensitive to the disturbance and smothering that would be associated with certain dredging processes. Other species, such as *Sabellaria spinulosa*, are of importance because the reef-like structures that can be built by this worm comprise complex habitats that support a wide range of dependent species. Although *Sabellaria spinulosa* occurs throughout the area, there are no records of any reef-like structures of this species and it is considered unlikely that they constitute habitats of conservation significance within the ECR.

Brittlestar beds have been recorded in high density within the study area. These species are slow moving and their dense aggregations mean they are prone to disturbance. Brittle star beds have mostly been recorded in areas of coarse sediment and strong currents. They are relatively intolerant of high sedimentation rates. Disturbance or loss of the brittlestar beds could have potentially damaging effects upon the rest of the benthos. These beds are considered to be an interest feature of marine SACs and it is believed that large beds may have significance in terms of ecosystem function.

In the absence of macrophytes, the sessile benthic epifauna may be highly important in terms of increasing habitat complexity and biodiversity. These include erect colonial species such as the hydroids *Hydrallmania falcata* and *Obelia* sp. as noted in Area 473 (Emu, 2002). These species may be important in the settlement and development of scallop spat (an important commercial species in the east English Channel). Being sessile these species are vulnerable and sensitive to disturbance, especially scouring and smothering.

4.4.8

Ornithology

Due to the distance of the ECR from the shore, and the water depth, there are no bird populations permanently resident within the Prospecting Areas (EMU, 2002). The depth of the water (>34m) precludes bird feeding on the seabed benthos. Any seabirds in the area are likely to be opportunistic species feeding on the zooplankton, fish and discards from fishing activity.

4.4.9

Marine Mammals and Sharks

The study area holds no particular importance for marine mammals or sharks. Species such as the basking shark *Cetorhinus maximus* and the common dolphin *Delphinius delphis* are thought of as occasional visitors (Emu, 2002).

4.4.10

General Conclusion

It can be concluded that the distribution and abundance of the benthic biological resource within the ECR is strongly linked to substrate type. The ECR contains a high diversity of benthic species that are generally long-lived with no dominance of a particular species throughout the region or within specific application areas. The overall distribution of community types is widespread but with patchy occurrences of varying sediment types with different community compositions. The benthic communities of the ECR are, in general, dominated by polychaetes, which in turn provide an important food source for fish. These communities have developed against a background of fishing.

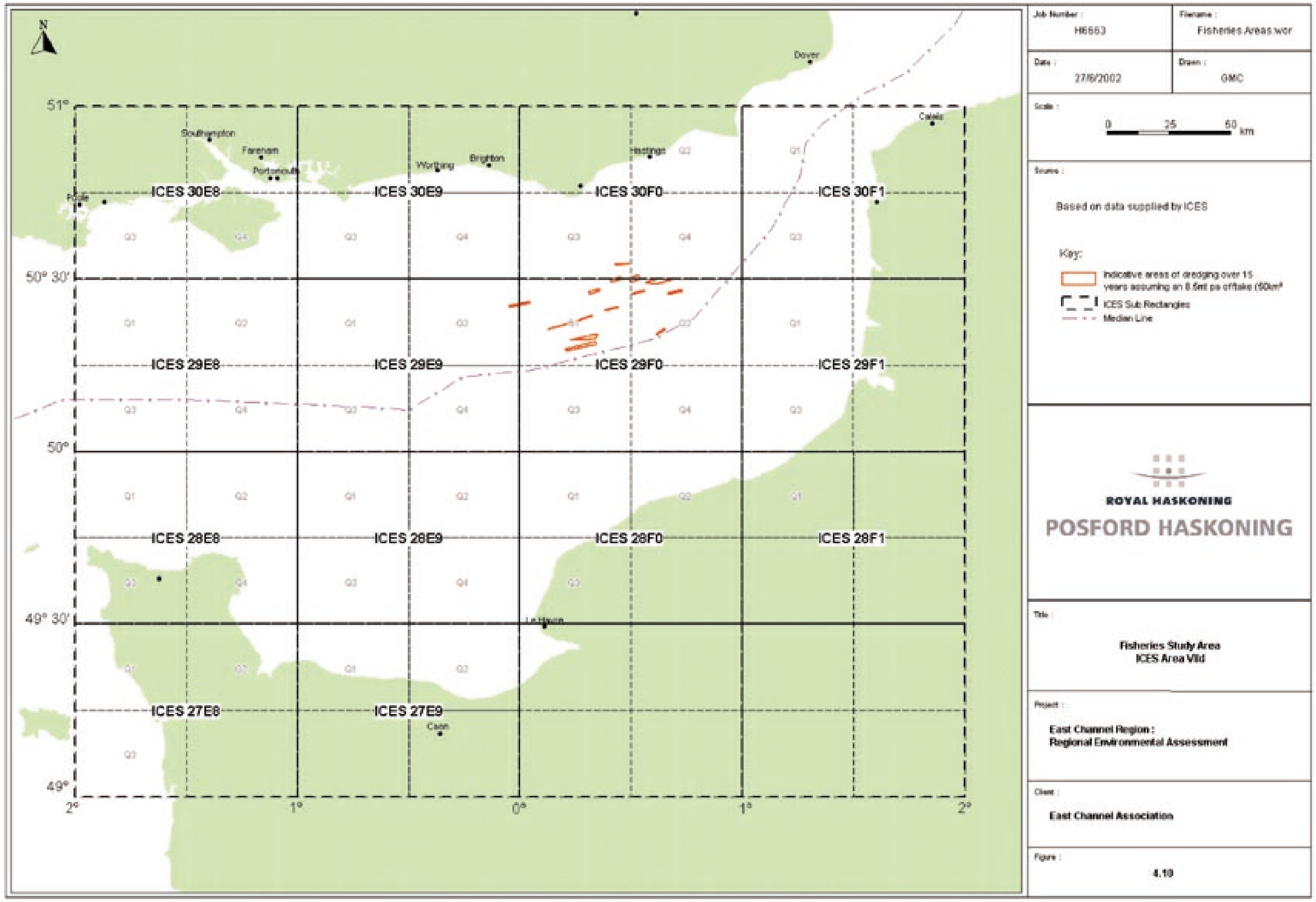
Mean values for the number of species, number of individuals and biomass per unit area in the ECR are similar to those recorded for comparable deposits in other areas in the coastal waters of the UK. In addition, there are no habitats and species of conservation significance within the ECR. However, due to the stable environment of the deeper waters of the ECR, the species and communities are likely to recover at a much slower rate than shallow water coastal communities where the component species are adapted to rapid recolonisation and recovery following episodic disturbance.

4.5
Fish Resources

4.5.1
Introduction

Knowledge of the fish resources of the ECR is well developed. Research carried out by CEFAS and IFREMER has provided comprehensive information on fish biology as well as commercial fisheries and their management. In addition, the International Council for the Exploration of the Seas (ICES) holds significant data that cover a wide range of issues, including oceanographic parameters, biological and contaminant data, fisheries resources, fish stocks and fish catch data (see Poseidon Technical Report, 2002).

The ECR is located within ICES area VIId, which extends from 2° W to 2° E. ICES areas are divided into rectangles (measuring approximately 4,116 km²) and further subdivided into 4 quadrants (approximately 1,029 km²) as shown in Figure 4.10. ICES Area VIId has been defined as the study area for the fish resource based on migratory patterns to and from the Eastern Channel and wider habitat dependencies.



4.5.2

Overview

The ECR, together with the surrounding offshore area, is characterised by stable, complex and slow growing benthic communities, which support greater numbers of larger, more mature fish than the inshore zone, making the area attractive to the fishing industry. In general, species diversity in the ECR is higher than that of the Southern North Sea, with a greater range of sediment types (both inshore and offshore) providing for a wide range of fish assemblages. The benthic communities of the ECR provide the main food resource for commercially significant fish stocks but are not a limiting factor for the stock. Estimates of supported annual fish production amount to about 9,800 kg/km^2 per year (Poseidon Technical Report, 2002)

A list of the principle commercial fish and shellfish found in the ECR is shown in Table 4.1. Known spawning and nursery grounds for those species considered to be of importance in the ECR application areas are summarised in Table 4.2.

Table 4.1 Principal Shellfish and Fish Species of the Eastern Channel

Group	Scientific name	English	French
Shellfish and Crustacea	*Pecten maximus, Aequipecten opercularis*	Scallop	Coquille St-Jacques
	Sepia spp.	Cuttlefish	Seiche
	Cancer pagurus	Edible Crab	Tourteau
	Maja squinado	Spider Crab	Araignée de mer
	Homarus gammarus	Lobster	Homard Européen
Finfish	*Dicentrarchus labrax*	Bass	Bar
	Spondyliosoma cantharus	Black bream	Dorade grise or griset
	Gadus morhua	Cod	Morue or Cabillaud
	Solea solea	Common sole	Sole
	Clupea harengus	Herring	Hareng
	Pleuronectes platessa	Plaice	Plie
	Aspitrigla cuculus	Red gurnard	Grondin rouge
	Trachurus trachurus	Scad	Chinchard
	Sprattus sprattus	Sprat	Sprat
	Scophthalmus maximus	Turbot	Turbot commun
	Merlangius merlangus	Whiting	Merlan
	Scyliorhinus sp. Mustelus sp.; Squalus sp.	Small sharks	Petit requins, Rousettes, Aiguillat
	Raja spp.	Rays and skates	Raies

Table 4.2	Spawning and Nursery Activities in Area VIId and the ECR Application Areas				
Species	ICES Area VIId		ECR Application Areas		Comment
	Spawning	Nursery	Spawning	Nursery	
Bass	Yes	Yes	Yes	No	Inshore nurseries
Cod	Yes	Yes	Yes	No	Mainly in East
Edible crab	Yes	Yes (inshore)	Yes	Unlikely	Highly migratory
Herring	Yes	Yes (pelagic)	Yes	Yes (pelagic)	Imp. Spawning area
Plaice	Yes	Shallow water	Yes	No	Imp. Spawning area
Scallop	Yes	Yes	Yes	Yes	Plankton 4-5 weeks
Turbot	Yes	Yes (pelagic)	Yes	Planktonic	
Whiting	Yes (pelagic)	Yes (pelagic)	Possible	No	Pelagic spawning

Some of the commercially important Channel fish stocks are migratory, with the ECR representing the eastern limit of the range for many species. Exceptions include herring, which migrate from the North Sea to spawn in the eastern English Channel (including the ECR); plaice, which return to the North Sea after spawning in the region; and sole and bass. A number of demersal and pelagic spawners exploit the strong local currents to maximise larval dispersion. The ECR is considered, therefore, to be an important source of juveniles for other parts of the Channel and the Southern North Sea.

The ECR rarely has a nursery function, since most fish and crustaceans move inshore as juveniles, returning to deeper waters as adults. That is, whereas a wide range of key commercial species are known to spawn in the ECR (including bass, cod, crab, herring, plaice, scallop and turbot) most of these move inshore to develop. Important exceptions are herring and scallop, which would appear to have nursery areas within the ECR. Consequently, those species listed in Table 4.2 may be regarded as potentially more vulnerable to direct or indirect impacts from activities within the ECR.

The most important fish species in the ECR include scallop, bass, sole, cod, plaice and herring, as detailed below.

4.5.3

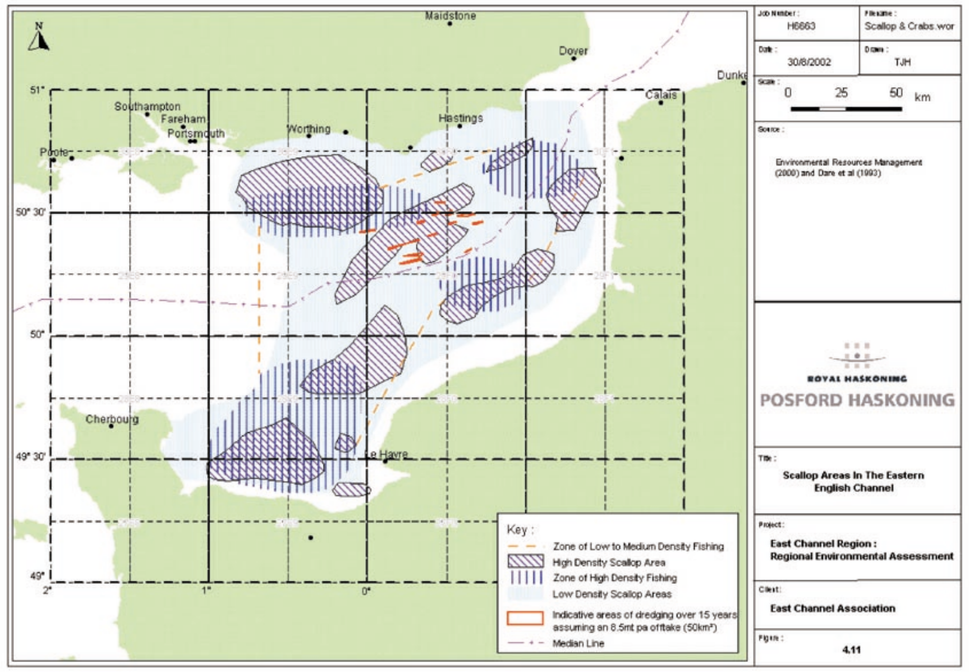
Scallop

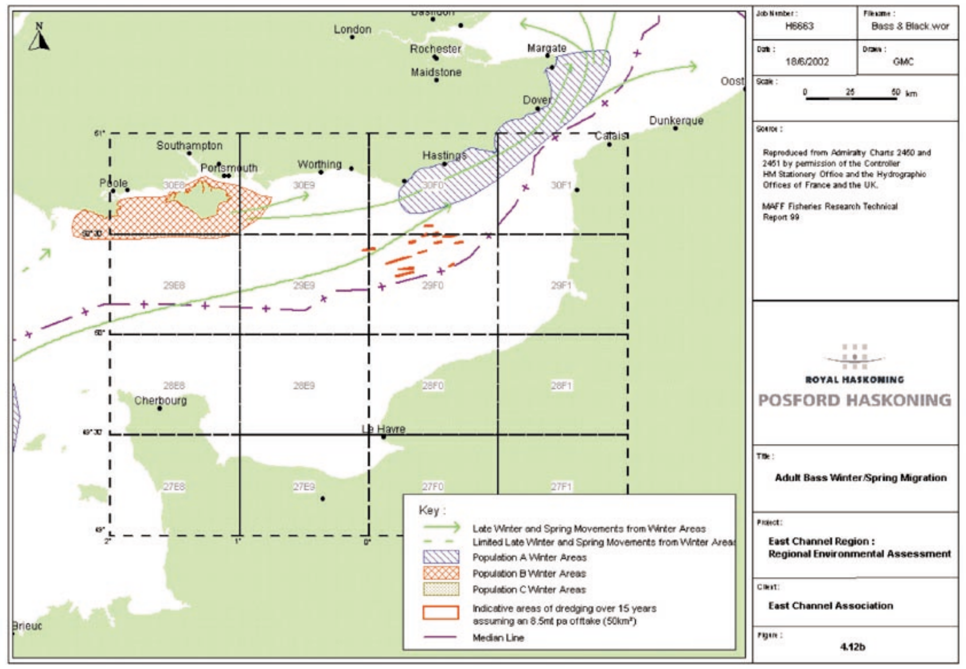
Scallops are most abundant on gravel, sand/shell or stony substrates at depths of 15 to 75m. Two species of scallop are present in the channel, king scallops *(Pecten maximus)* and the smaller queen scallops *(Aquipecten opercularis)*. Biological surveys of commercial fisheries have led to the identification of at least 11 scallop grounds in the ECR. Since scallops are largely sedentary, their spawning areas correspond to their adult distribution (Figure 4.11).

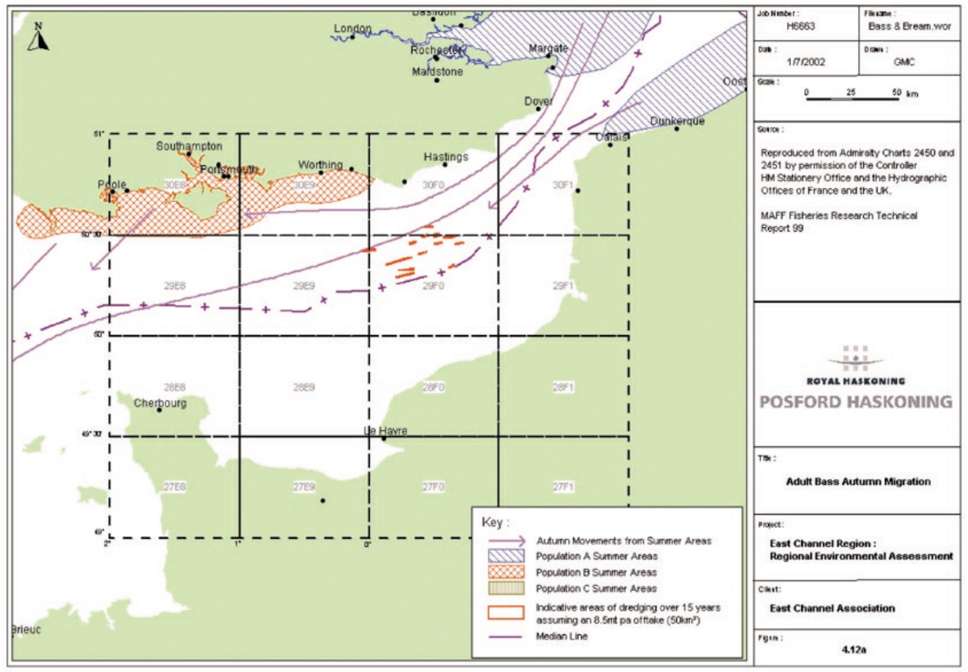
4.5.4

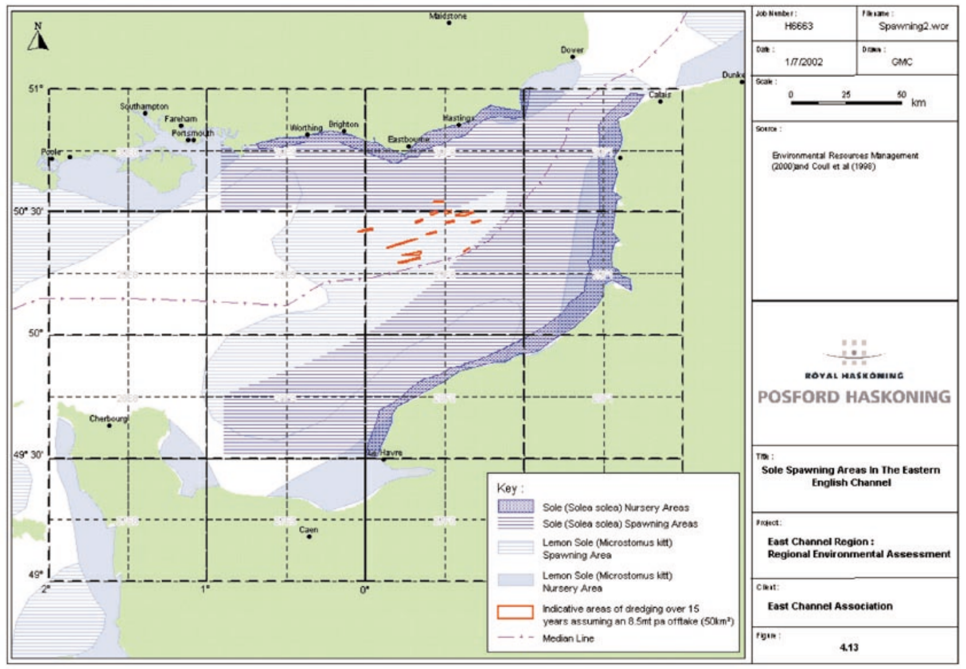
Bass

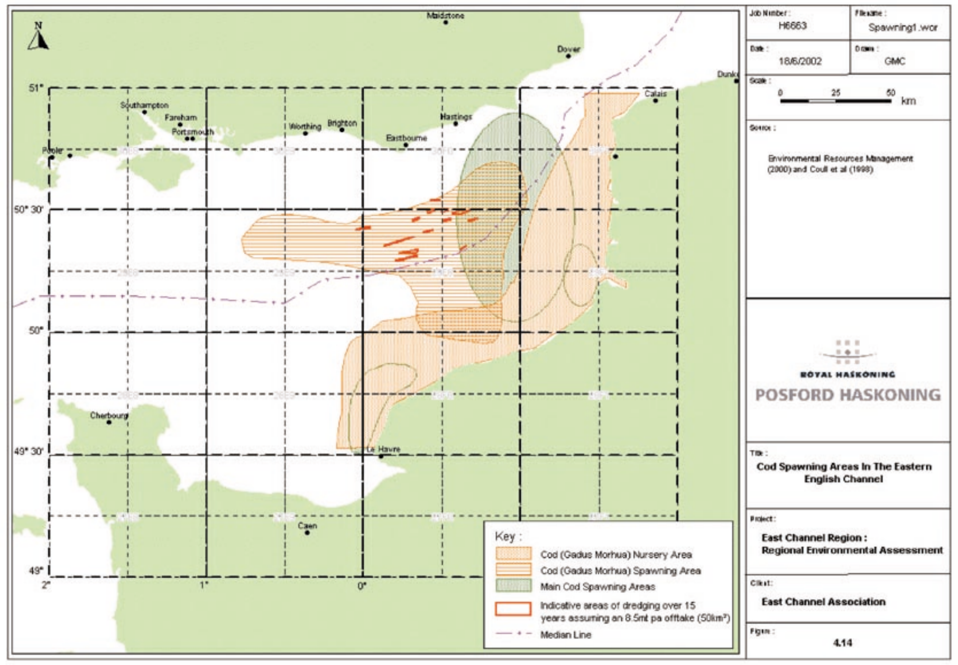
Bass is a highly regarded commercial species distributed around the British Isles and southern North Sea. Although more typical of the Western Channel region, spawning does take place in parts of the ECR and it has been suggested that there may be a distinct eastern stock that moves between the Channel and the Southern North Sea (Figures 4.12a and b).

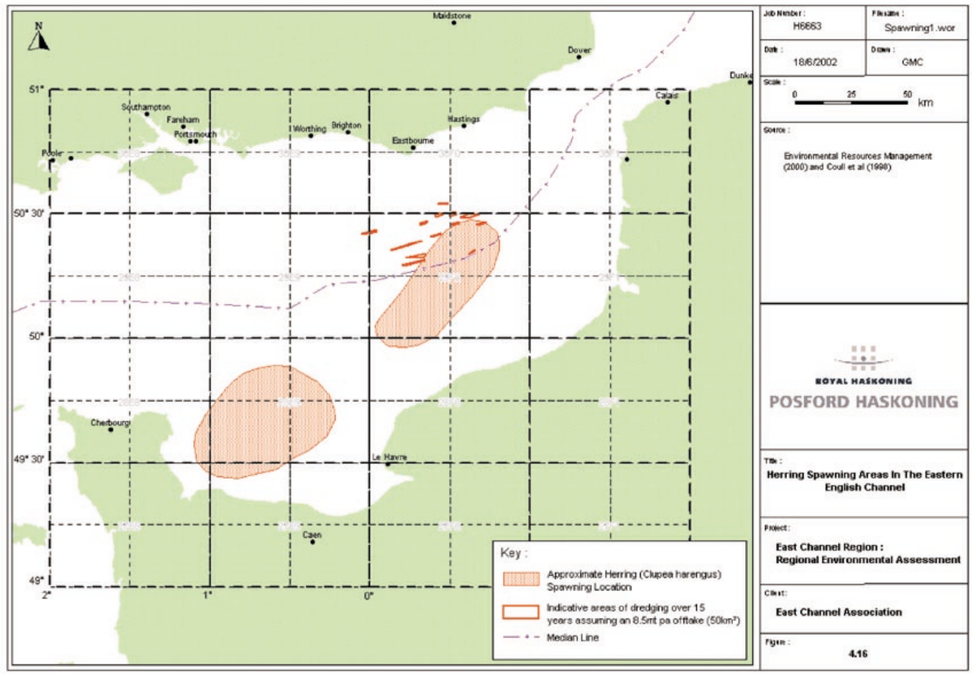


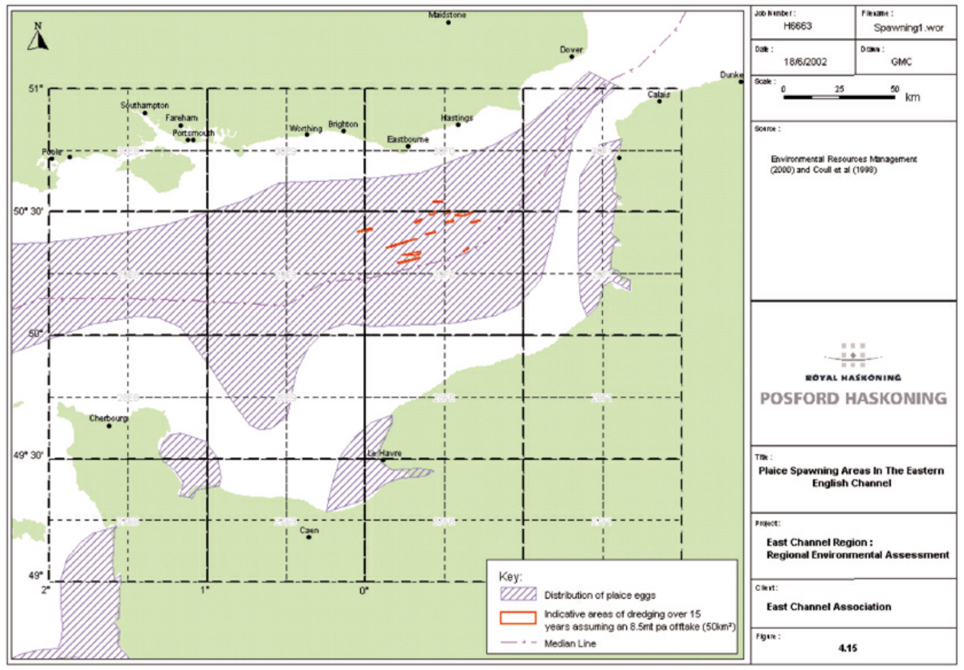












4.5.5

Sole

Stocks of sole in the ECR are currently considered to be within safe biological limits . Sole typically move inshore from deeper waters in response to a rise in water temperature and spawning usually ends around June. The main spawning areas are located within the inshore waters of the eastern English Channel (Figure 4.13).

4.5.6

Cod and Plaice

Cod is heavily over-fished and stocks are at a historic low, with high fishing mortality. Spawning areas include the south-east coast of the UK, the sea off Dieppe and the Baie de Seine, and eggs have been found near the Bassurelle Banks and in the central Channel between Beachy Head and Dieppe (see Figure 4.14). Plaice is a valuable, largely sedentary species caught along the UK and French coasts. Stocks in the eastern Channel are currently over-fished (Figure 4.15).

4.5.7

Herring

Herring are typically demersal spawners and are divided into discrete spawning groups. Spawning usually commences in late November, peaks in December and declines through January into February. A series of larval surveys over the past 30 years has indicated that there have been no permanent changes in the locations or timing of spawning in the eastern English Channel (Figure 4.16). Generally, herring stocks have suffered from fishing mortality since the early 1940s. Recent data suggest that stocks should be managed with some caution.

4.6
Fishing activity

4.6.1
Introduction

A wide range of data relating to fishing activity in the ECR has been made available by DEFRA for the UK and obtained from the ICES databases, as well as from maritime authorities and fisheries committees in France, the Netherlands, Belgium and Denmark. Data from DEFRA have been substantially complemented through access to records from the main fishing organisations operating in the ECR (see Poseidon Technical Report, 2002).

In addition, specific fishing activity information on vessel type and nationality within the ECR has been obtained from over-flight data, satellite surveillance data, catch data by country, vessel type, season and area, and interviews with national port associations and committees.

The study area for fishing activity extends from Dungeness – Calais to the west of the Isle of Wight.

4.6.2
Catch Value and Volume

A wide range of fleets from EU countries have traditionally operated in Area VIId, namely those from France, Belgium, Denmark, the Netherlands, Germany and the UK. Historically, fishing activity in Area VIId has targeted around 28 species, including cod, plaice, sole, herring, mackerel, whiting and pollack, and more recently scallop, cuttlefish, crab, lobster, squid, skate, turbot, lemon sole, brill, gurnard and bass.

Table 4.3 below summarises the distribution of national quotas (by main species) in 2001 for key countries operating in Area VIId. Table 4.4 provides a breakdown of catch in ICES Area VIId by value and volume and Table 4.5 provides the sum total catch in terms of value and volume for key EU countries.

Table 4.3 demonstrates that a number of countries have historic fishing rights in Area VIId regardless of current activity. In fact, as can be seen in Table 4.5, France accounts for as much as 68% of the current total catch value and 58% of the total volume; while the UK accounts for 18% of the value and 15% of the volume; and Belgium 11% and 4% of the total value and volume respectively.

The data in Table 4.4 represent average annual catch from 1991 to 2000 in Area VIId (data provided by ICES). The total value of this catch was approximately £112M for around 107,400 tonnes. The main target fisheries are sole and plaice (Belgium, France and the UK), scallop (France, the UK and the Netherlands), cod (France, the UK, and Belgium), and cuttlefish and squid (France and the UK). Lobster, crab and whelks are also targeted, while turbot, brill and skate are targeted through small-scale net fisheries.

More specifically, sole accounts for 24% of the total value but only 4% of the volume while scallop account for 20% of the value but only 9% of the tonnage (shell-on), reflecting the high value of these species. Other catches of significant economic importance include cod, plaice, mackerel, cuttlefish, whiting, gurnard and herring.

Data for the individual quadrants within Area VIId are available (in terms of catch, seasonality, fishing effort by nationality and vessel type), but these need to be used and interpreted with some caution. It is difficult, for instance, to identify specific activities within small scale fixed boundaries and data obtained from over-flights and satellite surveillance, although valuable, remains limited.

The indicative areas of dredging over 15 years ($50km^2$) are located within ICES Area VIId but, more specifically, in rectangles 29E9, 29FO and 30FO (see Figure 4.10). Fishing activity within these three 'areas' is considered to be significant at a regional level. For example, over-flight data, available for rectangles 29E9, 29FO and 30FO in the period 1996-2001, show the vessel activity in each area by fishing method and nationality. Although these data are intermittent and the identification of vessels is not always straightforward, specific findings include very significant French activity in 29FO; UK activity confined largely to coastal areas; Belgian activity concentrated in 29E9 and 30FO and minor activity by Dutch and German vessels mainly in 29E9.

Recognising the considerable overlap in fishing activity within key rectangles and that obtaining data to a high level of certainty is difficult, the relevant importance of the three main rectangles with regard to the principal commercially important species can be seen from Figure 4.17. This figure illustrates the division of catches by value. The area with greatest economic value in VIId is 29FO. ICES areas 30FO and 29E9 are also important catch areas. It appears that sole, scallop and plaice are significant species in areas 30FO, 29E9 and 29FO, while cod is important in 29FO and less so in 30FO and 29E9. Herring is relatively important in areas 28E9 and 29FO; while mackerel is of minor relevance only in 29FO; and cuttlefish in 29FO and 30FO.

Table 4.3 Distribution of National Quotas in 2001 (In Tons)

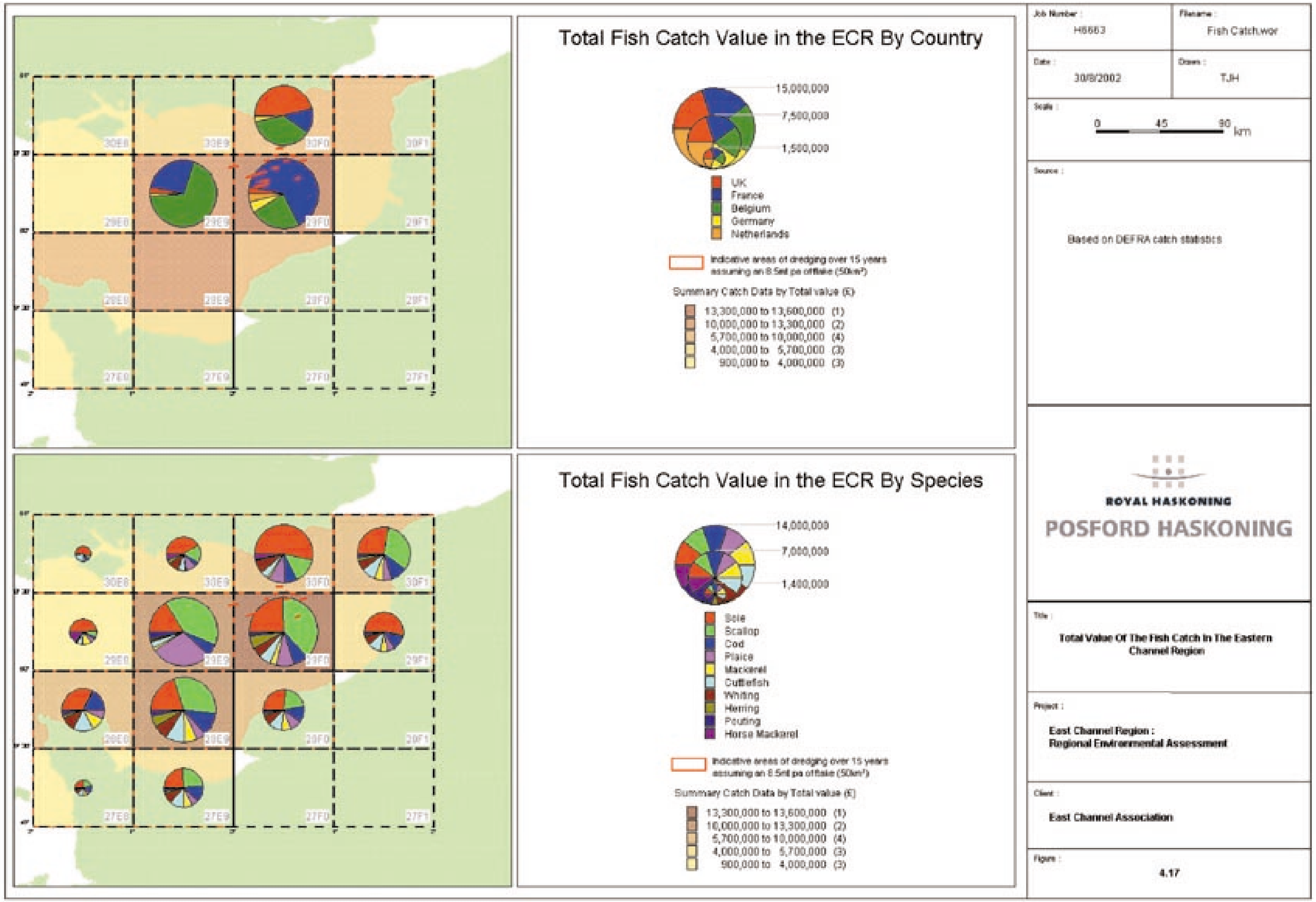
Country	Sole VIId	Cod VII b-k	Whiting VII b-k	Pollock	Plaice VIId & e	Saithe VII	Mackerel	Horse mackerel	Herring	TOTAL IV c / VIId
France	2,475	8,020	12,610	12,180	3,270	2,950	14,410	11,170	8,472	75,557
United Kingdom	885	870	2,250	2,960	1,750	805	198,069	22,850	1,693	232,132
Belgium	1,240	470	200	530	980	10			7,528	7,528
Netherlands		70	100				31,510	80,620	6,630	118,760
Germany							21,610	16,900	339	38,849
Denmark								21,140	339	21,479
TOTAL	4,600	9,430	15,160	15,670	6,000	3,765	53,120	118,660	25,001	251,406

Table 4.4 Breakdown of Catches in ICES Area VIId (ranked by Value and Volume), annual average for the period 1991– 2000

	A. Ranked by Value			B. Ranked by Volume		
Rank	Species	£ '000	% total catch by value	Species	Tonnes	% total catch by volume
1	Common sole	27,354	24%	Atlantic herring	19,293	18%
2	Great Atlantic scallop	22,416	20%	Atlantic mackerel	10,362	9%
3	Plaice	9,071	8%	Great Atlantic scallop	9,675	9%
4	Cod	7,944	7%	Atlantic horse mackerel	8,965	8%
5	Cuttlefish, squids nei	7,051	6%	Whiting	7,083	7 %
6	Whiting	5,350	5%	Plaice	5,019	5%
7	Atlantic mackerel	3,930	4%	Cod	4,473	4%
8	Red gurnard	3,165	3%	Cuttlefish, squids nei	4,608	4%
9	Atlantic herring	2,449	2%	Common sole	4,131	4%
10	Atlantic horse mackerel	2, 322	2%	Red gurnard	3,551	3%
11	Lemon sole	1,662	2%	Pouting(=Bib)	2,492	2%
12	European lobster	1,650	2%	Saithe (=Pollock)	2,242	2%
13	Common dab	1,589	2%	European pilchard (=sardine)	2,241	2%
14	Various squids nei	1,475	1%	European sprat	2,138	2%
15	Pouting (=Bib)	1,435	1%	Edible crab	1,323	1%
16	Edible crab	1,424	1%	Small-spotted cat shark	1,272	1%
17	Megrims	1,377	1%	Various squids nei	1,158	1%
18	Mullets	1,362	1%	Total Common dab	1,151	1%
19	Red mullet	1,141	1%	Megrims nei	997	1%
20	Rays	1,098	1%	Mullets nei	986	1%
21	Black sea bream	1,037	1%	Tub gurnard	947	1%
22	Small-spotted cat shark	1,017	1%	Red mullet	827	1%
23	Saithe (=Pollock)	903	1%	Raja rays nei	795	1%
25	Sea basses nei	651	1%	Whelk	577	1%
26	Spiny spider crab	509	1%	Lemon sole	554	1%
27	Brill	333	0%	Spiny spider crab	473	0%
28	Others	3,722	3%	Others	9,283	9%
	Total	**111,945**	**100**	**Total**	**107,367**	**100**

Table 4.5 Total Annual Catch in Area VIId by Country (Volume and Value)

Country	Value	Volume		
	£'000	%	Mt	%
France	69,798	68 %	59,882	58 %
UK	18,615	18 %	15,534	15 %
Belgium	10882	11 %	3,945	4 %
Germany	1,128	1%	3,936	4 %
Netherlands	1,888	<2 %	14.761	14 %
Denmark	773	<1 %	5,824	<6 %
Total	111,945	100 %	107,367	100 %



4.6.3

Vessels

A wide range of fishing vessels are known to operate in the ECR and the various types are described in detail in the Poseidon Technical Report (2002). The main types of fishing vessels include: stern trawlers, twin rig stern trawlers, pair trawlers, pelagic trawlers/freezer trawlers, beam trawlers, scallop dredgers and gill netters. Table 4.6 summarises vessel types and numbers for the most significant countries operating in the ECR. France operates the largest fleet in the region with over 250 vessels, followed by the UK with between 80 and 130 vessels and Belgium with between 50 and 70 vessels.

A detailed breakdown of this data indicates that quadrants 3 and 4 (Q3 and Q4 Figure 4.9) in area 30FO are possibly the most 'visited' by both French (up to 150 vessels) and UK vessels (up to 100), whereas quadrants 1 and 2 of area 29FO are used by up to 80 French vessels and a few Belgian and Dutch vessels. Area 29E9 is visited by up to 50 French vessels but only a few UK, Belgian and Dutch vessels.

Table 4.6	Vessel types used by selected nationalities operating in the ECR
France:	163 to 171 stern trawlers active in the region 8 to 12 scallop dredgers 6 potters 1-4 beam trawlers 3 gill netters
Belgium:	42-55 beam trawlers 2 stern trawlers 1 long liner 1 pelagic stern trawler
UK:	22-49 stern trawlers 27-37 beam trawlers 7-21 scallop dredgers 15-19 potters 5 - 12 gill netters 2 seine netters 1-2 pair trawlers 3 pelagic trawler / freezer trawlers intermittent activity by a suction dredger
Netherlands:	2-5 stern trawlers 1-3 beam trawlers 2 pelagic freezer trawlers
Germany:	1 trawler 1 beam trawler 2 pelagic freezer trawlers

Activity data (in terms of vessels, nationality and seasonality) is also available by quadrant and can be found in the Poseidon Technical Report (2002). Caution is recommended in the interpretation of this information, as data by quadrant may include vessels fishing in more than one area and there may be discrepancy in vessel definitions. For example, vessels defined as trawlers may in fact be scallop dredgers while vessels described as potters may indeed be netters. Information is also available on the home port of most vessels operating in the ECR.

4.6.4 Seasonality

Information on the seasonality of fishing activities indicates that although activity is highest in the winter months, some quadrants experience continued levels of activity throughout the year. Area 30FO and the north-eastern parts of 29FO, for example, appear to be subjected to continuous levels of activity throughout the year, except July. Area 29FO is continually fished but concentrations are greatest in the northern part of the ECR. May to August represent less active times but it is also reportedly the period when UK netters operate in the ECR. In general, area 29E9 is associated with less intensive periods of fishing in the summer months. A detailed analysis of fishing activity by season can be found in the Poseidon Technical Report (2002). Figure 4.18 provides an illustrative overview of seasonal fishing effort in the study area (quarterly) and Table 4.7 describes fishing effort by month.

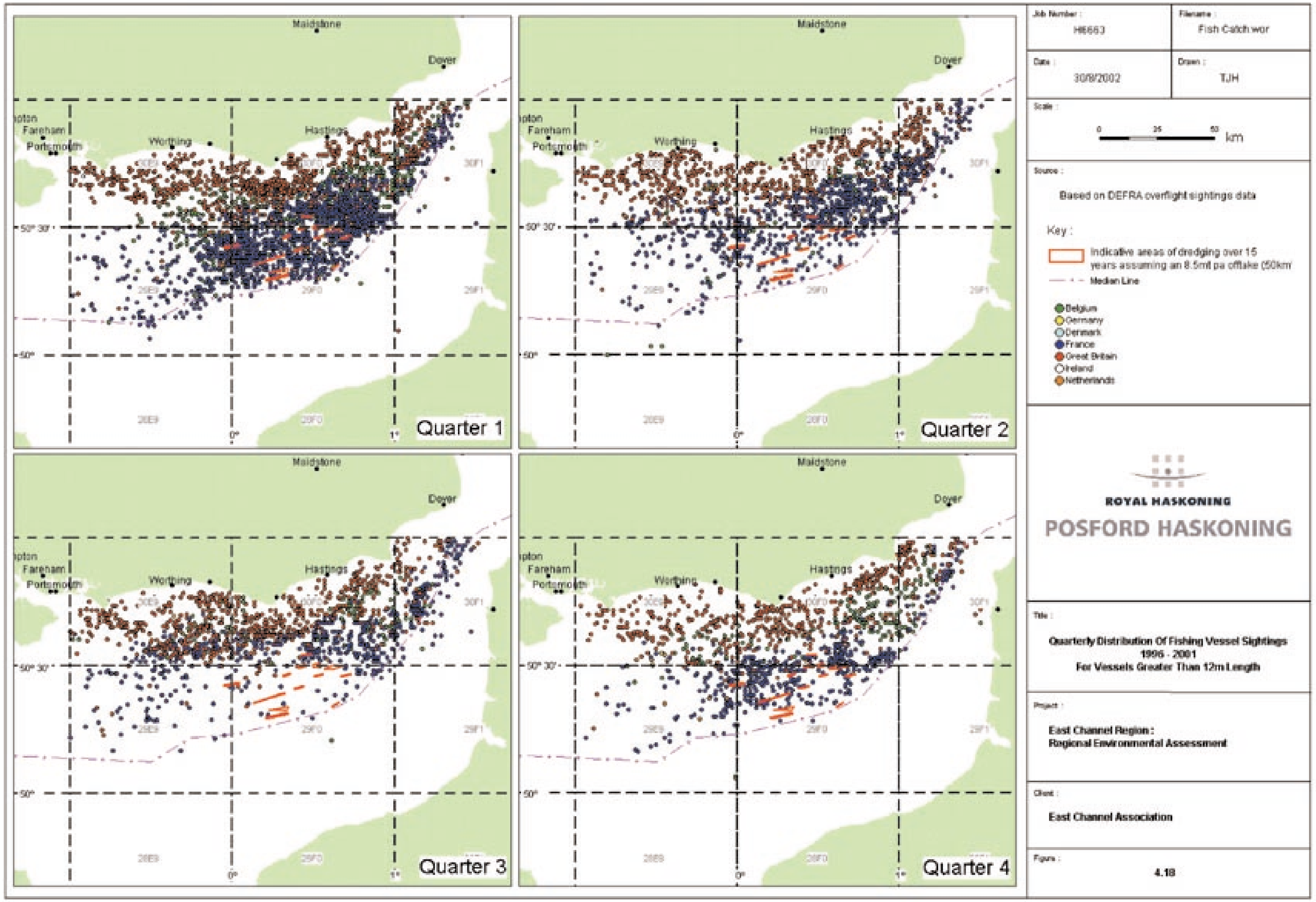

Maidstone
Dover
Fareham
Portsmouth
Worthing
Hastings
50° 30'
50°
0°
1°
Quarter 1
Quarter 2
Quarter 3
Quarter 4
Job Number :
H6663
Filename :
Fish Catch.wor
Date :
30/9/2002
Drawn :
TJH
Scale :
0
25
50
km
Source :
Based on DEFRA overflight sightings data
Key :
Indicative areas of dredging over 15 years assuming an 8.5mt pa offtake (50km²
Median Line
Belgium
Germany
Denmark
France
Great Britain
Ireland
Netherlands
ROYAL HASKONING
POSFORD HASKONING
Title :
Quarterly Distribution Of Fishing Vessel Sightings 1996 - 2001 For Vessels Greater Than 12m Length
Project :
East Channel Region : Regional Environmental Assessment
Client :
East Channel Association
Figure :
4.18

Table 4.7	Monthly distribution of fishing activities (note that concentration of activity is relative)		
Month	29E9	29FO	30FO
January	High concentration of French activity inside the ECR. Belgian activity largely outside the ECR.	Belgian and French activity throughout the ECR. Greater concentrations of French activity in the south. Some Dutch activity in the south. Some UK activity in the North, but outside the ECR.	High concentrations of Belgian and French activity. Some British and Dutch activity.
February	Greater concentration of activity than in January. French, Belgian and Dutch activity inside ECR.	Greater concentration of activity than in January. Largely French activity inside ECR.	Greater concentration of activity than in January (France, Belgium, UK & NL).
March	High concentration of French and Belgian activity.	High concentration of French activity.	Very heavy concentration in 30FO by French vessels. Some Belgian activity.
April	Activity by French vessels inside the ECR.	Activity (French / Belgian) spread throughout the area but of lower intensity).	Very heavy concentration of French activity.
May	Very low level of activity inside ECR (1 French vessel).	Much reduced levels of activity by French and Belgian vessels.	Still reasonably high levels of activity by French and Belgian vessels.
June	Increased levels of French activity.	Much reduced levels of activity. Southern ECR, almost totally clear of activity.	Still reasonably high levels of activity by French vessels. Some UK / Belgian activity.
July	Almost totally clear of activity.	Almost totally clear of activity.	Almost totally clear of activity.
August	Almost totally clear of activity.	Almost totally clear of activity. Some UK activity in the Northern part of the ECR.	Marginally higher levels of activity than July.
September	Small amount of UK / French activity.	Activity largely confined to north-eastern end of the ECR.	Increased levels of activity by UK, French and Belgian vessels.
October	Almost totally inactive inside ECR, but high levels of activity just outside by UK, French and Belgian vessels.	Increased French / UK activity in the northern part of the ECR.	French and a small amount of UK / Belgian activity.
November	Increased activity – Belgian vessels.	Higher levels of French activity in northern and eastern parts of the ECR.	High levels of UK, Belgian, French and Dutch activity.
December	Reasonably high levels of French activity.	French activity greatest in central part of the ECR.	Belgian and French activity.

4.7 Navigation

4.7.1 Introduction

A considerable amount of data is available on shipping and navigational activities in the ECR. Data sources include information from the Maritime and Coastguard Agency, the Channel navigation information services and the Met Office Marine Consultancy Service. Several studies on the shipping and navigational issues associated with dredging in the ECR have been undertaken by the Applicant companies, and these have provided a basis for the REA (Hanson, 2001; Volker, 2000; Oakwood, 2000).

The navigation risk assessment undertaken as part of the REA focused on the Eastern English Channel Traffic Separation Scheme (TSS); in and around which the proposed dredging licence areas are located. An overview is presented in Figure 4.19. The TSS is the vessel management system operating in the Dover Strait, which ensures that vessels proceeding in a south westerly direction are separated from those proceeding in the opposite north easterly direction.

Figure 4.19 The Eastern English Channel Traffic Separation Scheme (from UKHO Chart 2675)

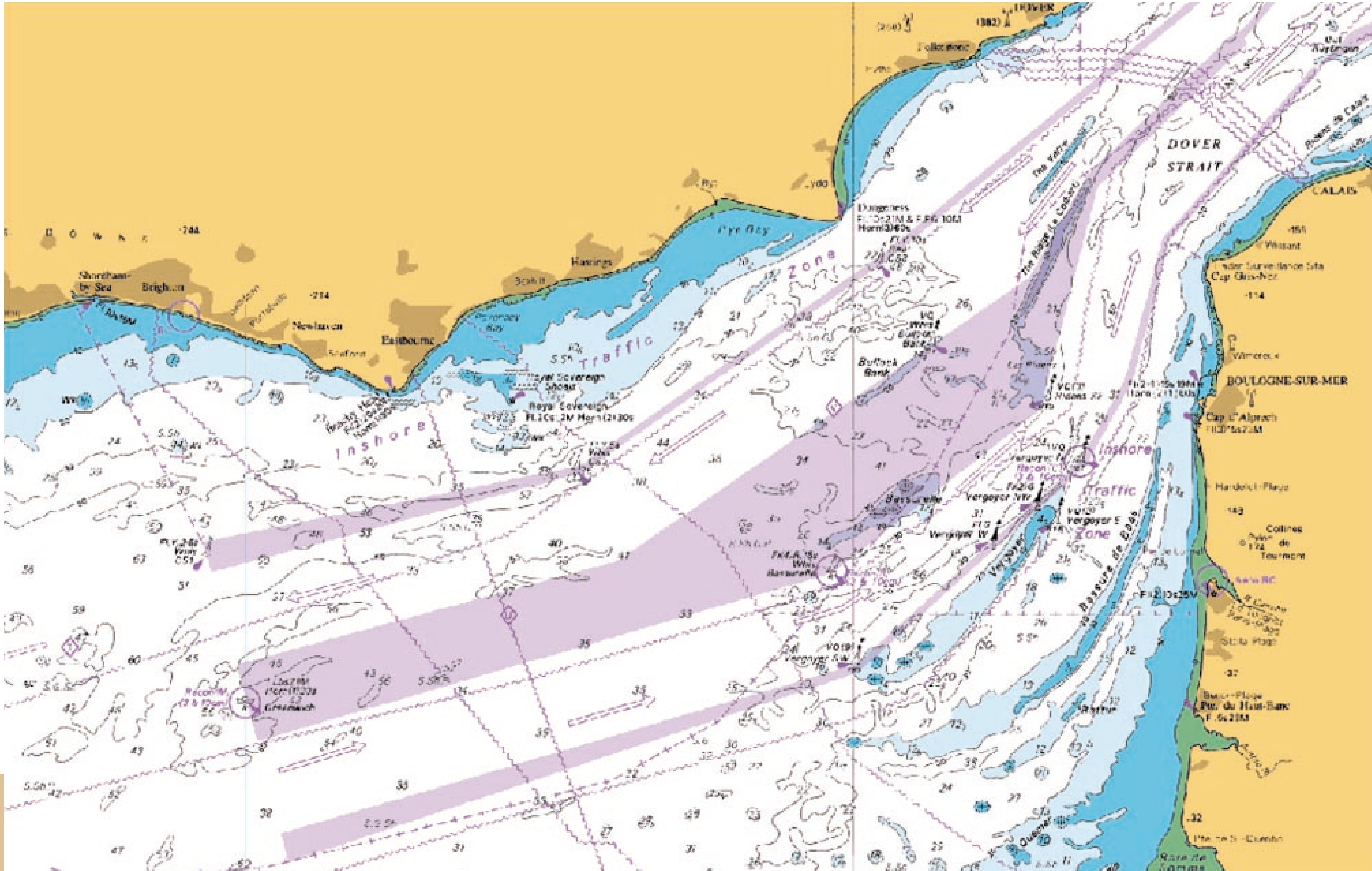
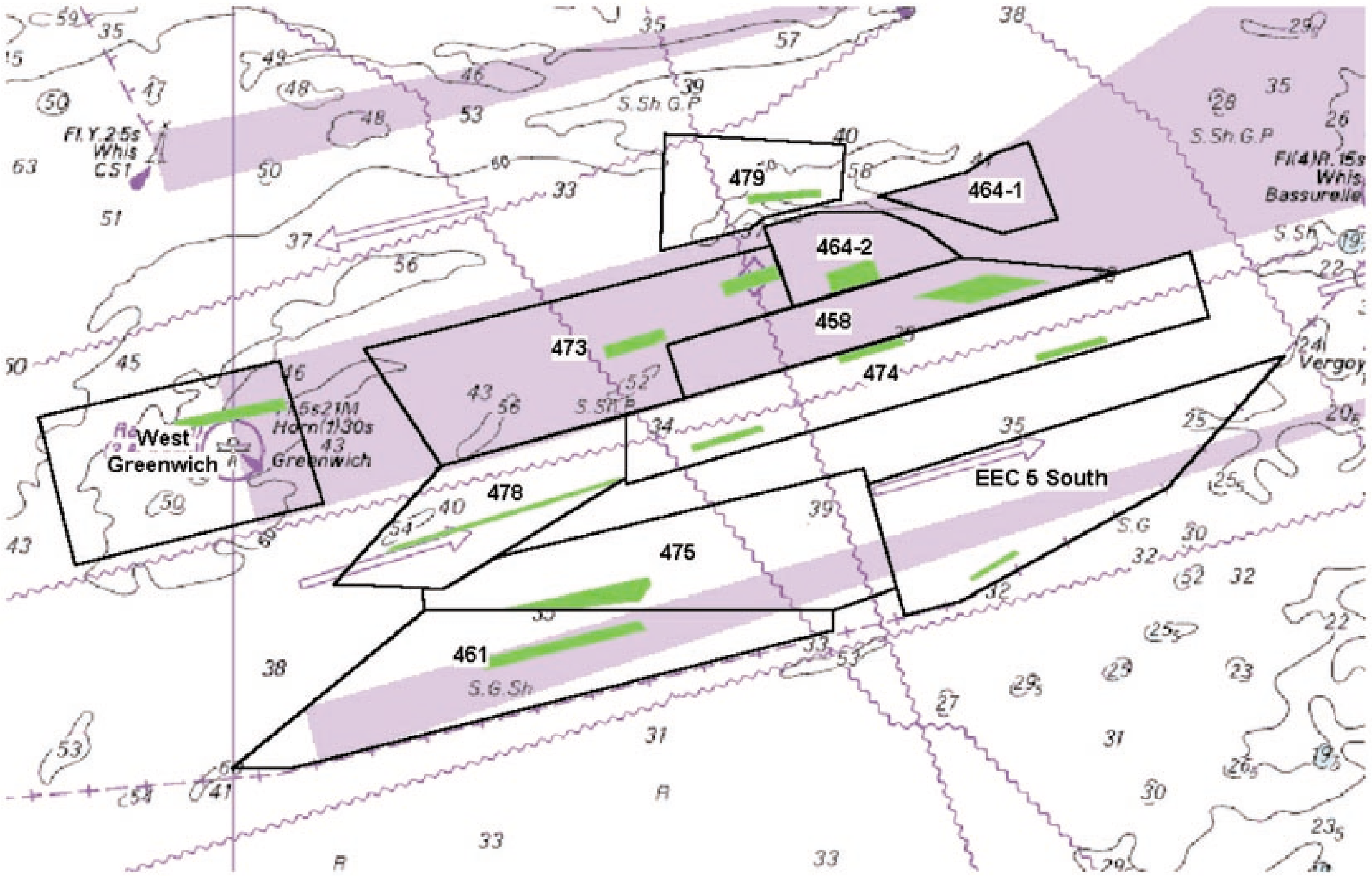


Figure 4.20 The ECR Prospecting Areas and Indicative Dredging Areas (based on UKHO Chart 2675)



Tidal stream data for the area shows that the current generally runs in the direction of the traffic lanes, i.e. directly with or against the traffic. This will assist in minimising the disruption to traffic associated with the dredging operation, in that the dredgers in the traffic lanes will be dredging roughly parallel to the flow of traffic.

All vessels navigating in the area, including dredgers, must comply with the International Regulations for Preventing Collision at Sea 1972 (as amended) (the 'ColRegs'). The ColRegs provide a set of rules to facilitate safe navigation and to minimise collision risk and disruption during encounter situations. In particular, Rule 10 of the ColRegs covers TSSs, for example, a vessel shall:

- Proceed in the appropriate traffic lane in the general direction of traffic flow for that lane;
- So far as practicable keep clear of a traffic separation line or separation zone;
- Normally join or leave a traffic lane at the termination of the lane, but when joining or leaving from either side shall do so at as small an angle to the general direction of traffic flow as practicable.

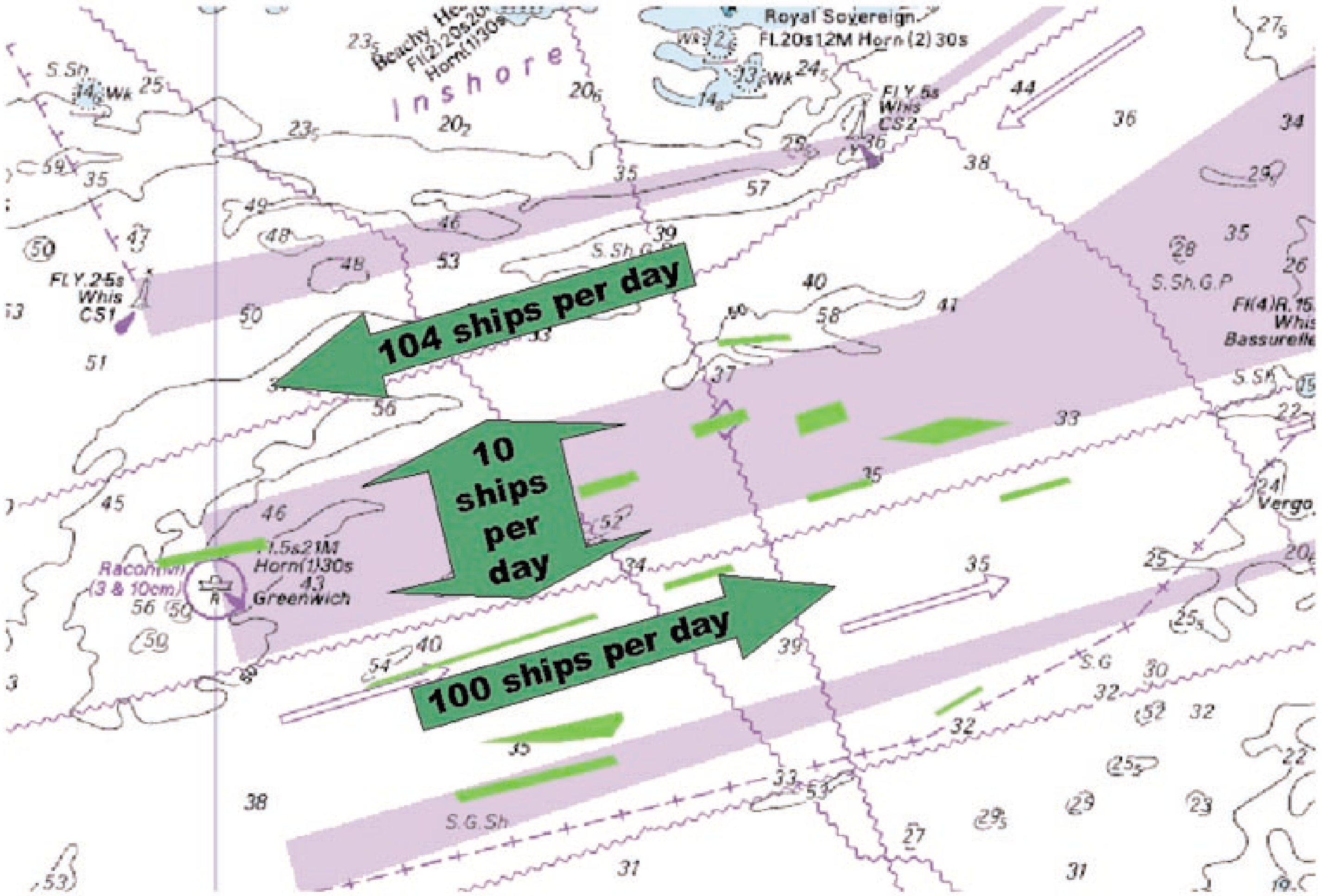
In addition, a mandatory reporting scheme applies in the Dover Straits where all vessels over 300 GRT are required to report to the CNIS at Dover for vessels using the South-west lane and to Gris Nez in France for vessels using the North-east lane. SW-bound vessels generally report when approaching the Falls Light Vessel and NE-bound vessels at the Bassurelle buoy.

Other legislation that pertains to the safety of shipping includes the International Management Code for the Safe Operation of Ships and for Pollution Prevention (the ISM Code). The Code establishes safety-management objectives and requires a Safety Management System (SMS) to be established by "the Company", which is defined as the shipowner or any person, such as the manager, who has assumed responsibility for operating the ship.

A GIS-based grid was created to carry out the risk modelling, encompassing the following features of the TSS:

- NE-bound and SW-bound Traffic Lanes;
- Southern, Central and Northern Separation Zones; and
- Sea areas adjacent to TSS (up to approximately 10nm).

Figure 4.21 Overview of Main Shipping Movements in the Area



This covered an approximate area from west of the Greenwich buoy to the Bassurelle buoy, as presented in Figure 4.20, which also shows the indicative dredging areas.

It can be seen that the indicative dredging areas represent only a small proportion of the sea area in and around the TSS (total dredging area of 50km^2 or 15nm^2 over 15 years).

To put the activity in perspective, the width of the NE-bound traffic lane (from southern to central separation zone) is approximately 6nm, with the central separation zone at 4 to 5nm and southern zone 1 to 2nm. The dimensions of a typical dredger are 100m (length) by 20m (beam).

4.7.2

Shipping Densities in the ECR

The traffic lanes of the TSS are characterised by very high shipping densities (approximately 100 vessels per day in each direction). Within the separation zones and to the south of the TSS the shipping density is much lower, with approximately 10 vessels per day crossing these zones.

An illustration of the average daily merchant shipping densities passing through the area is presented in Figure 4.21.

The distribution of ship types passing through the East Channel Region is presented in Figure 4.22. Non route-based traffic, such as fishing, naval and recreational vessels, has not been considered.

The majority of vessels using the ECR are cargo ships (just under 60%), bulk carriers (11%) and oil tankers (10%). The ferries identified are travelling on the Hoverspeed route between Newhaven and Dieppe.

More detailed information has been collected on individual shipping routes within the area based on the COAST shipping database, CNIS radar plots and reference to the latest ferry timetables (Hoverspeed Newhaven/Dieppe service).

From this data, a shipping density plot was generated to show the variation in shipping density within the area (Figure 4.23). More details on shipping data is provided in the Anatec Technical Report, 2002.

Figure 4.21 Vessel Type Distribution within the East Channel Region

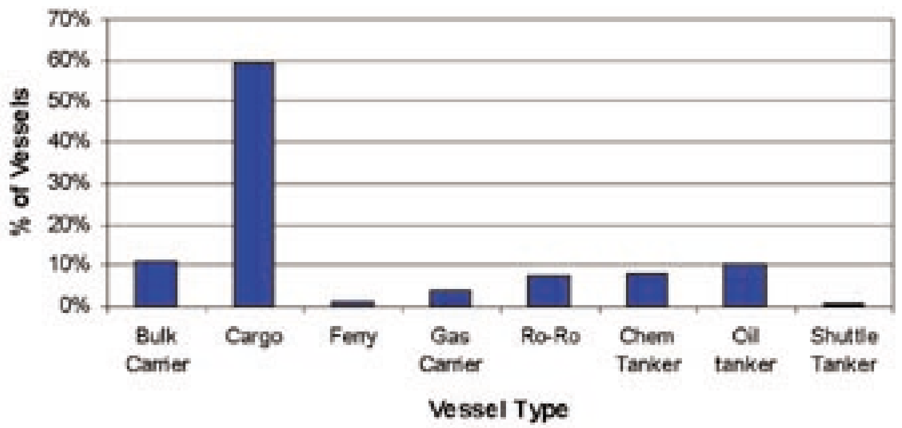
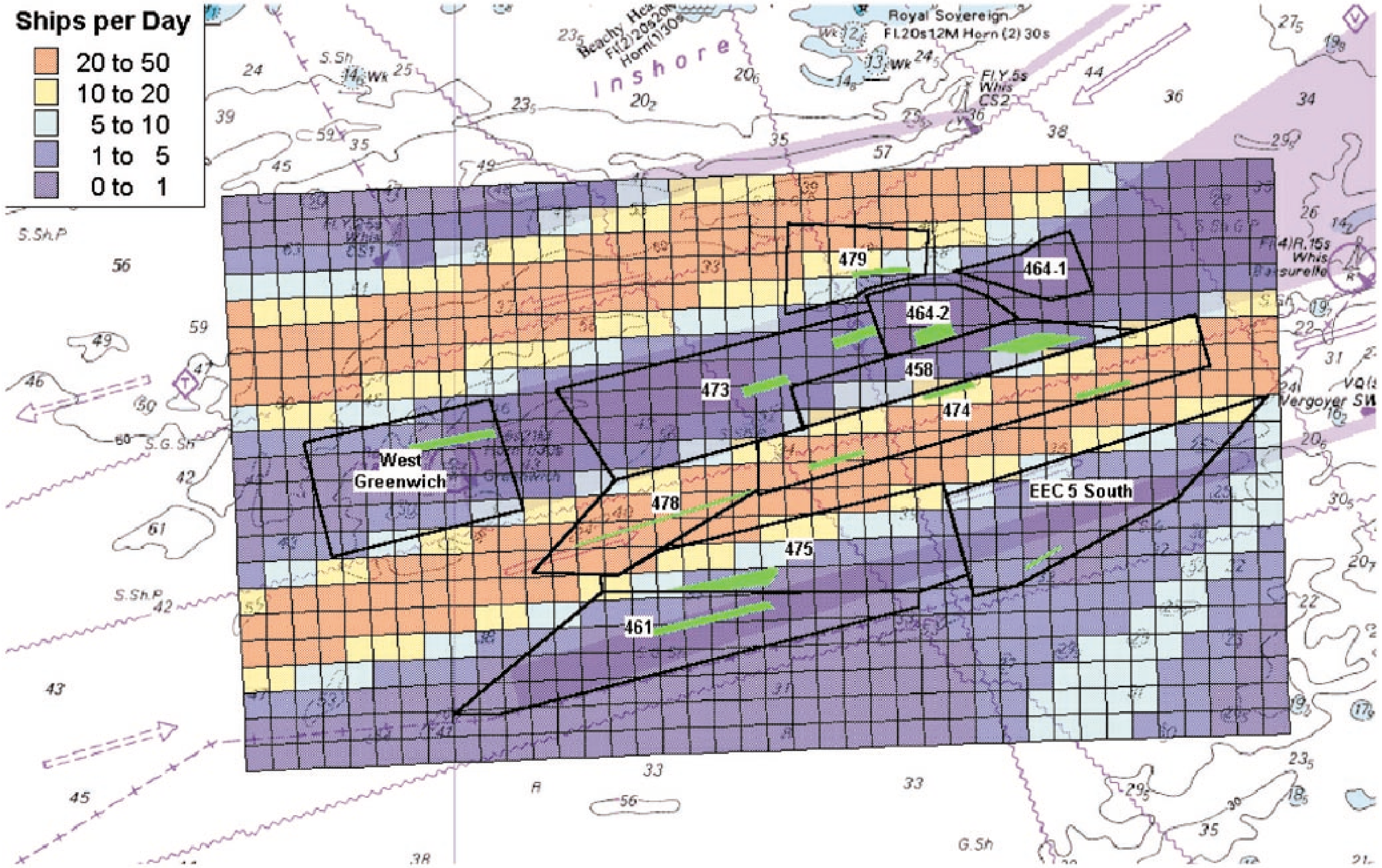


Figure 4.23 Average Daily Shipping Densities within the ECR



From the colour-coded shipping plots it can be clearly seen that the traffic lanes within the TSS have the highest shipping levels (coloured red). Use of the fringe of the separation zones, immediately adjacent to the traffic lane, tends to be low to moderate in terms of shipping, with the use of the remainder of these zones generally being low to very low (coloured blue).

In terms of the existing shipping density, Table 4.8 provides the relative ranking for each of the proposed dredging areas.

4.7.3

Historical Ship Collision Data

During the period 1 January 1983 to 9 October 2001 there were a total of 77 ship collisions reported by CNIS in the ECR and Dover Strait. Throughout this period the number of collisions varied considerably between individual years, with no collisions in 1993 and ten in 2001. Of the 77 ship collisions, 75 had the location of the incident reported and these are presented in Figure 4.24. From the plot, it can be seen that the vast majority of collisions have occurred in the Dover Strait, where the traffic lanes are narrower than they are in the ECR. Also of note is that the vast majority of collisions have occurred within the traffic lanes.

Table 4.8 Shipping Densities in the ECR Prospecting Licence Areas

Rank	Area (see Figure 3.1)
High	474, 478, 479
Medium	458 (adjacent to traffic lane), 475, EEC5 South
Low	458, 461, 464-1, 464-2, 473, 477

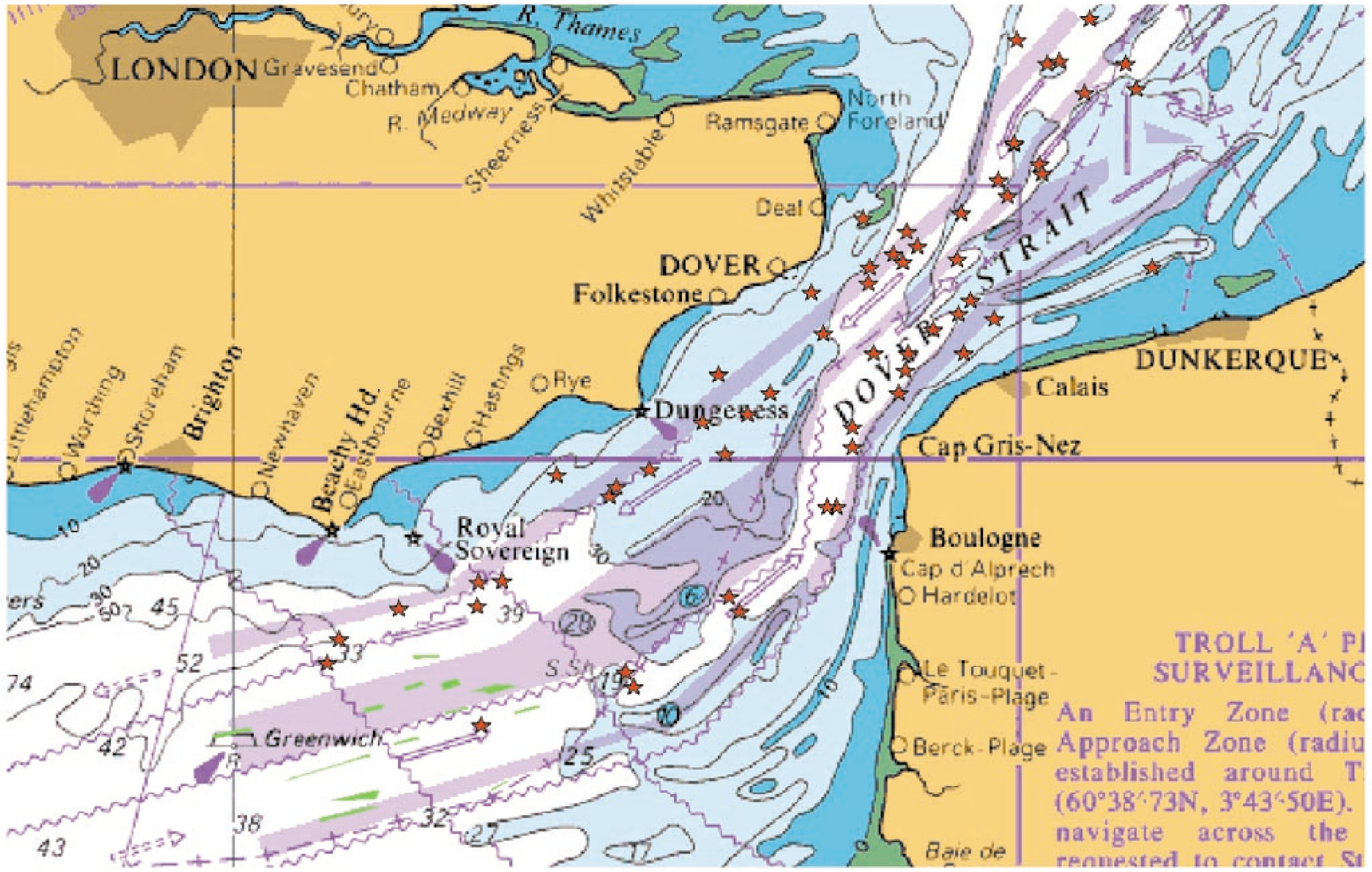


Figure 4.24 Location of Ship Collisions Reported by CNIS (1983 to Oct 2001)

Analysis of the incidents shows that poor visibility (defined as less than or equal to 1nm) was a factor in 26% of the collisions reported by CNIS (see Anatec Technical Report, 2002). Comparison of this figure with the average yearly probability of poor visibility (3.5%), indicates that poor visibility is a significant factor in the risk of ship to ship collisions.

The distribution of vessel types involved in collisions indicates that over two-thirds involved merchant vessels and tankers. Of the other vessel types, 23% involved fishing vessels (French or Belgian), 4% yachts and 3% others, such as tugs and barges.

4.7.4
Ship Collisions in the ECR

Analysis of the ship to ship collisions that have occurred in the ECR indicates that:

- In the north-east bound lane, two of the three collisions occurred in bad visibility, involving five merchant vessels and one fishing vessel;
- In the south-west bound lane nine collisions occurred, involving 12 merchant ships, five fishing vessels and one tanker. Two of the nine collisions occurred in bad visibility;
- The single collision within the central separation zone occurred in 2001 between two fishing vessels in bad visibility; and
- Two collisions were reported in the northern separation zone.

4.8
Archaeology

4.8.1
Introduction

Data used to compile an overview of the archaeological interests in the ECR has been drawn from a number of sources, including the Maritime Section of the National Monuments Record; the Wreck Index of the UK Hydrographic Office; the database (DRACAR) of the Direction Regionale d'Archeologie de Haute-Normandie and the internal database of the Musée Departemental de la Somme.
Three themes of archaeological concern are addressed:

- Lower, Middle and Early Upper Palaeolithic;
- Late Upper Palaeolithic and Mesolithic;
- Maritime.

With respect to each theme, this chapter addresses what is *Known*, the *Potential* for archaeological material to have been deposited within ECR, the *Importance* of any such material, and its possible *Survival* to the present day.

The archaeology study area covers the Prospecting Areas in the ECR. In addition, information has been obtained about the prehistoric archaeological heritage from a broader region, encompassing the south coast of England and the north coast of France. The study area and broader region are shown in Figure 4.25.

4.8.2
Lower, Middle and Early Upper Palaeolithic

The Lower, Middle and Early Upper Palaeolithic periods cover c. 460,000 years of human inhabitation, from the Cromerian interglacial site at Boxgrove to the Devensian glacial maximum c. 18,000 BP. These periods encompass several glacial cycles, including cold periods when the ECR, now lying at 35 to 55m below Chart Datum, may have been exposed as dry land. It is estimated that sea level was at least 50m below that of the present day for around 40% of the Lower, Middle and Early Upper Palaeolithic, that is c. 180,000 years. Former land surfaces and occupation sites from these periods are known to survive either side of the English Channel.

Additionally, the ECR is thought to include the palaeo-valleys of the rivers Somme, Canche and Authie. These palaeo-valleys include deposits of material eroded from higher parts of their respective catchments. Comparable deposits from terrestrial sections of the Somme, Canche and Authie, and from equivalent catchments in southern England, are known to contain derived artefacts of Lower Palaeolithic date, sometimes in large numbers that are capable of interpretation.

Known

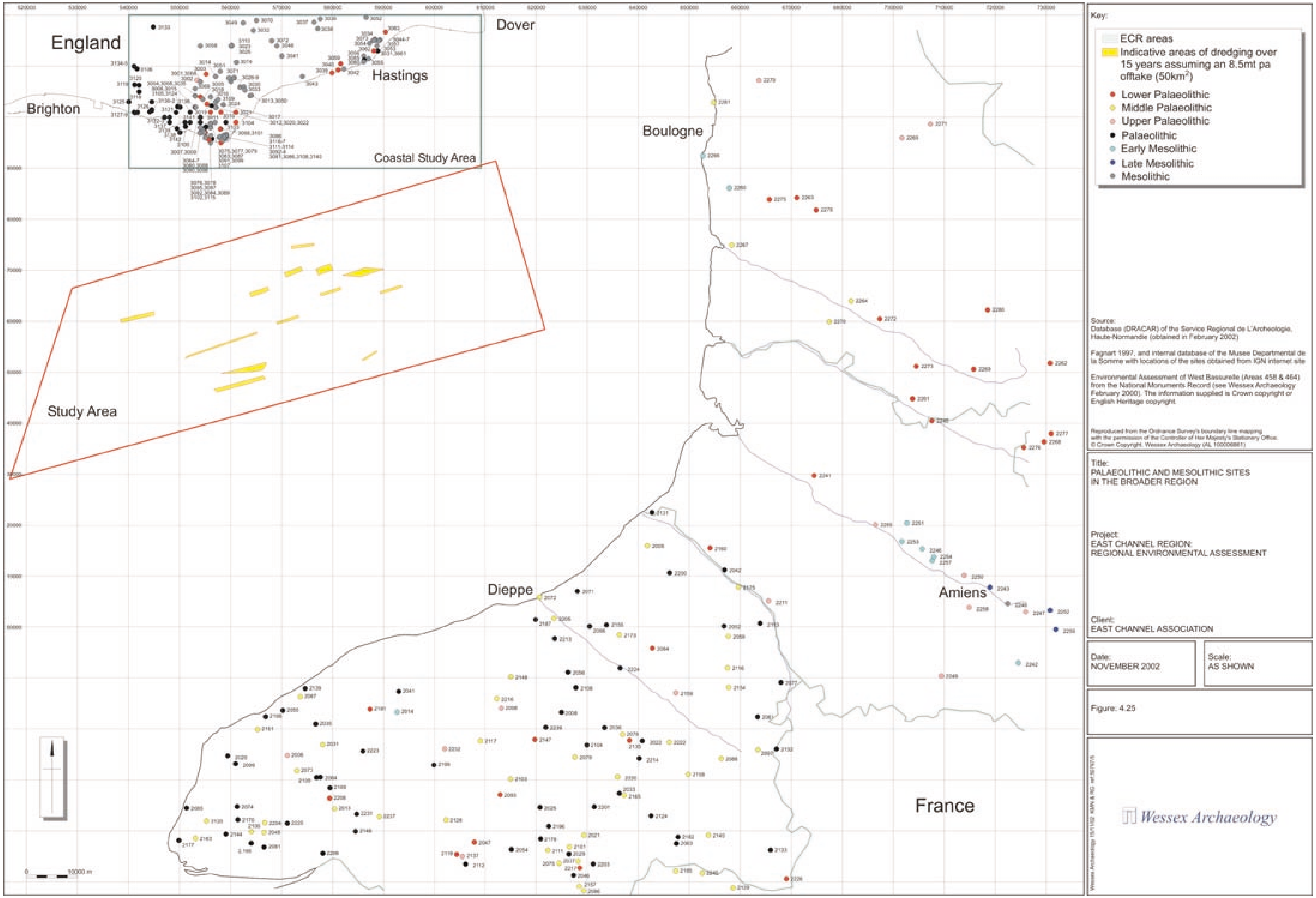
There are no reported sites or artefacts of Lower, Middle and Early Upper Palaeolithic date from the ECR. However, relevant sites are known to exist within the broader region (Figure 4.35), encompassing the south coast of England and the north coast of France (see Wessex Archaeology Technical Report, 2002)

Potential

The palaeo-environmental context of the ECR and the known sites in the broader region indicate that the ECR would have been inhabited at various times during the Lower, Middle and Early Upper Palaeolithic. There is potential for relics of this inhabitation, and of inhabitation further up the palaeo-catchments of the Somme, Authie and Canche, to be present within the ECR. These relics may comprise *in situ* scatters of artefacts, hearths, faunal remains and deposits of palaeo-environmental interest, plus derived artefacts and flakes within bodies of sand and gravel.

Importance

It is likely that any archaeological material of Lower, Middle and Early Upper Palaeolithic date within the ECR will meet at least one of the criteria of importance set out by English Heritage in *Identifying and Protecting Palaeolithic Remains: Archaeological Guidance for Planning Authorities and Developers* (May 1998). As the palaeo-catchments present in the ECR rise in France, then any archaeological material will also be relevant to the archaeological heritage of France and will, by definition, be of international importance. Moreover, the successful location and investigation of Lower, Middle and Early Upper Palaeolithic material from the UK Continental Shelf is likely to be of international importance on methodological grounds alone.



England
Dover
Hastings
Brighton
Coastal Study Area
Boulogne
Study Area
Dieppe
Amiens
France
Key:
ECR areas
Indicative areas of dredging over 15 years assuming an 8.5mt pa offtake (50km²)
Lower Palaeolithic
Middle Palaeolithic
Upper Palaeolithic
Palaeolithic
Early Mesolithic
Late Mesolithic
Mesolithic
Source:
Database (DRACAR) of the Service Regional de L'Archeologie, Haute-Normandie (obtained in February 2002)
Fagnart 1997, and internal database of the Musee Departmental de la Somme with locations of the sites obtained from IGN internet site
Environmental Assessment of West Bassurelle (Areas 458 & 464) from the National Monuments Record (see Wessex Archaeology February 2000). The information supplied is Crown copyright or English Heritage copyright.
Reproduced from the Ordnance Survey's boundary line mapping with the permission of the Controller of Her Majesty's Stationery Office. © Crown Copyright. Wessex Archaeology (AL 100006881)
Title:
PALAEOLITHIC AND MESOLITHIC SITES IN THE BROADER REGION
Project:
EAST CHANNEL REGION: REGIONAL ENVIRONMENTAL ASSESSMENT
Client:
EAST CHANNEL ASSOCIATION
Date:
NOVEMBER 2002
Scale:
AS SHOWN
Figure: 4.25
Wessex Archaeology

Survival

The glacial cycles referred to above will have had a considerable effect on the geomorphological processes active in each palaeo-valley, and the whole ECR has undergone several major marine transgressions. These processes will have had an effect on both *in situ* and derived material of archaeological interest. The extent of disruption and disturbance, however, is not known. Vibrocores suggest that, notwithstanding the massive forces at play, some delicate former terrestrial deposits have survived. Such survival implies that archaeological material may have also survived *in situ* or in deposits that retain sufficient integrity to warrant investigation.

4.8.3
Late Upper Palaeolithic and Mesolithic

The Late Upper Palaeolithic and Mesolithic periods encompass human inhabitation of the ECR between the Devensian glacial maximum, around 18,000 BP when relative sea level was about 120m below present, and the onset of fully marine conditions around 8600 BP when sea level had risen to about 35m below present. Re-occupation of the north west margin of Europe following the Devensian glacial maximum is thought to date to around 13000 BP, hence the ECR is likely to have been capable of inhabitation over c. 4000 years.

Amelioration of the climate following the Devensian maximum (the Windermere interstadial) was interrupted by a relatively brief return to harsh conditions during the Loch Lomond Stadial c. 11,000 BP, after which conditions improved and sea level rose rapidly. Late Upper Palaeolithic peoples inhabited the broader region during the Windermere interstadial and, following the Loch Lomond Stadial, transient late glacial populations clearly developed more Mesolithic attributes as tundra gave way to woodland.

Known

There are no reported sites or artefacts of Late Upper Palaeolithic or Mesolithic date from the ECR. However, relevant sites are known to exist within the broader region.

Potential

As for the previous period, the palaeo-environmental context of the study area indicates that the ECR is likely to have been inhabited during the Late Upper Palaeolithic and Early Mesolithic, with the potential for the presence of similar relics of inhabitation. Although the populations in these periods are likely to have been small and widely dispersed, the quantity of artefactual material that they generated can be high (sometimes greater than 80 items per square metre), especially where encampments were subject to repeat visits.

Importance

Again, as for the previous period, it is likely that any archaeological material of Late Upper Palaeolithic or Early Mesolithic date would be considered to be of national or international importance, because such sites have only rarely been subject to controlled investigation in the past.

Survival

As for the previous period, the major marine transgression in the course of the Late Upper Palaeolithic and Early Mesolithic will have had an effect on *in situ* material of archaeological interest. Although the extent of disruption and disturbance is not known, vibrocores of former terrestrial deposits suggest that some delicate material has survived. Such survival implies that archaeological material may also have survived *in situ*.

4.8.4
Maritime

Known

A search of the maritime section of the National Monuments Records and the wreck index of the UK Hydrographic Office produced 294 recorded sites of maritime archaeological interest in the wider study area, comprising 96 located wreck sites, 102 seabed obstructions and 96 casualties (recorded losses). Within and close to the proposed dredging Permission Areas there are seven located wreck sites and two obstructions, whereas in the ECR (Prospecting Areas) there are 31 located wreck sites, 17 seabed obstructions and seven casualties (see Figure 4.26). Where dated, the sites in the ECR span the Post-medieval and Modern periods. Seafaring within the ECR may, however, date back to the inundation of the ECR in the Mesolithic. Maritime sites of Prehistoric, Roman and Medieval date are known elsewhere in Europe and many of the processes that caused ships to founder in the ECR in the last 450 years will have caused losses in previous millennia.

Potential

The seabed obstructions may indicate the presence of wreck sites of archaeological interest, and the remains of at least some casualties may be present in the ECR. The potential also exists for the remains of other wrecks to be present which are not sufficiently prominent to have been identified as seabed obstructions. Furthermore, it is likely to be the case that many more losses occurred within the ECR than are represented by the recorded casualties, particularly in earlier centuries. As indicated above, the potential for maritime sites encompasses all periods from the Mesolithic to Modern times.

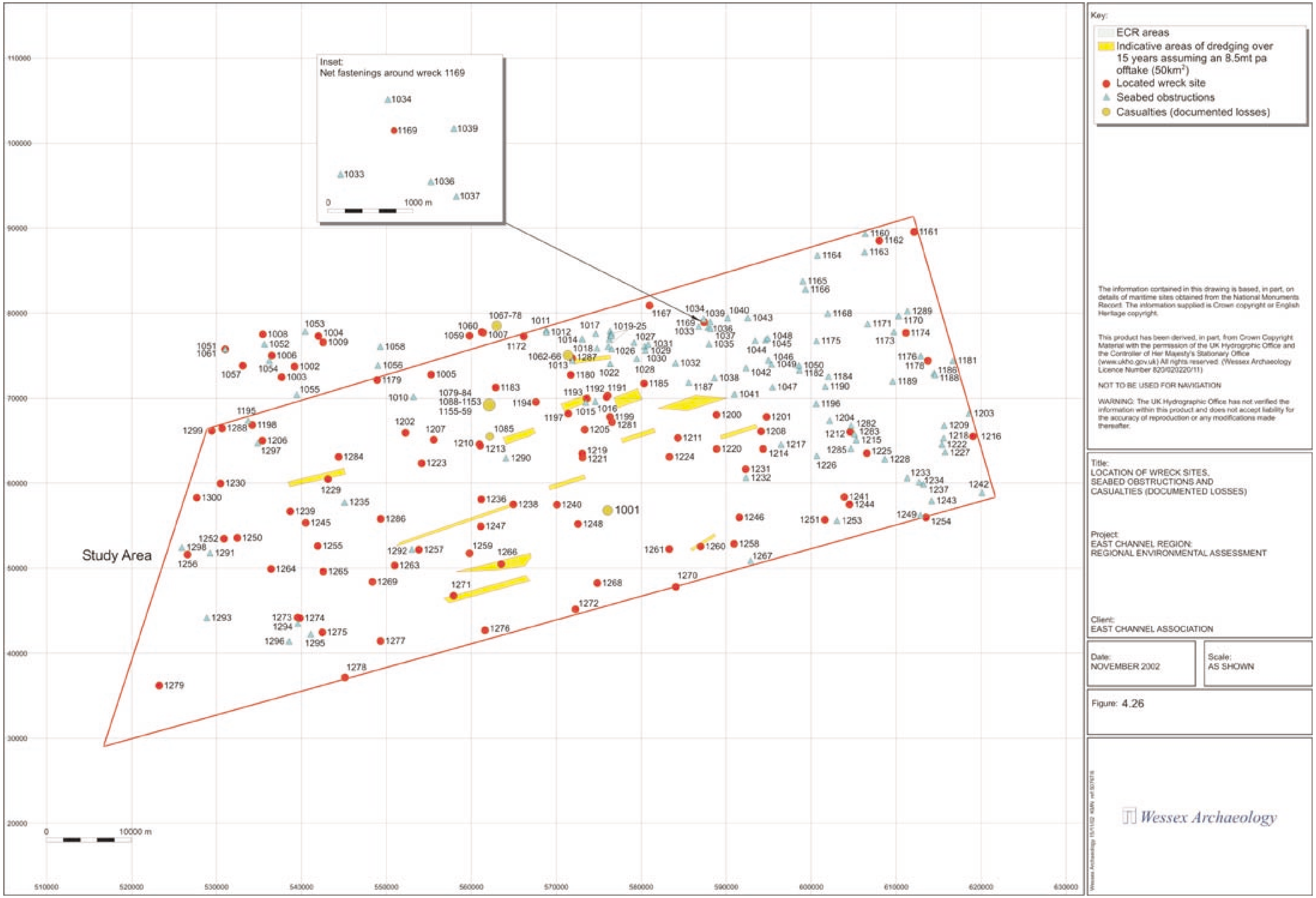


Chart reproduced from admiralty charts by permission of the controller of Her Majesty's Stationery Office and the UK Hydrographic Office. Not to be used for navigation.

Importance

Any maritime site of Prehistoric, Roman or Medieval date is almost certain to be of national or international importance. In addition, some of the maritime sites of Post-medieval and Modern date may be of at least national importance, although the evaluation of importance can only be made on a case-by-case basis. Of these sites, some are also likely to be relevant to the archaeological heritage of France as well as Britain (and possibly to the archaeological heritage of other countries also) and will, by definition, be of international importance.

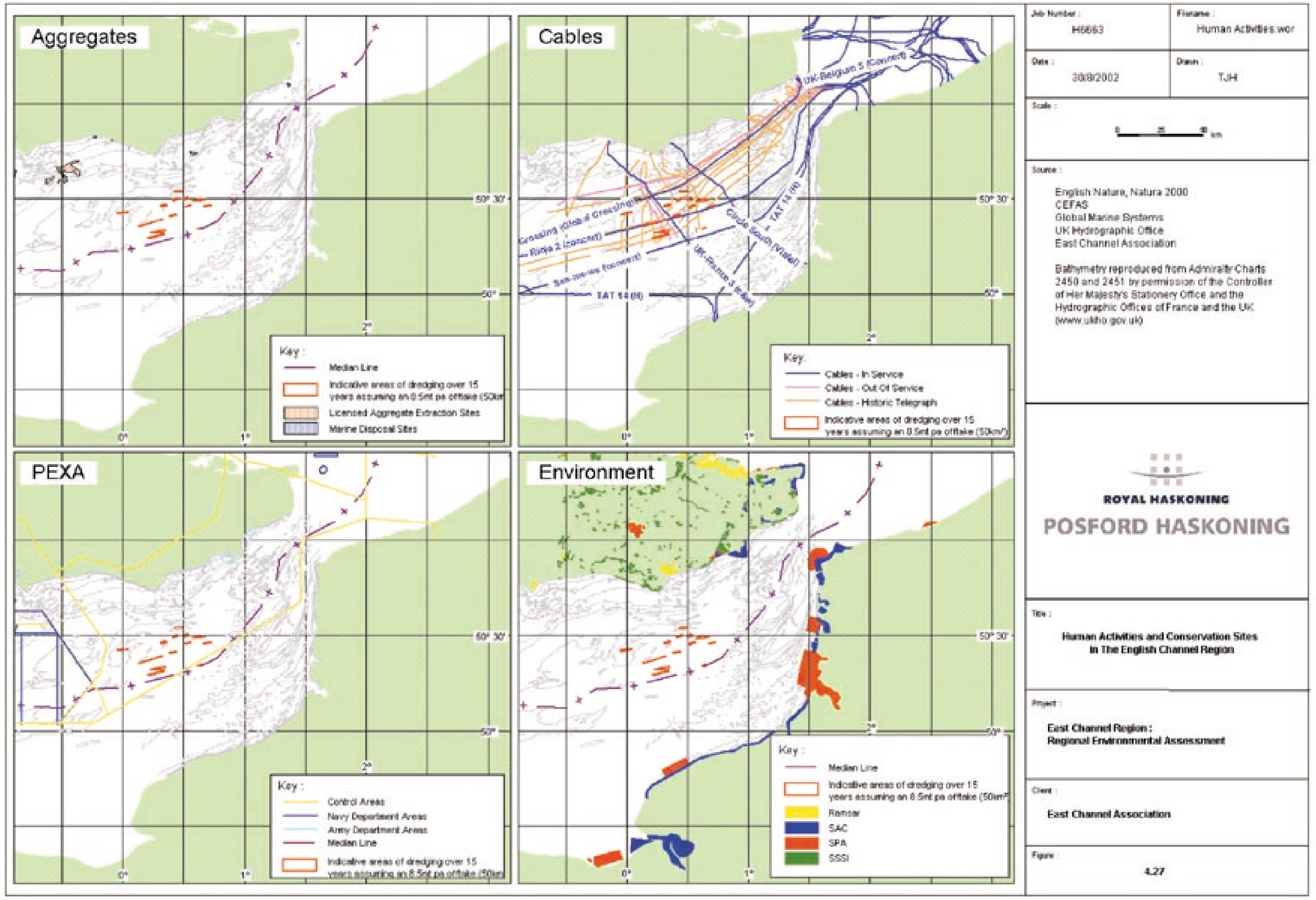
Within the ECR there are around 20 wrecks dated from the First World War and 10 wrecks from the Second World War sunk while in military service or due to military action. These sites may be regarded as important on account of their status as military remains.

Survival

Maritime sites undergo a series of destructive processes in the course of wrecking up to the point at which they reach the seabed. Thereafter, a series of further processes cause additional and often rapid deterioration until a state of relative stability with the environment is achieved. Once a site has stabilised, however, the continued preservation of surviving remains is often very good. Notably, material that is buried or protected in upstanding hulls will be well preserved, especially where anaerobic (low oxygen) conditions prevail. Further instability, caused by natural or human impacts, may cause additional episodes of deterioration and re-stabilisation.

The located wreck sites and seabed obstructions comprise sufficient material to have been located and, in some cases, dived. However, some of the seabed obstructions may be wholly natural (e.g. rock outcrops, gravel patches) in origin. The quality of located sites and obstructions can only be evaluated on a case-by-case basis.

As indicated above, additional sites are likely to be present in the ECR that have not yet been located. Where the current invisibility of such sites is attributable to them being buried, then preservation of surviving remains is likely to be good, even if formerly upstanding elements have been destroyed.



4.9
Other Activities

4.9.1
Introduction

This section is concerned with other activities in the ECR that may be influenced by, or influence, the extraction proposals, including cables and pipelines, military activities, offshore oil and gas, and recreation.

The study area includes the sea area between the Dover Straits and east of the Isle of Wight, up to and including the French coastline.

4.9.2
Cables

There are a number of submarine cables (telecommunications and fibre optic) in the ECR which can be classified into short distance, long-distance and disused cables (UKCPC), as follows.

Short Distance Cables

The "UK-France 3" cable links Brighton with Dieppe. It is 154km long and dissects the ECR, passing through six of the application areas (www.alcatel.com). It does not pass through any of the proposed dredging Permission Areas.

The "Circe South" cable is located close to the western boundary of the ECR and links Pevensey Bay in the UK with Cayeux-sur-Mer in France (www.iscpc.org). Both are indicated on Figure 4.27.

Long Distance Cables

At the northern boundary of the ECR, the "Atlantic Crossing 1" cable passes in an east-west direction connecting the United States with the UK, the Netherlands and Germany. This cable runs for a distance of over 14,000km (globalcrossing.com)

The 39,000km cable "SEA ME WE 3" is located to the south of the ECR and links 41 landing points in 35 countries and 4 continents from Western Europe (including Germany, England and France) to the Far East (including Japan, China, and Singapore) and on to Australia (www.telekom.gov.tr).

The "Rioja 2" cable passes in an east-west direction through the centre of the ECR and connects the UK with Belgium (see Figure 4.27).

Disused Cables

There are a number of disused cables which are located in or close to the ECR, shown in Table 4.9.

Table 4.9 Disused Cables in the ECR

Cable	Direction
Brest-Borkum 1882/1912	south-west to north-east
Borkum-Fayal 1926/60	south-west to north-east
Vigo-Borkum 1836	south-west to north-east
Vigo-Borkum 1896	south-west to north-east
Lisbon-La Panne 1896	south-west to north-east
Vigo-Borkum 1925/53	south-west to north-east
Cherbourg-Dunkerque	south-west to north-east
Birling Gap-St Nazaire	north-south
Cuckmere-Le Havre	north-south
Cuckmere-Antifer No1	north-south
Cuckmere-Antifer No2	north-south
Eastbourne-Dieppe 1861	north-south
Cuckmere-Veules No 1	north-west to south-east
Cuckmere-Veules No 2	north-west to south-east

4.9.3
Military Activities

The ECR is located within the Ministry of Defence (MoD) Worthing Control Area. There are no military sites within the ECR, however, on the Kent coast at Dungeness, Army Department Area D 044 Lydd Ranges is used for firing and demolition firing and has an altitude range of 3.2 SFC (thousands of feet).

To the west of the ECR, south of Worthing, are areas "Alpha Three Four", "Romeo Two Five" and "Golf Two Seven". Navy Department areas "D 039", "D 040" and "D 037" are located to the south of Selsey Bill, and west of the ECR. Figure 4.27 shows the boundaries of these areas and the Table 4.10 details the activities carried out in them.

4.9.4
Proposed Wind Farms

The first licensing round for offshore wind farms was announced by the Crown Estate in April 2001 with 18 proposed locations around the coast of England and Wales. There are no proposals for the south coast of England and the nearest proposed site is at Kentish Flats in the Thames Estuary.

4.9.5
Offshore Oil and Gas

The ECR is situated within DTI oil and gas exploration blocks 99 and 100. Neither has been licensed and there has been no previous exploration drilling in the area. Consequently, no abandoned oil or gas wells are located in the region.

4.9.6

Waste Disposal

Marine disposal sites in English waters are designated by DEFRA, with the disposal of dredged material controlled under the Food and Environment Protection Act 1985. There are no marine disposal sites in the ECR or its environs. The nearest sites are located within 2km of the UK coast off Newhaven, Brighton and Shoreham and receive silt and sand from routine maintenance dredging of the navigation channels and berths at these ports.

There are no known marine disposal sites in French waters adjacent to the ECR.

4.9.7

Leisure Activities

Recreational vessels

Yachting and motor cruising are popular leisure activities that take place predominantly from the South Coast of England and Brittany and Normandy coastlines. A number of sailing clubs have members who sail offshore, including the Sussex Yacht Club (Shoreham Harbour), Brighton Marina, Newhaven and Seaford Club, Eastbourne Sovereign Harbour and Rye Harbour Sailing Club.

Yachts in excess of 7m are capable of making cross channel trips and, therefore, boats sailing to French and UK ports may pass through the ECR, en route to and from destinations such as Dover, Boulogne, Calais, Folkestone, Ramsgate, Eastbourne, Newhaven, Dieppe, Le Havre and St. Vaast. All vessels, including recreational vessels, must concur with the TSS requirements, that is, proceed in the direction of the traffic lanes and, when crossing the lanes, do so by the shortest route and perpendicular to the lanes.

Angling

Angling is a popular activity along the South Coast of England, usually taking place either from the shore or in inshore coastal areas from small vessels. It is possible that some charter boats may use the ECR, but the level of use is unknown (ERM, 2001).

Diving

Diving is a popular sport that occurs widely on the South Coast of England. Both shore and boat diving take place and there are numerous wrecks recorded in the waters off the Sussex and Kent coastlines.

From the dive site information available, there are more than 80 diving sites within 20km of the South Coast, including seven important sites. No specific dive sites have been identified within the ECR. In general, the water depths in the ECR and its distance from the shore, along with the high density of navigational traffic, limits diving activity in this area.

The dive site closest to the ECR is in French Waters and is approximately five kilometres south-east of the Median Line (ERM, 2001).

Table 4.10 Military Activities in the English Channel

Serial Number	Name	Activity	Altitude (SFC)
D 037	Quebec Two	Anti-aircraft, General Practice, Surface-to-Surface, Surface Ship General	55
D 039	Romeo Two/Three	Anti-aircraft, General Practice, Surface-to-Surface, Submarine General, Surface Ship General	55
D 040	Sierra One/Two	Anti-aircraft, General Practice, Surface-to-Surface, Surface Ship General	55

Source: UK Practise and Exercise Chart

5 Effects of dredging on the physical environment

5.1 Introduction

This chapter discusses the various effects of dredging on the physical environment within the study area. Effects will arise due to dredging processes and the resulting removal of sand and gravel, leading to a lowering of seabed levels, influencing the water column and the bed.

Potential water column effects include:

- hydrodynamic changes to the wave and current regimes;
- water quality changes as a result of dredging plumes.

Potential effects on the seabed include:

- sedimentation from plumes; and
- transport of dredging derived sediment across the seabed.

Study area

Three aspects of marine aggregate dredging operations release sediment into the water column. These are referred to as source terms. Each source term is listed below in increasing order of the volume of sediment released into the water column (Figure 5.1):

Source Term 1 - seabed sediment is disturbed and forced into suspension by the passage of the dredger's drag-head across the seabed. The draghead is typically 2 to 3m across and disturbs sediments lying up to 0.3m below the seabed;

Source Term 2 - fine-grained sediment pumped into the dredger is returned to the water column as suspended sediment within the excess water (overflow) draining through spillways on each side of the hopper or through the keel; and

Source Term 3 - fine-grained sediment rejected as a consequence of screening unwanted grain size fractions before reaching the hopper. This sediment is directly returned to the sea surface via reject chutes on the screening towers or through the keel.

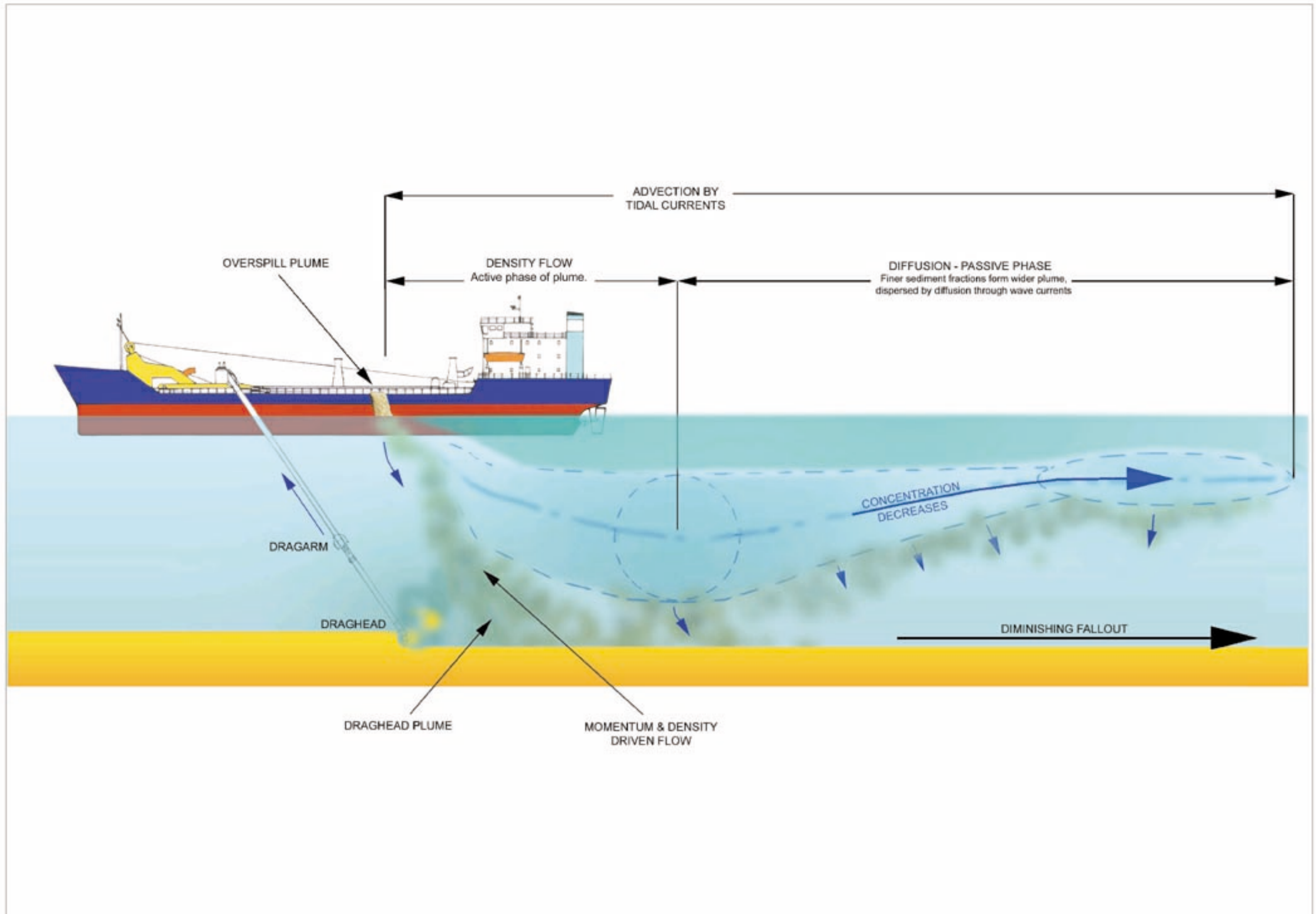


Figure 5.1 Processes associated with marine aggregate dredging (Entec 2000)

Measurements of plumes generated by the movement of the drag-head alone (Source Term 1) have shown that the volume of sediment introduced into the water column is barely detectable, and is of the order of 1% of the material introduced by screening and overflowing (Hitchcock *et al.* 1998, John et al. 2000). This effect is extremely localised and masked by the direct effects of dredging. This mechanism is not therefore included in the modelling undertaken to predict the effects of aggregate dredging and is not considered further here.

Source Terms 2 and 3 are strongly influenced by the composition of the marine aggregate resources. The proportions and sorting of silts, sand and gravel in the seabed sediments of the ECR vary both laterally and vertically. The grading of the seabed silts and sands is particularly important for Source Term 2, as turbulent water within the hopper will contain proportionally higher volumes of sediment composed of clays, silts and fine-grained sand than coarser sands (see Section 4.2.3). Compared to Source Term 3, therefore, overflow contains higher concentrations of clays, silts and fine-grained sands.

Source Term 3 reflects the total composition of the aggregate resource. In order to load a cargo of the required aggregate quality, the naturally occurring deposits are sorted or 'screened' as they are pumped up to the dredger (see Section 3.3.2). This results in the rejection of a proportion of the finer-grained sediment (typically silts and sands up to a grain size of about 5mm) from the screening tower reject chutes on the side, or keel, of the dredger.

The deposition of sediment on the seabed and water quality changes are likely to be greatest within and immediately surrounding the areas of the bed that are dredged in the ECR, i.e. 'nearfield' effects (Section 5.2). Wave changes and seabed sediment transport may result in 'far field' effects, potentially extending as far as the coastlines of the English Channel (Section 5.3). Detailed analysis of the spatial and temporal extent of the plumes potentially generated by multiple dredging activities and far field effects has been carried out by HR Wallingford (Technical Report, 2002).

For the purposes of this impact assessment, it is significant to recognise that changes in the physical environment due to dredging are not in themselves necessarily considered to represent impacts. That is, effects on the physical environment represent 'changes' that may or may not be translated into 'impacts' as a result of their influence on the biological (and potentially the human) environment. The significance of these effects (i.e. impacts) are considered in Chapters 6 to 11.

Therefore, while in this section the predicted effects arising from aggregate extraction are *described* in turn and assessed in terms of the cumulative influence of potentially multiple, simultaneous dredging operations, impact levels are not defined and hence mitigation measures are not developed. Relevant mitigating actions in terms of the dredging process are, however, set out in Chapters 6 to 11 *(mitigation)* and dredging management is detailed in Chapter 13.

5.2 Near field effects of dredging in the ECR

5.2.1 Water Quality Effects Arising from Sediment Plumes

Description of effect

Dredging operations create a plume of suspended, fine-grained (clay, silts and sands) sediment. Settling of the suspended sediments occurs at differing rates (roughly proportional to grain size) and results in the deposition of the sediment around and beyond the extraction area. Clays and silts (<63μm) are readily suspended within the water column and may be transported several kilometres by the tide, whereas sands settle more quickly through the water column, to be deposited closer to the dredging areas.

Sediment plumes caused by aggregate dredging will affect water quality by locally increasing turbidity and, through settling (see Section 5.2.2), will potentially change the composition of the sediments on the seabed, both within and outside the dredged area (i.e. the area of seabed dredged throughout the duration of the permissions).

Assessment of the cumulative effects of plumes on water quality

Modelling of turbid plumes has been undertaken for a number of dredging applications in the ECR. The modelling is based on the dispersion of silts and very fine sands during neap and spring tides. In the ECR, tides are asymmetric, with the flood tide being stronger but of shorter duration (up to 1.1m/s to the NE) than the ebb (up to 0.8m/s to the SW; see Section 4.3.3). Studies of proposed dredging in Areas 461, 458/464, 473, 474 and 475 indicated the following.

- Depth-averaged concentrations

At low concentrations (depth-averaged; less than 20mg/l) plumes generated by dredging activity in the ECR are predicted to extend up to 5 to 10km from the dredging area along the tidal axis, but are expected to be essentially confined to a width of 2 to 3km across the tide. Concentrations of greater than 50mg/l are expected to be confined to the vicinity of the dredging area and to occur up to 400m across the tide (200m either side of the dredger) and up to 1km along the tide beyond the boundary of the dredged area. Theoretically, plumes will persist at low concentrations for at least 6 hours following the cessation of dredging and for up to 12 hours in total (however, following each slack water the sediment will become increasingly dispersed, rapidly tending towards background concentrations). Figures 5.2a and 5.2b provide an example of the modelled depth-averaged concentration and dispersion of dredging plumes from Areas 473, 474 and 475, 5 hours after dredging has commenced and 6 hours after dredging has ceased.

The highest concentrations of suspended sediment will only occur very close to the dredger's track, and just for a short period around slack water (less than 1hr per tide). Concentrations decrease with increasing distance from the dredger, typically falling to below 20mg/l within 1km of the path of the dredger. Figure 5.3 demonstrates this decline and provides an illustration of the predicted total extent of the plume (based on instantaneous peak values) generated along the full extent of the predicted dredging tracks in Areas 473, 474 and 475 over the duration of a dredging event.

The higher suspended sediment concentrations associated with the plume created by dredging are short-lived, with concentrations quickly falling to almost match natural background levels within a few hours of the dredging finishing (Figure 5.2). On spring tides, models predict typical depth averaged concentrations of 5 to 10mg/l 12 hours after the onset of dredging, apart from a very localised concentration of 20 to 50mg/l confined to the dredged area.

Very fine-grained sediments (clays and fine silts) will travel considerable distances in suspension beyond the dredging area (10km or more), but at extremely low concentrations (<5mg/l), merging with background suspended sediment levels.

- Near bed concentrations

Peak near bed concentrations (estimated to be 3 times depth-averaged concentrations by HR Wallingford) are predicted to only persist for 0.75 to 1.5 hours per spring or neap tide. In the dredging areas, near bed concentrations will range from 150mg/l to greater than 300mg/l. Temporary increases in near bed concentrations of over 60mg/l will also occur in areas ranging in size from 5 to 25km^2 (maximum instantaneous envelope)[1] depending strongly on the length of the dredging zone (for example, for Areas 473, 474 and 475 the area of influence is predicted to be between 5 to 13km^2). These increases will be centred on the dredged track (Figure 5.3).

1 The maximum instantaneous envelope represents the aggregated peak values of suspended sediment as the plume travels past each point over the life of the plume (i.e. the peak values, like the total area of excursion, will not be attained at the same time).

An approach to assessing the predicted cumulative impact of the proposed dredging in the ECR is to consider dredging across the indicative dredging areas over 15 years (50km^2). On this basis, peak near bed concentrations are predicted to increase to 50 to 60mg/l over a wider area (Figure 5.4). That is, between 10 and 30km^2 for each indicative dredging area. Note that Figure 5.4 represents the potential total extent of the affected area over 15 years; however, even if the entire area is dredged, this effect will not be apparent at any one time. Whether or not this pattern of sediment suspension occurs in reality depends on the size (particularly the cross-tide, north-south dimension) of each dredging area and whether extraction operations take place during spring or neap tides (where the dispersion of higher concentrations of material is expected to be more extensive on spring tides).

Conclusion

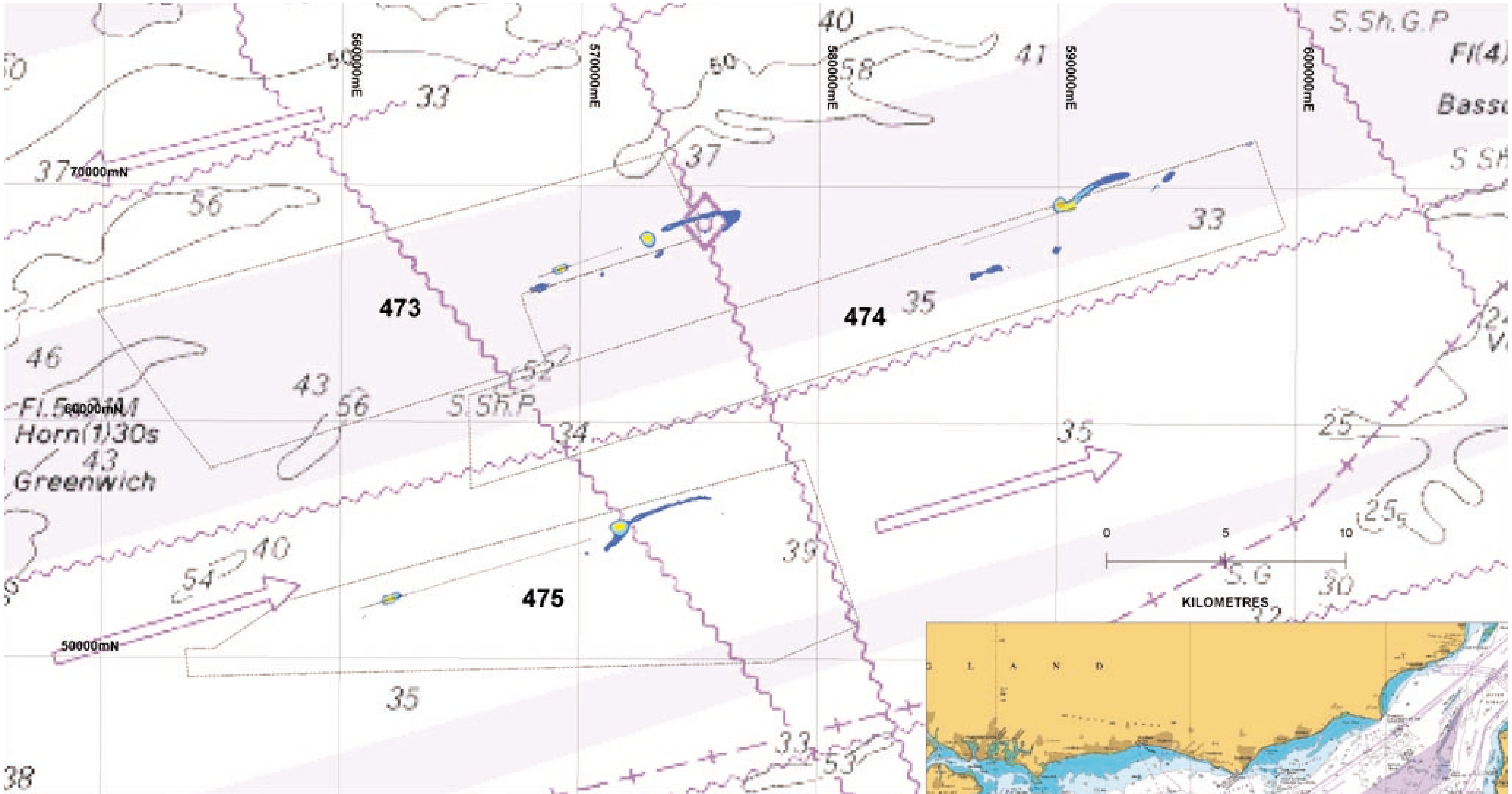
The plumes likely to be generated from each dredging area and, similarly, each dredging operation are expected to extend several kilometres (up to 5 to 10km) along the direction of the tide at low depth-averaged concentrations, e.g. 5 to 10mg/l, whilst concentrations of greater than 50mg/l are typically expected to be confined to the dredging areas. In addition, the higher concentrations are expected to be short-lived, even when screening forms part of the process. Near bed concentrations, although elevated during dredging operations, will quickly fall to background levels as the fine-grained sediment disperses on the tide.

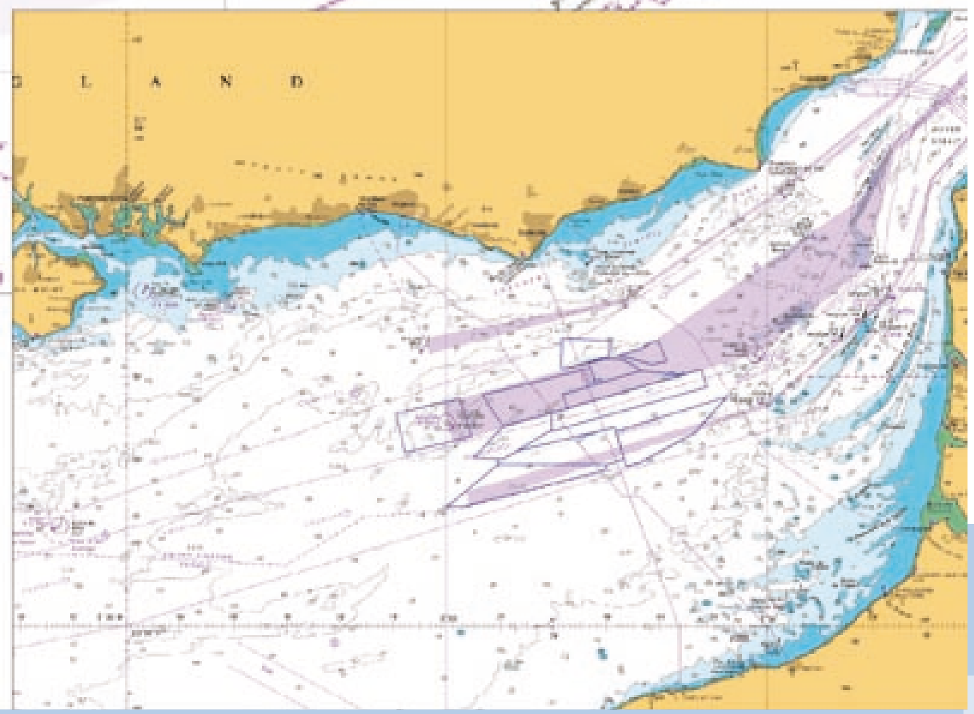
Multiple simultaneous dredging operations could theoretically create overlapping turbid plumes, additively increasing the quantity of sediment suspended in the seawater (see Figure 5.4). However, the separation of the proposed dredging areas is typically 5 to 10km (Figure 3.1) within the ECR, itself an area of over 1000km^2. In addition, plume persistence is low and the predicted annual extraction rate of 8.5Mt means that average occupancy will only be 5 dredgers per day in the ECR. For these reasons, the likelihood of plume coalescence is small. Even if plumes do rarely coalesce, it is likely to occur at low concentrations, perhaps at <5 to 10mg/l.

If the extraction rate increases to 17Mtpa, the likelihood of plume coalescence would remain small, providing that the dredging Permission Areas remain in the same locations as those now proposed. If the number of dredging areas increased or moved closer together then there would be more potential for coalescence.

It is clear that the opportunity for cumulative plume effects increases when proposed dredging areas lie within 5 to 10km of each other and along the same tidal axis, for example, Areas 474 and 478 (see Figure 5.4). Potential for coalescence is also increased when proposed adjacent dredging areas lie less than 2 to 3km apart across the tide, e.g. Areas 474 and 458. Acknowledging these proposed dredging locations, the likelihood of plume coalescence remains small, particularly given the low concentrations of settlement in suspension predicted at these distances.

In terms of future dredging management, concurrent dredging zones should be spaced across the tide such that plumes do not coalesce at high concentrations (i.e. >20mg/l), thereby preserving zones of minimal plume sedimentation between dredged areas (see Chapter 13).





Concentration
mg / l
(above background)

- 200
- 100
- 50
- 20
- 10
- 5

(Note nearbed concentrations are estimated to be 3 times the depth-averaged concentration)

Modelled dredging track (Note that modelled dredging tracks differ slightly from proposed Dredging Permission Areas)

Figure 5.2a

Example of spring tide simulation of dredging plume with screening from areas 473, 474 and 475, showing depth averaged suspended sediment concentration increases 12 hours after onset of dredging and 6 hours after completion of dredging.

(HR Wallingford, EX4441, 2002)

5.2 Simulations of depth-averaged suspended sediment concentration associated with proposed dredging of representative areas in the ECR. The examples show increases 5 hours after the onset of dredging and 12 hours after the onset of dredging.

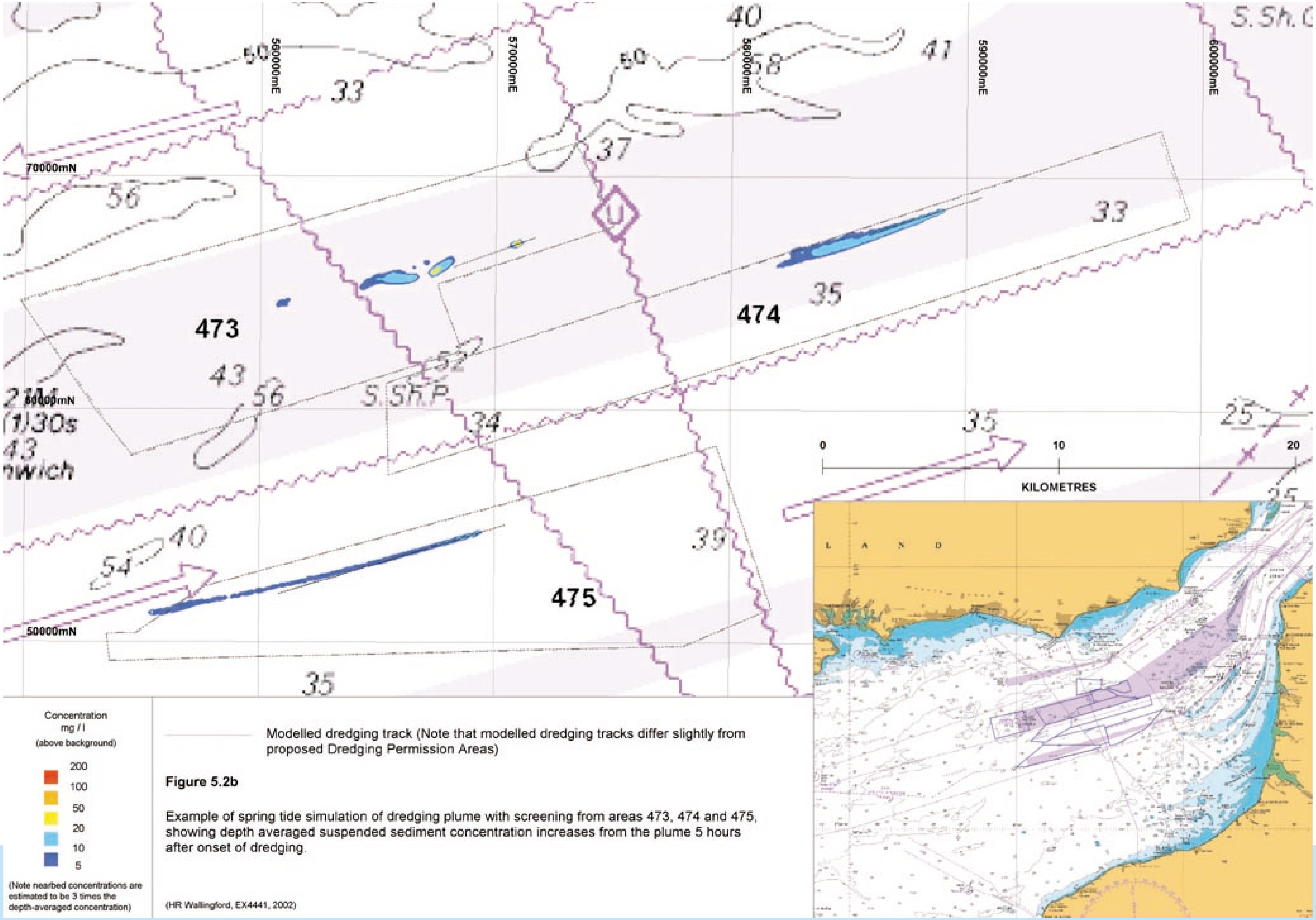
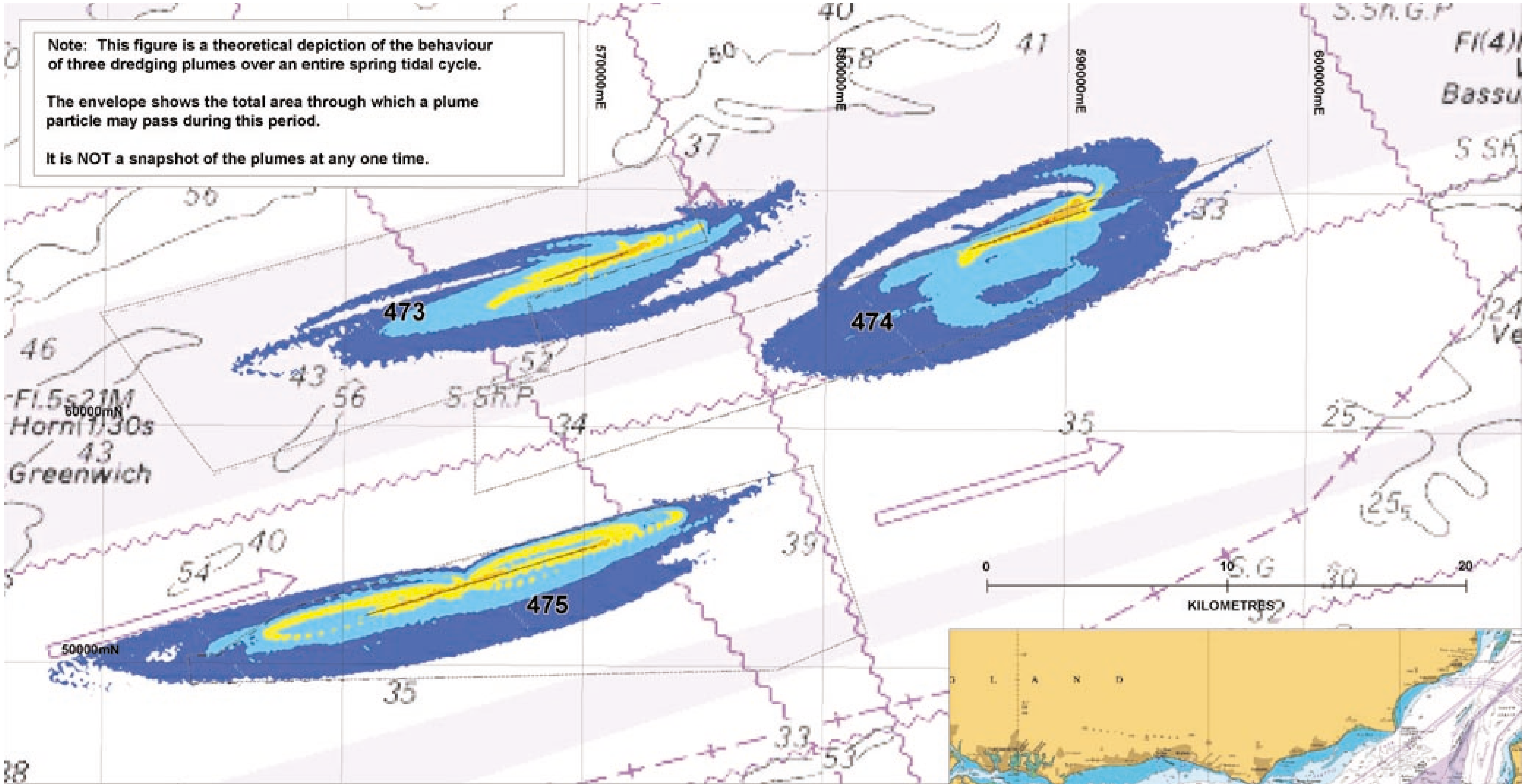


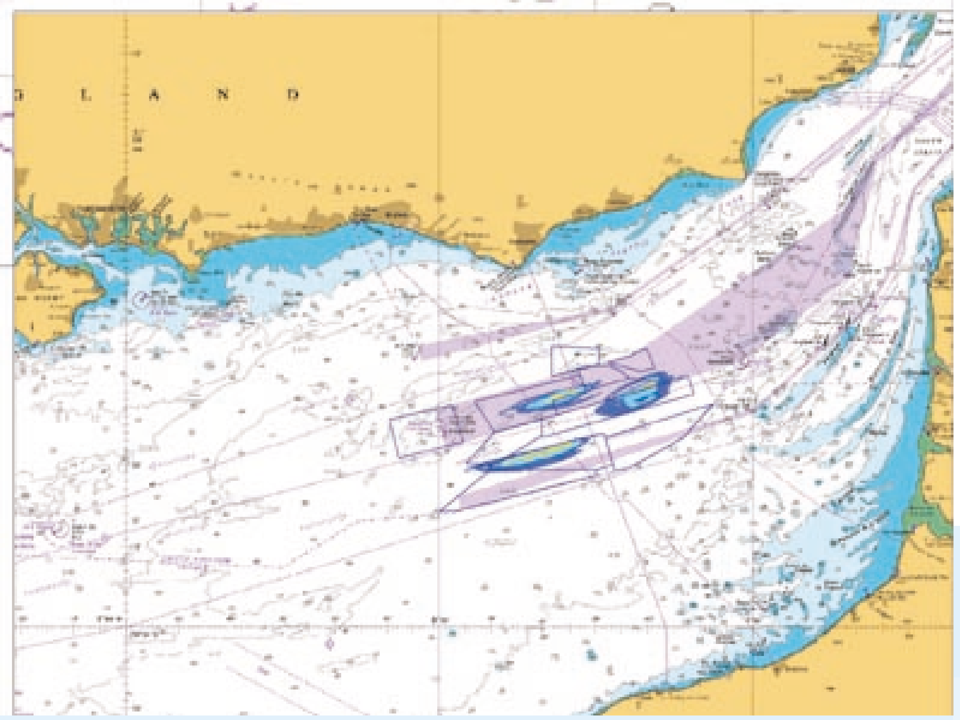
Figure 5.2b

Example of spring tide simulation of dredging plume with screening from areas 473, 474 and 475, showing depth averaged suspended sediment concentration increases from the plume 5 hours after onset of dredging.

(HR Wallingford, EX4441, 2002)

5.2 Simulations of depth-averaged suspended sediment concentration associated with proposed dredging of representative areas in the ECR. The examples show increases 5 hours after the onset of dredging and 12 hours after the onset of dredging.





Concentration
mg / l
(above background)

200
100
50
20
10
5

(Note nearbed concentrations are estimated to be 3 times the depth-averaged concentration)

Modelled dredging track (note that modelled dredging tracks differ slightly from proposed Dredging Permission Areas).

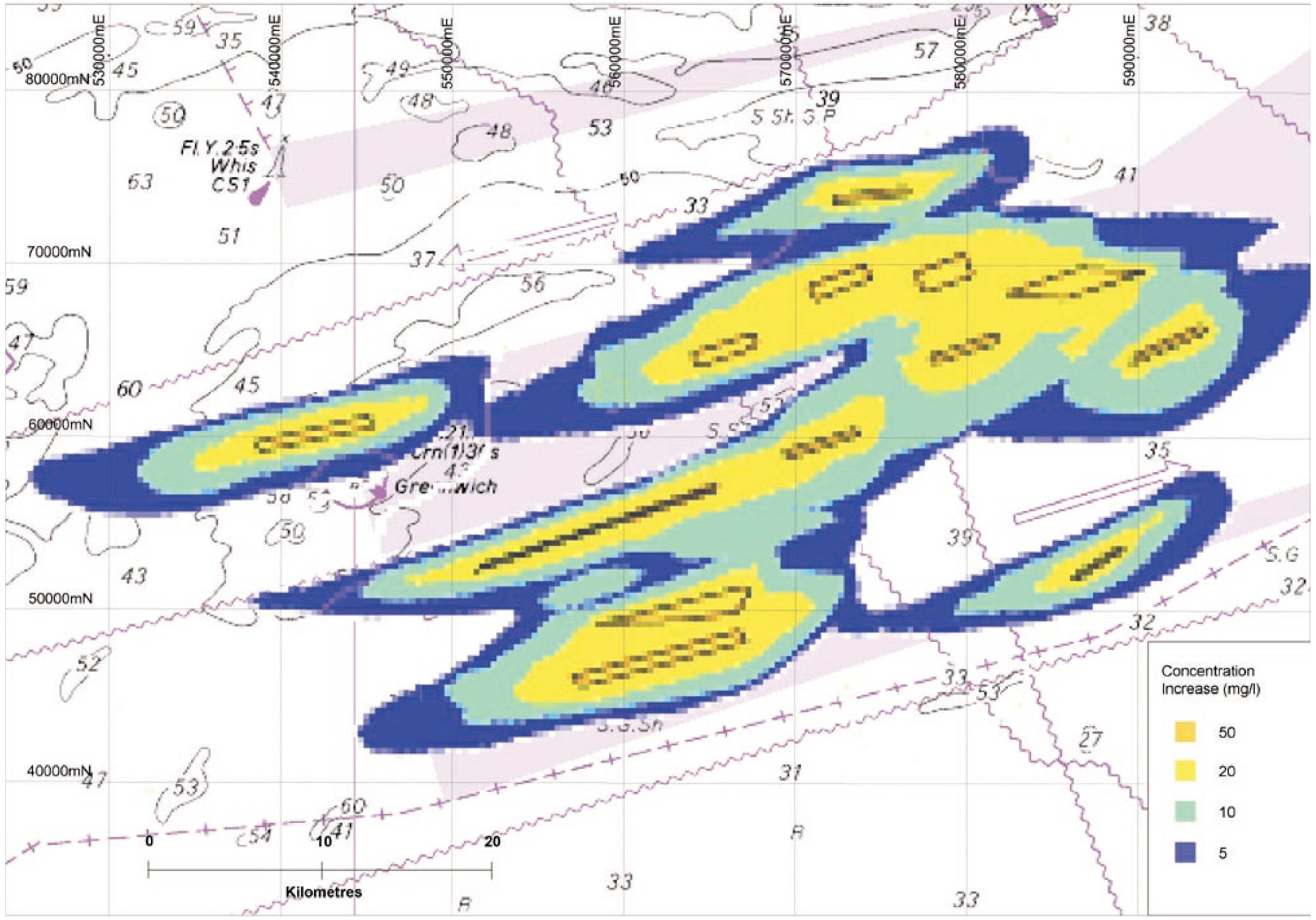
Figure 5.3

Maximum instantaneous depth averaged increases in suspended sediment concentration above background levels for a spring tide in areas 473, 474 and 475.

Peak values are not attained at the same time, but occur over different times as the plume travels past each point.

Owing to the action of the dredger moving with and against the tidal current, the plume produced by some of the dredger tracks are more dense than others and the individual trajectories of some of these plumes can be identified.

(HR Wallingford, EX4441, 2002)



5.4 Extent of maximum instantaneous depth-averaged suspended sediment concentrations across the proposed dredging areas (50km²) of the ECR. This figure summarises the dredging plume envelope over the 15 year period and assumes all of proposed area is dredged (HR Wallingford Technical Report, 2002).

It is also useful to set the predicted dredging plumes within some context. Increases in suspended sediment levels are commonly associated with trawling (particularly close to the seabed) and storms. In offshore areas of the English Channel, including the ECR, suspended sediment concentrations are typically low, of the order of 1 to 10mg/l (Velegrakis *et al.* 1999). However, during storms, natural suspended sediment concentrations in the proposed dredging areas would be expected to be considerably higher. Although there are no available measurements of storm-induced suspended sediment concentrations from the middle of the English Channel, experience in other coastal areas indicates that concentrations can rise significantly, that is by up to an order of magnitude.

According to Palutikof *et al.* (1997) there were 17 storms (force 10 winds) across the UK in the period 1970 to 1990 and 10 severe gale (force 9) events annually. Therefore, both trawling intensity and the natural range of suspended sediment concentrations should be borne in mind when assessing the impact of increases produced by dredging plumes.

5.2.2 Seabed Deposition and Transport of Sediment Arising from Sediment Plumes

Description of effect

Over time the sediment particles suspended in the plume settle out of the water column, resulting in the deposition of sand and silt onto the surface of the seabed in and around the dredged area. Proximal deposition of sand (fine, medium and coarse-grained) from the plume around the dredging area is considered separately (below) to more distal settling of silts and fine sand from suspension.

There is no established method of precisely predicting sedimentation rates and sediment transport arising from dredging plumes. However, for the purposes of this study, it is reasonable to adopt a series of assumptions (based on current understanding) to begin to evaluate the type and scale of sedimentation and seabed sediment transport that potentially could arise due to multiple dredging operations in the ECR.

- Deposition of clays and silts

On spring tides in the ECR, it is predicted that a single dredged cargo will result in the maximum temporary deposition of up to 0.5mm of silt at slack water, in an area of seabed extending up to 10km outside the dredged area (see Figure 5.5). Temporary siltation of greater than 0.5mm will be restricted to the dredged area. In the ECR, the tidal currents, even during neap tides, are capable of disturbing and transporting all of the silt that settles on the seabed. Hence any silt deposited during or just after the dredging operation will be dispersed rapidly (at production levels of 8.5Mtpa or 17Mtpa). Possible exceptions may rarely occur around highly localised seabed irregularities, providing sheltered conditions.

Modelling studies for individual ECR applications have also predicted that the seabed in and immediately adjacent to the dredged area, during and immediately after a single visit from a dredger, will be covered by no more than a few millimetres of silts for the few hours around each relevant period of slack-water. Continual resuspension will then disperse the silts until their concentration reaches background levels and they are gradually transported out of the ECR to the north-east.

- Fine, medium and coarse-grained sand deposition

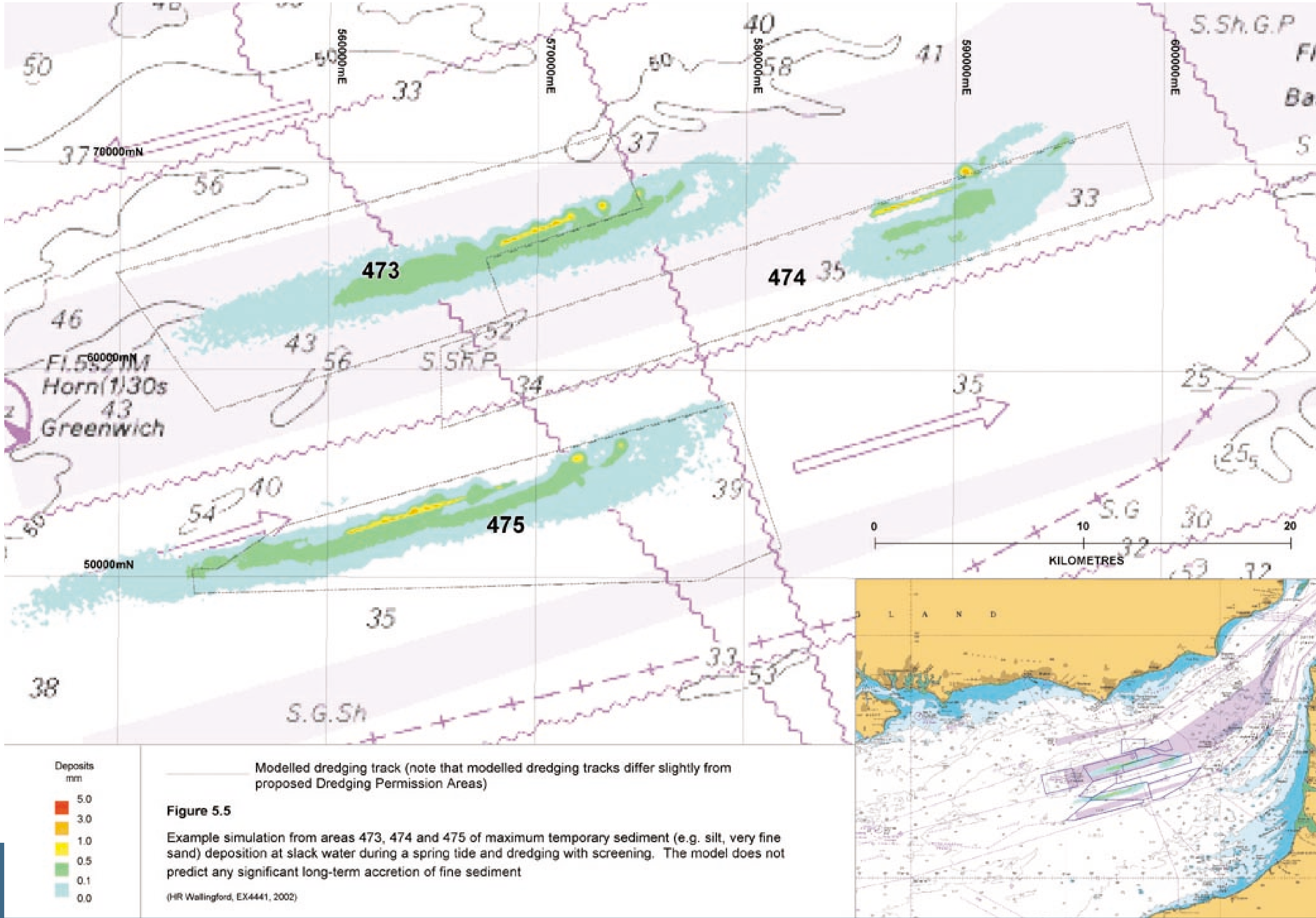
As a result of the mechanisms controlling settling in water depths greater than 40m and in currents typically greater than 0.5m/s, sands will be dispersed over the dredged area and the seabed along the tidal axis – both upstream and downstream of the dredged area. Simple analysis (Table 5.1) infers that fine to medium sand will be transported up to about 1km from the dredging area prior to deposition, whereas coarse sand will largely be deposited within the dredged area.

Following deposition, the sands could be either rapidly dispersed by each successive tide across a wide area of seabed, or could accrete close to the dredging area. Rapid dispersion will occur if the sand is mobilised and transported on each tide.

It is reasonable to assume that the tides will not immediately disperse all of the sands given the range of sand grain sizes forming the plume in the ECR (Figure 5.6) and its dynamics. Therefore, accretion will occur and sand will accumulate in, and immediately surrounding, the dredged area. Whilst deposition is occurring, only the surficial sands will be available to be transported on each tide, as in the ECR only the highest spring tide currents are capable of mobilising sand up to 1mm for transport as bedload.

Table 5.1 Theoretical settling rates and tidal transport distances for selected sediment grain sizes (settling rates derived from Hjulstrom's diagram)

Grain Size	Settling rate m/s	Water depth m CD	Theoretical maximum horizontal distance travelled before settling (m)	
			Ebb 0.75 m/s	Flood 1.1 m/s
250µm	0.05	40	600	880
		50	750	1100
500µm	0.10	40	300	440
		50	375	550
1.0mm	0.18	40	167	244
		50	208	306



Deposits mm

- 5.0
- 3.0
- 1.0
- 0.5
- 0.1
- 0.0

Modelled dredging track (note that modelled dredging tracks differ slightly from proposed Dredging Permission Areas)

Figure 5.5

Example simulation from areas 473, 474 and 475 of maximum temporary sediment (e.g. silt, very fine sand) deposition at slack water during a spring tide and dredging with screening. The model does not predict any significant long-term accretion of fine sediment

(HR Wallingford, EX4441, 2002)

As a result, in the ECR, it is predicted that the rejected sand will form a sheet within and close to the limits of the dredged area, where deposition is occurring faster than dispersion. This sheet will consist of poorly sorted sands derived from the dynamic phase[2] of plume dispersion when sediment rejected during screening descends rapidly to the seabed, as described by HR Wallingford (1999).

Plume sedimentation has been investigated in dredging licence areas off the south coast of England where water depths are shallower, i.e. on the Owers licence off Littlehampton (Hitchcock *et al.* 1998) and in the southern North Sea around licence 408 (Newell *et al.* 2002). Water depths at these locations are 20m (Owers) to 25m (408) and peak current speeds are around 0.7m/s (408) and 1.0m/s (Owers).

The ECR is different to these areas; the sediments are poorly sorted and coarse-grained, water depths are 35 to 60m and current speeds of up to 1m/s prevail. Consequently, and in the absence of actual plume data for the ECR, it is only possible to 'model' rather than observe comparable sedimentation patterns. There are no close analogues to the ECR in existing UK dredging licence areas.

To assist in understanding the processes, a conceptual depositional and sediment transport model has been established for the ECR (Figures 5.7 and 5.8). The conceptual model suggests that the majority of the descending screened sediment will be displaced by up to 200m along the tidal axis beyond the dredged area by the time it reaches the seabed. This estimate is based on the premise that the theoretical settling rates for different grain sizes presented in Table 5.1 do not account for the momentum of the descending plume (density flow), which is composed largely of coarse-grained sands, from the dredger's reject chutes and spillways. That is, the momentum is influenced by the higher proportion of coarse-grained sediment in the ECR, which means that the faster rates dominate. Therefore, the theoretical settling rates are considered to be too low and correspondingly the horizontal distances travelled are expected to be lower for dynamic phase plume sediments. The estimate of 200m of displacement along the tidal access beyond the dredged area reflects the dominance of the coarser sands (>1mm) in plumes that will arise from dredging in the ECR.

Minor volumes of fine to medium-grained sands are also expected to be transported for up to 1km along the tidal access in the water column due to finer material being 'stripped' from the plume as it descends. However, this effect will be insignificant.

Lateral deposition is predicted to extend up to 200m either side of the dredger, although the majority of the sand will be deposited up to 100m either side of the dredger.

Subsequent transport of elements of the sheet sediments (mainly sands) as bedload will occur principally in the direction of the tidal residual (along the tidal axis to the NE). The conceptual model suggests that sands will form a transverse bedform field (ripples) or ribbons with ripples up to 1km beyond the sheet and be further dispersed 1 to 2km beyond the sheet to form sand streaks. The effect of the strength and orientation of the currents in the ECR is such that deposition and transport of sands across the tidal streamlines is highly unlikely (see Figures 5.7 and 5.8).

2 The 'dynamic phase' represents the jet of sediment-laden water that initially (after release from the dredger as overflow or screened material) moves rapidly downwards towards the bed. The 'passive plume' represents the subsequent movement of suspended sediment under the action of tides and currents (John et al. 2000).

Assessment of the cumulative effects of plume sediment deposition

In assessing the effect on the sea bed of the overflow and screening source terms (2 and 3), the geometry and composition of the sheet and bedform field predicted in the conceptual model (see Figure 5.8) are the critical factors. Bedform geometry and composition are dependent on two variables: (a) the volume/intensity of the sediment supply and (b) the grading of the sediment supply in relation to the prevailing currents.

- Volume and intensity of the sediment supply

The rate of sand supply and the area over which deposition occurs control the scale of impacts arising from dispersed sediments. The ECA estimate that, during dredging, 25 to 33% of the mass of sediment pumped will be rejected as a result of screening (the larger proportion) and overflow (representing around 10% of the rejected material) or, typically, 1660 to 2500 tonnes per 5000 tonnes of loaded cargo. Although dredging rates will vary between areas, an average dredging rate of up to 2 cargoes per dredged area per day may occur. Therefore, deposition of 3300 to 5000 tonnes of sand per day may arise from a single dredging area, assuming 5000 tonne cargoes. If the proportion of sediment rejected increases (e.g. increased screening times) then the rate and volume of sand supply will increase.

Finer sand will be winnowed and transported from the accreting sand sheet by tidal currents, resulting in increased sediment sorting. This effect is only likely to influence the top few centimetres of the seabed. However, winnowing will soon result in a coarsening of the remaining seabed sediments, forming a lag composed of very coarse sands/fine gravels (an armoured seabed) which will be resistant to further erosion. This factor is significant when dredging permanently ends in an area, because bedload sediment supply from the plume will cease, sheet winnowing will diminish and bedforms will gradually migrate and degrade beyond the dredged area into the dispersed zone (see Figures 5.7 and 5.8). Ultimately, the finer sands could reach sediment sinks; the sandbanks of the eastern English Channel such as the Bassurelle and Vergoyer. However, the majority of the material is expected to remain within the dredging zone and its sedimentological footprint.

It is, therefore, predicted that a small proportion of the mobile, fine to medium-grained sands released from the ECR resources by screening and plume dispersion will eventually move over the seabed towards the sand-rich bedload convergence zone of the eastern English Channel. They will not persist over the pre-existing gravelly sediments indefinitely. However, bedload transport rates on the tidal residual are currently unknown in the ECR, so it is not possible to state how quickly this process will occur, although it is likely to take several years to decades.

Some sand already travels over the seabed of the ECR. Despite this, the sediments on the seabed are gravelly, indicating that sand temporarily deposited, e.g. at slack water, is removed later by tidal flows. This observation also supports the prediction that the sands released by screening are unlikely to persist indefinitely once dredging operations cease.

The area impacted by the deposition and transport of sands is highly sensitive to the orientation of the dredging zones. If dredging zones are orientated across the tide the area affected by sedimentation beyond the dredged area will be greater. Conversely, if the dredging zone is orientated parallel to the tide, the area affected by sedimentation is minimised. Sedimentation impacts and mitigation are discussed in Chapters 6, 7 and 8 while dredging management and monitoring proposals are summarised in Chapter 13.

- Grading of the sediment supply

A predicted representative particle size distribution of the screened sand-sized sediment in the ECR is provided in Figure 5.6, based on data from Area 475. This analysis indicates that around 20% of the rejected sediment will be sand smaller in diameter than 0.3mm (300μm), i.e. mainly fine-grained sands (20% of 1600 to 2500 tonnes, i.e. 320 to 500 tonnes). About 40% of the rejected sand has a grain size of greater than 1mm. In general, the silt content of the ECR resources are low - at around 3 to 5% - and are not therefore considered in this analysis. They have, however, been considered in the plume modelling by HR Wallingford (see Section 5.2.1).

Peak spring tidal currents in the ECR reach 1m/s (Figure 4.5) and are capable of moving sand up to 1mm in grain size. Therefore, up to 60% of the sediment deposited from the plume potentially could be moved by a spring tide, with 40% remaining and accumulating on the seabed in and immediately surrounding the dredging zone (see Figure 5.8). However, finer sands (less than 300μm) will potentially move on all of the spring and neap currents. This is discussed further below.

It is easier to initiate the movement (i.e. transport) of fine to medium-sized sand grains than medium to coarse sand grains on a uniform seabed, although transport is more difficult to predict if the seabed sediments are mixed sands and gravels. Taking the worst case, it can be assumed that following screening all of the fine to medium-grained sand will be mobilised and subsequently transported by all (spring and neap) tidal currents (Section 4.3.3) after it is deposited on the seabed. Using this assumption, between 0.56 and 0.85 million tonnes of mobile fine to medium-grained sand will be deposited on the surface of the seabed each year as a result of dredging in the ECR and 'moved' by the tides (Table 5.2).

Figure 5.6
Composition of sand in the ECR resources

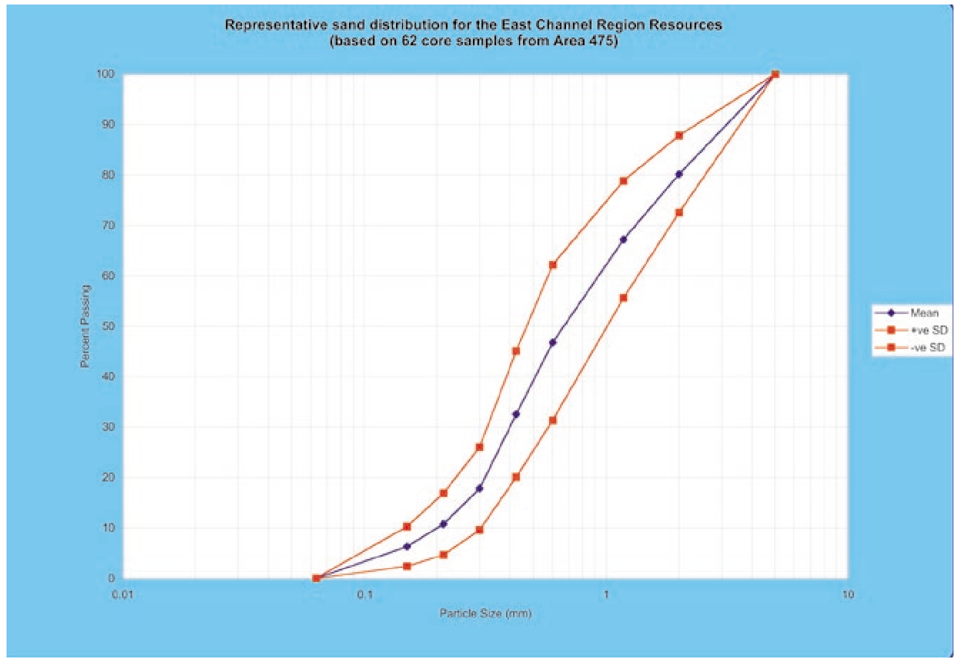


Table 5.2 Estimated totals of sand deposited on the seabed in the ECR as a result of the proposed dredging operations

Extraction rate (Mtpa)	Total rejected sediment (Mtpa at 25-33% screening)	Total rejected sediment over 15 years (Mt)	Total rejected fine sand <300μm(Mtpa)	Total rejected sand (<300μm) over 15 years (Mt)
8.5	2.8 - 4.25	42 - 63.75	0.56 - 0.85	8.4 - 12.75
17.0	5.6 - 8.5	84 - 127.5	1.12 - 1.7	16.8 - 25.5

Note that for each 1m depth of sediment dredged, around 0.3m of sand will be returned to the seabed. Sand is defined sediment with a grain size between 63μm to 5mm.

Importantly, the amount of sand available for subsequent transport is in reality much less than that deposited. Some of the finer grains will be covered by, or mixed in with, larger particles as they settle and move on the seabed. These grains will be prevented from moving by the "armouring" provided by the larger particles. In addition, smaller particles will be trapped in the void spaces between larger grains. Because of this, the volumes of mobile sand on the seabed surface will be substantially smaller than that estimated in Table 5.2.

Consequently, the majority of the sediment rejected by screening will return to the seabed within the dredged area and will be contained within the boundary of the dredged area and sheet and will not be transported along the transport pathway (i.e. into the bedform field).

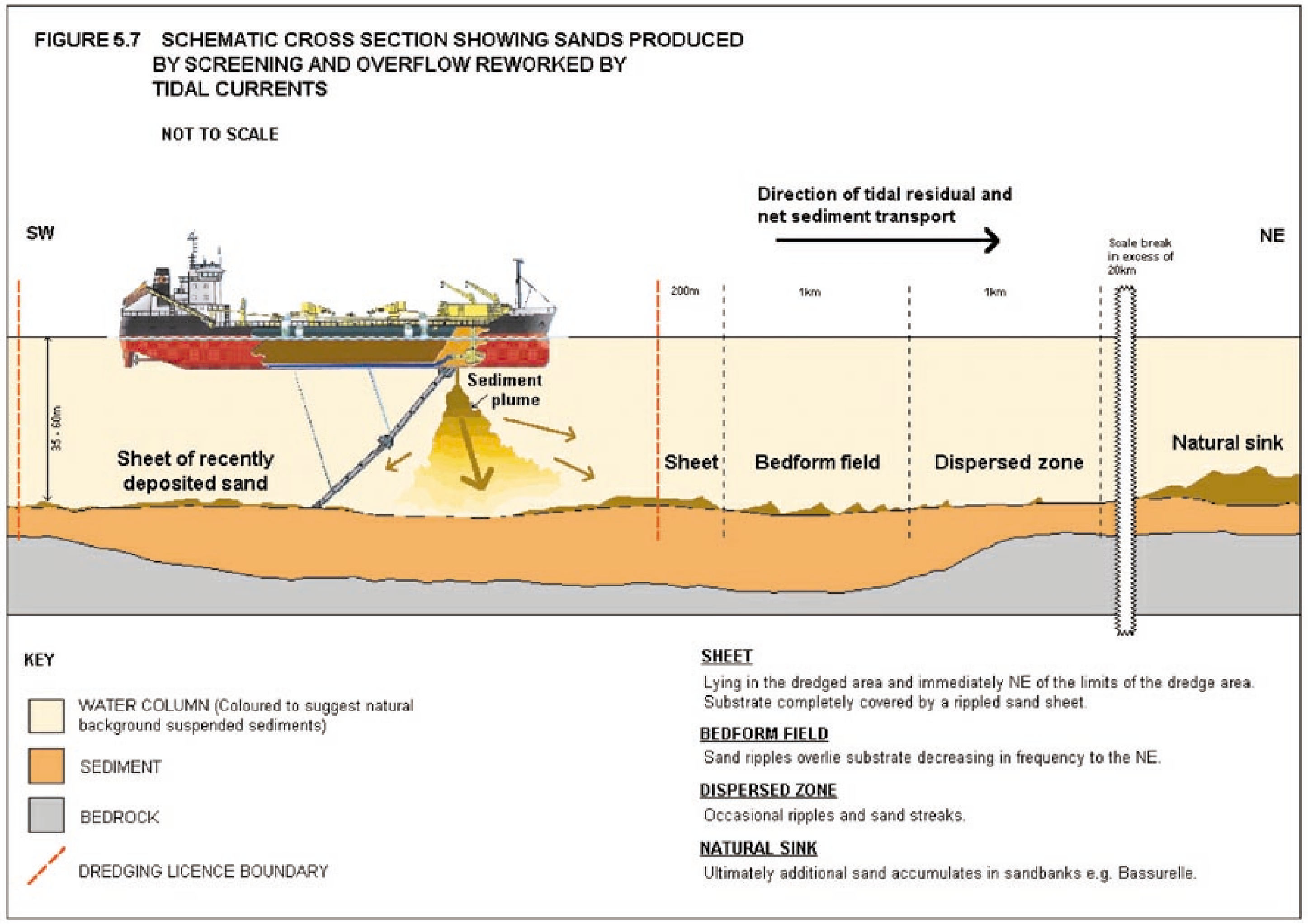
Within the dredged area, mobile fractions of the sand sheet will disperse to the north-east, but the coarser size fractions (>1-5mm, perhaps up to 10mm) and trapped finer fractions will remain *in situ*. A continuum will exist where (generally) very fine sand will be transported in suspension while essentially immobile sediment above 1mm will remain within the dredged zones. The sand sheets will be dominated by fine to coarse sands (200µm to 1mm) while the bedforms will be dominated by fine to medium sands (200 to 400µm).

On cessation of dredging, within dredged areas of gravelly seabed, the surface sediments will initially be sandier than the seabed that existed before dredging. The depth of this sandier sediment and the degree of subsequent reworking will depend on the original composition of the resources, the depth of dredging and the amount of screening undertaken.

However, it is envisaged that the seabed in the dredged area will eventually be composed of very coarse-sands and fine gravels (up to 10mm), that is, it will be similar to the seabed before dredging occurred, although this recovery may take several years to decades to occur.

The conceptual sediment transport model suggests that during the dredging of a dredging zone, the proportion of the fine to medium-grained sand transported away from the dredged area as bedload will form a thin (perhaps 10 to 25cm thick), continuous sand sheet or bedform field. The sheets will lie adjacent to the dredging areas, along the tidal axis, but mainly to the north-east in line with the tidal residual. The thickness of the sheet is only an estimate based on observations of existing dredging areas. The sheet will also consist of an even smaller proportion of sand, up to 1mm, which is mobile only on the highest spring tide currents.

5-7
Conceptual model (cross-section) predicting sand deposition, transport and bedforms associated with dredging in the ECR



Further along the sediment transport pathway, the sands are likely to be increasingly dispersed and form isolated bedform (ripple) fields and patches, which will degrade into discontinuous layers, a few grains thick, infilling seabed irregularities. This is likely to occur within a distance of 1 to 2 kilometres of the limit of each dredging area (Figures 5.7 and 5.8).

To summarise, within the dredged area itself, mobile fractions of the sand sheet will disperse to the north-east but the coarser size fractions (>1mm) and trapped finer fractions will remain *in situ*. This indicates that within dredged areas of gravel seabed, the surface sediments will be sandier than existed before dredging. The depth of this sandier sediment and the degree of subsequent reworking will depend on the original composition of the resources, the depth of dredging and the amount of screening undertaken.

In each case, this effect is expected to be dredging Permission Area specific and additive, rather than cumulative, since sand sheets and bedform fields within adjacent applications are highly unlikely to coalesce.

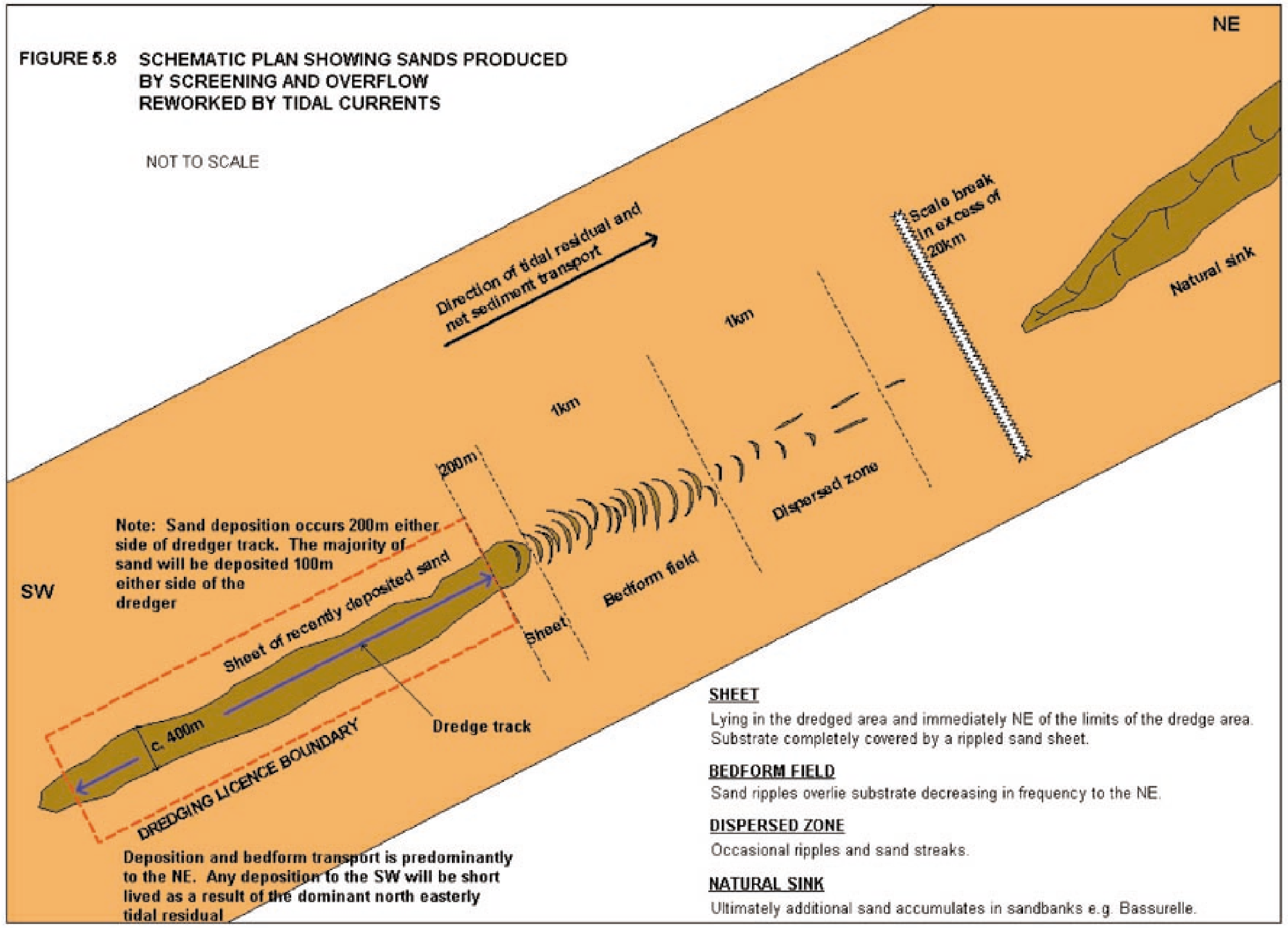
Conclusion

The prediction of seabed sedimentation and transport is based on theory and experience, however, there is no direct analogue for dredging ECR-type sediments in water depths of between 35 and 60m. A conceptual model has therefore been developed for this assessment, based on a sound understanding of the key processes. However, there are clear data gaps in the quantification of the processes and fluxes, which demand a cautious approach.

- Silts

Siltation effects are short-term and localised as all tides in the ECR have the capability to resuspend silts, consequently there will no noticeable change to seabed sediments. Continual resuspension will result in gradual transport of the silts out of the ECR to the north-east. Cumulative siltation due to multiple, simultaneous dredging operations is predicted to be negligible given the scale of the ECR. If production increases to 17Mtpa, siltation is again expected to be insignificant.

5.8
Conceptual model (plan view) predicting sand deposition, transport and bedforms associated with dredging in the ECR



Sands

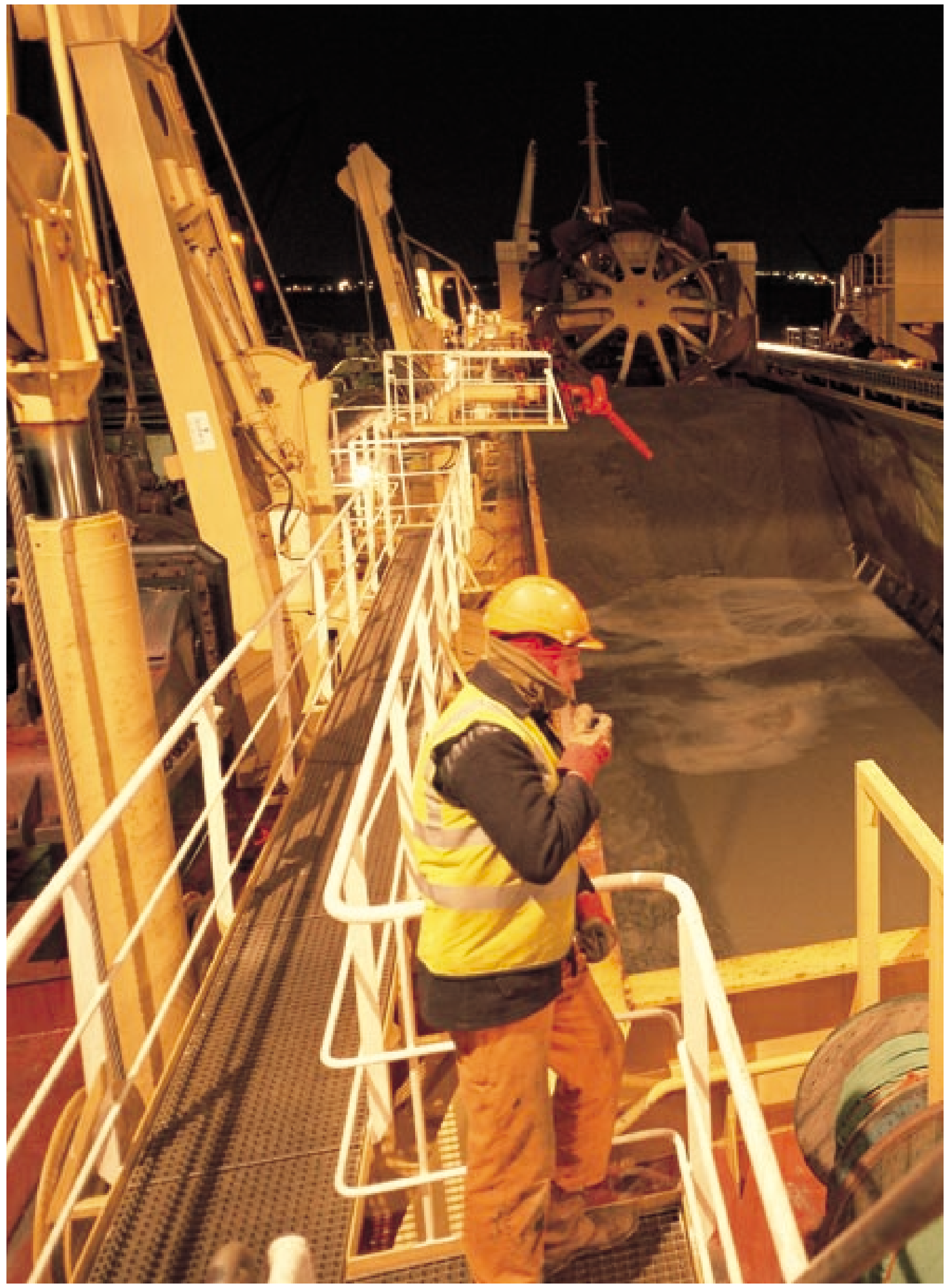
The scale, distance and arrangement of the proposed dredging areas are unlikely to lead to coalescing sand sheets or bedform fields arising from bedload transport. However, the potential for coalescence, particularly for proposed dredging areas that lie along the same tidal axis exists, and should be continuously reviewed. In addition, any proposals to modify the arrangement of dredging areas so that dredging would occur within 2km of another dredging area across the tidal axis, should also be reviewed with a view to preserving intervening areas of seabed where sedimentation is expected to be minimal (see Chapter 13).

With this separation of areas, and the predicted footprint associated with each dredging zone, no in-combination sedimentation effects are expected to arise due to multiple dredging operations in the ECR. The extent of the cumulative effect will therefore be limited to the additive influence of the footprint associated with the individual dredging areas. In essence, interpretation of the data suggests that sedimentation will be largely confined to the dredged area, with sedimentation of fine to medium-grained sands extending up to 1km along the tidal axis from the licence limits. This potentially represents the direct impact zone due to sedimentation. A poorly sorted sheet, or complete coverage of the substrate, is estimated to extend up to 200m from the dredged area based on sediment settling rates, grain size distributions and predictions of dynamic phase plume behaviour in 35 to 60m of water. A bedform field consisting of reworked sediment is expected to extend from 200m to 1.2km beyond this. Dispersed sand (mainly composed of medium-grained sand) could then occur on the seabed (as occasional ripples or sand streaks) in an area extending to a maximum of 2.2km from the limit of the dredged area. Therefore, the total extent of the near field impact (including the dredged zone itself, assuming it is 3km long and 250m wide) is expected to be 5km along the tidal axis and up to 650m wide.

Laterally, most sand is in fact expected to be deposited within 100m of the dredging zone, potentially limiting the impact zone to a width of 450m.

Overall, if the total dredged area in the ECR is confined to 10km^2 (see the Industry Statement), then sedimentation and seabed sediment transport will occur in this area, together with two zones characterised by differing bedforms: (i) extending laterally 100 to 200m either side of the dredged areas, as well as (ii) extending up to 2.2km beyond the dredged area to the NE (up to 13 dredging zones are currently proposed). Because the zone of influence is expected to be significantly greater in the direction of the tidal residual compared to across the tide, dredged areas that are narrower across the tide will have a smaller NE influence than wider dredged areas.

Once supply to the bedform field has ceased (i.e. the dredging ceases in a zone) the mobile sand will begin to be dispersed. This is predicted to commence immediately on cessation of dredging. It is, therefore, suggested that there will be a tendency for the seabed beyond the dredged area to revert towards a gravelly, pre-dredging state, i.e. for it to become armoured. The duration of this process is unclear since bedload transport rates are not known in the ECR, but may take several years, possibly decades. Consequently, during the 15 year term of the licences, there will be seabed within the proposed total dredged area of 50km^2 in various states of re-adjustment (winnowing), following the completion of dredging.



The predictions form a robust conceptual model against which monitoring can be undertaken. It is clear, however, that the depositional and sediment transport processes should be a focus of a monitoring programme, at least in the early stages of dredging, to confirm this interpretation. A review of the sedimentary processes associated with the dredging should be a priority and should therefore be undertaken each year until quantification of the processes is achieved (see Chapter 13).

5.2.3

Summary of Near Field Effects

Significant increases in suspended sediment concentrations (near bed and depth-averaged) are expected to arise from the dredging process and particularly due to overflow and screening. However, these increases will be largely confined to the dredged area and will be limited in duration to the period while dredging is being carried out and the few hours following. Short-term near bed concentrations of greater than 60mg/l are expected to occur across areas of 5 to 25km depending on the size of the dredged area, but depth-averaged increases of greater than 60mg/l will be far more limited in extent (i.e. typically confined to the dredging zone). Predicted licence occupancy (5 cargoes per day) across the ECR suggests that infrequently there may be minor, localised plume coalescence at low concentrations (<5-10mg/l), particularly where adjacent dredging areas lie along the same tidal axis. Typically, concurrent plumes are likely to be separated by several tens of kilometres. The cumulative effects of plumes on water quality are therefore expected to be minor and essentially site specific within the ECR. Siltation will only occur at slack water and at low concentrations outside the dredged area.

Much of the plume sediment (mainly sand) will descend directly to the seabed during the dynamic phase of plume dispersion. It will accrete and some sand will be available for reworking by tidal currents. The conceptual model presented above (Figures 5.7 and 5.8) predicts that a sheet of poorly sorted sediment will accumulate up to 200m beyond the dredging area, largely along the tidal axis to the NE. Bedforms will move in the direction of the regional tidal residual (to the NE), extending from 200m to around 2.2km from the dredged area. The bedform field is expected to diminish to dispersed sand steaks and ripples. In common with naturally occurring seabed sands in the ECR, some finer sediment will eventually travel towards the bedload convergence zone of the eastern English Channel, including sand bank sediment sinks.

Whilst extending for several kilometres down tide, across the tide the zone of sedimentation is predicted to cover less than 200m either side of the dredger track, because sediments will not travel significant distances across the current. This factor will permit dredging to be located to preserve zones of minimal sedimentation between concurrent working areas, reducing cumulative effects (see Chapter 13).

The Industry Statement estimates that only 10km^2 of seabed, and the associated sediment transport zone, will be affected at any one time. As dredging progresses across the seabed, the previously dredged area will begin to equilibrate through winnowing. As a result, although the disturbed seabed sediments will initially be sandier than existing sediments, the dredged sediments will be winnowed, over several years, to form a coarse sand and fine gravel dominated seabed, similar to that present before dredging.

5.3
Far field effects of dredging in the ECR

5.3.1
Changes to Wave Propagation and Shoreline Wave Conditions

Description of effect

Dredging operations could potentially cause changes in wave propagation, and modify wave conditions at the coast, through the long-term alteration of seabed levels affecting the refraction and shoaling of waves.

Dredging aggregates from the seabed will inevitably lead to increased water depths over the dredging areas. Any changes in bathymetry may alter the pattern of wave propagation locally and further inshore where the wave height and direction could be modified. This may, in turn, alter the strength of longshore currents and drift rates and could, ultimately, result in coastal recession or realignment.

Assessment of the cumulative effects of dredging on wave propagation and shoreline wave conditions

The majority of offshore aggregate extraction takes place in relict deposits which are exposed at the seabed in areas of limited seabed sediment flux. As a result, the depressions created during dredging are often permanent and any modifications to the offshore and inshore wave climate would also be permanent. The potential effects of dredging in the ECR on wave climate could influence both the English and French coastlines.

The effects of dredging on wave refraction and coastal evolution have been studied using a beach plan-shape model developed by HR Wallingford during the 1970s. This research showed that for dredging carried out in water depths of greater than 14m, changes in wave propagation are insignificant, assuming a typical South Coast wave climate. In the proposed ECR dredging area, water depths range from 30 to 65m and, therefore, the magnitude of any changes in wave propagation over the extraction area would be insufficient to affect wave conditions at the coast.

Numerical modelling of wave propagation over the ECR was also carried out as part of the REA in order to examine whether the volumes of material dredged from up to ten proposed sites would affect wave conditions near the coasts of England or France (HR Wallingford Technical Report, 2002).

The hypothetical dredging plan used by the model deliberately over-estimated the maximum dredged volumes and selected the most relevant, sensitive stretches of the English and French coastline as evaluation points. This served to establish a worst case from which to assess the potential effects of dredging on wave propagation.

Conclusion

Despite adopting pessimistic assumptions, and taking into account the effects of dredging in the ECR and from the Hastings Bank, no significant changes in wave conditions were predicted at any of the sensitive locations. This result clearly demonstrates that the cumulative effects of all proposed dredging in the ECR, in combination with that currently licensed along the English coast, will not affect wave conditions along the coastlines of either England or France.

5.3.2
Reduction in Shelter from Waves to Coastline

Description of effect

Dredging operations that lower seabed levels on offshore banks potentially reduce the level of protection against wave action that they provide to the coast.

Large sandbanks are common features of the European continental shelf. These structures often shelter the adjacent coastline from wave action. Lowering the crest level of a bank could reduce this sheltering effect, leaving the adjacent coast vulnerable to wave attack. The crest level could be lowered as a result of dredging the bank itself, or by dredging close to the foot of the bank, thereby causing draw-down of the sediment from the side of the bank into the depressions within the dredged area.

Assessment of the cumulative effects of dredging on shelter from waves to the coast

The seabed immediately to the east of the proposed dredging areas is composed of sandwaves, but there are no banks of sufficient size to dissipate wave energy within or close to the ECR. However, several large, mobile banks are present in the Eastern Channel and Dover Straits, including the Vergoyer, Bassure de Baas and Bassurelle banks (Figure 4.4). Given that the nearest of these banks is at least 10km east of the application area boundaries, the banks are extremely unlikely to be affected by any dredging activity.

The series of extensive sandbanks lying close (7.5 to 25km) to the French coast undoubtedly influence wave action. For example, during strong wave action from the west or south-west both the Bassure de Baas and the Quemer banks have waves breaking over them. These banks lie over 30km from the location of the proposed dredging. The wave modelling carried out deliberately examined the possibility of waves approaching these banks being affected by the changed water depths in the ECR (HR Wallingford Technical Report, 2002). The modelling concluded that, as there are no changes in wave conditions predicted as a result of the proposed ECR dredging, there will be no changes to wave conditions on these banks.

Conclusion

No reduction in the shelter provided by offshore sand banks to the English or French coastline from waves is predicted as a result of the proposed dredging.

5.3.3
Changes to Tidal Currents

Description of effect

Dredging operations reduce seabed levels which could have an effect on tidal currents beyond the confines of the area actually dredged.

In general, it is not necessary to consider the effects of dredging on tidal currents close to the shoreline unless the proposed extraction area is in shallow water or is close to the coast (CIRIA, 1998).

Marine aggregate extraction is usually carried out parallel to tidal currents, leading to the development of shallow (typically 2 to 5m below the adjacent seabed); elongated depressions in the seabed orientated parallel to the tidal streamlines. The very slight increase in the water depth of these depressions increases the flow discharge through the dredged areas and produces a corresponding relative reduction in flows along both sides. Although current speeds adjacent to the dredged area may increase, those within the area will vary only slightly. In general, tidal current variations are restricted to a zone approximately twice the size of the dredged area.

Assessment of the cumulative effects of changes to tidal currents

All of the dredging areas in the ECR are typically situated over 30km from the coast and localised changes in tidal currents will not have an effect on either the English or French coastlines.

In the ECR, the tidal currents tend to flow parallel to the seabed contours, which have a predominantly north-east to south-west alignment. Therefore, any perturbations caused by dredging will extend furthest from the dredging area along this axis, further reducing the impact upon tidal currents close to the coast.

Conclusion

No effects on the English or French coastline due to changes in tidal currents are expected to arise due to dredging in the ECR.

5.3.4
Draw-Down of Beaches into Dredged Depressions

Description of effect

Dredging operations could potentially cause beach draw-down and hence lead to problems of erosion and flooding along a coastline.

Beach draw-down is a natural phenomenon that occurs during storms along an open coastline, with recovery taking place during calmer weather. The seaward limit of offshore sediment movement and subsequent onshore return depends upon a number of factors, including wave climate, sediment type, grain size and nearshore topography. For example, sand may be transported a considerable distance, while shingle tends to remain close to the low water line. If sand or gravel is extracted too close to the coastline, sediments may be drawn-down into the dredged depression and become trapped, which could lead to a reduction in beach volume and potential coastal recession.

Assessment of the cumulative effects of dredging on beach draw-down

Research into nearshore coastal processes, involving field measurements by the US Army Corps of Engineers, have shown that along the swell dominated Pacific coast of California seasonal variations in sand level may extend from the beach to about 10m depth. However, beyond 10m, seasonal bed changes are insignificant (Inman and Rusnak, 1956). On the coastline of the United Kingdom, where shorter period waves predominate more so than on the Californian coast, the depth to which seasonal beach and seabed fluctuations take place is smaller. A study of conditions on the eastern coast of England (Sir William Halcrow & Partners, 1991) suggests a maximum limit of 7m.

Conclusion

The proposed dredging areas in the ECR are situated at least 20km from the nearest coast. The minimum water depth in the region is 30m and, hence, there is no possibility of beach draw-down occurring due to the proposed dredging.

5.3.5
Changes in Sediment Supply to Beaches

Description of effect

Dredging operations may influence the supply of sediment to the coastline. This impact may be direct, by extraction from the source of such sediment, or indirect by altering the natural pattern of the transport of sediment across the seabed. Additionally, changes in sediment transport pathways outside of the actual extraction area might be caused by changes in waves or tidal currents, although current effects are known to be extremely localised. A more widespread effect on sediment transport patterns might arise if sand transported as bedload became trapped in the dredged depressions. This could conceivably restrict sediment supply to the coast under certain circumstances.

Assessment of the cumulative effects on sediment supply to beaches

Evidence from geophysical surveys shows that sand transport through the ECR is limited. Bedform evidence suggests that the sand transport that does occur is generally in a north-easterly direction. It is not possible to quantify the volume of mobile sand in the ECR, although it appears to be low given the size and scarcity of existing bedforms. The proposed dredging operations will release additional mobile sediment onto the seabed adjacent to the dredging areas. Therefore, the amount of mobile sand on the seabed in the ECR will increase as a result of dredging.

Given the distance of the proposed dredging areas from the coast, there is no risk of disrupting sediment supply. In addition, the currents of the ECR are too weak to transport the coarser-grained sediment (coarse sand and gravel) shoreward, with the north-easterly tidal residual taking sediment towards the Dover Strait (see Section 4.3).

Variations in sediment transport pathways as a result of changes to the hydrodynamic regime due to the proposals are likely to be very localised (i.e. a few hundred metres outside each dredged area). This conclusion is based on the results of numerous previous studies of the effects of offshore aggregate dredging in areas where the water depths are less than in the ECR and, hence, where the relative changes in depths after dredging are larger (John *et al.* 2000).

Furthermore, sediment travelling over the seabed is unlikely to be trapped by the dredged depressions, primarily because natural seabed fluctuations are comparable to those caused by extraction operations. The dredged depressions will have gently shelving side-slopes, particularly in the direction of the pathways taken by the dredgers, which will be aligned with the tidal streamlines. The likely depth of these depressions will be up to about 5m, while in some of the proposed dredging areas the natural depth changes are in excess of 15m. Whilst there may be local zones along the edge of the dredged areas where slopes are present (perhaps up to 1 in 10), and therefore where sediment might accumulate, the overall "trapping" effect of the dredged depressions will be insignificant.

Conclusion

The proposed dredging in the ECR will not reduce the shoreward transport of coarse seabed sediment particles (e.g. gravel), since these are not presently mobile. There is little evidence of shoreward transport of finer sediment (e.g. sand) over the seabed in the ECR at present. A substantial volume of sand will be deposited on the seabed as a consequence of the screening of dredged sediment, and subsequently this will be 'available' for transport by the tidal currents. There is, therefore, no risk of the supply of sediment to the coastlines of either England or France being diminished by the proposed aggregate extraction operations.

5.3.6

Summary of Far Field Effects

Potential cumulative far field effects of dredging in the ECR are: changes in offshore and shoreline wave conditions; reduction in the coastal protection provided by sand banks; changes to tidal currents; beach draw-down; and changes in sediment supply to beaches. The cumulative effects assessment, including numerical modelling, undertaken by HR Wallingford (Technical Report, 2002) has concluded that the proposed ECR dredging is sufficiently far offshore and in sufficiently deep water that no adverse effects on the English and French coastlines will arise.

6 Potential Regional Effects on Benthic Biological Resources

6.1
Introduction

The aggregate extraction activities proposed for the ECR have the potential to affect the **biological resources** in a number of ways. However, from the review of the regional resources provided in Chapter 4 (and particularly Sections 4.4 and 4.5), it is apparent that any impacts will primarily be limited to two key elements: the ‘benthic resource’ and the ‘fishery’. The ECR has no particular importance for bird species or marine mammals and sharks (where they are occasional visitors only). Predicted influences on the benthos of the ECR are therefore considered below and Chapter 7 considers effects on fish and shellfish resources.

In order to predict the influence of the proposals on the biological resource, a number of reasoned assumptions have been made on the implications of the dredging process for the physical resource (for example, regarding the extent of the predicted sedimentological footprint of the dredging activity). These effects are considered in the conceptual model presented in Chapter 5 (see Figures 5.7 and 5.8) and are translated into impact assumptions in Figure 6.2. These reasoned assumptions (in conjunction with the predictions contained within Chapter 5) are then used as the basis of the impact assessment developed below (and in Chapters 7 and 8).

Potential impacts on the benthos due to aggregate extraction in the proposed individual dredging areas are considered in detail within the relevant Environmental Statements. Within the context of the REA, further information relating to the investigation of dredging impacts and their potential effects on the benthos is provided within MES Technical Report (2002). Based on this, the following assessment considers the potential cumulative impacts on the benthic communities of extraction from all proposed dredging areas across the ECR.

Study area

The benthic communities of the ECR (As described in Chapter 4) are complex, stable gravel communities, which co-exist with the high levels of current activity that characterise the eastern English Channel (including fishing and shipping).

The majority of the effects of aggregate dredging in the ECR on benthic resources will occur in the near field (see Chapter 5) and fall into the following categories:

- The direct removal of habitats and species during dredging;
- The indirect influence of the plume in the water column;
- The direct influence of sediment deposition from dredger overspill and screening and its subsequent remobilisation and transport; and
- The resulting habitat alteration.

These effects are considered in turn below.

6.2
Near field effects

6.2.1
Removal of Habitats and Species during Dredging

Description of effect

The dredging process removes sediment directly from the dredged area with its associated species. The ECA have proposed that, at an initial annual extraction rate of 8.5Mt and a dredging depth of 2m, an area of $50km^2$ will be dredged over the 15-year permission period (although not at the same time). The predicted area of direct impact as a result of the removal of substrate is, therefore, expected to be $50km^2$. The targeted resources will be ‘sandy gravel’ or ‘gravelly sand’. The habitats and species associated with these substrates may vary spatially and temporally within these broad categories but, at a regional level, the use of these terms allow a degree of assessment to be made. Table 6.1 below details the area of each substrate type/habitat in the ECR (derived from Figure 4.1) and the extent of the potential impact based on the proposed dredged area. Table 6.2 provides the same information based on aggregated BGS data for the wider region (where the BGS chart refers to the whole region as sandy gravel).

Table 6.1 shows that each of the habitat types present is widely represented within the ECR and that dredging will directly impact only a small percentage of each type. These habitats are also widespread across the English Channel beyond the boundaries of the ECR (Table 6.2). Therefore, within the regional context, the proportion of habitat potentially impacted is further reduced.

Table 6.1	Substrate/Habitat types within the ECR and extent of potential impact		
Habitat	Area (km^2)	Potential impact area (km^2)	Proportion of habitat potentially impacted (%)
Muddy Sandy Gravel	202	12	6%
Sandy Gravel	589	29	5%
Gravelly Sand	401	9	2%

Note: that the Prospecting Areas shown on Figure 4.1 are indicative; with the geological information covering a slightly larger area (i.e. 1192ha) than the ECR itself (1132ha)

Table 6.2	Seabed sediment types in the eastern English Channel				
Sediment type	Eastern English Channel Offshore	% sediment type within 50km^2	Prospecting Areas	Prospecting Areas as % of Offshore EEC	% sediment type within 50km^2
Sandy Gravel/ Gravelly Sand	>7500km^2	≅ 0.7%	1132 km^2	15%	4.4%

Note the BGS classification of gravel is 2mm; includes areas of muddy sandy gravel

Assessment of the cumulative effect of the removal of habitats and species in the ECR

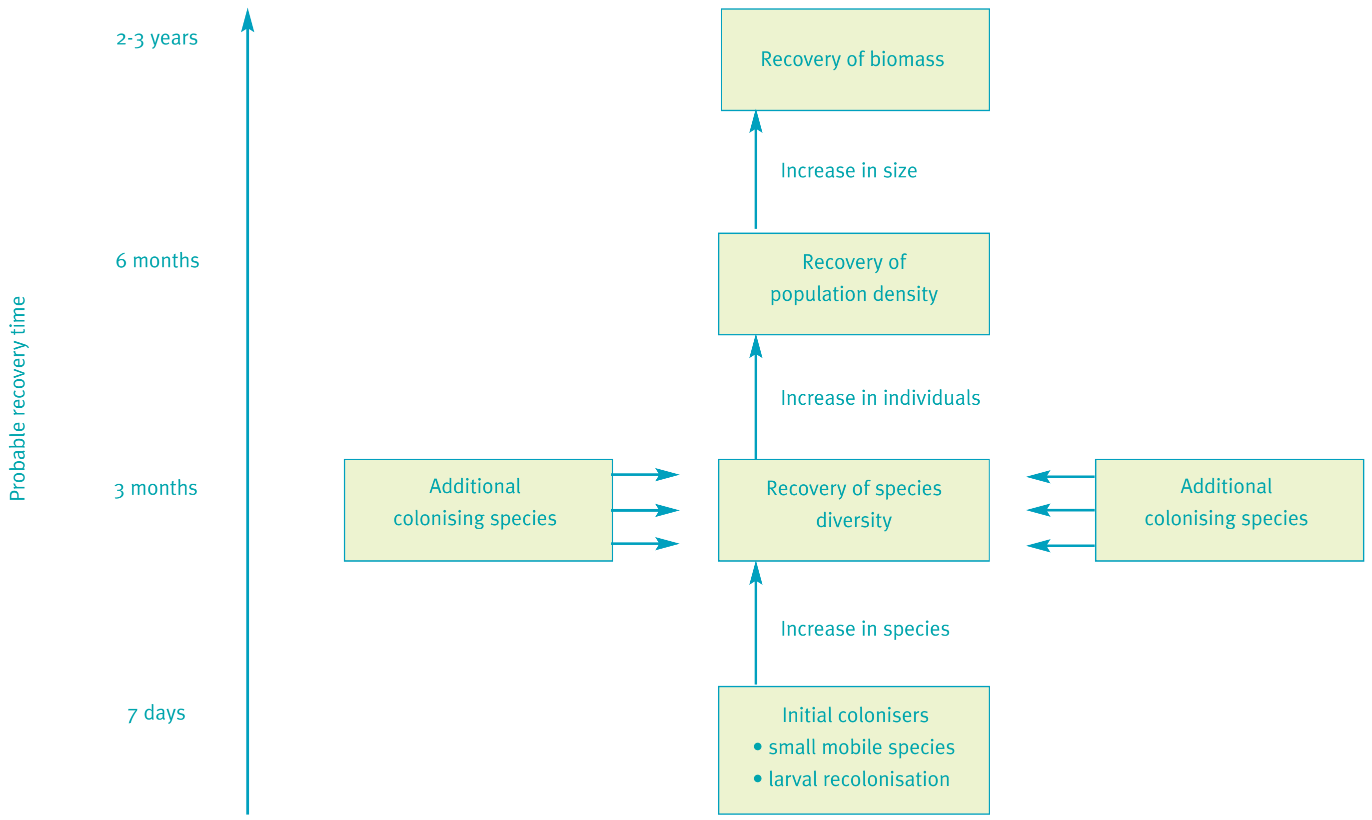
The dredging process typically removes up to 50cm of sediment during a single pass with the width of each dredge track being 2 to 3m. Deeper troughs occur where the dredger repeatedly extracts from the same area. A typical operational dredging zone in the ECR has been estimated to be 3km long by 250m wide, dredged to at least 2m. Dredging zones are typically expected to be operational for 1 to 3 years, depending on production rates.

Most benthic macrofauna (estimated at 90%) inhabit the uppermost layers of the sediment. It is, therefore, likely that the removal of the substrate will significantly reduce macrofauna diversity, abundance and biomass in the operational dredging zones (Emu, 2002). Mobile epifauna may escape the draghead. Overall, it is likely that 50 to 90% of benthic fauna species variety, population density and biomass will be suppressed in the dredged area (MES Technical Report, 2002).

Rates of recovery of the benthic community depend on various factors, including the availability of new recruits, remaining benthic stock and the nature of the remaining habitat. These factors, in conjunction with recovery rates, are discussed in detail in the MES Technical Report (2002). In essence, in order to assess this potential impact, it is necessary to consider a number of phases of the recovery process.

Figure 6.1 shows the various phases of recovery and possible duration of each phase based on current research in shallow water environments. Recovery will commence almost immediately following the cessation of dredging, with mobile and some sessile species that escaped the draghead resettling following disturbance. Available larvae in the water column can also establish themselves in the disturbed area, according to their substrate/habitat preference. Opportunistic species will then start to invade the newly created habitat within a number of days. Within approximately 6 months there should be some recovery of population density, particularly for polychaete worms. Following this, the diversity of species should recover, assuming that a recolonising population remains. Biomass will then recover, with the speed of recovery being dependent upon the species type.

Figure 6.1 Generalised recovery sequence showing the nature and rate of recolonisation of benthic macrofauna in coastal deposits following dredging.



after Newell *et al* 2001

It is likely that this general sequence of recovery of the colonising species diversity, population density and then biomass can be applied to other community types. The time course for the restoration of species diversity and biomass is, however, dependent on the types of colonising organisms, and their rate of recruitment and growth. In the case of the ECR 'equilibrium' communities, the recolonisation sequence may extend to many years (or decades) for the final restoration of biomass of the slow-growing components of the community.

There are two particularly relevant scenarios to consider in terms of recovery relating to the assessment of impact significance:

- Recovery to a biomass that will support predator species (e.g. fish); and
- Recovery of the long-term, stable communities present prior to dredging.

Many of the species that are prey items for fish are likely to partially recover within the first 6 months, even though the biomass may not be up to a pre-dredge value. Recovery of the biomass of polychaetes, which are the key prey items for many fish species for example, is likely to occur within 2 years of the cessation of dredging (bearing in mind their relatively short life span). Within the equilibrium communities that characterise the gravel deposits of the ECR, at least 50% of the species diversity and population density is likely to have been restored within 4 to 6 years of the cessation of dredging. The effect on predator species, therefore, is likely to be minor since fish are generally opportunistic feeders and will take alternative prey if their regular food supply is not available (see Chapter 7).

Long-term recovery will depend on the community composition. Complete restoration (species composition, density and biomass) of the stable equilibrium community that characterises the ECR may take 10 to 20 years. It has been estimated, for example, that one particular bivalve mollusc present in the ECR *(Glycymeris glycymeris)*, could take up to 24 years to recover its full pre-dredging biomass. This species is, however, long-lived and is not representative of the gravel community as a whole. Most of the components of the community are more short-lived and it is considered likely that most of the typical species recorded in the deposits of the ECR are likely to recolonise and reach adult size within 5 to 10 years of the cessation of dredging.

Within the broad habitat types shown in Table 6.1 there will be a natural 'patchiness' of the sediment composition (sand to gravel ratio). This patchy nature will also occur post-dredging. In order for communities to recover to their pre-dredge condition a particular habitat must achieve a similar condition once dredging has ceased. It is likely that, because of the patchiness of the habitat and the variation of the substrate with depth, this will be achieved in some areas but not others. It has not been possible within the present study to quantify the area that could change, as this will be dependent on sediment variability as well as the extent of dredging within a given area.

The MES Technical Report (2002) summarises the data contained within the Environmental Statement for the individual application areas and concludes that the benthic infaunal communities within the ECR are dominated by species within the class of Polychaeta (see Section 4.4). The dominance of polychaetes is likely to continue following dredging given the potential changes to the habitat types, although the dominance of one polychaete species over another could change.

In assessing the significance of the removal of habitat and species during dredging, the following factors must be considered:

- The habitat in most of the proposed Permission Areas may have already been affected to some degree by trawling activity. This may have removed species from the area and disturbed the habitats present;
- The area of sandy gravel habitat that could be impacted is approximately 29km^2 or 5% of this habitat type in the ECR, and the area of muddy sandy gravel is approximately 12km^2, 6% of the ECR;
- The area of gravelly sand habitat that could be impacted is approximately 9km^2, representing 2% of this habitat type in the ECR;
- Generically, the area of 'sandy gravelly' habitat potentially affected represents around 0.7% of the offshore resource across the eastern English Channel;
- The nature of marine habitats is such that there will be some variation in the habitat and species types within any given area. Patchiness of distribution and variability in community composition has been shown within and between the individual application areas;
- The species and communities within the ECR are of high diversity and are generally long-lived, with no overall dominance of a particular species;
- The species and communities within the ECR are widespread in terms of their distribution within a regional context (i.e. the eastern English Channel);
- There is no evidence of species or communities of conservation significance within the ECR and no species have been reported that are not also widely represented beyond the boundaries of the ECR;
- Similarly, the species known to be present in the proposed extraction areas have widespread abundance within the ECR and throughout the gravel-sand deposits of much of the English Channel;
- There will be recovery of the species/communities beginning soon after the cessation of dredging. The extent and duration of recovery will be dependent on the type of habitat remaining following dredging activity; and
- Some recovery of the benthos in terms of the prey available for fish is likely to occur within 6 months in the dredged areas.

Taking all of the above factors into account, the significance of the direct removal of habitat and species will vary based on the receptor under consideration. Overall, the impact is of a relatively small scale in the context of the extent of similar habitats within the ECR and eastern English Channel. However, full recovery of some of the long-lived components of the equilibrium community may take 10 to 20 years. Most of the components of the community are likely to recolonise and grow to adult size within 5 to 10 years, but a shorter period - 4 to 6 years - will apply for the full recovery of the shorter-lived species.

Even so, the 'recovered' habitats and, therefore, communities in the dredged areas may differ slightly from those present prior to dredging. A reversion to communities characteristic of 'gravelly sand' rather than 'sandy gravel' is likely in the immediate vicinity of the dredged sites. However, over time, deposited sand is likely to be winnowed away from the dredged zones. This is addressed further in Section 6.2.3.

Given the above, the impact associated with the potential removal of habitats and species over 50km^2 of the ECR is considered to be of **moderate adverse significance**, although there will be some local variability (i.e. lesser or greater effects) that relate to the differences in the recovery rates of the localised habitats and species. Furthermore, the total area of predicted dredging over the 15-year permission period will not be dredged at the same time. Therefore, the areas that have been dredged will be available for re-colonisation within that period.

Mitigation and monitoring

The industry have already sought to reduce the significance of this impact by undertaking to limit the total area to be dredged within each Permission Area, and the area to be dredged at any one time. This will allow a considerable area to be available, adjacent to the proposed dredged sites, from which the recolonisation of species and communities can begin. The rate of initial recolonisation should, therefore, be more rapid than if a larger area was dredged.

However, in terms of the cumulative impact, 50km² will be affected directly by dredging over 15 years. In order to reduce the significance of the cumulative effect further it is recommended that, where possible, dredging is undertaken in lanes in such a way as to leave strips of undredged habitat between dredged areas (i.e. buffer zones). This reduces the distance for colonising species to travel and thereby should increase the rate of colonisation. Since similar sand-gravel communities are widespread in the eastern English Channel, outside the boundaries of the Permission Areas, a substantial pool of new recruits from the plankton will be available to re-colonise suitable substrates. Minimum timescales should also be set before dredging commences in adjacent areas, to allow time for recovery. It should be noted that the strips of undisturbed habitat potentially to be left as an aid to re-colonisation do not need to be permanent. Once monitoring indicates that the benthos in the dredged area has recovered sufficiently, the buffer zones could then be dredged.

As a further aid to re-colonisation, it is recommended that efforts are made (through targeted screening and dredging) to leave a habitat similar to that which existed before dredging, following the cessation of dredging.

A monitoring plan should be instigated (see Chapter 13) in order to record and compare the actual direct effects with the predicted effects, the total area affected, the habitat left following dredging and the rates of recovery of the seabed following dredging.

Effective implementation of the monitoring and management strategy proposed may reduce the significance of the impact of habitat and species removal from a **moderate to a minor** level in certain areas, over time.

6.2.2

Water Quality Effects Arising from Sediment Plumes

Description of effect

Sediment plumes will be generated by the dredging process, as described in Section 5.2.1. Sands will mainly be deposited in the vicinity of the dredging zone (see Section 6.3.3), while fine-grained sediments (silts and clay) will be suspended within the water column and may be transported several kilometres with the tide.

No contaminants are present in the sediments to be dredged, therefore, no contaminants will be released into the water column as a result of the proposals.

The estimated peak concentrations will be experienced in the near bed environment; reaching levels from 150mg/l to more than 300mg/l above background concentrations in the dredging area, but only persisting for 0.75 to 1.5 hours per tide. Temporary increases in near bed concentrations at over 60mg/l will occur in areas ranging in size from 5 to 25km², for each dredging zone, depending on the length of the dredging track.

Over the full depth of the water column (i.e. the depth-average), suspended sediment concentrations of greater than 50mg/l are expected to be confined to the vicinity of the dredged area (i.e. up to 400m across the tide and up to 1km along the tide), and will only persist at low concentrations beyond 6 hours. At such low concentrations (i.e. less than 20mg/l) dredging plumes are expected to extend up to 5 to 10km from the dredged area along the tidal axis.

Background levels of suspended sediment concentrations in the ECR are in the order of 1 to 10mg/l, rising during storm conditions. In addition, existing trawling activity throughout much of the ECR is expected to have an effect on these suspended sediment concentrations, particularly the near-bed concentrations.

There are two likely impacts on the benthic environment to consider with respect to the water column: (a) attenuation of light, and (b) physical effects on benthic organisms.

- Attenuation of light

The release of sediment can have an impact on certain species while the sediment is in suspension, by reducing the light availability to species below. This is less of a problem for benthos at the depth of water (circalittoral) present in the ECR, as the community structure is dominated by fauna (rather than flora) due to the lack of light at depth.

Within the ECR there will be seasonal plankton blooms (in spring and autumn) that could be affected by sediment in suspension. The plankton drifts with the currents and cannot actively avoid an area of increased suspended sediment concentrations. The effect of an increase in suspended sediment concentrations could be to reduce the light availability to the phytoplankton, thereby affecting their photosynthetic productivity and, ultimately, the organisms that feed on them. However, there is significant variability in phytoplankton production naturally due to variations in incident light.

- Physical effects on benthic organisms

The predicted near bed increases in suspended sediment could impact the benthic resource if it occurs to such an extent to interfere with filter feeding and the respiratory structures of benthic fauna. Early life stages, i.e. larvae and eggs, are generally more vulnerable to the effects of suspended sediments, as are suspension and filter feeding benthic invertebrates. Sediment in suspension can clog feeding and respiratory apparatus, resulting in the reduced efficiency of these activities and, over time, reduced survival rates. The eggs and larvae of some species are particularly susceptible to sediment in suspension; where siltation (even if temporary) may have an adverse affect on fish eggs by impeding their ability to absorb oxygen. The effects on the eggs and larvae of fish and shellfish are discussed further in Chapter 7.

In contrast, some evidence exists of a potential enrichment effect due to the settlement of organic material from the plume. It is thought that the fractured benthic organisms may provide an additional food source for filter feeders and may increase productivity in the immediate vicinity of a dredging area (Newell et al. 1999). However, research to date on plumes has not been undertaken in hydrodynamic or geological conditions similar to those within the ECR.

Assessment of cumulative effects of plumes on benthic organisms

In assessing these effects it is important to acknowledge the uncertainties surrounding the predictions made. Some of these uncertainties are discussed in Chapter 5 and relate mainly to the fact that dredging has not been undertaken within this region before; the extent of the area that will potentially be affected by the dredging plumes is, therefore, based on a number of reasoned assumptions. The predictions made are based on existing knowledge and dredging experience. Knowledge of the region's physical parameters is good and the assumptions made are robust.

The total extent of the area that could be affected over the 15 year application permission period (but not at any one time) by the plume associated with the ECR-wide dredging activity is illustrated in Figure 5.4 and discussed in Section 5.2.1.

- Attenuation of light

The majority of the sediment suspended within the plumes generated by dredging activity in the ECR is expected to settle out quickly (i.e. within hours), with plumes only persisting at low concentrations following the cessation of dredging. However, the silt will only settle temporarily and will be remobilised on the next tide. In addition, plumes generated by adjacent dredging activity are not expected to coalesce to any significant extent. The resultant effects on benthic communities due to increases in turbidity and light attenuation are expected to be negligible, due to their limited duration. In addition, due to the dominance of fauna over flora within the ECR communities (due to the depth of the water), any localised reduction in light attenuation is unlikely to have any effect. A localised impact on phytoplankton populations could occur at certain times of year (during the spring and autumn blooms) but this is also expected to have a negligible impact on the benthic resource due to the large scale of distribution of phytoplankton blooms.

- Physical effects on benthic organisms

In contrast, the increases in near bed levels of suspended sediment could affect filter and suspension feeders by reducing the efficiency of their feeding and respiratory apparatus. Near bed concentrations of suspended sediment within the dredging areas, during and immediately following dredging, will range from 150mg/l to over 300mg/l. However, following dredging, the majority of species that could potentially be affected within this area will have already been removed. It is therefore the species immediately adjacent to the dredged areas that would be most affected. Temporary increases in near bed concentrations of over 60mg/l are expected to occur in areas ranging in size from 5 to 25km^2 for each dredging area.

It is apparent that during storms levels of suspended sediment will rise above background levels. It is, therefore, expected that some species that occur within the ECR will be tolerant of such increases in suspended sediment concentrations, although the length of time that the species can tolerate these higher levels of suspended sediment concentration is not known. Epifaunal species, such as brittlestars and hydroids, that characterise the current-swept coarse deposits of the ECR, however, are generally less tolerant of high levels of suspended sediment. Given the limited predicted duration of the plume at high concentrations (less than 2 hours), it is not expected that the dredging activities will cause any permanent losses due to the physical effects of the plume.

In a regional context, given the temporary nature of this effect and the fact that the greatest impact will be localised, occurring in an area already impacted by the dredging process, the impact is considered to be of **minor adverse significance**. However, some caution should be exercised because this effect will occur repetitively in some areas (the consequences of which are unknown) and the significance of the effect could vary locally.

Mitigation and monitoring

Due to the extent of the area that could be affected by the sediment plume, the rich and varied communities supported by this relatively stable environment and the degree of uncertainty that is inherent in assessing the impacts associated with dredging plumes within an area previously undredged, it is recommended that appropriate mitigation measures are adopted to reduce the significance of this effect.

The following measures could be effective: Zoning the proposed dredging areas in order to target the sediment types with the lowest percentage of fine sediments (silts and clays). Resources with high silt concentrations should be avoided. This measure can only be fully implemented once a company has gained further knowledge of their proposed dredging area, through dredging. The Applicant companies have already agreed to adopt this approach. Targeting those resources with the lowest proportion of fines within each proposed dredging area has clear operational advantages.

The companies have also already committed to ship-related mitigation measures that can be adopted to reduce the significance of the plume. Measures to reduce the amount of screened material rejected are clearly advantageous in terms of minimising the effects on the benthic resource. As such, these measures will be adopted as a matter of course in order to provide the associated benefit to the environment. Such measures include loading as efficiently as possible to decrease loading time, as well as targeting areas with the lowest likely requirement for screening. It should be noted that within the ECR there will be variation in the amount of screening required.

Licence conditions suggested in MMG1 include the requirement for each dredging vessel to be equipped with an Electronic Monitoring System (EMS). The dredging operation data acquired from the EMS is provided to the Crown Estate and ODPM on a monthly basis. In addition to dredging activity data, it is suggested that individual licence holders prepare annual screening reports. It would be advantageous to also provide details of any additional measures taken to minimise environmental effects (e.g. zoning).

Due to the number of uncertainties associated with the predicted dispersion of sediment plumes in deeper water environments, and variation in the amount of material that will be screened across the ECR, a co-ordinated monitoring programme should be instigated. This should record plume dispersion and suspended sediment concentrations arising due to dredging in different locations across the ECR and any potential plume coalescence due to simultaneous operations (see Section 5.2.1). Such monitoring would not need to be continuous, but should be used to provide a picture of dispersion and records of suspended sediment levels (for example, through the use of ADCP) once a dredging zone is fully operational.

Should monitoring reveal a significant effect, potentially above an agreed threshold (see Section 13.4.4), then mitigation measures must be put in place to reduce the extent of the impact to an acceptable level.

6.2.3

Potential Effects from Deposition and Transport of Seabed Sediments

Description of effect

It is estimated that 25 to 33% of the total quantity of sediment dredged will be screened and returned to the water column in the form of 1660 to 2500 tonnes of fine, medium and coarse grained sand and low proportions of silt per 5000t cargo. Around 75% of this sediment is larger than 300μm. Settlement of silt is unlikely to occur on a permanent basis because the tidal currents at the ECR are always capable of disturbing and transporting the silt that settles on the seabed. Chapter 5 describes the process of deposition and transportation of screened and overflow material from the dredged zone (and as depicted in Figure 5.8).

Two zones of deposition are predicted (see Figure 6.2): firstly, laterally around the dredge track and, secondly, beyond the dredge track as described below:

1. Lateral zone of deposition:

The majority of the sand deposited laterally will fall within 100m (either side) of the dredger track, outside the margins of the dredged zone.

2. Along the tidal axis to the North-East:

i) Sand sheet - a sheet 10 to 25cm deep will form to the NE of the dredged zone, in the direction of the tidal residual. The substrate up to 200m to the NE will be completely covered by a rippled sand sheet formed by the initial movement of sand.

ii) Bedform field - a zone of bedforms will be created upto 1km away from the sand sheet as the sand continues to be moved with the tidal residual away from the dredging zone. This area will consist of sand ripples overlying the substrate with decreasing frequency to the NE. It is likely that the substrate in this zone will be intermittently covered by bedforms.

iii) Dispersed zone - as the bedforms become more diffuse away from the dredging area, a zone of dispersed sand streaks and ripples will be formed. This zone may extend upto 1km from the end of the bedform field.

The transition described above sets out the process by which the screened and overflowed sand is deposited and then winnowed from the dredging zone towards natural sediment sinks. Over time the sediment within the dredged zone will become coarser as the finer sands are winnowed away. This process will occur over a period of several years to decades, although the exact timescale is unknown.

Three key effects arise due to the processes described above:

(1) deposition of sediment;
(2) movement of sediment as winnowing occurs; and
(3) temporary alteration of the substrate to a sandier habitat.

Only the zone of deposition and the sand sheet will be completely covered by a layer of sand at any one time. The depth of substrate coverage will decrease as bedforms decay to become sand streaks.

Assessment of cumulative effects of sediment deposition on the benthic resource

During the dredging process finer sediment is released in the overflow and through screening which falls back to the seabed within and immediately adjacent to the dredged area. This released sediment will affect the remaining habitat. The process will disturb and extract the gravel and the rejected sand will settle the interstitial spaces of the remaining gravel to produce a habitat that is sandier. The extent of change, however, will be limited due to the presence of gravel within the material left behind on the seabed. Past experience has shown that the seabed sediments could change from, for example, approximately 40% gravel and 60% sand to 25% gravel and 75% sand (although within the ECR there is a large range of sediment size distributions) (*pers. comm.* ECA, 2001). This would potentially change the habitat from sandy gravel (characteristic of the south-west of the ECR) to gravelly sand. However, the difference in the size distribution between 'sandy gravel' and 'gravelly sand' could be as little as 1%. In addition, the relative contribution of the main faunal groups across the ECR is broadly similar in terms of number of species and abundance.

By way of quantifying the potential effects of the impact of the dredging activity due to the deposition and mobilisation of screened sediment, the potential dredging scenario presented in Figure 6.2 is proposed. A typical operational dredging zone, 3km long and 250m wide, will have an area of 0.75km². Beyond the boundary of the dredged zone, as sediment is mobilised in the direction of the tidal residual, the width of the bedform field and dispersed zones is likely to be equal to the width of the dredged zone (i.e. 250m). However, the coverage of the seabed by sand will decrease with distance from the dredged zone both in line with the tidal residual and across the tide. The scale of the impact, therefore, will vary with distance from the dredging zone. With increasing distance from the activity, and as the winnowing of sand occurs, the coverage of sand will become more patchy.

In general terms, based on the conceptual model proposed, for each dredging zone (0.75km²), an additional area of 1.15km² will be affected by the deposition of screened sediment and its transport away from the dredging zone (Figure 6.2).

note sediment thickness will decrease with distance from the dredging zone

Impact assumptions for deposition and transport of sand around an example of an operational dredge zone in the East Channel Region

Assumption 1: Operational dredging zone

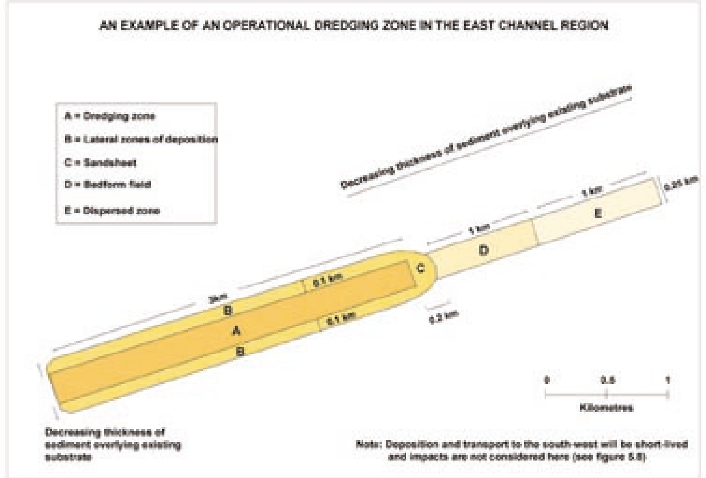
An operational dredging zone will be 3km long by 250m wide in the East Channel Region – **Zone A**

(Note: the sizes of operational dredging zones may differ; some may be longer or narrower)

Assumption 2: Sand Deposition and Transport

The model indicates two zones of deposition:

1. **Lateral** zone of deposition 100m either side along margins of the dredged zone – **Zone B** in diagram
2. Deposition **along the tidal axis** to the Northeast of the dredging zone
   - i) Sheet deposition for the first 200m – complete coverage – **Zone C**
   - ii) Bedform field – 1km of sand ripples with decreasing frequency to the NE – **Zone D**
   - iii) Dispersed zone – 1km of sand streaks – diffuse coverage of sand - **Zone E**



Factor	Zone	Calculation (km)	Area (km²)
Operational dredging zone	A	0.25 * 3	0.75
Lateral zone of deposition either side of dredging zone	B	(0.1 + 0.1) * 3	0.6
Sand sheet	C	0.25 *0.2	0.05
Bedform field	D	0.25 *1	0.25
Dispersed zone	E	0.25 *1	0.25
Total area of direct impact per operational dredging zone	A		0.75
Total area of indirect impact for an operational dredging zone	B + C + D + E	0.6+0.05+0.25 +0.25	1.15
Total area of impact per operational dredging zone	A+B+C+D+E	1.15+0.75	1.9

- A typical operational dredging zone in the ECR and the potential coverage of the seabed by sand is shown in the above figure. This is a dynamic system, where sand will be input from the screening process and simultaneously winnowed by tidal currents. Coverage of the substrate and thickness of the sediment decreases laterally from the dredging zone and in the direction of the tidal flow.
  - For every active dredging zone of this size (area of 3 * 0.25 km), there will be a direct area of impact through dredging of 0.75km² and an indirect area of impact through deposition and transport of sand of 1.15km². Therefore, should 10km² be dredged in any one year, an area of 15km² will be subject to sand deposition and transport at varying intensity. The total area of impact would be 25km².

6.2 Impact Assumptions

A number of potential effects on benthic and epibenthic species are recognised as a result of the above activity. These are:

- Deposition of fine-grained sediment returned in the overflow;
- Deposition of screened sediment;
- Alteration of the habitat type;
- Movement of the sediment.
- Deposition of fine-grained sediment returned in the overflow

It is estimated that between 1 to 10% of the material dredged will be returned to the water column via the overflow spillways. Overspilled sediment will consist of clays, silts and fine-sand. However, the quantity returned is likely to vary across the ECR depending on the silt content of the sediment.

Modelling has shown that the deposition of this fine sand and silt could reach a thickness of 1 to 2mm in the dredged zone and up to 0.5mm in an area extending up to 10km outside the dredged area during slack water. This effect, however, is temporary as the sediments will be remobilised on the next tide and continual resuspension will quickly disperse the sediments (see Section 6.2.1). The influence of this effect on the benthic resource is therefore considered to be negligible.

Many species are silt intolerant. A thin layer of silt could inhibit the settlement of epifaunal organisms that require clean surfaces. Larval settlement is also generally linked to site-specific features of the substrate. However, although a small covering of silt could inhibit settlement during the time that it is present, the temporary nature of this effect (measured in hours) means that its influence on the benthic resource of the ECR is expected to be insignificant.

- Deposition of screened sediment

Research undertaken in 1996 (Desprez, 2000) showed that deposition surrounding a gravel dredging site resulted in a greater impact on the benthic biological resource than dredging itself. If 33% of the material dredged is rejected overboard during the screening process, this could result in an estimated total of between 2.8 and 8.5 million tonnes of material rejected per year over a total area of $25km^2$ to $125km^2$ (including the dredged area and assuming 8.5Mtpa and 15-year extraction rates respectively).

The coarse sand element of the rejected material will settle rapidly within the dredged area. As suggested in Chapter 5, material will be deposited laterally, mostly within 100m, and up to 200m outside the dredging area in the direction of the tidal residual (NE) (Figure 5.8). Medium to fine sand is likely to be transported as bedforms, ie. occasional ripples and streaks, up to 2.2km from the dredging site (to the NE) decreasing in depth with increasing distance from the dredge site. It has been estimated that within the zone of the sand sheets and bedforms (e.g. within 2.2km of the dredge site), the depth of sedimentation could build up to 10 and 25cm, potentially covering a total area of $1.15km^2$ (Figure 6.2).

Burial of organisms through the settlement of suspended sediment can have a detrimental effect upon the benthic community. Maurer *et al*. (1986) described the comparative responses of four species of benthic invertebrates to burial at an offshore dredging disposal site in terms of vertical migration and mortality in dredged material. The study demonstrated that certain species of infaunal invertebrates have developed morphological and behavioural features to cope with shifting sediment and burrowing.

Maurer *et al* concluded it is critical to compare the settling sediment with the existing sediment at a site – the greater the difference in sediment, the greater the effect is likely to be. These findings supported initial results achieved by Maurer *et al.* in 1980 and showed that mortality generally increased with increased sediment depth (although many species can tolerate burial of up to 30cm), increased burial time and with overlying sediments whose particle size distribution differed from that of the species native sediment. A major finding was that vertical migration is a key mechanism for the re-colonisation of dredged sites, on a similar scale to larval recruitment from external sources.

Some species within the ECR are particularly sensitive to burial, such as the brittlestar *Ophiothrix fragilis*, which is unlikely to be able to tolerate smothering by 5cm or more of material. Brittlestars occur within localised areas across the ECR. However, the majority of the sediment that settles as a result of the proposed dredging operations will settle quickly and onto the area already impacted directly by removal of the substrate. As such, the area is unlikely to be affected further. The sand sheet areas immediately adjacent to the dredge zone will be affected by smothering to a greater extent (see Figure 6.2). However, some species present in the ECR (e.g. some polychaetes and bivalves) will be capable of burrowing vertically through the deposited sediment.

In addition, a layer of deposited sand may inhibit settlement of epifauna larvae to their preferred substrate.

In order to assess the significance of the settlement of sediment on the benthic resource adjacent to the dredging areas the following points need to be considered:

- The majority of the studies on the impacts of aggregate extraction on benthic communities have been undertaken in shallower water environments. However, the judgements made in the present study are based on direct knowledge of the species and communities present within the ECR and the implications of deeper water environments have been considered;
- Sediment will be released and settle in smaller quantities than at disposal sites, as pulses from each cargo. Settlement of sand will potentially build to 10 to 25cm in thickness at any one time. Many of the studies undertaken on species sensitivity and tolerances are based on disposal site impacts;
- The significance of the impact will decrease with distance, as most of the sediment will be deposited in close proximity to the dredging zone. With distance from the dredge site, bedforms will be created and winnowing will result in sediment transport towards the natural sediment sinks south of the Dover Straits;
- The settlement of finer sediments (silt and clay) will only be temporary and the plume will be remobilised and move away from the area of initial settlement relatively quickly (often within one tidal cycle);
- Settlement of sediment will be restricted to a narrow band (eg 250m wide for each operational zone) due to tidal currents in the region. This will aid the recolonisation of adjacent unaffected areas;
- Local effects on the fauna will vary depending on the species sensitivity within the area;
- Some infaunal species are tolerant of a certain degree of smothering and can migrate through sediment. Tolerance is dependent on a number of parameters (such as rate of settlement, type of sediment and species characteristics);
- The habitats and species within the proposed application areas are widely distributed throughout the ECR and beyond; and
- Trawling and scallop dredging may have already had an impact on benthic communities in the region.

Taking these points into consideration, the significance of this effect is expected to be **moderate adverse** within approximately 1.2km of each dredge site (i.e. over 11.7km^2 of the ECR at 8.5Mtpa) and of **minor significance** further away from each site (over 3.25km^2 of the ECR) although these impacts will be moderated by habitat recovery in the medium term.

- Alteration of habitat type

Longer-term changes in sediment composition due to the extraction of aggregate, leading to a finer residual substrate, could result in a change in the diversity of benthic macrofauna and a community composition dominated by polychaete worms. However, the extent of this change is likely to reduce over a long timescale, with the finer sediments gradually being winnowed away and transported to the sediment sinks south of the Dover Straits. That is, a similar sediment size distribution to that present prior to dredging should return following the cessation of dredging. As a consequence of the winnowing process, it is also important to recognise that because the settlement of sediment may be temporary in certain areas, it has the potential to affect (albeit to a lesser extent) a broader area.

Potentially, the benthic species most affected will be those that require hard substrate for settlement. Certain crustaceans require specific sized interstitial space for shelter; and hydroids and bryozoans generally require low turbidity water and hard substrate for settlement. Some key species require a specific substrate for spawning and nursery areas, for example herring and scallop (see Section 7.2.3).

The habitat types present the ECR are widespread in the eastern English Channel (Figure 4.1 and Table 6.2), with the sandy gravel and gravelly sand biotopes of the ECR largely characterised by similar communities (dominated by bivalve molluscs and polychaete worms); although local variations exist. Therefore, the significance of a potential alteration in habitat type, in this case to a sandier habitat following dredging, will be dependent on the specific habitat type affected locally.

Generally, the extent of change in the ECR is expected to be limited due to the presence of gravel within the material left on the seabed. Any increased sandiness will potentially change the habitat from sandy gravel to gravelly sand. In a regional content, in those locations where the habitat is characterised by a higher percentage of gravel now, the habitat is likely to remain within the sandy gravel category, whereas in those locations where the sand content is higher, the habitat could change to slightly gravelly sand. Significantly, the relative contribution (species and abundance) of the faunal groups in these areas is broadly similar.

Nevertheless, a slightly different community is likely to recolonise the habitats in the sandier depositional footprint of the dredging operations. Due to the nature of the sediment and the communities present in the ECR, the community in affected areas is likely to continue to be dominated by polychaete worms, although the dominant species may be different.

The importance of this impact outside of the dredged areas will vary depending on the sedimentological characteristics of each particular dredging zone, but given the assumptions set out in Chapter 5, it is only likely to be of minor adverse significance. That is, although increased sandiness could potentially affect up to 25km^2 of the ECR (at over 1,000km^2) per annum, if 10km^2 are dredged, the extent of change will be less significant in certain parts of the region and many of the recolonising communities are likely to vary very little from the original communities. It is also predicted that, over time, those habitats will regain their original grain size profile. The potential alteration of the habitat, therefore, is unlikely to affect its value regionally for spawning and recruitment. However, in areas characterised by species that require hard substrates, the impacts are expected to be greater, particularly in the short-term.

- Movement of sediment

The movement of the more mobile sediment, following initial deposition, could affect certain benthic and epibenthic species by potentially causing scour and affecting the recolonisation potential of the substrate. Scour would be detrimental to any soft-bodied and delicate species inhabiting affected areas.

Species sensitive to abrasion could include soft-bodied polychaetes with no protective tubes. Other species are tolerant of mobilised sand and intermittent burial, e.g. *Sabellaria spinulosa* and some hydroids and bryozoans (Holme & Wilson, 1985).

The mobilisation of fine sediment could also affect the rate of recolonisation of the impacted substrate by removing some of the initial colonising species as the sediment moves. The mobilisation potential of the sediment, however, is such that the majority of any settled sediment likely to be remobilised will be moved on the following tide. The effect will, therefore, be extremely short-lived.

Although there is expected to be an effect on some of the species within the ECR due to the mobility of sediment, this effect is predicted to be of minor significance.

Mitigation and monitoring

The mitigation measures proposed with respect to the deposition of sediment onto the seabed are largely the same as those proposed to limit the water quality impacts of the plume, detailed in Section 6.2.2. These include:

- Zoning the proposed dredging areas, targeting resources;
- Minimising screening; and
- A detailed plume study.

Reductions in the amount of sediment put into suspension due to the dredging activities, particularly at critical times (e.g. during spawning periods, see Sections 7.2.1/3) will reduce the potential significance of sediment deposition. The Industry Statement sets out the Applicant companies commitment to reduce screening.

In addition to the mitigation recommended in Section 6.2.2, and in order to reduce the significance of settlement at any one time in any one area, it is recommended that dredging be undertaken in strips along the direction of the tidal currents (see also Section 6.2.1 *Mitigation*). This would enable the plume to be concentrated in a narrower zone of impact and in an area already directly affected, to some extent, by the dredging.

A programme of monitoring will also be essential in order to allow the development of a better understanding of the sediment deposition and transport processes that characterise the ECR and the biological response to dredging. It is recommended that once production has started an intensive data collection programme is initiated in order to provide data that allows the validation of the conceptual model and quantifies the response of the benthic resource.

Initially, detailed, site-specific case studies should be implemented to help develop an understanding of the patterns of sedimentation (i.e. the zone of sediment deposition and transport), how these relate to dredging activities and the pre- and post-dredge character of the benthic community and seabed. This will require an intensive programme of data collection and interpretation to be undertaken prior to and once dredging starts. Data required will include bathymetry and seabed sediment/benthic sampling across the proposed dredging zones, and extending 2km across the tide and up to 10km along the tide. The scope and timing of follow up surveys should be re-assessed against the results obtained. Repeat surveys should be undertaken at agreed intervals to determine the rate of change. Initially these will need to be at shorter intervals in order to increase understanding, with the ability to extend the intervals between surveys as knowledge increases.

The settlement of sand is also influenced by the ability of the system to remove the settled sand. This effect and the development of bedform fields and ripples should therefore also be monitored in order to determine any long-term patterns and influences of habitat change.

The residual effect of the settlement of the plume is expected to be of **moderate significance** within 1.2km of each dredge site and of **minor significance** further away. Significant habitat alteration is not expected to occur.

6.3
Far Field Effects

The 'physical environment' cumulative effects assessment undertaken by HR Wallingford (see Section 5.3) concluded that **no adverse effects** on the English and French coastlines will arise due to changes in wave conditions or tidal currents. Furthermore, no changes in sediment supply to beaches or offshore sandbanks will occur. Therefore, the benthic biological environment of these coastal areas will similarly be unaffected by the dredging proposals.

The influence of plumes of fine grained sediments suspended in the water column will, however, extend well beyond the boundaries of the dredging sites, and potentially up to 10km from the dredging zone boundary. The implications of this potential far field effect on the benthic resource are considered in detail in Section 6.2.2. In essence, sediment plumes in the ECR are only expected to persist at low concentrations (less than 20mg/l) following the cessation of dredging and to have typically dispersed within 12 hours.

Their effects on benthic communities in the ECR (which are dominated by fauna rather than flora) due to increases in turbidity and light attenuation are, therefore, expected to be negligible. The influence of predicted near bed increases in suspended sediment concentrations of over 60mg/l in areas ranging in size from 5 to 25km^2 (depending on the shape of the dredging track) has the potential to have a greater effect, particularly on filter feeders and suspension feeders. However, the duration of this effect will be short (less than 2 hours). This effect is therefore considered to be of **minor adverse significance**. An ECR-wide monitoring regime should, however, be implemented to measure plume persistence and influence (see Chapter 13).

6.4
Summary of Benthic Effects

The benthic and epibenthic communities of the ECR are expected to be affected by the proposed dredging activity as a result of the direct effects of extraction (on habitats and species), the indirect effects of the sediment plume and the deposition and subsequent transport of sediment. The overall significance of the effects will vary across the ECR depending on a number of factors, including the nature of the targeted resource within each dredging area and the scale at which dredging occurs over the ECR at any one time.

When considering the significance of the impacts predicted it is important to bear the following general points in mind:

- The habitat in much of the area (characterised by 'equilibrium' communities) may already have been affected to some degree by trawling activity. This would have removed species from the area and disturbed the habitats present;
- The area of sandy gravel habitat that could be impacted by the dredging proposals is approximately 29km^2 or 5% of this habitat type in the ECR, and the area of muddy sandy gravel is approximately 12km^2, 6% of the ECR;
- The area of gravelly sand habitat that could be impacted is approximately 9km^2, representing 2% of this habitat type in the ECR;
- Generically, the area of 'sandy gravelly' habitat potentially affected represents around 0.7% of the offshore resource across the eastern English Channel;
- The sedimentological footprint of the dredging in any one year is expected to encompass 25km^2 of the ECR, i.e. 2.2% of the total area (based on a targeted resource of 8.5Mtpa from 10km^2). For 50km^2 (i.e. after 15 years of activity) the footprint will encompass 125km^2, 11% of the ECR;
- The nature of marine habitats is such that there will be some variation in the habitat and species types within any given area. Patchiness of distribution and variability in community composition has been shown within and between the individual application areas;
- The species and communities within the ECR are of high diversity and are often long-lived, with no overall dominance of a particular species;
- The species and communities within the ECR are widespread in terms of their distribution within a regional context; and
- There is no evidence of species or communities of conservation significance within the ECR that are not also well represented beyond the boundaries of the ECR.

The predicted cumulative effects of the proposed dredging activity on the benthic communities amount to the combination of the impacts in each individual application area. Given the management measures proposed, including careful targeting of resources and the careful location of proximate dredging areas, there is not expected to be an additional impact due to the overlapping influence of effects from adjacent application areas.

7 Potential Regional Effects on Fish and Shellfish Resources

7.1
Introduction

The potential effects on the fish and shellfish resources of the ECR due to proposed aggregate extraction at individual application sites are set out in their relevant Environmental Statements. This section aims to describe the potential cumulative impacts of all the proposed dredging operations and their significance in a regional context. The assessment is based on data obtained from the individual Statements as well as the regional fisheries study commissioned as part of the REA. The information was gathered and interpreted as a basis for the cumulative environmental assessment of the East Channel Region.

The full Technical Review of fish resources and fishing activities in the ECR can be found in the Poseidon Technical Report (2002).

The potential impacts on fish resources considered below include: the direct impact of the removal of biomass, the indirect effects of the dredging plume (created by the overflow of the material during the dredging process), the deposition of material onto the seabed in the vicinity of the dredging activity and its subsequent re-mobilisation outside the dredged area. Potential longer term effects are also considered and, due to their uncertainty, have been taken into account in the proposed monitoring programme (set out in Chapter 13). The prediction of the extent of these influences is made on the basis of the conceptual model presented in Chapter 5 and the impact assumptions given in Figure 6.2

In describing these effects and determining their significance the following considerations have been taken into account:

- A significant amount of information has been gathered on the fish resources of the eastern English Channel. However, there is a lack of detailed information on the distribution of fish resources in the ECR, especially in its central area;
- Fish stocks vary naturally with time and space;
- Although it is clear that a number of commercially and ecologically important species spawn in parts of the ECR, the inability to precisely define the location of these areas makes it difficult to assess and accurately quantify the potential effects of aggregate dredging on the spawning patterns of these species;
- The potential effects of the proposals on the spawning behaviour of some of the species found within the ECR may have implications in areas outside the region. For example, some commercially and ecologically important species, such as herring and plaice, are known to migrate from areas within the ECR to parts of the North Sea, where they represent important stocks. Similarly, it has been suggested that a distinct eastern stock of sea bass migrate from parts of the ECR to the southern North Sea;
- Longer term changes to predator-prey relationships are likely to have very different effects on the various different species present in the ECR. For instance, a simplification of the benthic communities in the dredged areas (e.g. a decrease in their diversity and abundance) and consequent changes in food availability will impact fish resources differently. Hence, sandier sediments (which may occur due to sands settling from on-board screening) would benefit crab and sole, which favour sandier sediments and are more opportunistic in their feeding habits. In addition, a sandier seabed will support a community dominated by polychaetes, which are important prey items for many fish;
- As set out in the Industry Statement, the extent of the area to be dredged over a 15 year period is expected to be 50km² based on an initial dredging effort of 8.5Mtpa, typically with 10km² being worked in any one year (noting that the same 10km² may be dredged for a number of years). The area of potential impact (50km²) represents approximately 0.2% of ICES Area VIId (which is between 25,000 and 30,000km²) and 4.4% of the ECR. Similarly, the total area likely to be dredged in one year is 0.04% of the fisheries study area and 0.9% of the ECR; and
- The region is already subject to fishing activity and is likely to have been impacted to some extent by this activity.

Each recognised potential impact is described below with respect to each relevant species (e.g. scallop) or group of species (e.g. crustacea, finfish). A level of significance is provided and mitigation measures and residual effects described, if applicable.

Study area

7.2
Near field effects

7.2.1
Biomass Removal

Description of effect

The direct removal of a number of sessile or slow-moving organisms by the drag-head will occur as a result of dredging. Most demersal and pelagic juvenile and adult finfish are likely to avoid dredging areas during operations in response to noise levels and increased turbidity. However, the less mobile shellfish and crustaceans, as well as the fish eggs and larvae of some species (see below), may not be able to avoid direct uptake and are likely to be removed from the seabed. For crustacea, this is likely to be fatal and most shellfish are unlikely to recover from the direct effect of the drag-head; some of the smaller individuals may survive when returned to the seabed with the overflow.

Investigations into the rates of mortality (and potential survival) caused by dredging have looked at a variety of shellfish and finfish. Armstrong *et al.* (1987), for example, suggested that between 0.7% and 8.6% of potential harvestable crab at a number of sites in Washington State (US) could be lost through dredging. In contrast, Larson & Moehl (1990) and Armstrong (1990) concluded that only negligible rates of mortality were recorded among larger finfish; similarly, a small proportion of the smaller individuals are reported to 'escape' (Lunz, 1985). Typically, most bivalves (adults and larval) are assumed to suffer up to 100% mortality due to direct uptake. There is, however, some video evidence of avoidance behaviour exhibited by scallop (Emu, 2002).

In addition to direct effects, the fish and shellfish resource could be affected indirectly by a reduction of approximately 50 to 90% in benthic species richness, population density and biomass in the dredged areas, i.e. potential prey. Full recovery of prey communities able to support fish populations in the region (i.e. species diversity and population density) is expected to take 4 to 6 years. However, it is predicted that the biomass of the main prey species (polychaetes) will recover within 2 years of the cessation of dredging and many prey items will partially recover within the 6 months.

With a predicted increase in the sand content of the dredged areas and their surroundings following dredging, there is also likely to be a suppression of biodiversity in these areas, leading to a simpler less heterogeneous assemblage and the removal of specific prey items. Despite the fact that most fish species in the ECR are omnivorous and will probably adapt to such simpler benthic assemblages and food availability, some fish species will be negatively affected and may move to areas with more suitable food availability. This could, potentially lead to a reduction in fish resources in some parts of the ECR, but increases in others.

Assessment of the cumulative effects of the direct removal of biomass on fish resources

- Scallops

Most *adult* scallops are likely to be removed completely in the areas dredged; although some smaller individuals may return to the seabed via the overspill material and video evidence has shown some avoidance behaviour. If we assume complete removal of resident scallops from the dredged area, under the predicted extraction scenarios, direct removal will impact 0.9% of the potential spawning stock (i.e. a total area of $10km^2$ per annum) across the ECR and 0.2% of the scallop grounds of the eastern English Channel each year (estimated to be $5200km^2$ (Emu, 2002)). Following extraction, there is likely to be some re-colonisation of the affected areas from spat falls outside the dredging zones. More specifically, the central and north-western parts of ECR, and the seabed north-west of the ECR, lie in areas considered to be high density spawning grounds (see Figure 4.11). Transport of larvae from surrounding areas may be sufficient to re-stock individual dredging areas, especially if buffer zones are left along the tidal axis to encourage re-colonisation.

Scallop densities in the offshore areas of ICES Area VIId (incorporating the ECR) are believed to range between 0.3 and $1.9g/m^2$ (Rees and Dare, 1993). If scallop densities at the high end of this range (i.e. $1.9g/m^2$) are assumed, as well as the complete removal of adults during extraction (although this is unlikely), dredging $10km^2$ per annum in the ECR has the potential to remove 19 tonnes of scallop. Based on the information provided in Table 4.4, between 1991 and 2000, scallop dredging removed an average of 9,675 tonnes of Great Atlantic scallop a year from ICES Area VIId (at between 25,000 and $30,000km^2$).

Based on the above, the impact is considered to be of moderate to **minor adverse significance** in view of its magnitude, that is, most adult scallops are likely to be removed from the dredged area, however, the extent of the affected area only represents a small percentage of the ECR. Furthermore, the impact is considered to be short to medium term in its duration. The resource has no conservation significance and its recoverability should be relatively high as a result of re-colonisation and spat falls from both within and outside the ECR.

Scallop *larvae* in areas adjacent to the dredging zones may be affected by the deposition of material on the substrate (i.e. smothering) during spat fall and larval development (see Section 7.2.3). This potential effect is difficult to quantify precisely. However, the removal of larvae as a result of the dredging process will only represent a small proportion of the spawning stock. Recovery is also likely to occur as a result of re-colonisation from spat falls outside the dredged zones (and in some cases the ECR) throughout the spring and autumn period (Pawson, 1995); although the settlement of scallop larvae will be dependent on the substrate remaining, as they prefer erect epifauna or empty shells. The survival of settled larvae may be additionally influenced by settling silt, however, this effect will only be temporary (Emu, 2002).

Most other sessile shellfish will be removed from the seabed within the dredged area. With a target of 10km^2 to be dredged in any one year, 0.9% of the ECR will be directly impacted by removal through dredging activity. However, it is envisaged that recovery will occur from recruits from the wider region both within and outside the ECR.

- Crabs and Lobster

In general, these species are unlikely to be affected by direct removal because they have the ability to move away from the area of extraction. However, during the overwintering phase, in particular, the dormant egg-bearing female brown crab could be taken up with the aggregate and some mortality could occur. It is believed that the females bury themselves between November and December; therefore they would be vulnerable to uptake during this period. Given that the area typically dredged in a year is likely to be 10km^2, the overall risk to the crab populations is low. However, as the distribution of egg-bearing female crabs in the ECR is unclear, monitoring should investigate this issue in greater detail.

Lobsters prefer habitats in shallower waters, but may forage over the wider gravel areas and could then be susceptible to direct uptake. However, this is only likely to occur at low densities.

Given the extent of the initial dredging effort proposed and the general mobility of crabs and lobsters, the significance of this impact is considered to be **minor adverse**. The resource has no known conservation value.

- Other Crustacea

Some of the less mobile crustaceans may be removed from the seabed as a result of the dredging activity. However, this impact is considered to be small scale and of **minor adverse significance** in view of the overall affected area as a percentage of the ECR. The resource has no known conservation significance and its recoverability should be high as a result of re-colonisation and spat falls from both within and outside the proposed Dredging Permission Areas.

- Finfish

As indicated above, most finfish will avoid dredging areas during operations largely in response to increased noise levels and suspended sediments. However, finfish may be attracted to the dredged area immediately following extraction to feed on fragmented organic material released by the dredging process. As a result, the significance of the potential impact of extraction on this resource is considered to be **negligible**.

Finfish could also be affected by a reduction in food availability in the dredged areas. However, because the extent of impacted habitat across the ECR is limited (i.e. 0.9% per annum) and the feeding resource appears to be abundant (i.e. there is not expected to be a detectable impact on the carrying capacity of the eastern English Channel for fish stocks due to the reduction in prey), this potential effect is considered to be **insignificant**.

- Herring

Although adult herring will avoid dredging activity, dredging operations in the ECR could impact herring spawning and egg survival. Herring are one of the few bottom spawners in the central zone of the Eastern English Channel. Eggs are typically laid in a carpet 1 to 2cms thick in established areas of up to 1.5km^2 (Poseidon, 2002). They are laid in late November through to January and hatch after about 2 to 3 weeks, when the larvae drift into the water column. Direct extraction of eggs during this period could potentially lead to 100% mortality in the dredged zones. However, given that the ECA has proposed an annual dredged area target of 10km^2, which compares favourably with the predicted distribution of herring spawning within the ECR (i.e. predominantly over the south-east third; see Figure 4.16), in conjunction with very high natural mortality rates, the impact is expected to be of **minor adverse significance** regionally. Mitigation measures have also been proposed to further reduce the risk of impact (as set out below).

Mitigation and monitoring

By way of 'mitigation through design' the extent of the impact of the direct removal of biomass has been reduced as far as possible through the dredging plans, which aim to limit the area to be dredged, to dredge at depth and to target resources effectively. A target of 10km^2 has been proposed for the annual active dredging zones. Compliance with the targets set will be reported annually by way of a record of the area dredged (see Chapter 13).

In addition, it is recommended that the feasibility of implementing seasonal limits is investigated. Specifically, dredging can be undertaken, avoided or minimised during particular times or at particular states of the tide to reduce potential impact levels. For example, successful mitigation of the potential impacts of benthic boundary layer plumes on breeding areas for crab has been achieved by dredging only when the tidal stream transports sediments away from the sensitive area. Similarly, dredging can be minimised during particular 'environmental windows' (seasons) in order to reduce potential effects. For example, if high densities of egg-bearing brown crabs are identified within the licence areas, mitigation should focus on seasonal reductions in dredging and avoidance measures. Such recommendations are already detailed within the Environmental Statements for the individual dredging applications, recognising local areas of sensitivity.

With specific reference to herring spawning, as proposed by the applicant companies, access to vulnerable areas will be minimised during critical spawning periods. This mitigation is likely to reduce the potential impact on herring populations to a negligible level.

In contrast, even with mitigation in place, as a result of the direct removal of biomass due to aggregate extraction, an impact of minor to moderate adverse significance is predicted to arise with respect to crabs and adult scallops. However, the effect will arise across only a small part of the ECR (through the above actions) and, with appropriate buffer zones (see Section 6.2.1 *Mitigation*), re-colonisation is expected occur within 2 to 4 years.

For scallops, larval mortality may be more significant than the removal of adults, since the rate and extent of re-colonisation from external spat falls will depend on the type of habitat/substrate remaining. This is difficult to predict. In addition, the precise location of herring spawning areas and (potential) populations of female brown crabs in the ECR is not well known and difficult to confirm. It is, therefore, suggested that the potential for the application area (or parts of an area) to be of significance should be investigated. Such detailed information will be important to the success of the proposed mitigation (see Chapter 13).

7.2.2
Water Quality Effects due to Increased Suspended Sediment

Description of effect

The overspill and screening of material through the process of dredging results in the creation of a sediment plume. Modelling of the plumes produced by dredging the proposed dredging activity areas in the ECR simultaneously has shown that over each dredging zone a depth-averaged increase in suspended sediment concentration of greater than 50mg/l will occur (see Figures 5.3 and 5.4). The equivalent near bed increase could be up to 300mg/l in the dredged area. This highest increase in the concentration of suspended sediments in the water column in the vicinity of the dredging activity will only last for a short period of time over slack water.

Further afield, instantaneous near bed suspended sediment increases of over 60mg/l will occur in areas from 5 to 25km^2 around the dredged zone, depending on the size of the dredged area. Depth-averaged increases of 5 to 20mg/l will occur over similar areas and could extend up to 10km from the dredging activity along the tidal axis.

Notably, due to the distances between the proposed active dredging areas and the predicted timing of dredging activities, it is unlikely that individual plumes will coalesce significantly. As a worst case, where dredging areas are located in close proximity, coalescence may occur but only at 5 to 10mg/l above background concentrations (see Section 5.2.1).

Suspended sediment released into the water column by dredging activities can affect finfish and shellfish in a variety of ways. Turbidity and suspended sediment concentrations will vary throughout the water column, with higher concentrations occurring at the seabed closer to the dredging activity and decreasing exponentially away from the dredging site (vertically and horizontally) (Hayes et al. 1984; La Salle, 1990). Lake & Hinch (1999) have reported gill injury, through clogging, leading to mortality. Other studies have indicated that suspended sediments affect fish functions, such as avoidance responses, territoriality and feeding and homing

behaviour, and decreased schooling ability. Similarly, reduced foraging in migrating fish, increases in the risk of predation and migration delay have been linked to higher levels of suspended sediment (Simenstad, 1990). In contrast, it has been suggested that moderately high sediment levels of 20 to 50mg/l (such as those experienced after storm conditions) may initially attract species, like herring, because of the greater availability of organic material (detritus), which in turn may attract species like cod and bass (ICES, 1994).

The quantification of impacts on fish larvae is more complex, in that larval fish naturally experience very high mortality rates. In terms of potential impacts from plumes, Matsumoto (1984) has shown that fish larvae can be affected by sedimentation, loss of illumination by turbidity and changes to water properties. The direct effects of suspended solids on the early stages of fish development can include blocked food intakes and clogged gills. However, these effects generally occur at much higher turbidities and after longer exposures than those anticipated for aggregate dredging.

Deposition, even if temporary, may have an adverse effect on fish eggs by impeding their ability to absorb oxygen. However, little is known about the effects of exposure to silt on the eggs of fish in the eastern English Channel. Very high levels of suspended sediment have been shown to have adverse effects on the eggs and larvae of some estuarine fish species (Wilber and Clarke, 2001), but the levels anticipated in the ECR are well below suspended sediment concentrations at which acute effects have been recorded.

Although the physics of turbidity generation are well understood, there is a general lack of adequate data to quantify biological response in terms of threshold sediment dosages and exposure durations that can be tolerated by various marine organisms. As far as fish communities are concerned, and in order to assess impact significance, the key issues have been identified as (1) the spatial and temporal extent of the impact and (2) the options available to fish to avoid the impact.

Assessment of the cumulative effects of increases suspended sediment levels on fish and shellfish

It is estimated that, for a 5000t cargo, 25 to 33% of the sediment dredged will be screened or contained within the overflow and returned to the water column, that is between 1660 and 2500 tonnes of fine sand, coarse sand and low proportions of silt. This will generate a turbid plume extending between 5 to 25km^2 for a short period of time.

In general, impacts on finfish and shellfish resources due to the suspended sediment caused by plumes in the ECR are unlikely to be significant. Depth-averaged concentrations of sediment in the plumes will be above 50mg/l in close proximity to the dredging activity, with low concentrations (less than 20mg/l) spreading up to 10km from the activity (expect for the near bed concentrations). Most mobile fish and shellfish will avoid the higher levels of suspended sediments and move away from the active dredging area. It is unlikely that the lower increases of 5 to 20mg/l will have an adverse effect on the behaviour or survival of the fish resources of the ECR.

Based on the above factors the following impacts are predicted:

- Scallops

An assessment of the potential impact of suspended sediment on scallop populations (at most stages of their life history) must bear in mind the fact that fine sand forms a component of the sediment normally associated with scallop populations. Scallops have the ability to deal with fine-grained particles at low concentrations through the production of pseudofaeces. However, scallops and other crustacea will potentially be affected by the highest levels of suspended sediment increase due to near bed suspended sediment levels. Precise estimates of a threshold above which mortality increases due to the dredging are not available. It is likely, however, that some impact will occur immediately beyond the extraction zone but that this impact will be limited in its extent (i.e. within a few kilometres of the dredged area) and of short duration (6 to 12 hours). If mortality occurs, recovery should be moderately rapid through re-colonisation from nearby areas. Given the above and the size of the area involved, this impact is considered to be of **minor adverse significance.**

- Crustacea

Many crustaceans are adapted to elevated suspended solid loads and are likely to be unaffected by the plume, e.g. brown crab. Furthermore, during the more active summer months, many species move out of the sediment. They are likely to do this during dredging but would normally quickly return to forage once sediment levels have returned to normal. The significance of increased suspended sediment levels in the water column on crustacea is therefore likely to be **negligible**.

• Finfish

The effects of temporary increases in suspended sediment will result in avoidance behaviour for most finfish, especially where sediment concentrations are sufficient to cause irritation to sensitive organs such as the gills and eyes. Plaice and sole are used to high levels of suspended sediments. It is likely that most species will avoid areas affected by increased levels of suspended sediment, but return to the affected area once the dredging activity has moved elsewhere. Furthermore, beyond the immediate area affected by the dredger, the increased rates of suspended sediment predicted are expected to be sufficiently low so that any effects on finfish will be relatively insignificant. The significance of increased suspended sediment levels on finfish is therefore expected to be **negligible**.

• Herring and herring spawning

Herring can be attracted to low concentration plumes because of the organic material available from fractured benthic organisms. As facultative zoo-planktivorous filter-feeders, herring can switch to filter-feeding if the food density and particle size are appropriate.

Nevertheless, herring avoid suspended sediment at certain threshold concentrations; for fine sediments this is 19(±5)mg/l and for coarser sediments containing 30% sand it is 35(±5)mg/l (Wildish *et al.* 1977). Siltation may impede larval feeding success or interfere with gills. However, given the short duration of elevated suspended sediment loads predicted, this effect is unlikely to have major impact on larval survival.

Wilber and Clarke (2001) describe the biological effects of suspended sediments on estuarine species in relation to dredging activities. The effects of high doses of suspended sediment on herring eggs and larvae were investigated. The study showed that herring egg development was not impaired at dosages of 300 to 500mg/l, with larval pacific herring showing sublethal effects at 1000 to 4000mg/l. These levels are well above those likely to occur from dredging in the ECR.

Herring could be more vulnerable to the influence of suspended sediment during spawning. That is, increased suspended sediment concentrations adjacent to or over the gravelly spawning substrates favoured by herring could led to these areas being avoided. Potentially, this effect could be of **moderate adverse significance** if it inhibits spawning. However, the locations of herring spawning areas in the ECR are not well known. Some tolerance to higher suspended sediment levels is also suggested by the fact that suspended sediment levels are higher in other areas, such as the North Sea, where herring spawn.

Otherwise, the influence of increased suspended sediment levels in the water column on herring, as for other finfish, is expected to be of **negligible significance**.

• Combined influences

The generation of large scale, overlapping, low concentration sediment plumes represents a potential cumulative effect of the dredging proposals in the ECR on fish resources. Modelling suggests that, although it is unlikely, plumes may coalesce at low concentrations (<20mg/l; Figure 5.4). The extent and magnitude of such concurrent plumes will depend on the location and timing of dredging activity across the ECR. For example, typical simultaneous operation is expected to be 3 dredgers with, on average, 4 to 5 dredgers operating across the ECR over an 18-hour period (with an occupancy range of 6 to 24 hours). Therefore, an additive, cumulative impact on water quality due to suspended sediment is not predicted due to multiple operations.

In general, impacts on finfish due to the dredging plumes are unlikely to be significant because concentrations of sediment will be low, dispersed and will propagate at a slow speed, allowing for most finfish to avoid affected areas. Shellfish resources may be influenced by higher near-bed concentrations of sediment, but a number of species are adapted to variations in water quality.

As a result, the combined impact of enhanced suspended sediment levels on fish and shellfish in the ECR is considered to be of **minor adverse significance**.

Mitigation and monitoring

In terms of the impacts of suspended sediment increases on fish within the water column, it does not appear to be necessary and is difficult to mitigate the short-term avoidance reactions that might be exhibited by pelagic fish species feeding in the area. One exception is herring, where spawning behaviour may be modified by the presence of suspended sediment concentrations above 35(±5)mg/l. Therefore, if congregations of spawning herring are known to be present in a dredging zone, dredging activity should be moved to another area or screening strategies modified to reduce the level of suspended solids.

Present knowledge provides insufficient information on the potential residual effects of largely low concentration, large-scale sediment plumes on fish resources. Only long-term investigations will provide the necessary in-depth knowledge to attempt to assess longer term residual impacts. However, in general, the effect of increased suspended sediment levels on the fish and shellfish resources of the ECR is expected to be of minor adverse significance. This conclusion is reached because, although the combined aggregate extraction activity proposed will generate concurrent plumes, the concentration of suspended sediments will be low over most of the area influenced and most of the species potentially affected can either avoid the effect or are adapted to elevated suspended sediment loads.

In order to attempt to better assess and quantify potential impacts on fish and shellfish resources either directly or indirectly through changes to physical and biological features of the benthos, a range of additional information is required (see Chapters 5 and 6). One of the key objectives of the monitoring programme will be to attempt to provide more precise details regarding the physical characteristics of the plume, including speed, density, dispersion etc.

7.2.3

Potential for Effects from Deposition and Transport of Seabed Sediments

Description of effect

As set out in Sections 5.2.2 and 6.2.3, it is estimated that, for a 5000t cargo, 25 to 33% of the sediment dredged will be screened or contained within the overflow and returned to the water column, that is, 1660 to 2500 tonnes of fine sand, coarse sand and low proportions of silt. The predicted deposition and remobilisation of this material is described in detail in Chapter 5 and depicted in Figures 5.8 and 6.2. The conceptual model has predicted that the likely area of deposition will constitute a sand sheet extending NE along the tidal residual for 200m; bedforms extending 1km beyond that (i.e. partial coverage of the existing seabed) and then a dispersion zone of 1km (intermittent coverage, patches of seabed and ripples). Finer sands are expected to move out of the ECR over time through winnowing.

Initially this process is expected to result in sandier sediments in the dredged areas, which would winnow away over time, possibly decades, to recreate coarse sand and gravel capped habitats.

The potential effects on fish and shellfish resources as a result of these processes can be summarised as direct smothering effects due to the deposition of sediment; abrasion effects due to the movement of sediment as winnowing occurs; as well as the longer term effects of an altered substrate and therefore habitat. A sandier environment in and immediately around the dredged areas may have direct impacts on predator-prey relationships.

Assessment of cumulative effects due to sediment deposition on fish and shellfish

Within the ECR (based on an 8.5Mtpa extraction rate), should 10km^2 be dredged in one year, a total area of 25km^2 has the potential to be 'covered' by the settlement and transport of sediment (including the dredging zone). Sediment thickness within the depositional zone is expected to build up to 10 to 25cm. The thickness and extent of cover will reduce with distance from the operational zone (i.e. sand sheet to bedforms to intermittent ripples and mobile sand); see Figure 6.2.

Most infaunal shellfish species can migrate vertically through deposited sediment. However, sandier sea beds are characterised by a paucity of benthic macrofauna and tend to be dominated by polychaetes. Different predator-prey relationships will therefore develop while the sand content at the substrate remains high in the depositional zones, with the prey items available to fish potentially changing. With an increase in sand content occurring in the dredged areas, there is likely to be a suppression of biodiversity leading to a simpler, less heterogenous assemblage of benthos and the removal of specific prey items. However, fish are generally opportunistic feeders; if their regular food supply is not available they will find alternative species. Benthos is not a key limiting factor in the ECR, although some species will be negatively affected. For example, whereas sole, crab, plaice and turbot may favour a more homogenous 'diet' others, such as cod, bass and rays, may have to move to areas with greater and more suitable food availability. This could potentially lead to a relocation of fish resources in some part of the ECR.

Abrasion by mobilised sand is also associated with relatively impoverished epifaunal communities. Impacts on the epifauna of pebbles and cobbles can be anticipated, but the nature and extent of such effects are not clear due to the complex faunal associations that exist.

These effects are considered below for each of the key fish and shellfish species in the ECR in turn.

- Scallops

The deposition of sands immediately adjacent to the dredging zone could increase scallop mortality, although most adult scallops should be able to move out of the affected area. Nevertheless, some adults close to the areas of impact may suffer sub-lethal effects, i.e. through a reduction in feeding efficiency and/or growth rates. (Within the dredged zone itself the majority of adult scallops will be lost.) In addition, sand on the seabed may have an influence on the behaviour of adult scallops, because they prefer clean gravel substrates.

The predicted alteration of the habitat may have a further effect, in that adult scallop numbers may reduce in areas that become sandier (although scallops do occur in areas of sand). Hence the spawning stock in these areas will reduce. Settlement rates may also be reduced due to the loss of attachment sites.

The total area of scallops in the eastern English Channel (see Figure 4.11) has been estimated to be 5200km^2 (Emu, 2002). Therefore a depositional area of 15km^2 (excluding the zone of direct loss) across the ECR as a percentage of the scallop grounds represents around 0.3% on an annual basis (with 0.5% of the scallop grounds being affected overall). However, based on the indicative location of dredging areas and scallop grounds, some areas may be affected more markedly than others, for example, Greenwich Light East (Area 473) and West Bassurelle (Areas 458 & 464) are located in the high-density scallop spawning area. Overall, the effect of deposition and sediment remobilisation on adult scallops is expected to be of **negligible to minor adverse significance** locally.

Smothering (even if only short-term) during spat fall and larval development could also impact scallop populations if the deposition of sand inhibits successful establishment on the seabed. Mortality is likely to be higher than in adult populations, but recoverability should be high as a result of re-colonisation and spat falls from outside of the Permission Areas. This impact is therefore considered to be of **minor to moderate adverse significance** in the short to medium term, i.e. during and for a short period following the exploitation of a dredging zone (i.e. 2 to 4 years).

Other shellfish will be similarly affected, with a number of infaunal shellfish species exhibiting the ability to move vertically through deposited sediment.

- Crabs and lobsters

Crustaceans such as crabs and lobsters will avoid areas of sediment deposition. Furthermore, they do not exhibit a spawning substrate preference and alteration of the habitat by way of an increased sand content is unlikely be of concern for over-wintering female crabs. The influence of dredging on lobsters, in particular, is expected to be generally insignificant.

The impact of sedimentation on crustaceans due to dredging in the ECR is therefore expected to be of **negligible significance**.

- Herring

Herring could be particularly vulnerable to the effects of sedimentation because they have a preference for uniform gravelly substrates; where their eggs adhere to the gravel in small specifically selected spawning beds. Herring spawn in uniform gravelly substrates where a constant flow of oxygen is available. Smothering the eggs may therefore affect their viability. Consequently, adult herring exhibit a preference for coarse gravel substrate or raised gravel beds that benefit from the circulation of clean water; the general locations of which tend to remain the same over time. Any alterations to the substrate type may therefore have important consequences for recruitment success. The deposition of sandy sediment on spawning areas may deter adults from spawning in that location and could smother any eggs present, affecting their metabolic exchange.

However, the annual zone of impact (i.e. the sedimentological footprint of the proposed dredging activity) will only cover around 1% of the total area of the herring spawning ground in the ECR (see Figure 4.16). Difficulty arises in that the precise location of the favoured herring spawning areas in the ECR is unknown. The potential for an impact of **moderate adverse significance** therefore exists locally, if the dredging zones inadvertently encompass herring spawning areas.

- Other finfish

The settlement of sediment on the seabed is unlikely to affect finfish directly, but will influence them indirectly as a result of impacts on their prey. However, as stated above, fish are generally opportunistic feeders, and will feed elsewhere and on alternative species if their regular food supply is affected. Although the availability of food may be affected in the short to medium term within the dredged areas, prey availability in adjacent areas will not be influenced and partial recovery will occur within 6 months. Therefore, this impact, potentially affecting 2.2% of the ECR, is expected to be of **negligible significance** in the context of the ECR as a whole, but may be of minor significance locally.

More specifically, sole migrate inshore and offshore. Seabed sedimentation patterns may therefore influence the migrating fish as they settle to rest.

Plaice and cod also spawn in ECR, but substrate condition is not important to these species for spawning.

Mitigation and monitoring

The extent of the predicted impacts on fish and shellfish due to the deposition and partial remobilisation of sediment are relatively insignificant and are strongly limited by the proposed dredging plans (10km² per annum target). As discussed previously, appropriate seasonal windows for minimising dredging in relevant areas should be investigated (particularly with respect to scallops and herring spawning) and dredging buffer zones should be implemented (to allow for recruitment from adjacent areas).

A monitoring programme should also be implemented in order to identify favoured herring spawning areas, where dredging should be minimised.

The residual effect of sedimentation on fish and shellfish resources should then be of **minor adverse significance** at worst.

7.2.4 Effects on Fish and Shellfish as a Result of Noise

Description of effect

It has been documented that noise can influence fish behaviour. Fish detect and respond to sound, utilising its cues to hunt for prey, avoid predators and for social interactions (Hawkins, 1986; Cox *et al.* 1987).

Blaxter (1981) has reported that herring show an avoidance response to sound stimuli. Sound has also been shown to affect growth rates, fat stores and reproduction (Meier and Horseman, 1977). More recently, Popper and Carlson (1988) have shown that the use of a wide range of noises to control and modify fish behaviour has provided ambiguous results.

In attempting to quantify potential effects on fish and shellfish deriving from noise, it should be borne in mind that the area already has relatively high baseline levels of noise as a result of fishing (beam trawling and scallop dredging) and shipping activities.

Assessment of cumulative effects due to noise

- Scallops

Dredging noise may invoke a short-term avoidance reaction in adult scallops adjacent to the extraction areas; this reaction is likely to be similar to that exhibited to scallop dredgers. However, noise caused by scallop dredgers does not appear to have led to a decline in the resource. This impact is considered to be of **negligible significance**.

- Crabs and Lobsters

Most crustaceans and mobile shellfish are expected to avoid the immediate area of dredging operation in response to the elevated noise levels. They are likely to avoid the draghead itself in response to localised noise. Some crustaceans are known to migrate through the wider Eastern Channel region either in large-scale movements or smaller-scale seasonal movements as part of their life cycles. The precise route of this migration is unknown, however, these species are likely to avoid areas of excessive noise. Furthermore, over-wintering buried female crabs are unlikely to be disturbed by dredging noise.

In view of the limited area expected to be affected by the proposed dredging operations at any one time and the ability of crustaceans to respond, this impact is considered to be of a low magnitude and of **negligible significance**.

- Finfish

Although, in general, noise is likely to simply cause an avoidance reaction in most finfish, some finfish might display more complex responses. For example, cod and plaice spawning behaviour could be inhibited and the localisation of herring (which have very sensitive hearing) spawning areas may be affected by certain noise frequencies.

Furthermore, some finfish migratory patterns may be affected by higher levels of noise. The potential for more complex responses to noise to arise due to the dredging activity in the ECR is currently unknown. At present, however, this impact is considered to be of **minor significance** in view of the size of the area likely to be affected at any one time and the duration of the effect.

Mitigation and monitoring

There are no known measures to reduce the noise generated by the dredging operations. However, in the initial phases of extraction, dredging operations are only expected to occur for around 18 hours a day and will be widely spaced, should all areas be licensed. Therefore, through management of the dredging activity any impact will have a short duration. Nevertheless, given that there is considerable uncertainty over the long-term impacts of noise on fish resources, it is recommended that the effects are considered in the monitoring programme, particularly with respect to spawning patterns and feeding behaviour.

7.2.5 Altered Substrate Topography

Description of effect

Longer-term substrate alteration due to aggregate extraction is described in detail in Chapters 5 and 6. Briefly, repeated dredging of the same area of the seabed over time may potentially alter the topography and, more specifically, its habitat structure.

Assessment of cumulative effects arising from topographic changes to the seabed

Although no immediate impacts of significance are predicted as a result of this habitat change, due to its limited extent (i.e. potentially 2 to 6m depressions over 250m zones), a few issues should be considered.

- Scallops

With scallop densities in the offshore area of ICES Area VIId of no more than 2g/m^2 of live weight, and existing natural seabed topographic variations in the ECR, it is unlikely that small, changes in topography caused by dredging will significantly influence the distribution of spat fall. Although there have been indications that deep furrows may influence the distribution of spat fall, at present there is no evidence to support this. However, adult scallop distribution (through changes in spawning patterns as a result of localised changes in water current velocities) may, in the longer term, be affected (although not necessarily impacted) by changes in substrate topography. Therefore, this issue should be addressed in the monitoring programme. Based on existing information, however, this impact is considered to be of **negligible significance**.

- Finfish

Existing information suggests that most finfish are unaffected by changes in topography. In most cases, therefore, this impact is considered to be of **negligible significance**.

Exceptions to this may include species such as plaice and herring. It is likely that the majority of herring recruits tend to spawn on the parent ground (Harden Jones, 1968). This may, in part, be determined by their ability to recognise ‘noise’ features such as those caused by tidal flows. Localised changes in substrate topography and tidal patterns through gravel ridge profiles could affect this homing ability, that is, the ability of herrings to locate habitual spawning areas.

In contrast, plaice tend to avoid depressions and troughs. However, the predicted slow rate of substrate change and recovery across the ECR is unlikely to have a significant effect on patterns of use (i.e. a negligible impact). Nevertheless, in view of the complexity of the substrate changes predicted over the longer term, this issue should also be considered in the monitoring programme.

Mitigation and monitoring

The ECA has indicated that dredging depths will vary, but will average between 2 to over 4m during the 15-year permission period. It is recommended that the influence of varying dredging depths on benthos is investigated and related, as far as possible, to fish resources. This should be linked to routine bathymetric/side scan sonar surveys of active dredging zones, in order to determine the scale and extent of change. The baseline position will obviously need to be established prior to dredging being initiated; regular monitoring surveys will then follow.

At least two long term post-dredging monitoring sites should be established; preferably sites previously used for spawning (although key spawning sites will be avoided by the dredging activity as far as possible) and dredged to different depths. This should allow their future use (or otherwise) for spawning to be demonstrated.

Based on our current understanding, the significance of longer term changes in the seabed topography on fish and shellfish spawning is expected to be **negligible**.

7.2.6
Long-term Impacts of Dredging Operations on Shellfish and Finfish

Although difficult to identify and quantify at this stage, it is nevertheless important to mention the potential longer-term effects of aggregate dredging. These may include:

- Changing substrate type, with transition from sandy gravel to gravelly sand following dredging and then a gradual return to a more gravelly substrate as sand is winnowed away and moved across the ECR;
- Persistent, large scale, low concentration sediment plumes; and
- The potential long-term loss of suitable habitat for herring spawning.

It is known that herring prefer well-oxygenated clean gravel beds. The timescale required for the substrate to recover to its initial state is unclear. Given the particular nature of herring spawning beds (i.e. gravelly substrate characterised by the circulation of clean water), 'clogging' the gravel matrix with sand in the sedimentological footprint of the dredging (amounting to $25km^2$ across the ECR in one year and $125km^2$ over the 15-year permission period) is likely to reduce the substrate's attractiveness and suitability as for spawning. However, the whole $125km^2$ (based on the extraction of $50km^2$) will not be affected at once. The first extraction zones will be recovering as others are targeted.

Such longer-term impacts will need to be addressed in a comprehensive monitoring programme. Results from such a programme would then provide the necessary information to address these issues and, if required, recommend adequate mitigation measures.

7.3
Far field effects

As set out in Sections 5.3 and 6.3 no opportunity exists, through physical changes in coastal processes, for the biological resource of the English and French coastlines to be affected by the dredging proposals.

The predicted implications of the passive plume on fish and shellfish are considered in Section 7.2.2. In general, the effect of increased suspended sediment levels is expected to be of **minor adverse significance**. That is, although the combined aggregate extraction activity proposed could generate a low concentration plume over a large area, most of the species potentially affected can either avoid the effect (i.e. finfish) or are adapted to elevated suspended sediment loads (e.g. scallops). Monitoring of plume characteristics and biological response is nevertheless recommended.

7.4
Summary of effects on fish and shellfish

Five key impacts have been identified on fish and shellfish resources due to aggregate dredging: direct biomass removal; smothering due to the movement of the dynamic plume in the vicinity of dredging; increased levels of suspended sediment as a result of dispersion of the passive plume; avoidance due to noise; and altered topography potentially affecting spawning patterns.

The species with the highest vulnerability to impacts are scallops, which are less mobile, and herring, which favour gravel substrate for spawning. Egg-bearing female crabs may also be vulnerable during the overwintering period.

In terms of their combined influence, it is clear that the direct removal of biomass and smothering of the adjacent benthic resource will have a combined impact of **moderate adverse significance** on particular species in the dredging zone until habitat recovery occurs. Similarly, increased suspended sediment and noise levels act in-combination to encourage fish and shellfish to avoid affected areas. However, these influences are not generally additive. That is, either one will cause fish to avoid the area, but they will not cause them to avoid the same area twice and they are unlikely to avoid a larger area due to the combined influence. This impact is considered to be of **minor or negligible significance**. Alteration of the seabed topography represents a longer-term effect, but is not expected to be significant.

Any attempt to consider in more detail the effect of impacts such as noise, increased suspended sediment, substrate topography etc. across the ECR in a synergistic manner would be a complicated endeavour without observational evidence. For example, it may be that finfish avoiding an active dredging zone because of high levels of noise might find themselves in an adjacent area characterised by increased suspended sediment concentrations, further limiting their availability to visit habitual feeding or spawning grounds. The synergistic effect of these impacts may have an increased influence on the spawning patterns by some key commercial species.

Critical to the determination of the extent of these potential effects and the realisation of successful mitigation measures will be a comprehensive ECR-wide fisheries monitoring programme, also investigating responses to dredging activity (see Chapter 13).

8 Regional Effects on Fishing Activity

8.1 Introduction

This Chapter aims to describe the potential impacts of aggregate extraction in the ECR on fishing activities and to assess their significance in a regional context. It is based on the analysis contained in the Poseidon Technical Report (2002). Any effects on fish and shellfish resources (for example, on herring spawning) could also affect fishing activity; therefore, these effects are considered in detail in Chapter 7.

A detailed description and assessment of the potential effects on fishing activities at individual application sites is contained within the relevant Environmental Statements. The individual assessments analyse potential impacts specific to the area concerned, such as the potential for dredger vessel operations to interfere with established trawl lanes and fishing vessel operations, as well as potential changes to seabed topography reducing the efficiency of trawl or scallop dredging gear.

As highlighted in Section 4.6, it is often difficult to produce a comprehensive and accurate description of fishing activities within a defined region. In addition, calculating the degree of impact of the proposed dredging activity on fishing activity is problematic due to the necessity for certain assumptions to be made and the variability of the data obtained.

In order to evaluate the potential impact of aggregate dredging on fishing activity in the ECR it has been assumed that the area has been intensively fished over many years and that the fishery is subject to annual fluctuations. Fishing activity itself has the potential to impact the marine environment, which may in turn impact key target species. Indeed, some investigations have concluded that the impact caused by present day fishing in the area is considerable. For example, Ambios (1999), in a review of side scan sonar data for Area 461, showed that the area has already been exposed to a high degree of physical disturbance due to intensive scallop dredging and trawling (see Figure 4.3). In some cases, scallop dredging is reported to destroy as many scallops as it catches (Hill *et al.* 1999).

There are several factors that may contribute to the overall potential impact of dredging on commercial fisheries, including:

- the potential restriction of fishing activity from the dredging zone;
- the potential loss of benthic organisms in the dredging zone and hence the food available for fish (see Section 6.2.1);
- the potential removal of the fish stock from the dredging zone (see Section 7.2.1);
- the potential interference with set trawling runs; and
- the potential displacement of the fish stock due to noise and plumes produced as a result of dredging.

To fully assess the potential impacts of aggregate dredging on the fishery, a number of assumptions have been made. The worst case scenario, for example, is based on the complete removal of the benthic community throughout the 15 year period in the indicative dredging areas (followed by its slow recovery over a number of years) and the loss of access to active dredging areas by fishermen. The reality will not be this extreme because extraction will be managed to encourage recovery and dredging activity will be dispersed in both time and space. However, given the uncertainties associated with accurately defining the extent of fishing activities, a precautionary approach has been adopted in the REA in order to assess any potential impacts.

In describing effects and determining significance levels, the following considerations have been taken into account:

- Fisheries assessments are generally imprecise, due to the natural variability of fish stocks and fish behaviour, changes in fishing practice as well as the reliability of the information. However, there is sufficient information to allow reasonable conclusions to be reached, based on a series of assumptions;
- Historically, assessments of economic dependency have linked potential losses to the proportion of the fishing grounds to be dredged and to revenue;
- The information available for such an assessment include catch data in the last 10 years for the specific ICES Area (VIId), average vessel revenue, costs and profits (2000) and prices for the last ten years;
- There is considerable uncertainty over the published data on catch size and effort, the information on the location of fishing vessels operating in the ECR is frequently unreliable and there is a systematic history of under-recording by fishing fleets;
- The present assessment is based on the area intended to be dredged over a 15 year period, as predicted by the ECA, estimated to be 50km^2 based on an initial dredging effort of 8.5Mtpa but, importantly, the prediction of economic loss (dependency) is based on 10km^2 typically being dredged annually (see Section 3.4). The area presumed to be impacted on a yearly basis, therefore, represents approximately 0.9% of the ECR and a significantly smaller percentage of the offshore eastern English Channel;
- The dredged areas are dispersed across the ECR and occupancy has been estimated at approximately 5 dredgers a day; and
- The area concerned has been fished extensively for many years.

Study area

In addition to the above points, the process of assessing the effect of aggregate extraction on fishing activities has highlighted a number of uncertainties. These include the difficulty associated with quantifying the potential financial dependency linked to the influence of the plume, dredging induced noise and damage to substrate.

This section will therefore focus on the following potentially significant impacts:

- Reduction in catches due to the direct influence of extraction;
- The disruption to fishing activities; and
- The indirect influence of sediment plume effects.

Each predicted effect is briefly described and a level of significance is provided, along with mitigation measures, where applicable.

8.2 Effects on Fish Stocks

8.2.1 Reduction in Catches due to Extraction

Description of effect

The dredging activity proposed may remove, through the extraction of sand and gravel resources, a proportion of the fin and shellfish inhabiting the dredging areas (see Sections 6.2.1 and 7.2.1). This is likely to have a greater effect on shellfish, because they are generally sessile and infaunal. Scallop, however, are capable of swimming short distances to potentially avoid disturbance. The reduction in the available fish resource may affect fishing activity.

The percentage of the ECR that it is proposed will be directly affected by extraction in any one year will be approximately 0.9% (i.e. $10km^2$ of $1132km^2$), with 4.4% being affected over 15 years based on a $50km^2$ extraction area derived from 8.5Mtpa (or 8.8% based on $100km^2$ and 17Mtpa). It is also apparent that from one year to the next more than 0.9% of the ECR will be affected, because as active dredging zones move (typically after 1 to 3 years) the initial dredging zone will take some time to recover. It is expected to take 4 to 6 years from the cessation of dredging for more than 50% of species diversity, population density and biomass to have been restored (see Section 6.2.1); with scallops forming part of the benthic resource. Therefore, after the first 5 years it is likely that around 2% of the ECR will be 'unavailable' to the shellfishing industry at any one time.

Assessment of the cumulative effect of extraction on fishing

As described in Chapter 7, there is unlikely to be an impact on finfish due to direct removal since they will generally avoid the area of impact. However, they may be indirectly affected by the loss of prey in the dredging zone. The potential implication of this for fishing activity is that fish may be displaced from the dredging zone until extraction ceases and the benthos recovers. A number of the benthic species that are prey items for fish are likely to partially recover within 6 months of the cessation of dredging and recovery of the pre-dredge biomass of polychaetes, which are the key prey items for many species, is likely to occur within 2 years (Section 6.2.1).

Shellfish and the shellfishery, on the other hand, will be directly impacted by this effect. As set out in Section 7.2.1, it is assumed that most adult scallops will be removed in the dredged areas; representing around 1% of the spawning stock each year. There is a need for a clearer understanding of the localised distribution of scallops within the application areas. However, based on current information, this impact is considered to be of minor to moderate adverse significance to fishing activity; potentially affecting 0.2% of the total scallop area in the eastern English Channel annually (0.5% in-combination with the effects of depostion from the plume).

The impact of direct extraction (setting potential disruption aside; see Section 8.2.3) on finfishing activity, in contrast, is expected to be **negligible**. Changes to the seabed could affect bottom towed fishing gear, however, the potential impact on fishing activity has to be considered in the context of the existing variability in the topography of the seabed in the ECR. Slope changes due to extraction are also expected to be relatively gradual and to become smoother over time. Furthermore, the slopes of dredged depressions will be managed to avoid interference to trawling in the ECR.

Mitigation and monitoring

As set out in Section 6.2.1, limiting the area to be dredged within each Permission Area and the area to be dredged at any one time will reduce the extent of this impact. It is further recommended that dredging is undertaken in narrow strips so as to leave areas of undredged habitat from which recolonisation can occur; potentially enhancing the rate of colonisation.

With specific reference to scallop dredging, it is recommended that scallop densities in the proposed dredging areas be assessed to define the pre-dredging stocks and local distribution and that stocks should be subsequently monitored during the dredging period.

8.2.2

Potential Effects Arising due to the Sediment Plume

Description of effect

Sediment plumes have the potential to influence fishing activity in various ways. Of particular relevance to this assessment, they are likely to cause certain fish species to disperse from the area of dredging activity (potentially either moving them away from or towards areas of fishing activity); sediment may settle out of the plume onto static nets, reducing their effectiveness by making them 'visible to fish'; and the deposition of sediment onto the seabed may reduce catches.

With respect to the first two effects, it is extremely difficult to attempt to measure the economic 'losses' potentially associated with low concentration sediment plumes outside the proposed extraction areas without greater knowledge of the likely response of fish and shellfish in this environment.

With respect to the third effect, it has been postulated (see Section 5.2.2 and Figure 6.2) that an area of sand sheets and bedforms around 2.2km long and 200m wide arising due to the settlement of sediment from the dynamic plume could originate from each dredging zone. Based on a 10km^2 dredging area per annum this equates to an additional 15km^2 of seabed that could be affected to varying degrees (decreasing away from the dredging zone).

Assessment of the cumulative effect of the sediment plume on fishing

Temporary increases in suspended sediment will lead to avoidance behaviour by most finfish. This is likely to be reinforced by the noise associated with the dredging activity. This response, however, is unlikely to significantly influence fishing activity, although it may have a greater influence on some specific groups such as Belgian beam trawlers and gill netters (the exact significance of this effect is difficult to quantify).

The deposition of sediment on the seabed will, however, increase the area affected by dredging, i.e. from 10km^2 a year to 25km^2 (representing 2.2% of the ECR); with a total area of 125km^2 affected over 15 years (11% of the ECR), but not at any one time.

Significantly, outside of the active dredging zones, this impact will be restricted to shellfishing and most scallops, crabs and lobsters should be able to move out of and up through the affected area.

Deposition is expected to build to 10 to 25cm in depth and recovery should occur within a year of the cessation of dredging (amounting to a total 'impact period' of 2 to 4 years, depending on exploitation rates). Furthermore, only 0.5% of the scallop grounds in the eastern English Channel are expected to be affected annually. This impact is therefore expected to be **minor adverse significance** for fishing activity as a whole.

Mitigation and monitoring

Section 6.2.2 contains recommendations for mitigation measures aimed at reducing the amount of sediment put back into the water body through overflowing and screening, such as carefully targeting resources; minimising screening; and minimising dredging during critical periods (e.g. spawning) or in critical locations during key periods (e.g. where congregations of spawning herring have been identified in the past; see Section 7.2.2).

Key to limiting the influence of low concentration sediment plumes on fishing activities, will be keeping the fishing industry well informed of the location and timing of dredging activity.

The monitoring recommended in Sections 6.2 and 7.2 will provide relevant data on changes to benthic community structure, the fish and shellfish resource and substrate topography in the ECR, allowing the consequential implications for fishing activity to be explored more comprehensively. It is currently difficult to quantify with any degree of accuracy the impact of the plume on this activity. The implications of the plume for fishing should therefore be a focus of the monitoring initiatives. Similarly, the relevance of any mitigation measures in place should be reconsidered based on any findings.

8.3 Effects on Fishing Activity

8.3.1 Exclusion from Operational Dredging Areas

Description of effect

Trawling operations, including pelagic trawling, beam trawling and other demersal trawling, involve fishing vessels maintaining a constant course, although trawlers have the potential to modify their direction of travel. Pair trawling, however, tends to be less flexible in terms of direction of travel. Trawl lines for Belgian vessels have been noted to be up to 15 miles long, for vessels travelling at 5 knots. UK vessels work in line with the direction of other traffic in the Channel or at right angles to it. There is no reason to believe that methods employed by the French and vessels from other nations differ from these. The presence of operational dredgers could, therefore, disrupt trawling operations by reducing the area available to be trawled or requiring trawl lines to be altered. Seabed type is also important to demersal trawling, in that hard ground and wrecks may displace fishing vessels into other areas. The presence of dredgers in the ECR would introduce an additional constraint.

Furthermore, the operation of dredging vessels within the active dredging areas may interfere with the placement of static fishing gear, such as set nets. This is most likely to occur when the dredging vessels are moving to and from site, rather than on site. While the vessel is on site it will either be static or moving at a slow speed, up to 2 knots. Static dredging is not permitted within the traffic lanes of the TSS, however, applicants may request static dredging in the separation zone. The selected dredging method will depend on the shape of the extraction zone. The fishing activity data clearly indicates that potting gear is employed in inshore waters away from the proposed dredging activity. Netting activity, however, particularly that originating from the UK, has increased in the ECR since the beginning of the 1990s.

It should be emphasised that the ECA has proposed a likely annual dredged area of $10km^2$, whereby there will typically be 5 dredgers present in the ECR over an 18 hour occupation period. This is set against a background of very high use of the ECR by shipping (with over 200 vessels transiting the region each day in the traffic lanes of the TSS), with which fishing activity currently co-exists. In other words, a very small percentage of the ECR will have dredgers in at any given time and the vessels are likely to be widely spaced (on average about 10km apart). This will allow fishing vessels considerable access in terms of both area and time. Active dredging areas will also be available for mobile fishing when dredgers are not on site.

Assessment of the cumulative effect of the exclusion of fishing vessels

For calculating the predicted degree of potential loss to income (assuming fishing is not relocated) as a result of a lack of access to the active dredging zones by fishing vessels the tools available include: catch data over the last ten years for every ICES area; average vessel income, costs and profits; and price data as derived from statistical databases (Seafish Industry Authority and DEFRA). The calculations used for this assessment can be found in Poseidon Technical Report (2002). As indicated above, there are a number of key uncertainties associated with this assessment and these are reflected in the significance attributed to this effect.

The starting point for calculating potential impacts is an assessment of economic values associated with the areas of seabed to be dredged, for the main groups of vessels fishing in the ECR (see Table 4.6). Such values do not necessarily directly equate to an economic loss, since dredging may not coincide with traditional 'tows' or areas of nets for fishing vessels (particularly over time). The assumption of no access is adopted here in order to complete the analysis of economic dependency on the ECR. Furthermore, the effective implementation of recommended mitigation measures is likely to allow close to normal use of fishing lanes (see below) although some disruption could remain for Belgian beam trawlers, pelagic mid-water trawlers and gill netters in densely fished areas.

The assessment of economic returns (i.e. *added value excluding costs*) associated with the areas of seabed proposed to be dredged in the ECR (over the 15 year licence period) for each relevant group of fishing vessels is estimated to be:

- Belgian beam trawlers - £4,212/km^2;
- French trawlers/scallop dredgers - £635/km^2;
- British trawlers/scallop dredgers/beam trawlers - £749/km^2;
- British/German/Dutch pelagic freezer trawlers - £765/km^2; and
- British/French gill-netters - £152/km^2;
- Dutch trawl/scallop trawl - £18/km^2.

Thus the total economic return associated with the area concerned could lead to a potential 'loss' of approximately £6,531/km^2 per annum (that is, £65,310 for the 10km^2 area that it is assumed will be dredged annually) (see Poseidon Technical Report, 2002). This assumes a 100% loss of access to dredging areas and no additional catches from elsewhere. There will be regional economic variations within the ECR in relation to fishing activity.

Based on this value, the potential impact on the ECR fishery, without mitigation, is considered to be of **minor to moderate adverse significance**. As a proportion of the value of the fishing industry in ICES area VIId (for which the average annual added value is estimated to be just over £110M), the 10km^2 referred to above represents approximately 0.06% of the total. The value of the fishing industry in the area covered by the proposed dredging activity (i.e. 50km^2 over 15 years) is estimated to be approximately £327,000, which is approximately 0.3% of the average annual value added to the sector.

These estimates have been made on the basis of declared fishing activities in the area and based on the ECA's assumptions about the area to be dredged and the intensity of dredging at any given time. If the level of activity were to exceed these values or monitoring identify additional impacts, such as long term damage to the fishing grounds, the significance of this effect would have to be reassessed.

Mitigation and monitoring

Mitigation measures referred to in general as 'environmental windows' are detailed within the Environmental Statements accompanying individual licence applications. These potentially include seasonal, temporal or spatial reductions in dredging effort. A key mitigating measure in the context of limiting dredging impacts on fishing activity is the detailed specification and communication of dredging plans, including the precise location and duration of activity in any given area. This greatly reduces the risk of direct interference but also of damage to nets and other equipment. These measures should be part of a formal and wide ranging commitment to communicate with the fishing industry on the part of all members of the ECA.

It is clear that effective mitigation will derive from the establishment of a comprehensive liaison programme with the fishing industry.

The following measures are, therefore, recommended:

- Designation of a liaison officer whose key task will be to ensure that effective communication takes place between the fishing industry (fishermen, fisheries committees etc.), the dredging industry and the statutory bodies involved in both industries (e.g. DEFRA, ODPM etc.). This should include regular liaison meetings;

- The establishment of effective contacts with all relevant counterparts in other countries influenced by the proposals;

- The establishment of effective means of communication, involving for instance, the provision of regular/updated information on the location of dredging operations, zoning charts and the use of VHF to inform all concerned of planned activities;

- Local fishing associations could be used to establish more formal communications, depending on the area being worked, where direct communication between vessels proves to be difficult; and

- Dredging companies should contact local fishing associations in advance, with the assistance of DEFRA district fisheries offices as necessary, when they are about to start dredging operations in new zones.

Detailed recommendations for monitoring are contained in Section 7.2 and are summarised in Chapter 13.

Effective mitigation measures should reduce the magnitude of potential impacts on fishing activity. Previous experience has indicated that it is possible to minimise loss of access to fishing grounds through effective communication plans. With mitigation in place, the extent of the impact is expected to be of minor adverse significance.

8.4

Summary of Effects on Fishing

Disturbance to finfish species and the removal of shellfish species is likely to reduce the density of target species in and around each of the dredging areas and, in the longer term, potentially cause a reduction in productivity of the fish resource in the region. This could have effects on the catches of established trawl and scallop fisheries in the area including and surrounding the active dredging zones or other adjacent areas affected by deposition of overspill or screened material.

Disturbance or loss of commercial fish and shellfish species, could affect revenues from traditional fishing grounds. Displacement could also increase pressure on other fishing grounds and conflict between fishing fleets.

However, finfish are unlikely to be significantly affected by the dredging activity because, although the benthic resource will be directly affected over part of the ECR (potentially 10 to 25km^2 each year (0.9 to 2.2%) and 50 to 125km^2 (including the bedform fields) over the 15 year licence period (4.4 to 11%)), fish are opportunistic feeders and will move. Furthermore, they will avoid the sediment plume and noise associated with dredging. Most crustacea will similarly move from the affected areas.

Active dredging areas will be available for mobile fishing when dredgers are not on site. The assumption of no access is adopted here in order to complete the analysis of economic dependency on the ECR.

The long term effects of dredging upon demersal fisheries in the ECR, i.e. after cessation of dredging, will depend upon the degree of re-establishment of a healthy benthic food web, upon which commercial fish species depend, and the nature of the physical alteration of the seabed. Benthic communities are likely to recover within 4 to 6 years of the cessation of dredging in each zone, provided that marked changes in the nature of the seabed surface substrate have not occurred. However, the benthic food supply is likely to recover much more quickly, that is, within 6 months to a year.

The long-term effects upon the scallop fishery will depend on the actual scallop community present in the areas prior to dredging activity. Should the scallop beds have a high density, then the recovery period following dredging is likely to be 2 to 3 years, as the benthos establishes a community similar to that present before dredging began.

Depressions of the seabed or other alterations to bottom topography have the potential to hamper fishing in the long-term, especially trawling. Static dredging is more prone to causing such effects than trailer dredging. However, the order of magnitude in gradient changes made by dredging would be managed to be within the range of gradients found naturally on the seabed.

Based on the assumption that the mitigation measures proposed are adopted, the long-term effects upon commercial fisheries of exclusion and dredging are expected to be of locally moderate to minor significance, particularly once the benthic community has re-established. There may be a period of reduced catch of shellfish from the resource zones between the cessation of dredging and re-establishment of the benthic community. However, finfish are likely to return more rapidly, since it is unlikely that they will be displaced or affected to a significant degree during the activity.

With adequate communication, the potential disruption of fishing activities due to dredging activity is expected to be minimal.

9 Effects on Navigation

9.1 Introduction

This section details the assessment that was undertaken to consider the risk of a collision between a dredger and a passing merchant ship given the dredging activity proposed by the ECA across the East Channel Region. The risk assessment has been undertaken by extrapolating the results from previous studies (undertaken in the ECR by Hanson and Volker), taking into account updated shipping traffic and historical collision data. Full details of the model used, analysis and assumptions made are detailed in the Anatec UK Ltd Technical Report (2002).

Study area

9.2 Ship Collision Risk

Description of effect

In order to assess the navigational risk of a collision, a staged assessment was undertaken. Firstly, a quantitative assessment was made of the risk of collision for each separate licence area and, secondly, a qualitative assessment estimated the total cumulative annual risk from dredging in the ECR based on previous risk modelling for a number of dredging scenarios.

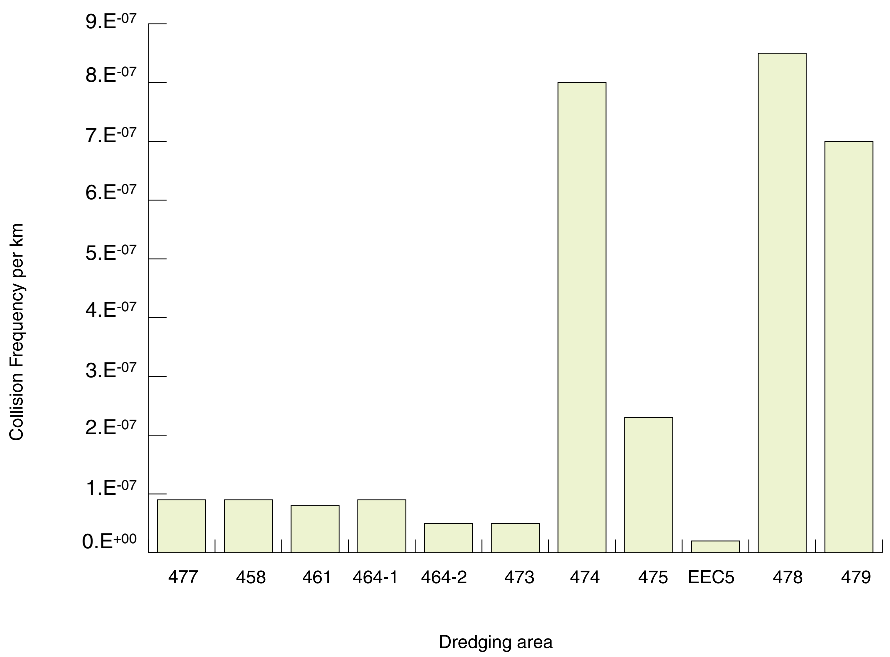
The average annual ship collision frequency associated with dredging operations within each licence area has been estimated on the basis of dredging 8.5Mtpa. The results are summarised in Table 9.1 on a per kilometre and per hour basis (assuming a dredge speed of 1.5 knots). The average distance travelled while dredging and average time between collisions is also presented, together with the total volume dredged and cargoes loaded. For example, in the West Greenwich licence area (Area 477) the collision frequency is estimated to be 1.1×10^{-7}/km. This means an average of one ship collision in each 8.8 million kilometres of dredging, which is equivalent to loading 4889 million tonnes. On a time basis, the collision frequency is one collision in 3.1×10^{-7}, i.e. an average of one collision per 363 years (or 3.2 million hours) of dredging.

Table 9.1 Estimated Collision Frequencies for ECR Dredging Areas

Licence / application areas	Per km dredged	Dredging distance per collision (M km)	Millions of tonnes dredged per collision	Per hour dredging	Dredging time per collision (years)	Thousands of cargoes
477	1.1×10^{-7}	8.8 million	4889	3.1×10^{-7}	363	530
458	1.1×10^{-7}	8.8 million	4889	3.1×10^{-7}	363	531
461	1.0×10^{-7}	9.6 million	5333	2.9×10^{-7}	396	578
464-1	1.1×10^{-7}	8.8 million	4889	3.1×10^{-7}	363	531
464-2	6.1×10^{-8}	16.3 million	9056	1.7×10^{-7}	671	980
473	6.1×10^{-8}	16.3 million	9056	1.7×10^{-7}	671	981
474	8.3×10^{-7}	1.2 million	667	2.3×10^{-6}	50	73
475	2.7×10^{-7}	3.8 million	2111	7.4×10^{-7}	155	226
EEC5 South	2.2×10^{-8}	45.4 million	25222	6.1×10^{-8}	1865	2723
478	8.8×10^{-7}	1.1 million	611	2.4×10^{-6}	47	69
479	7.3×10^{-7}	1.4 million	778	2.0×10^{-6}	56	82

Note: assumes a production rate of 8.5Mtpa, Figure 9.1 presents these results by kilometre.

Figure 9.1 Estimated Collision Frequencies for ECR Dredging Areas



Note: Y axis values use scientific notation (i.e. 10^{-7})

Putting these very low frequencies in perspective, the average dredging collision risk is one collision per 11 million kilometres travelled. This equates to an average of one collision while dredging a distance equivalent to 276 times around the World (at the equator), or alternatively, the distance to the moon and back 14 times. (The distance dredged by a dredger on a typical voyage is about 11km.)

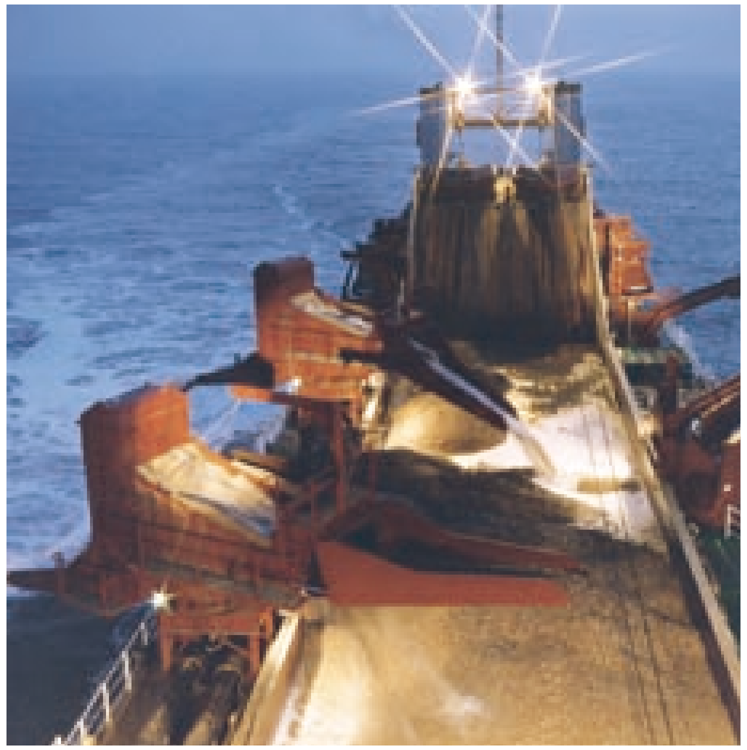
As expected, the licence areas within the TSS traffic lanes have the highest collision risk, in particular Areas 478, 474 and 479 (see Figure 3.1). Dredgers operating in licence areas predominantly within the separation zones or outwith the TSS are estimated to have a much lower collision risk, which is related to the much lower level of shipping likely to be encountered within these areas.

Comparing the dredger risk results with merchant shipping, the average collision frequency per kilometre travelled by passing shipping in the CNIS coverage area (see Section 4.7) is estimated to be 2.3×10^{-7} (based on an average of 4.1 collisions per year and an annual distance travelled by shipping of 18 million kilometres). Comparing this with Figure 9.1, it can be seen that collision frequencies in the licence areas within the traffic lanes are above average, whereas those in the separation zones are below average.

In terms of exposure per hour within the ECR, based on an average steaming speed of 13.7 knots (25km/h) from survey data of ships passing through the CNIS coverage area, the collision frequency per hour for passing shipping is 5.7×10^{-6}. This is higher than the hourly risk associated with dredging in any of the proposed licence areas, where the highest is 2.4×10^{-6} (see Table 9.2). The lower collision frequency for the dredgers relates to the more stringent operating procedures applied, mainly restricting operations in periods of reduced visibility as well as dredging in the direction of the traffic flow.

Table 9.2	Estimated Annual Collision Frequencies for ECR Dredging Areas			
Company	Area	Dredging Hours/Year	Collision Frequency/Hour	Annual Collision Frequency
Britannia	477 Greenwich	1556	3.1×10^{-7}	4.9×10^{-4}
UMD/	458	1556	3.1×10^{-7}	4.9×10^{-4}
RMC Marine	464-1	-	N/A	N/A
	464-2	1556	1.7×10^{-7}	2.6×10^{-4}
Hanson/RMC	473	895	1.7×10^{-7}	1.5×10^{-4}
Hanson	474	895	2.3×10^{-6}	2.1×10^{-3}
	475	1791	7.4×10^{-7}	1.3×10^{-3}
	EEC5 South	-	N/A	N/A
Dredging	478	196	2.4×10^{-6}	4.8×10^{-4}
International	479	196	2.0×10^{-6}	4.0×10^{-4}
Volker	461	1556	2.9×10^{-7}	4.5×10^{-4}
Annual Total	10,200	N/A	6.1×10^{-3}	

Note: assumes a production rate of 8.5Mtpa



Assessment of the cumulative effect of ship collision risk in the ECR

The cumulative annual risk of dredging in the ECR can be derived from the activity levels estimated by each of the companies for each application area and the collision frequencies calculated above. This can then be compared with the existing ship-to-ship collision risk levels in the same area identified from CNIS accident statistics.

The dredger activity levels per licence area were estimated assuming a total production rate of 8.5Mtpa per year distributed across the region, according to information supplied by each company in respect to their applications.

Combining the estimated hours in each licence area per year (see Anatec Technical Report, 2002) with the collision frequency per hour for that licence area (see Table 9.1), annual risk figures have been estimated. The results are presented in Table 9.2 and Figure 9.2.

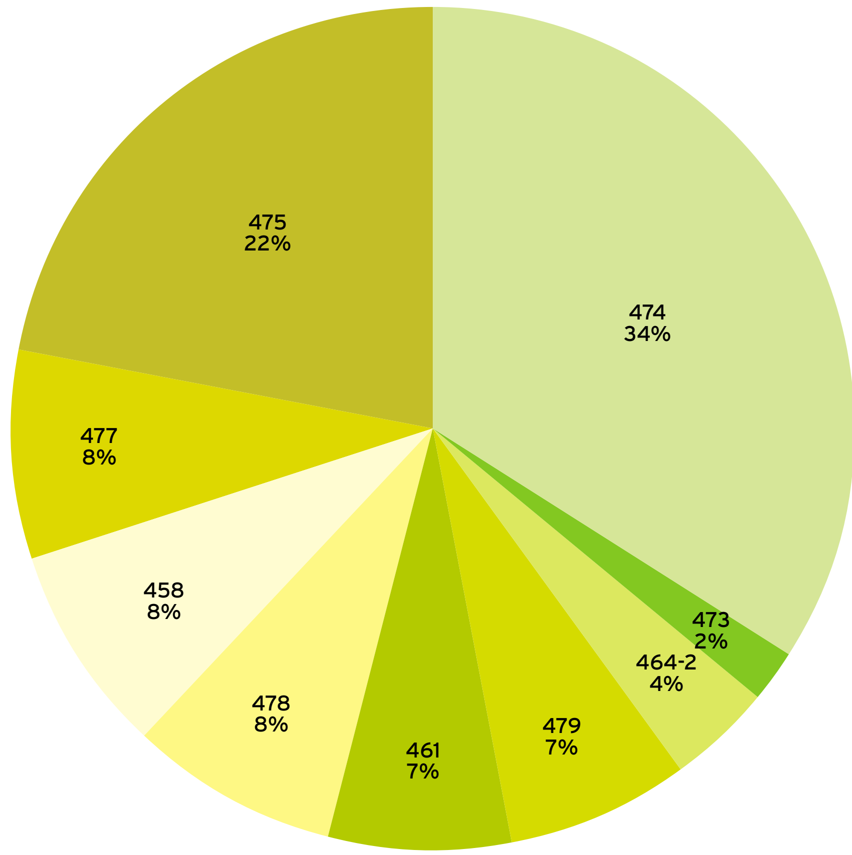
Therefore, the total annual collision frequency associated with dredging in the ECR based on production of 8.5Mtpa is 6.1×10^{-3}; an average of one collision in 164 years of dredging (which is equal to 1197Mt or 239,000 cargoes). If the production rate were to double to 17Mtpa, the collision frequency estimate would similarly double to 1.2×10^{-2} (a collision return period of 82 years or dredging 598Mt).

From Figure 9.2 it can be seen that the planned activity in Area 474 contributes just over one-third of the total annual collision frequency, which is mainly due to its position within the NE-bound traffic lane. The hourly risk of collision for a dredger working in Area 474 was estimated to be 2.3×10^{-6} per hour, or an average of one collision per 435,000 hours of continuous dredging (50 years), which is equal to dredging 365Mt.

The analysis of the CNIS collision data identified an average of 4 ship collisions per year in the Dover Strait and Eastern English Channel between 1983 and 2001. Therefore, dredging activity in the area at 8.5Mtpa is estimated to increase the frequency of collisions by 0.006 per year, an increase of 0.15%. Based on a production rate of 17Mtpa, the increase in risk rises to 0.3%.

In overall terms for the Dover Strait and East Channel Region this increase is insignificant. However, the collision risk to the dredgers operating in the area is still relatively high compared to other dredging areas in the UK. Therefore, risk mitigation procedures and monitoring measures have been developed to ensure that the risk is as low as reasonably practicable and to minimise disruption to other ships (see Chapter 13).

Figure 9.2 Distribution of Annual Dredger Collision Frequency per Area based on proposed extraction rates outlined in Table 9.2



Simultaneous Operations

The quantitative assessment above estimated the risk associated with dredging within each area. However, some of the proposed areas are in close proximity to one another, therefore, dredging within these areas simultaneously could result in additional effects on shipping navigation and collision risk.

Based on a production rate of 8.5Mtpa, it is estimated that an average of 5 dredgers per day will operate in the ECR, with a typical maximum of 3 dredgers operating at any one time. If the rate were to be 17Mtpa, it is likely that 10 dredgers would operate daily in the ECR.

In either case, dredgers would typically be at least 10km apart; although where dredging areas are in close proximity they could be separated by around 5km.

During operation, the dredger will be the 'stand-on' vessel (required to keep her course and speed under the Collision Regulations) and it will be the responsibility of all other vessels to take avoiding action. In this situation, it is conceivable that a ship taking avoiding action from one dredger may subsequently encounter a second dredger and be required to take further avoiding action. Standard procedures are in place under the ColRegs to cover these situations (see Section 4.7), which all navigating vessels will be familiar with. However, it is recommended that simultaneous operations are monitored and, if required, procedures are developed to further minimise disruption to shipping.

Mitigation and monitoring

Common measures have been agreed between the ECA companies for implementation both during dredging operations and in co-ordinating dredging activities. Procedures have also been agreed for consultation with external parties, such as the CNIS. These were confirmed by the ECA following discussions between representatives of the dredging companies (operations management and Masters) and the MCA, CNIS and DfT in July 2002.

The following issues have been addressed (examples of the procedures to be implemented are detailed in Table 9.3):

- Equipment;
- Logistics;
- Pre-Planning Measures;
- Operating Procedures;
- Hazard Management; and
- Monitoring.

Given full implementation of the above collision risk mitigation measures, the residual risk of collision is low.

In addition, simultaneous operations should be monitored.

9.3
Summary of Effects on Navigation

The cumulative annual risk of dredging in the ECR has been derived from the activity levels estimated for each application area and calculated collision frequencies, compared with existing ship-to-ship accident statistics. From this assessment it has been concluded that the total annual collision frequency associated with dredging in the ECR (based on a production of 8.5Mtpa) will be 6.1×10^{-3}; that is, an average of one collision in 164 years (or one collision in 82 years for 17Mtpa). Although the risks in some Permission Areas are higher than in others (e.g. for Area A74 the risk is one collision in 50 years). Dredgers will also typically be at least 10km apart.

However, simultaneous operations should be monitored, specifically with reference to its influence on shipping (i.e. avoiding action). Overall, the proposed combined dredging activity in the ECR is expected to have an insignificant influence on collision risk in the region, increasing the frequency of collisions by 0.18% (and 0.3% at 17Mtpa). In addition, all vessels navigating in the area must comply with the International Regulations for presenting collision at Sea 1972, the ISM code and a mandatory reporting scheme is applied in the Dover Straits.

Table 9.3 Agreed Operating Procedures in the ECR to minimise collision risk

Category	Example Measures
Equipment	• All dredgers will be equipped with AIS transponders and electronic charting systems; • All vessels will have as near as practicable 360° visual lookout and radar coverage; • All vessels will have the ability to communicate with CNIS using either VHF, email and/or satellite communications.
Logistics	• Dredging activity will be co-ordinated to allow CNIS to monitor the dredging and provide information to other vessels in the area via their scheduled radio broadcasts. CNIS will also liaise with the French Coastguard at Gris-Nez; • One hour before arrival, dredgers will contact CNIS and inform them of their planned operation. A zone reference will be provided so that CNIS know exactly where the dredger will be operating. The vessel will contact CNIS again at the end of the operation.
Pre-Planning Measures	• Through liaison with UKHO, it will be ensured that details of the dredging activity are included in Navtex broadcasts, Notices to Mariners and Admiralty Charts of the area; • Dredgers will broadcast a warning message to fishing vessels one hour before arrival, in English; • Passage plans will be developed for all voyages in line with SOLAS requirements.
Operating Procedures	• Vessels will adhere to the ColRegs at all times; • In the TSS traffic lanes, dredgers will dredge parallel to and in the general direction of traffic; • Horizontal visibility of one nautical mile (1nm) will be the minimum working limit within the traffic lanes. • A minimum of three people will be on the bridge during dredging to include the Navigation Officer, the dredge master and a dedicated lookout.
Hazard Management	• Alarm zones will be set at appropriate ranges around identified underwater hazards; • In a potential collision scenario, the Master (following management guidelines and acting in strict accordance with the Collision Regulations No 17) will be responsible for deciding what action to take, e.g. when to lift the dredge pipe and prepare to take avoiding action.
Monitoring	• Exchange of information and sharing of experience between the companies will take place via the navigation subcommittee of the ECA technical forum (see Chapter 13); • A system will be in place for recording and sharing information on accidents, near misses and hazardous occurrences; • A formal review of dredging operations and their affect on shipping will be carried out at set periods.

10 Effects on Archaeology

10.1

Introduction

This section describes the form and scale of the predicted impact (including cumulative and transboundary effects) of the dredging operations on the archaeological resource of the Palaeolithic and Mesolithic prehistoric periods, and maritime sites in the ECR.
Full details of the regional archaeological assessment are set out in the Wessex Archaeology Technical Report (2002).

Study area

10.2

Prehistoric periods

10.2.1

Loss of or Disruption of Lower, Middle and Early Upper Palaeolithic Materials

Description of effect
Derived artefacts such as tool and flakes, and *in situ* material of Lower, Middle and Early Upper Palaeolithic date contained within the sands and gravels of the proposed dredging areas will be removed from their context and are likely to be lost within the volume of dredged material. The scope for intercepting such material in the course of dredging and screening is very limited and not practical.

Assessment of the cumulative effect of the loss of or disruption to early prehistoric materials
The cumulative effect of the aggregate dredging proposals in the ECR on the Palaeolithic archaeological heritage is difficult to assess. The actual presence of both *in situ* and derived material has not been established in the ECR, in submerged sections of the same palaeo-catchments lying outside the ECR, or in submerged sections of the broader region as a whole. Consequently, it is not possible to gauge the overall quality and quantity of the Palaeolithic archaeological heritage in the Channel generally, or in the specific context of the Somme, Authie and Canche. However, the upper reaches of all three catchments are known to contain important remains from these periods, and substantial sections of their lower reaches fall within the ECR. Consequently, unmitigated aggregate dredging could have an impact on the Lower, Middle and Early Upper Palaeolithic archaeological heritage of moderate adverse significance. Mitigation measures are therefore set out below.

The effects of aggregate dredging may also have a secondary influence, where aggregate dredging reduces the thickness of cover over *in situ* Lower, Middle and Early Upper Palaeolithic material and thus exposes it to direct impacts from fishing activities.

- Transboundary effects

The Lower, Middle and Early Upper Palaeolithic archaeological heritage of the ECR is strongly linked to French prehistory, as the area forms part of the palaeo-catchment of the Somme, Authie and Canche. Damage to archaeological material in the ECR would have moderate adverse transboundary effects on the archaeological heritage of France.

Mitigation and monitoring
Mitigation for the potential implications of dredging activities on the archaeological resource should be guided by advice set out in *Marine Aggregate Dredging and the Historic Environment: assessing, evaluating, mitigating and monitoring the archaeological effects of marine aggregate dredging* (BMAPA/EH, *in prep.*). In addition, it is recommended that modelling of the deposits and surfaces that may be of archaeological interest on account of their prehistoric archaeological potential is undertaken as part of the environmental assessment work associated with individual applications. The data provided for the REA could be enhanced through the use of more detailed bathymetry. It is recommended that they also draw on interpreted seismic data and the results of geotechnical investigations. Geophysical survey techniques are used routinely as part of aggregate extraction. The scope of these surveys (both baseline and monitoring) should take account of archaeological requirements, as the data derived can be used to cost-effectively clarify the potential character and extent of archaeological sites.

The following recommendations should also be included within the individual application Environmental Statements:

- Provision should be made to sample, analyse and date deposits and surfaces identified as having prehistoric archaeological potential, as archaeological field evaluation methodologies develop;
- Provision should be made to implement dredging exclusion zones around areas shown to contain important archaeological material of interest and to implement monitoring, as appropriate;
- Provision should be made for protocols to facilitate the reporting of fortuitous discoveries of prehistoric archaeological material (although the difficulty of intercepting prehistoric material in the course of dredging and screening is acknowledged); and
- Provision should be made for archiving and disseminating archaeological results arising from specific schemes.

In order to enhance knowledge of the prehistoric archaeological heritage of the ECR, it is recommended that liaison with curatorial archaeologists in northern France as well as southern England should become routine, with the possibility of a forum being established to improve general communication.

Therefore, given the implementation of the mitigation measures set out above, the residual effects of the aggregate extraction proposals on the potential Lower, Middle and Early Upper Palaeolithic archaeological resources of the ECR are expected to be of **minor adverse significance**.

10.2.2

Loss of or Disruption of Late Upper Palaeolithic and Mesolithic Materials

Description of effect

Dredging activity will disrupt any *in situ* assemblages of Late Upper Palaeolithic and Mesolithic date, including any associated organic deposits. The relationship between artefacts and their surroundings will be destroyed and individual elements lost within the volume of dredged material.

Assessment of the cumulative effect of the loss of or disruption to late prehistoric materials

The cumulative effect of aggregate dredging in the ECR on the Late Upper Palaeolithic and Early Mesolithic archaeological heritage is again difficult to assess. As for earlier periods, the actual presence of both in situ and derived material has not been established in the ECR, in submerged sections of the same palaeo-catchments lying outside the ECR or in submerged sections of the broader region as a whole. Consequently, it is not possible to gauge the overall quality and quantity of the Late Upper Palaeolithic and Early Mesolithic archaeological heritage in the Channel. However, the upper reaches of all three catchments are known to contain important remains from these periods, and substantial sections of their lower reaches fall within the ECR. Furthermore, the developing estuaries encompassed by the ECR may have been inhabited preferentially because of the range and richness of resources available to hunter-gatherers in this area. Consequently, unmitigated aggregate dredging could have an impact of **moderate adverse significance** on this resource.

The effects of aggregate dredging may also reduce the thickness of cover over *in situ* Late Upper Palaeolithic and Early Mesolithic material and thus expose it to direct impacts from fishing gear.

As for previous periods, the Late Upper Palaeolithic and Early Mesolithic archaeological heritage of ECR is strongly linked to French prehistory, as the area forms part of the palaeo-catchment of the Somme, Authie and Canche.

Mitigation and monitoring

The mitigation measures recommended for the avoidance or minimisation of impacts on the Late Upper Palaeolithic and Early Mesolithic prehistoric periods are the same as those provided above for the Lower, Middle and Early Upper Palaeolithic periods.

Given the implementation of the mitigation measures proposed, the residual effects of the aggregate extraction proposals on the potential Late Upper Palaeolithic and Mesolithic archaeological resources of the ECR are expected to be of **minor adverse significance**.

10.3 Maritime archaeology

10.3.1 Loss of or Disruption to Maritime sites

Description of effect

Dredging may cause direct damage to wreck structures and their contents; disturbance to relationships between structures, artefacts and their surroundings; destabilisation of sites prompting renewed corrosion and decay; loss of artefacts within the general volume of dredged material; and erosion leading to damage, disturbance and instability in the medium to long term. As encounters with wreck material are likely to damage suction gear and/or contaminate the dredged material, it is in the interest of dredging vessels to avoid such encounters.

It is also conceivable that dredging may have an impact on wrecks outside the dredging area as a result of the settlement of sediment plumes. Any wrecks within 1 to 3km of dredging activity may experience some deposition of sediment (see Section 5.2.2), however, deposition of thin layers of fine sediment is likely to have a beneficial impact on the future survival of wrecks.

In addition, dredging may have an impact upon discrete items of ship-borne debris which, depending on their size, may be lost within the volume of dredged material. The distribution and possible significance of any such items cannot be anticipated. There may be scope for identifying and retrieving some such items at the wharf, from the magnet or the oversize stone stockpile. Repeated discoveries of apparently discrete items from a specific area might indicate the presence of a coherent shipwreck.

Assessment of the cumulative effect of dredging in the ECR on maritime materials

The cumulative effect of aggregate dredging in the ECR on early (Prehistoric, Roman, Medieval) maritime sites is difficult to assess, as the actual presence of maritime sites from these periods within the ECR has not been established. Moreover, the overall quality and quantity of early maritime sites in the Channel generally is not known and, irrespective of any general findings, the importance of any particular site is likely to require evaluation on a case-by-case basis. Unmitigated dredging could, therefore, have an impact on the early maritime resource of **minor to moderate adverse significance.**

There are currently no overarching national assessments of the maritime archaeological heritage against which the importance of Post-medieval and Modern maritime sites within the ECR can be gauged, either individually or as an assemblage. However, dredging vessels will avoid identified sites (wrecks and seabed obstructions) in order to safeguard their equipment, therefore the effect of dredging across the region on these sites is likely to be negligible. The need for the removal of any specific wreck material or obstruction in advance of aggregate dredging will be addressed and undertaken on a case-by-case basis.

- Transboundary Effects

The maritime archaeological heritage is intrinsically international in character comprising craft that move between countries, that are built and equipped in different countries, that are crewed by nationals of many countries, that carry cargos and passengers from around the world, or that were engaged in international conflict. Substantial proportions of the located wrecks and recorded losses in the English Channel are British or French in origin, but other countries are also represented. The result of any continuing historical interest of these countries in maritime archaeological sites is such that any dredging impacts on such sites may have transboundary effects.

Mitigation and monitoring

As for prehistoric sites, mitigation for dredging activities should be guided by the advice provided by BMAPA/EH (*in prep.*).

In addition, the following recommendations should be included within the Environmental Statements for individual applications:

- Suitable geophysical survey techniques (including high frequency sidescan and magnetometry) should be used routinely, in order to clarify the character and extent of known maritime sites and to locate as yet undiscovered sites;
- Provision should be made for archaeological inspection by ROV or diving to provide direct evidence where the extent and character of maritime sites remains uncertain;
- Provision should be made to implement dredging exclusion zones around areas shown to contain important archaeological material;
- Provision should be made for the implementation of protocols to facilitate the reporting of fortuitous discoveries of maritime sites and artefacts, both during dredging and at wharves;
- Provision should be made for archiving and disseminating archaeological results arising from specific schemes;
- In addition, it is recommended that liaison with curatorial archaeologists in England, and with the Receiver of Wrecks and Ministry of Defence, be strengthened. It is also recommended that measures be formulated to facilitate communication with archaeologists in other countries in respect of maritime sites that have a verifiable link with that country; and
- In order to provide a comprehensive regional context for the maritime archaeological resource, it is necessary to enhance the database of maritime sites in the ECR, using documentary sources and the results of scheme-specific geophysical surveys, thereby providing a firmer basis for evaluating the importance of specific sites.

Therefore, given the implementation of the mitigation measures set out above, the residual effects of the aggregate extraction proposals on the potential archaeological resources of the ECR are expected to be of **minor adverse significance**.

10.4 Summary of effects on archaeology

There are no known sites or artefacts of Palaeolithic, Mesolithic or early maritime (Prehistoric, Roman or Medieval) date within the ECR. However, sites are known to exist within the broader region, encompassing the south coast of England and the north coast of France, and it is highly likely that the region would have been inhabited at various times during the Lower, Middle and Upper Palaeolithic and early Mesolithic; hence the potential exists for archaeological sites.

Searches produced records of 294 sites of maritime archaeological interest in the wider study area, comprising 96 wrecks, 102 seabed obstructions and 96 casualties. In the ECR there are 31 known wreck sites, 17 obstructions and 7 casualties. Where dated, the sites span the post-medieval and modern periods, however, seafaring may date back to the inundation of the ECR in the Mesolithic. Unmitigated dredging could therefore have an impact on undiscovered early maritime sites of **minor to moderate significance**. Dredging vessels will avoid identified sites.

To date, the presence of *in situ* and derived material has not been established in the ECR. However, geological structures outside the ECR, i.e. the upper reaches of the Somme, Authie and Canche, are known to contain important remains from these periods. As these are similar palaeo-catchments to those lying within the ECR, the potential exists for sites to be present within the ECR. Consequently, unmitigated aggregate extraction could have an impact on the Palaeolithic and Mesolithic archaeological heritage of the ECR of **moderate adverse significance**. The potential also exists for transboundary implications to arise as a result of the areas association with the palaeo-catchments of northern France and European prehistory.

A number of provisions, therefore, need to be made to minimise the potential for an impact to arise. For example, provisions to survey deposits where encountered, implement dredging exclusion zones and archive and disseminate archaeological results. The implementation of these measures will reduce the potential significance of the residual impact on the archaeological resources of the ECR to a minor level.

11 Regional Effects on Other Activities

11.1

Introduction

This section describes the regional effects predicted on human activities in the ECR due to the proposed dredging activities; excluding fishing and navigation, which have been covered in Sections 8 and 9 respectively.

Study area

11.2

Disturbance to submarine cables

Description of effect

There are a number of submarine cables in the ECR, some of which are in close proximity to the proposed dredging areas. Potential direct impacts on submarine cables include interaction with the dredger and the implications of sedimentation. Potential indirect impacts include the possible effect of changes in the local hydrodynamic regime, for example erosion and slumping, on the integrity of nearby cables.

Assessment of the cumulative effect of dredging on submarine cables in the ECR

Through zoning, dredging activity avoids the locations of all known cables.

The seabed in the ECR comprises immobile, relict sands and gravels extending to depth, with an occasional veneer of finer sand moving across the seabed under the influence of the tide (see Section 4.2). Where dredging activity occurs, a shallow depression will be created over time as a result of the seabed sediment being removed (eventually ranging in depth from 2 to 6m; Section 3.3.1). The composition of the seabed sediments, coupled with the shallow depressions that will result from the dredging process over a period of time are such that there is no potential for cables to be undermined.

Dredging operations will, however, release quantities of sediment back into the water column through overflow and screening. This is expected to return the majority of the coarse and medium sand entrained in the plume to the seabed within 200m of the dredging activity, and the rest of the medium and fine sand will be deposited within 1km of the dredging activity in the direction of the tidal residual (see Section 5.2.2). The depth of accumulation expected to occur in the resulting sand sheet and bedform field is 10 to 25cm. Further along the sediment transport pathway, the sands are expected to become increasingly dispersed and form isolated patches and streaks a few grains thick. This level of deposition is not anticipated to have an impact on the cables present. Over time, sand will migrate from the bedform field across the seabed towards the bedload convergence zone of the eastern English Channel. However, such movement naturally occurs in the ECR.

The assessment of the potential change in coastal processes due to dredging in the ECR, described in Section 5.3, indicates that changes to wave conditions and tidal flows will be insignificant. A recent study carried out by HR Wallingford (2002) to assess the effects of dredging on a pipeline found that there would be no change in hydrodynamic processes further than 500m from the dredged area. This study was in shallow water and comprised a bigger proportional increase in depth from the dredging than that proposed for the ECR. The influence of dredging, due to changes in wave propagation and tidal currents, on pipelines in the deeper waters of the ECR is therefore expected to be **negligible**.

The assessment of physical change described in Chapter 5 predicts that the effect of cumulative dredging operations on the seabed will not be any greater than the effects of each individual operation.

The potential implications of dredging for any specific cables will be considered in the individual EIAs and, where applicable, liaison will be undertaken with the relevant owner in order to agree any required protection or mitigation measures.

Mitigation and monitoring

The UK Cable Protection Committee (UKCPC) has negotiated an agreement with the Crown Estate to allow for a 'No Dredging Zone' of 250m either side of a cable and a 'Dredging Notification Zone' 250 to 500m either side of an in-service cable. The EMS monitoring that is mandatory under all Crown licences will enforce this zoning. Given the extent of disturbance predicted, these zones should effectively prevent any disturbance to submarine cables from either the direct or indirect effects of aggregate extraction.

As additional safeguards, the following measures should form part of best practice for dredging in the ECR:

- The same protocols for avoidance (i.e. no dredge/dredging notification zones) should be employed for all cables identified in the ECR, irrespective of whether they are in-service or not. This will be assessed by each applicant on an individual licence basis; and
- In conjunction with routine bathymetric and sidescan sonar monitoring throughout the ECR, where active dredging areas lie adjacent to a cable 'dredging notification zone', survey limits should be extended beyond the route of the cable. The data should then be assessed to determine whether any evidence of scour or undermining/slumping is evident, and the results reported to the UKCPC.

Given the above measures, an impact of **negligible significance** on submarine cables due to aggregate extraction is anticipated.

11.3

Other activities

Description of effect

At the time of writing this report, there were no existing or proposed wind farms, military sites, oil and gas activities or marine disposal sites in the ECR.

Leisure activities (including yachting and motor cruising) do occur in the environs of the ECR, as a result of recreational vessels passing through the area en route to either the English or French coastlines. It is not anticipated that dredging activities will have any effect on recreational navigation due to the slow speeds of dredgers and the avoidance of dredging activities within the traffic lanes in visibility of less than 1 nautical mile.

Details of dive sites in the ECR are unknown and as stated in Chapter 4.9 it is not anticipated that much diving takes place in the region due to the high level of shipping in the area and water depths. One dive site is known to exist south of the ECR in French waters. Potential effects on dive sites could include reduced visibility due to sediment plumes and interaction with shipping.

Assessment of cumulative effects

It is considered that the dredging proposed will have a negligible impact on recreational navigation given adherence by all parties to the TSS, the International Association of Lighthouse Authority's (IALA) requisite day and night lights and marks, and normal good seamanship practices.

Chapter 5 sets out the likely extent of sediment plume effects due to aggregate extraction in the ECR. The identified French dive site is a considerable distance from any likely plume and, therefore, no impact is anticipated. In terms of navigation, dive vessels would be expected under the ColRegs to keep clear of all vessels with limited manoeuvrability, such as dredgers.

Mitigation and monitoring

With reference to recreational navigation, the mitigation provided in Chapter 9 (Navigation) is also relevant, particularly charting, navtex warnings, Notices to Mariners, CNIS broadcasts and dredger broadcasts. In addition, articles in the yachting and diving press can also be used to highlight the location and extent of the proposed activities.

Therefore, the potential significance of effects arising from the dredging proposals on 'other activities' are considered to be of **negligible**.

11.4

Summary of effects on other activities

Dredging activity avoids all known cables. Direct effects should not therefore arise. Indirect effects are also predicted to be of negligible significance because cables are not expected to be undermined due to the dredging process and the level of deposition predicted (10 to 25cm) is insignificant in this context. Similarly, changes to tidal flows and wave conditions will be insubstantial.

Although no real potential for any cumulative effects on water-based recreation has been identified as a result of the ECA dredging proposals, many of the mitigation measures proposed for other purposes (e.g. navigation) will further reduce any potential for effect.

12 In-Combination and Transboundary Effects

12.1

Introduction

The potential exists for the predicted impacts associated with the proposed dredging activity to interact with existing human activities in the ECR. These interactions, illustrated in Figures 2.2 to 2.5, could lead to *in-combination effects*, i.e. lesser or, more commonly, greater impacts.

As a result of the requirement to estimate the impacts associated with existing fishing effort in the region as well as potential changes in predator-prey interactions, benthic carrying capacity and fisheries productivity of the ECR, assessment of the significance of in-combination effects should be considered with caution. It is nevertheless important to attempt to address potential 'in-combination' effects in order to avoid under-estimating the potential extent of any impacts. Furthermore, if any large scale monitoring and mitigation is to be successful, it is recommended that the approach taken in their design, methodology and interpretation should also consider in-combination effects.

Of the activities occurring in the ECR - fishing, navigation, cabling, recreation (sailing) and the proposed dredging - fishing activity obviously has the greatest potential to adversely affect the biological (and potentially the archaeological) resource in-combination with dredging activity. On a smaller scale and over a shorter timescale, cable laying would contribute to seabed disruption. The presence of commercial and, to a much lesser extent, recreational navigation in the ECR introduces the increased risk of collision given the added presence of dredgers. However, this effect is the subject of assessment in Chapter 9 and does not have implications beyond this.

The effects of the proposed aggregate extraction on the physical processes operating in the deep waters of the ECR (i.e. wave conditions, tidal currents and sediment transport) are expected to be localised and insignificant. Therefore, similarly, in-combination effects (for example, due to dredging and trawling) on physical processes are not predicted to arise. The discussion below, therefore, focuses on the potential for in-combination impacts on the biological resource (the benthic resource, fish and shellfish) and, to a much lesser extent, archaeology due to the combined influence of dredging and fishing. Existing fishing activity also obviously has the potential to influence future fishing activity.

Transboundary effects that could potentially arise due to the proposed extraction operations are also summarised, particularly with respect to coastal and physical processes, fishing and archaeology.

12.2

In-combination influences on benthic biological resources

The activities that are likely to have in-combination effects on the benthos in conjunction with aggregate extraction include effects relating to fishing activity and the installation of services (e.g. cables).

12.2.1

Aggregate Extraction and Fishing Activity

The REA has highlighted the importance of the eastern English Channel as a fishing area for a number of key commercial species, including scallop, plaice, sole and herring. Baseline data has also demonstrated that the fish and shellfish resources of the ECR have already been affected by fishing activity. Trawl marks are evident on the seabed (see Figure 4.3) and the fisheries data show that the area is exploited through a variety of fishing methods. The removal of biomass and direct effects on habitats are the consequences of fishing that are most likely to have in-combination effects with aggregate extraction activities. The changes that occur, for example, due to scallop dredging are likely to cause the removal of stock species, the disruption of the habitat and associated species within the trawl footprint and a change in habitat once trawling has occurred. Fishing activity is widespread and low intensity, whereas aggregate extraction is localised, intensive and undertaken in a controlled manner.

In terms of benthic recovery, it is also important to note that the majority of infaunal species inhabit the top 10 to 15cms of substrate. Therefore, recovery of the habitat and associated communities in dredged areas may be prolonged due to continual disruption by fishing activity.

Increased noise is expected to provoke short-term avoidance reactions in most finfish and crustacea present in the ECR. Spawning behaviour could be inhibited by noise and some migratory patterns may be affected. However, the significance of the in-combination effect of dredging noise and in-conjunction with existing levels of noise from ongoing fishing activity (trawling), and the shipping traffic in the TSS, is expected to be **negligible**.

It is likely that the in-combination effect of fishing and aggregate extraction on fisheries activity will be small and measurable, as dredging is confined to a restricted area. However, the effect that fishing activity itself has on the region as a whole is unquantifiable, as the information available on fishing activity is frequently unreliable or inconsistent. Historically, for example, catch data and figures on fishing effort have not been consistently recorded and the precise location and activity of fishing vessels are unknown. However, the fact the area is regularly fished, will reduce the significance of any additional disturbance due to dredging.

It is recommended that a wide range of information on fishing activity in the area is gathered, together with dredging data, in order for reliable predictions to be made of the in-combination effects. However, assessment of the effects of the fishing industry on the ECR would only be predictable with the co-operation of the fishing industry. It is in the interest of all activities to assist in defining baseline conditions.

In addition, there may be several effects relating to fishing activity that could influence the monitoring surveys proposed in this REA in order to determine the effect of aggregate extraction. It is therefore important that the monitoring regime takes account of potential in-combination effects and attempts to differentiate between actual effects relating to aggregate extraction and effects due to fishing activity.

It is recommended that a number of factors be considered in an attempt to more comprehensively address potential in-combination effects, including:

- Disturbance to or loss of commercial fish and shellfish species, affecting returns from traditional fishing grounds;
- Trends in fish catches;
- Patterns of existing fishing effort;
- Changes to the seabed potentially affecting bottom towed fishing gear; and
- Increased pressure on other fishing grounds and conflict between fishing fleets.

The assistance of the fishing industry and its regulators would be required to address these issues effectively.

12.2.2
Aggregate Extraction and the Installation of Services

Laying cables affects the seabed through dredging small trenches. This would remove the benthos from the area dredged and could cause localised disturbance of adjacent areas through hydrodynamics changes within the immediate area and sedimentation. However, the in-combination effects of this activity are expected to be extremely limited, as the width of channel necessary for laying a cable is very small (up to 2m) and proposals for new cables are limited (and would require full assessment).

12.3
In-combination influences on archaeological resources

Fishing activity, particularly trawling, and the laying of cables has the potential to influence the archaeological resource. However, most material of Palaeolithic or Mesolithic age will be covered by more recent seabed sediments and, while trawling marks clearly leave an impression on the bed and will affect infaunal communities in the top 10 to 15cms, in terms of the archaeological resource their depth of penetration is relatively limited. Early Maritime sites are likely to be more affected by trawling, with some discrete items having the potential to be disturbed. The effects of aggregate dredging may also reduce the thickness of cover over *in situ* Palaeolithic and Mesolithic sites and artefacts, thus exposing them to direct impacts from fishing activities.

Cables will be buried at greater depths and could therefore disrupt archaeological resources, however, the implications of this will be assessed (and, where appropriate, mitigated) as applications for cable laying are made.

12.4

In-combination influences on fishing activity

Fishing activity has the potential to be affected by the in-combination influences of aggregate extraction, cable laying and fishing on the benthic biological resource (as set out in Section 12.2 above). These are, however, expected to be limited. In addition, the potential for the interaction of activities arises due to the addition of dredging vessels to the shipping lanes. The fishing industry already co-exists with over 200 vessels transiting the region each day via the TSS. Dredging activity will typically only add 5 vessels to this traffic.

Without a detailed assessment of the effects of fishing activity on fish and shellfish resources in the ECR, in-combination effects are difficult to predict.

12.5

Transboundary influences

12.5.1

Coastal and Physical Processes

The REA considers in detail the potential for 'far field' hydrodynamic effects to arise as a result of the proposed dredging in the ECR. Potential transboundary effects in this case could affect the French coastline and include changes in wave conditions and tidal currents; reduction in the coastal protection provided by the sand banks off Baie de L'Authe, Berek, Le Touquet and Baie de Wissant (see Figure 4.4); beach drawn down and changes in the supply of sediment to beaches. However, HR Wallingford's (2002) assessment has concluded that the proposed dredging is sufficiently far offshore and in sufficiently deep water that **no adverse affects** on the French coastline will arise. For example, dredging in the ECR will not reduce the shoreward transport of sediment or reduce the shelter provided by offshore sand banks to the coast from waves.

The proximity of Areas 461, 475 and EEC5 South to the French-UK median-line, leads to the possibility that sedimentation from the plume could extend into French waters. Given the current proposals for the location of dredging activity within these Prospecting Areas, and the predictions from the conceptual model of the extent of the sedimentological footprint arising from the plume (see Figure 5.8), sediment deposition and transport (to the north-east) is not expected to occur outside of English waters. However, at low concentrations, suspended sediment plumes are predicted to extend up to 5 to 10km from the dredging area. Depending on dredging locations with Area 461 and EEC5 South, these plumes have the potential to extend into French waters at times. Importantly, they are only expected to persist for up to 12 hours, will only settle for very short periods at slack water, and will disperse after dredging has ceased.

The water quality implications of increased suspended sediment therefore have the potential to influence the biological resource in the French part of the eastern English Channel and should be reviewed. However, the impact of enhanced suspended sediment levels on the benthic resource, phytoplankton and on fish and shellfish is considered to be of **minor adverse significance** across the entire ECR (see Sections 6.2.2 and 7.2.2).

12.5.2

Fishing

A potentially significant transboundary effect could be associated with the effects on fishing predicted to arise due to the dredging activity. A wide range of fleets from EU countries have traditionally operated in ICES Area VIId (in which the ECR is located), including France, Belgium, Denmark, the Netherlands, Germany and the UK (see Figure 4.17). These potential impacts include the reduction in fish stocks due to the removal of benthic organisms and habitat alteration; the potential displacement of fish stocks due to sediment plumes and noise; and the restriction of fishing in the dredging zone and consequential effect on trawling. Specifically, an impact of **minor to moderate significance** is expected to occur in the ECR with respect to shellfishing (scallop dredging). Direct effects on finfish are expected to be limited, however, access will be locally and temporally restricted by the presence of dredging vessels.

Assessment of the potential annual economic value of the areas to be dredged (and therefore excluded) predicted the following:

- Belgian beam trawlers - £4,212/km^2;
- French trawlers/scallop dredgers - £635/km^2;
- British/German/Dutch pelogic freezer trawlers - £765/km^2;
- British/French gillnetters - £152/km^2.

For the 10km^2 area to be dredged each year, the effect represents approximately 0.06% of the value of the fishing industry in ICES Area VIId, for which the average annual catch value is around £110M (see Section 8.3.1).

12.5.3

Navigation

The effects of the proposed dredging activity on navigation also has the potential to have transboundary implications.

However, the presence of dredgers in the ECR is estimated to lead to a minor increase in the risk of collision (0.15%). In addition, a strict operating protocol has been agreed (see Section 9.2).

12.5.4

Archaeology

The Lower, Middle and Upper Palaeolithic and Early Mesolithic archaeological heritage of the ECR is strongly linked to European prehistory, as the ECR may form part of the palaeo-catchment of the Somme, Authie and Canche. Damage to archaeological material in the ECR due to dredging would therefore have a transboundary implication for the archaeological heritage of Europe.

Maritime archaeological heritage is intrinsically international in character. A significant number of the wrecks and recorded losses in the Channel are of European origin. All countries affected (or potentially affected) maintain a historical interest in such sites. However, given the implementation of the mitigation measures detailed in Sections 10.2.1 and 10.3.1, the residual effects of aggregate extraction on the potential archaeological resources of the ECR are expected to be **minor**.

12.5.5

Cables

Submarine cables are also international, connecting the UK with France, the Netherlands, Germany, Belgium the United States and the Far East. However, no impacts are expected on these cables due to the proposed dredging activity.

13 Conclusion: Mitigation, Monitoring and Regional Management

13.1

Introduction

As outlined in Chapter 2, the ECR REA is a study of the proposed cumulative impacts associated with multiple dredging activities occurring within the ECR. The end product of this assessment process is a series of recommendations that consider:

- Regional mitigation, monitoring and dredging management; and
- Options for facilitating a co-ordinated regional and long-term approach to dredging activities in the East Channel Region.

In order that the development of marine sand and gravel resources can take place in a way that is consistent with the Government's approach to protecting the environment and achieving sustainable development, an effective series of mitigation and management measures, backed up by appropriate monitoring, will be necessary. The scope of and need for these measures will be informed by the findings and predictions of the impact assessment process; whether site specific or, in this case, regional.

Marine Minerals Guidance Note 1 (MMG1) highlights the need to minimise the potential impacts of marine aggregate dredging activity, by identifying appropriate mitigation measures where potential concerns have been identified. The guidance goes on to recognise the role that monitoring plays in assessing the effectiveness of any mitigation measures imposed, as well as providing information on the actual environmental effects of the dredging activity taking place, based on site specific circumstances. This latter point is particularly important, as it is not always possible to predict in full the environmental effects that will arise from the dredging process. In this way, monitoring can be used to inform any changes to the mitigation or management measures initially defined.

In the case of the ECR, there are two key issues to consider. Firstly, the fact that the variability of the environment (habitats and species) and the extent to which it is subject to effects from other activities is largely unknown. Secondly, dredging for marine aggregate has not previously occurred in this area, or within a similar area (in terms of the water depth and hydrodynamic regime). Difficulties therefore arise in predicting the significance of the potential effects of aggregate dredging in the ECR. Hence, the feedback loop between the dredging activity and the mitigation/monitoring programme is fundamental in this instance to confirm the reasoned assumptions made as part of this regional assessment.

The definition of specific management measures by the Applicant companies will contribute to minimising environmental effects, while at the same time defining a framework for resource management and operational practice. This can incorporate those initiatives proposed as part of the ECA Charter (see the Industry Statement section). These include a commitment to carefully manage the dredged area with an aim to reduce it to a minimum and target particular resources, to zone Permission Areas to sufficiently separate concurrent dredging, to only dredge resources greater than 2m thick on average and to minimise screening.

To ensure a consistent and co-ordinated approach to the mitigation, monitoring and management of issues identified within the REA, an overarching framework of regional recommendations is required, over and above those arising from application-specific EIAs. This chapter outlines the scope of this framework - the regional management plan - before going on to summarise the predicted effects identified during the REA process and the resulting recommendations for further data collection, mitigation and monitoring that will form the plan itself.

13.2

A Regional Management Plan

The regional management plan for the ECR should comprise a series of recommendations arising from the conclusions (predicted effects) derived from the REA process. This encompasses such issues as mitigation and monitoring, but also includes recommendations for further research, for reporting and auditing of data and for co-operation. The scope of the plan can be defined by the following objectives:

1. To define SMART mitigation measures to ensure the minimisation of adverse environmental effects (**S**pecific, **M**easurable, **A**chievable, **R**ealistic and **T**ime-bound);

2. To implement a regional monitoring programme encompassing all relevant parameters;

3. To develop a partnership approach to the monitoring programme, that involves the ECA and other stakeholders working together when devising and undertaking monitoring;

4. To obtain further data on the quality and value of the baseline environment where data gaps have been identified;

5. To increase understanding of the effects of dredging activities (and in particular the sediment plume) on the biological resource in deeper waters;

6. To establish liaison and reporting mechanisms with key stakeholders, including the fishing industry and navigational interests;

7. To publicly report on dredging activities and operations along with the results of the monitoring programme;

8. To maintain the GIS database (developed as part of this initiative) for the effective collation and dissemination of information; and

9. To set up a Technical Review Forum involving industry, regulators and independent experts to determine the most appropriate way forward given reported results.

There is a synergy between the objectives of the regional management plan and the Applicants' Charter, set out in the Industry Statement.

Specific recommendations for mitigation, monitoring, liaison and additional data collection are outlined in the following sections, in response to the predicted effects identified within the preceding chapters of the REA. In certain circumstances, individual recommendations may fulfil multiple objectives (e.g. spatial restriction of dredging activity may minimise potential effects on benthos, fisheries and navigation). Therefore, the chapter concludes by drawing the recommendations together, in light of the ECA's Industry Charter, in order to form the basis for a regional management plan.

13.3 Summary of Issues Identified by the REA Process and Recommended Actions

This section summarises the conclusions of Chapters 5 to 11 of the REA on the predicted effects of the proposed cumulative dredging activity in the ECR. It sets out the data gaps that are apparent with respect to each effect considered and summarises the recommendations for mitigation. Relevant monitoring proposals are also developed. Tables 13.1 *Mitigation* and 13.2 *Monitoring* then draw together the issue specific recommendations.

13.3.1 Regional Effects on the Physical Environment

Near field water quality effects arising from sediment plumes

Predicted effects

Low concentration sediment plumes will extend from 5 to 10km beyond the dredged area following aggregate extraction. Suspended sediment levels exceeding 60mg/l will occur at the bed, but are expected to be short lived. Higher concentrations will only occur locally and plumes are not predicted to coalesce between dredged areas to any significant degree, particularly given the expected average occupancy rates (i.e. 5 cargoes a day). The opportunity for cumulative effects increases when proposed dredging areas lie within 5 to 10km of each other along the same tidal axis (NE/SW) and within 2 to 3km across the tide (NW/SE).

Data gaps

Aggregate extraction has not previously been undertaken in the ECR. Therefore, although a high level of confidence exists in the modelled results of plume dispersion (i.e. the level of magnitude will be correct), the expected extents and durations used as part of this assessment are reasoned predictions only. A greater knowledge of plume behaviour in the ECR is therefore required.

Recommendations for mitigation

- Concurrent dredging activity, that is, within 5 to 10km along the tide and 2km across the tide, to be managed and reported in order to minimise the potential for cumulative effects resulting from the coalescence of plumes in the water column;
- All dredging to be undertaken in the direction of the tidal axis (i.e. tide parallel – NE/SW);
- Screening to be minimised and reported annually; and
- High quality resources to be targeted for extraction.

Monitoring

Although the potential for cumulative effects to arise is considered to be low (based on the modelled predictions), it is recommended that a one-off monitoring study of cumulative water quality effects arising from sediment plumes be undertaken across the ECR. This will allow modelled predictions to be verified against measurements and will provide confidence that the proposed mitigation measures will be effective. As such, the survey will need to determine measurements for the 'worst case' proposed scenario, whereby multiple dredging activity occurs at a distance of 2km across the tide and 5km along the tide. The survey should employ the latest techniques, such as ADCP measurements coupled with water sampling and aerial photography, and be undertaken within the first year of dredging commencing in the ECR.

Near field seabed sediment deposition and transport of sediment arising from plumes

Predicted effects

Most of the sediment within the plume (mainly sand) is expected to descend directly to the seabed during the dynamic phase of plume dispersion. It will accrete within and adjacent to the dredged area and some sand will be available for reworking by tidal currents. That is, a sheet of poorly sorted sediment is expected to accumulate up to 200m beyond the dredged area, largely along the tidal axis to the NE. A bedform field is expected to extend beyond this in the direction of the tidal residual for 2km, diminishing to dispersed sand streaks and ripples. In common with naturally occurring seabed sands in the ECR, some sediment will eventually travel towards the bedload convergence zone of the eastern English Channel. Minimal sedimentation is expected to occur across the tide, between concurrent dredging areas.

The disturbed seabed sediments will initially be sandier than existing environments, however, over time the dredged sediments will be winnowed to form a coarse sand and fine gravel dominated seabed.

Data gaps

The assumptions set out above are based on the conceptual model for dredging derived sediment transport in the ECR developed as part of this work. Therefore, it represents a hypothesis based on a reasoned understanding of the seabed processes of the ECR and a good understanding of physical responses to aggregate extraction, uncertainties exist in terms of the precise scale, extent and duration of these plume effects. Aggregate extraction has not previously occurred in this environment and no analogues are available from experience elsewhere. Therefore, a data gap clearly exists in parallel with a requirement to confirm the deposition and transport predictions made here, based on regular reviews of the dredging works.

Recommendations for mitigation

- Dredging activity within adjacent Permission Areas, that is within 2km across the tide, to be restricted in order to manage and minimise the potential for effects arising from the coalescence of plume sedimentation and sediment transport;
- All dredging to be tide parallel
- Resources to be worked to economic exhaustion (i.e. at depth); and
- Screening to be minimised.

Monitoring

A programme of monitoring will be essential in order to allow the development of a full understanding of the sediment deposition and transport processes that characterise the ECR; to confirm the predictions made; and to verify the effectiveness of the proposed regional mitigation measures.

Initially, detailed, site-specific case studies should be implemented to help develop an understanding of the patterns of sedimentation and of how these relate to dredging activities and the predictions made. This will require an intensive programme of data collection and interpretation to be undertaken prior to and once dredging starts. Data required will include bathymetry, sidescan sonar and seabed sediment sampling across the proposed dredging zones, and extending 2km across the tide and up to 10km along the tide. Findings will then need to be considered against the predictions of the conceptual model developed herein. The scope and timing of follow up surveys should be re-assessed against the results obtained. Repeat surveys should be undertaken at agreed intervals to determine the rate of change. Initially these will need to be at shorter intervals in order to increase understanding, with the potential to extend the intervals between surveys as knowledge increases. It is expected that such monitoring will occur over several years.

Screening returns, where applicable, should also be recorded for each cargo (vessel capacity/all-in loading time/cargo retained/actual loading time) to provide an indication of the sediment balance returned in order to be able to relate these to the monitoring results observed.

The objective of this monitoring programme should clearly be to determine the scale, extent and process of sediment accretion and dispersion in the ECR following aggregate extraction.

Far field effects

Predicted effects

A cumulative effects assessment looking at: changes in offshore and shoreline wave conditions, reduction in the coastal protection provided by sand banks, changes to tidal currents, beach draw-down and changes in sediment supply to beaches, has concluded that the proposed ECR dredging is sufficiently far offshore and in sufficiently deep water that **no adverse effects** on the English and French coastlines will arise.

Data gaps, recommendations for mitigation and monitoring

No further investigation or mitigation measures are considered to be necessary.

13.3.2
Regional Effects on Benthic Biological Resources

Removal of habitat and species during dredging

Predicted effects

The dredging proposed will remove 50km² of habitats and species across the ECR (based on the assumptions set out in the Industry Statement) throughout the 15-year dredging permissions. The significance of this will vary based on the receptor (i.e. species or biotope) under consideration. The communities of the ECR are characterised by a high diversity and include long-lived species. However, they are widespread both within the ECR and the eastern Channel and there is no evidence of species of conservation significance that are not widely represented in the region. The extent of the loss is therefore considered to be of a relatively small scale in the context of the ECR (at over 1000km²) as a whole. Nevertheless, a period of 10 to 20 years may be required for more slow growing species to recover, although recovery will occur more quickly (4 to 6 years) for more short lived species. In terms of recovery of the benthos for fish prey, partial recovery of polychaetes is expected to occur within 6 months of the cessation of dredging. Overall, the impact is considered to be of **moderate adverse significance**.

Data gaps

As previously discussed, dredging has not occurred within the ECR or similar environments in the past. A number of reasoned assumptions have therefore been made which require validation.

Recommendations for mitigation

- Minimise the area available to be dredged at any one time (i.e. to 10km²);
- Resources in any one location to be dredged to economic exhaustion, before new areas are exploited;
- 'Buffer zones' to be left between production lanes to aid recolonisation and minimum timescales to be set before production commences in adjacent areas, allowing recovery; and
- Targeted dredging, screening and monitoring should be undertaken to leave a seabed similar to that which existed before dredging commenced.

Monitoring
Monitoring should record and compare the direct effects of dredging on the biological resource of the ECR with the predicted effects. This should monitor and measure the total area affected as well as the seabed sediment composition during and following dredging. The monitoring previously proposed in relation to physical impacts will also be applicable to monitoring biological impacts. The extent of biological surveys should be delineated in light of the settlement, accretion and dispersion of dredged sediment.

Specifically, the benthic resource should be monitored to define the direct impact of aggregate extraction within the dredging zones across the ECR, as well as the nearby effects, the response of buffer zones and subsequent changes and rates of recovery during and after dredging. The specification of and timescale (frequency and duration) for biological monitoring needs to be considered and agreed with the relevant regulatory bodies. In time, this should be determined in light of the monitored results.

Effects due to increased suspended sediment and deposition from the plume

Predicted effects
The effects on benthic communities due to increases in turbidity and the attenuation of light are expected to be insignificant given the limited persistent of the plume. In addition, the dominance of fauna over flora within the ECR means that any localised reduction in light is unlikely to have an effect. Localised impacts on phytoplankton could occur at certain times a year, but this is also expected to have a negligible influence on the benthic resource due to the larger scale distribution of phytoplankton blooms.

Increases in near bed levels of suspended sediment could affect filter feeders and suspension feeders adjacent to the dredging zones. Near bed concentrations within the dredged areas during and immediately following dredging are predicted to range from 150mg/l to 300mg/l and over areas ranging in size from 5 to 25km^2 near bed concentrations of 60mg/l could be experienced. However, given the localised nature and limited predicted distribution of the plume at high concentrations (less than 2 hours), and the fact that during storms (and potentially fishing activity) levels of suspended sediment will also rise, it is not expected that dredging activities will cause any permanent losses due to the physical effects of the plume. This impact is therefore considered to be of **minor adverse significance**.

It has been estimated that adjacent to each dredged area, within the zone of settlement of the sand sheets and bedforms (i.e. within 1.2km of each dredge site), the depth of sedimentation could be between 10 to 25cm. Beyond this, for another 1km, occasional ripples and sand streaks are expected to occur. In general, species tolerance to smothering varies depending on the rate of settlement, sensitivity of the species affected, type of sediment and timing of deposition. Some of the species present in the ECR are tolerant to smothering due to their ability to migrate vertically through sediment. It is anticipated, for example, that impacts to polychaetes, a main source of prey for finfish, will be negligible. Therefore, the significance of this effect is expected to be of **moderate adverse significance** within 1.2km of each dredge site (i.e. over 58.5km^2 of the ECA for the 15 year licence period; 11.7km^2 per annum) and of **minor adverse significance** further away (over 16.25km^2; 3.25km^2 per annum).

The effect of sediment deposition from the plume in combination with the direct loss of biomass will be to increase the impact footprint of the dredging activity from 50km^2 (i.e. the proposed dredged area) to 125km^2 across the ECR. Annually, this is expected to equate to 10km^2 and 25km^2. These impacts will be moderated by habitat recovery in the medium term, nevertheless, a slightly different community is likely to recolonise the habitats in the sandier depositional footprint of the dredging. It is anticipated that fine sands will be winnowed with the tidal residual to leave behind a similar habitat to that present before dredging commenced. The timescale, however, for this to occur is not known.

Data gaps
Uncertainty is inherent in assessing the impacts potentially associated with the predicted dredging plumes within an environment characterised by rich and varied communities that have not been subject to impacts from dredging. In addition, although the conceptual model predicting the area of sediment deposition and transport is based on reasoned assumptions, it incorporates an element of uncertainty.

It is therefore recommended that once production has started an intensive data collection programme is initiated in order to provide data that allows the validation of the conceptual model and quantifies the response of the benthic resource. The programme should focus on at least two of the first production zones, ideally representative of typical conditions in the ECR and adjacent to one another. A full suite of parameters should be monitored as part of a comprehensive, quality assured long-term data collection programme to establish the pre- and post-dredge character of the benthic community and seabed.

Recommendations for mitigation
- Dredged areas to be minimised at any one time;
- Screening to be minimised by loading efficiently and targeting appropriate resources;
- Zoning to target resources with a lower sand content (requires an initial knowledge of the resources with a dredged area to be gained);
- Resources to be dredged to exhaustion;
- Dredging to be tide-parallel;
- Minimum distances to be investigated and managed between ongoing dredging operations (5 to 10km along tide and 1 to 2km across tide), informed by the results of plume monitoring; and
- Buffer zones to be left between production lanes to aid re-colonisation.

Monitoring
Data should be collated on the location and extent of dredging operations, total loads and the amount of screened material as well as any measures taken to minimise environmental effects (e.g. seasonal measures).

Due to the uncertainties associated with the prediction of sediment plumes in deeper waters, and the variation in the amount of material that will be screened across the ECR, an ECR-wide monitoring programme should be instigated. The programme should be developed following baseline data collection and should include the investigation of plume distribution, the settlement and transport of sediment, as well as the biological response across the areas potentially affected (based on a number of controlled survey points and including the buffer zones). Repeat surveys will need to be undertaken at agreed intervals to determine the rate of change. Initially these should be at shorter intervals, in order to increase understanding, with the ability to extend the intervals between surveys as knowledge increases. It is suggested that the timing of monitoring surveys should correspond to tonnage offtake from the ECR, i.e. action levels should be specified (e.g. once 200,000 tonnes has been dredged).

In assessing the results of monitoring, care should be taken to identify the influence of other activities (e.g. fishing). In particular, any existing modifications to the environment should be acknowledged in the baseline (pre-dredge) assessment. The information obtained should be fed back into the management process (see Section 13.4).

13.3.3 Regional Effects on Fish and Shellfish Resources

Biomass removal

Predicted effects
The direct removal of biomass is unlikely to affect finfish, crabs, lobsters and other crustacea because they will generally avoid areas of extraction in response to increased noise and suspended sediment levels. Locally, the effect on scallops and other sessile shellfish will be more significant. Most adults will be completely removed from the dredged area. The potential for an impact on egg-bearing, buried female brown crabs during the overwintering phase has also been identified. However, the limited extent of the proposed dredging activity means that only a small proportion of the spawning stock (e.g. 1% of scallops per annum) will be affected and re-colonisation of the seabed will allow recovery to occur.

Predator-prey interactions have been considered to determine whether a localised reduction in benthos (i.e. food availability) as a result of aggregate extraction could in turn influence fish distribution within the ECR. Potentially, some local change in fish distribution may take place, related to predicted direct and indirect effects of the proposed aggregate extraction. However, as fish are opportunistic feeders, the localised removal of biomass is not considered to be significant in the context of fish resources. Certain species should be able to quickly adapt to changes in benthic assemblages and their subsequent recovery, e.g. sole, crab and plaice, while others are likely to be displaced to areas where more suitable prey are available, e.g. cod, bass and rays. Even so, many of the species that are prey items are likely to partially recover within 6 months.

Data gaps
The potential effect of dredging on scallop larvae is difficult to quantify. It is also apparent that the distribution of egg-bearing female crabs and herring spawning areas in the ECR are unclear. Monitoring should address these issues in order to inform the Applicants' approach to mitigation.

Existing commercial fishing activity will have had, and will continue to have, an impact on the fish resources of the wider ECR. However, in order to be able to make an assessment of the potential in-combination influence of fishing and dredging on fish and shellfish resources in the ECR, the impact of fishing would need to be quantified – an exercise currently limited by the data available.

Recommendations for mitigation
- Area to be dredged at any one time to be minimised;
- Resources to be dredged to exhaustion;
- Extraction to be minimised and managed during defined seasons (e.g. critical spawning periods) in particular areas (e.g. if high densities of egg bearing crabs or herring spawning habitats are identified) or at certain states of the tide (e.g. to encourage the tidal stream to transport sediment away) – to be informed by monitoring;
- Production areas to be limited until further information on the distribution of the herring spawning area has been gathered; and
- Buffer zones between dredging areas to be defined within high-density areas of scallop to facilitate re-colonisation.

Monitoring
It is of critical importance to define the extent of herring spawning areas in the ECR before dredging begins. Appropriate surveys should therefore be initiated as soon as possible. The distribution of female brown crabs during the overwintering period should also be investigated. Information on mobile epibenthic species, such as crabs, sole, plaice and scallop, can be obtained from epibenthic trawls (which form part of standard benthic surveys). The extent of scallop beds in the ECR should also be determined prior to an area being dredged and used to inform decisions as to the location of extraction zones.

It should be noted that the issue of 'stock' extends beyond the limits of the ECR. To improve understanding, broad-scale monitoring of key eastern English Channel finfish and shellfish stocks is recommended. Opportunities for joint research/monitoring initiatives should be investigated.

Effects due to increased suspended sediment and deposition from the plume

Predicted effects
The species that appear to have the highest vulnerability to the influence of sediment plumes are scallops and herring. Scallops may be affected by very high increases in suspended sediment levels at the bed, for example, but only in the area immediately beyond the extraction zone and for a short period. A temporary settlement of silt may also affect the settlement of scallop spat or the attachment of herring eggs. However, in general, plume effects on crustacea and finfish are expected to be of **negligible significance** because these species are either adapted to elevated suspended sediment levels or can move away from affected areas.

The deposition and transport of sediment adjacent to the dredging zone could also cause some scallop mortality immediately adjacent to the dredging zone. However, most scallops will be able to move away from the affected area. Smothering during spat falls and larval development could accentuate the impact on scallops in the affected areas of the ECR (i.e. 25km^2 per annum), but recoverability is expected to be high because the resource is widespread. These impacts are considered to be of **minor adverse significance**.

Herring are likely to be more vulnerable to this impact during spawning because they seek out gravely substrate in specific spawning beds. If dredging increases the sand content of the bed and causes avoidance behaviour in such locations, spawning could be adversely affected.

Data gaps
As previously indicated, further information is required on the location of favoured herring spawning areas. The natural variability of fish stocks needs to be taken into account in the interpretation of monitoring results with respect to spawning substrates and habitats.

Recommendations for mitigation
- Where congregations of spawning herring are known to be present or have been present in the dredging zone, activity to be moved to another area or screening strategies modified to reduce the level of suspended sediment concentration;
- Appropriate seasonal, temporal and spatial windows to be investigated (particularly with respect to scallop and herring spawning); and
- Buffer zones to be implemented to allow for recruitment from adjacent areas.

Monitoring
In order to better assess and quantify potential impacts on fish and shellfish resources either directly or indirectly through changes to physical and biological features, a range of additional information is required, as set out in Sections 13.3.1 and 13.3.2. For example, monitoring benthic community structure will allow an assessment to be made of the influence of the availability of habitat and food on fish resources. One of the key objectives of the monitoring programme will be to provide more precise details regarding the speed, concentration, duration and behaviour of the plume. This information will be essential to refining mitigation requirements.

Effects on fish and shellfish as a result of noise

Predicted effects
Increased noise is expected to provoke short term avoidance reactions in most finfish and crustaceans present in the ECR. Spawning behaviour could be inhibited by noise and some migratory patterns may be affected. However, in view of the limited size of the area likely to be affected at any one time, the duration of the effect and apparent adaptation to existing levels of noise from shipping traffic in the TSS and ongoing fishing activity, the significance of this effect is expected to be **negligible**.

Recommendations for mitigation
- Loading times and, therefore, time on site to be minimised; and
- Occupancy is expected to typically be about 18 hours a day and widely spaced across the ECR over a 24 hour period.

Monitoring
The effects of noise on fish resources should be considered within the overall fisheries monitoring programme, particularly with respect to spawning patterns and feeding behaviour.

Altered substrate topography

Predicted effects
No impacts of significance for the fishery are predicted as a result of topographic changes given the limited predicted extent of dredging in the ECR (i.e. 2 to 6m depressions over 50km^2 across the 1,132km^2 of the ECR), the slow rate of change due to extraction and existing seabed topographic variations. However, adult scallop distribution may be affected in the longer term due to changes in spawning patterns arising from the presence of furrows and local changes in water currents. Similarly, plaice tend to avoid depressions and local changes in the topography of gravel ridges could affect of the ability of herring to locate their habitual spawning areas.

Data gaps, recommendations for mitigation and monitoring
In view of the complexity of substrate changes predicted over the longer term, changes in topography should be considered within the wider fisheries monitoring programme. This should be linked to routine bathymetric/side scan sonar surveys of active dredge areas, in order to determine the scale and extent of any changes.

Combined near field influences on fish resources

The effects of the direct removal of biomass and the accretion/dispersion of sediment returned to the seabed during the dredging process will combine in the vicinity of the actively dredged zones. This analysis assumes that the impact footprint will amount to 125km^2 over the 15-year licence period and 25km^2 per annum. The marine environment adjacent to the dredging zones will also be influenced, at times, by increased levels of suspended sediment and noise. However, in general, the cumulative effects of the proposed activity on fish and shellfish will simply be additive. The main response of fish to the various aspects of dredging activity will be avoidance, therefore, direct effects will be limited. The dredging activity may, however, have indirect implications for both distribution and spawning patterns across localised areas of the ECR.

It is recommended that assessment of these potential dredging effects and the adoption of successful mitigation measures should be based on developing both a local and regional understanding of the spawning and feeding patterns of key species (i.e. scallop, herring and crab), as well as responses to dredging activity.

Far field effects

No opportunity exists, through physical changes in coastal processes, for the biological resource of the English and French coastlines to be affected by the dredging proposals.

Furthermore, although the combined aggregate extraction activities proposed could generate a low concentration plume over a large area, most of the species potentially affected can either avoid the effect (i.e. finfish) or are adapted to elevated suspended sediment loads (e.g. scallops). The effect of increased suspended sediment levels is therefore expected to be of **minor adverse significance**. Monitoring of plume characteristics and biological response is nevertheless recommended.

13.3.4 Fisheries Activity

Reduction in catches due to extraction and the sediment plume

Predicted effects

Fish and therefore related fishing activity is unlikely to be significantly affected by the loss of benthos associated with aggregate extraction. Shellfish and the shellfishery, on the other hand, will be directly effected. It is assumed that most adult scallops will be completely removed from the dredged areas (representing around 1% of the spawning stock in the ECR per annum), although some evidence of avoidance behaviour exists.

Temporary increases in suspended sediment (as well as noise) will lead to avoidance behaviour by most finfish and crustacea. However, this is unlikely to adversely affect fishing activity overall, although it may have a greater influence on some groups, such as Belgian beam trawlers and gill netters. The deposition of sediment outside the dredging zones could affect shellfishing but most scallops, crabs and lobsters should relocate to more favourable areas.

Consequential changes to the seabed are not expected to affect bottom towed fishing gear given their relatively limited extent and the natural variability of the bed that characterises the ECR now. Furthermore, the slopes of dredged depressions will be managed to avoid interference to trawling in the ECR.

It is envisaged that, generally, mobile fishing activity will be displaced from the active dredging areas as finfish are relocated and that static fisheries and scallop dredging will be reduced within these areas.

Data gaps

In general, a greater knowledge of the influence of plume and noise associated with dredging on fish/shellfish behaviour is required (see Section 7.2.2). However, it is difficult to predict the effect of aggregate extraction on fishing activities with any accuracy because the effect that fishing itself has on the fisheries resource of the ECR is largely unclear. Similarly, the influence of dredging is likely to be difficult to distinguish from the impact of fishing. This lack of clarity stems from the fact that the information available on fishing activity (e.g. catch data, fishing effort, vessel location) is frequently unreliable and inconsistent. Knowledge of the extent and effects of fishing activity represents on important data gap. However, as set out in Section 12.2.1, filling this gap would require the active participation of the fishing industry and the regulators.

Recommendations for mitigation

- Minimise the area available to be dredged and restrict the proximity of concurrent dredging activity along and across the tide;
- Resources to be dredged parallel to the tide and to economic exhaustion;
- Screening to be minimised;
- Dredging to be undertaken in narrow strips so as to leave areas of undredged habitat from which recolonisaton can occur;
- Dredging to be minimised and managed in key locations during critical periods;
- Slopes of dredged depressions to be managed to avoid interference with trawling; and
- The fishing industry to be kept well informed of the location and timing of dredging activity (liaison proposals detailed below).

Monitoring

It is recommended that scallop beds in the ECR be assessed prior to any works in order to define the pre-dredging stock and local distribution. Investigations into ground discrimination tools may be appropriate for this work. Stocks should then be monitored on an ongoing basis during the dredging period. The monitoring recommended with respect to benthic and fish resources will provide relevant data on changes to community structure and substrate topography in the ECR, allowing the consequential implications for fishing activity to be explored more comprehensively.

The implications of sediment plumes on the biological resources of the ECR will be investigated based on the recommendations set out in Sections 6.2 and 7.2. The implications for fisheries activity should be reassessed based on the monitoring results and the relevance of any mitigation measures reconsidered (e.g. the avoidance of dredging in particular areas).

Exclusion from operational dredging areas

Predicted effects

The presence and movement of operational dredgers in the ECR could disrupt trawling operations by reducing the area to be trawled or requiring trawl lines to be altered. Furthermore, the operation of dredging vessels may interfere with the placement of static fishing gear (particularly nets), although this is most likely to occur when vessels are moving to and from site. Occupancy modelling has predicted that there would typically be around 5 dredgers present in the ECR for a total of 18 hours a day. Given this assumption, this effect is considered to be of **minor adverse significance**.

A very small proportion of the ECR will have dredgers in it at any given time and the vessels present will be on average around 10km apart. This should allow fishing vessels considerable access in terms of both area and time available (noting the existing high number of ship movements that characterise this area in conjunction with existing fishing activity). Nevertheless, the estimated economic return associated with the areas proposed to be dredged (i.e. the potential zones of exclusion) has been undertaken and amounts to 0.06% of the average annual value added to ICES Area VIId (i.e. £65,310 for $10km^2$ from a total of £110M). Noting that the economic assessment was based on the assumption that fish resources would not relocate from the dredging zone and that access to the dredging area would be denied. In reality, mobile fish will be relocated and the active dredging zones will be available to mobile fishing when dredgers are not present.

Data gaps

The tools available for calculating the potential degree of loss of income due to lack of access include: catch data over the last 10 years; average vessel income, costs and profits; and price data. Clearly, significant uncertainties exist, largely due to a lack of confidence in the accuracy of the data and the difficulty associated with producing a comprehensive and accurate description of fishing activities in the ECR. (Hence, calculating the degree of impact of the proposed dredging activity on fishing is problematic).

Recommendations for mitigation

- Dredging plans to be specified in detail and communicated with the fishing industry, including location and duration of activity;
- Communication to begin prior to works being initiated, with the assistance of DEFRA district fisheries officers as necessary;
- Designated Fishing Liaison Officer to be put in place;
- Effective contacts with relevant counterparts in other countries to be established;
- Liaison to be formalised with local fishing associations, where possible;
- Protocols to be agreed for effective communication, i.e. the provision of updated information on the location of dredging operations, zoning charts and use of VHF; and
- Where necessary, seasonal, temporal, and spatial reductions in dredging effort (environmental windows) to be implemented.

The basis of mitigation in this case relies on the instigation of a comprehensive liaison programme with the fishing industry. Communications plans should be established.

Monitoring

Information on the fisheries activity in the ECR should continue to be collected. Consistent self-monitoring by the fishing industry should be encouraged. For example, log book monitoring could be used to help to determine current fishing effort and any consequential impact on fish resources or fisheries activity. Observations of fishing activity by dredging vessels on-site should also be recorded.

13.3.5
Navigation

Ship collision risk

Predicted effects

The cumulative annual risk of dredging in the ECR has been derived from the activity levels estimated for each application area and calculated collision frequencies, compared with existing ship-to-ship accident statistics. From this assessment it has been concluded that the total annual collision frequency associated with dredging in the ECR, based on a production of 8.5Mtpa, will be 6.1×10^{-3}; that is, an average of one collision in 164 years of continuous dredging, which is equivalent to dredging 1197Mt or loading 239,000 cargoes. The risks, however, in some Permission Areas are higher than in others (e.g. for Area 474 the risk is one collision in 50 years or after dredging 365Mt). The collision frequency associated with dredging 17Mtpa would double to one in 82 years, however, the dredged volume would remain 1197Mt. Dredgers will also typically work at least 10km apart.

The collision frequency for passing merchant ships in the ECR, at 5.7×10^{-6}, are higher than those associated with dredging (at their highest 2.4×10^{-6}) because of the more stringent operating procedures applied. Nevertheless, it is still recommended that simultaneous operations are monitored, specifically with reference to their influence on shipping (i.e. avoiding action).

Overall, the proposed combined dredging activity in the ECR is expected to have an insignificant influence on collision risk in the region, increasing the frequency of collisions by 0.15% (and 0.3% at 17Mtpa). In addition, all vessels navigating in the area must comply with the International Regulations for Preventing Collision at Sea 1972, the ISM code and a mandatory reporting scheme applied in the Dover Straits.

No data gaps are apparent.

Recommendations for mitigation and monitoring

- All vessels (dredgers) to be fitted with AIS transponders and electronic charting systems and to have radar coverage and visual lookout as near as practicable to 360º;
- Vessels must be able to communicate with CNIS either via VHF, e-mail and/or satellite communications;
- ECA to maintain an up to date listing of vessel details, including phone numbers;
- Activity to be co-ordinated to allow CNIS to monitor dredging and provide other vessels in the area with information via scheduled radio broadcasts;

- CNIS to liaise with the French Coastguard at Cap Gris-Nez;
- One hour before arrival, vessels will inform CNIS of their operation, including the zone where intending to load. Vessels to contact CNIS again at the end of the operation;
- Through liaison with UKHO, details of dredging activity to be included in Navtex broadcasts, Notices to Mariners and on Admiralty charts;
- Vessels to broadcast a warning to fishing vessels one hour before arrival, in English (general warning to be broadcast on Ch.16, before changing to another channel to provide full details);
- Passage plans to be developed for all voyages in line with SOLAS;
- Dredgers to avoid waiting or anchoring in the traffic lanes;
- In the TSS, dredger to run parallel to and in the general direction of traffic in the lane (exact course subject to resource, tide, weather etc.);
- 1nm horizontal visibility to be the minimum working limit in TSS lanes;
- Three people to be on the bridge during dredging with the following roles -Officer of the Watch, Lookout, Dredge Master;
- Alarm zones will be set out appropriate ranges around identified underwater hazards;
- In a potential collision scenario, the master will be responsible for determining what action to take;
- Exchange of information between operating companies to take place through an ECA navigation sub-committee;
- A system to be established for recording and sharing information on accidents, near misses and hazardous occurrences; and
- A formal review of dredging operations and their affect on shipping to be carried out after 12 months of the first activity. Following this, regular reviews will be undertaken at set periods.

Each of the measures set out above will be applied across the East Channel Association.

13.3.6 Archaeology

Loss of or disruption to Palaeolithic, Mesolithic and early maritime sites

Predicted effects

There are no known sites or artefacts of Palaeolithic, Mesolithic or early maritime (Prehistoric, Roman or Medieval) date within the ECR. However, sites are known to exist within the broader region, encompassing the south coast of England and the north coast of France, and it is highly likely that the region would have been inhabited at various times during the lower, middle and upper Palaeolithic and early Mesolithic; hence the potential exists for archaeological sites.

To date, the presence of *in situ* and derived material has not been established in the ECR. However, geological structures outside the ECR, i.e. the upper reaches of the Somme, Authie and Canche, are known to contain important remains from these periods. As these are similar paleo-catchments to those lying within the ECR, the potential exists for sites to be present within the ECR. Consequently, unmitigated aggregate extraction could have an impact on the Palaeolithic and Mesolithic archaeological heritage of the ECR of **moderate adverse significance**.

Data gaps

The presence of *in situ* and derived prehistoric artefacts in the ECR or in submerged sections of the same palaeo-catchments outside the ECR has not been established. It is not, therefore, possible to gauge the overall quality and quantity of the Palaeolithic and Mesolithic archaeological heritage in the ECR at this stage.

Recommendations for mitigation and monitoring

Mitigation for the potential implications of dredging activities on the archaeological resource should be guided by the advice provide in *Marine Aggregate Dredging and the Historic Environment* (BMAPA/EH, *in prep.*).

- Modelling of deposits and surfaces that may be of prehistoric archaeological interest should be (and is) recommended as part of licence applications;
- Geophysical surveys are used routinely in aggregate extraction, the scope of these surveys should take account of archaeological requirements;
- Provision should be made to sample, analyse and date suitable deposits and surfaces as archaeological field evaluation methodologies develop;
- Provision should be made to implement appropriate dredging exclusion zones and, where necessary, to undertake complimentary monitoring;
- Protocols should be implemented to facilitate the reporting of fortuitous discoveries (although the difficulty of intercepting prehistoric material in the course of dredging and screening is acknowledged);
- Provision should be made for a regional approach to archiving and disseminating archaeological results arising from specific schemes; and
- Liaison should occur with curatorial archaeologists in northern France and southern England.

Loss of or disruption to sites of Post-medieval or Modern maritime interest

Predicted effects

Searches produced records of 294 sites of maritime archaeological interest in the wider study area, comprising 96 wrecks, 102 seabed obstructions and 96 casualties. In the ECR there are 31 known wreck sites, 17 obstructions and 7 casualties. Where dated, the sites span the post-medieval and modern periods, however, seafaring may date back to the inundation of the ECR in the Mesolithic. Unmitigated dredging could therefore have an impact on unknown early Maritime resources of **minor to moderate significance**. However, dredging vessels will avoid identified sites.

Data gaps

In order to provide a comprehensive regional context for the maritime archaeological resource, it is necessary to enhance the database of maritime sites in the ECR. This would provide a firmer basis for evaluating the importance of sites.

Recommendations for mitigation and monitoring

- Suitable geophysical survey techniques should be used routinely to clarify the character and extent of known sites and locate as yet unknown sites;
- Where the extent and character of maritime sites remains uncertain, provision should be made for archaeological inspection by ROV or diving to provide direct evidence;
- Provision should be made to implement dredging exclusion zones around areas shown to contain important archaeological material;
- Protocols should be implemented to facilitate the reporting of fortuitous discoveries of Maritime sites and artefacts, both during dredging and at wharves;
- Provision should be made for archiving and disseminating archaeological results arising from specific schemes; and
- Liaison should occur with curatorial archaeologists in England and with the Receiver of Wrecks and Ministry of Defence. Measures should also be developed to facilitate communication with archaeologists in other countries in respect of maritime sites that have a verifiable link with that country.

13.3.7

Other Activities

There are no existing or proposed wind farms, military sites, oil and gas activities or marine disposal sites in the ECR.

Disturbance to submarine cables

Predicted effects

Dredging activity will avoid the locations of all known live cables. Direct effects should not therefore arise. Indirect effects are also expected to be **negligible** because cables are not expected to be undermined due to the dredging process and the level of deposition predicted (10 to 25cm) is insignificant in this context. Similarly, changes to tidal flows and wave conditions will be insubstantial.

Data gaps

Although largely predictable, the implications of dredging in the ECR as physical processes are as yet unproven (see Section 13.3.1).

Recommendations for mitigation

- Through the Crown Estate, UKCPC has established a 'No Dredging Zone' of 250m either side of active and out of service cables and a 'Dredging Notification Zone' 250 to 500m either side of cables throughout the ECR;
- Defined zones will be enforced through the Crown Estate's Electronic Monitoring System (EMS);
- The ECR are to liaise with the UKCPC in order to provide up-to-date information on active dredge areas; and
- Cable routes will be marked on dredging vessels charting systems, with appropriate hazard alarms.

Monitoring

Where an active dredge area lies adjacent to a cable route, i.e. within 250m, routine bathymetric and side scan sonar surveys should be extended at intervals to provide data coverage beyond the route of the cable. Data interpretation should consider any evidence of scour or slumping and the results should be passed on to the cable operator. If evidence of either becomes apparent, the proposed mitigation measures should be reviewed.

Yachting, motor cruising and diving

Predicted effects

Although no real potential for any cumulative effects on water-based recreation has been identified as a result of the ECA dredging proposals, many of the mitigation measures proposed for other purposes (e.g. navigation) will further reduce any potential for effect.

No data gaps are apparent

Recommendations for mitigation and monitoring

- Dredging activity to be co-ordinated through CNIS;
- Notices to Mariners to be issued as appropriate, with a wide circulation;
- Navtex warnings to be issued during the early stages of operations;
- Admiralty Charts to be amended with dredge areas and relevant information;
- Dredgers to broadcast warnings one hour in advance of commencing operations; and
- Information to be circulated widely prior to operations commencing. This should include ports and marinas along the south cost of England and north coast of France, as well as umbrella organisations such as the RYA and BSAC.

13.4 Recommendations for Regional Management

13.4.1 Local and Regional Responsibilities

The REA process is distinct from the application process that applies to individual site-specific production licence applications and has no formal standing within the application process. However, the members of the ECA committed to and commissioned the REA on the basis that it would increase the understanding of the cumulative issues arising from development in the ECR. This would allow recommendations for regionally based management, mitigation and monitoring, over and above those that would result from site-specific studies alone. In turn, a consistent approach to addressing common issues should be developed throughout the region.

There are two scales of issue that need to be considered in the decision making process: site-specific or local, and regional. Site-specific issues are identified and addressed through individual environmental impact studies, while regional scale cumulative issues have been identified through this REA. However, regional recommendations that apply to site-specific areas, such as the need to minimise the area dredged and the need to dredge parallel to the tide, are made in the REA and contained within the associated Industry Statement. Standard approaches to monitoring, mitigation and management should be adopted across the ECR, to ensure common standards and specifications, and to reduce the potential for duplication of effort in data collection and reporting.

It is proposed that recommendations made in the REA should be incorporated, as appropriate, into the mitigation, monitoring and management plans for individual licence applications. Furthermore, through discussions with the Regulator and key stakeholders, regional mitigation, monitoring and management proposals should be considered as part of proposed individual licence conditions. The REA recommends a common approach in order to ensure consistency between sites across the region and reduce the duplication of effort. As an example, the need for a fisheries liaison officer has been identified in the REA; for consistency, it would make sense for a single appointment to be made for the region as a whole.

Any Conditions set by the Regulator which apply regionally will need to be common to all operators in the ECR, to ensure those issues or data gaps identified within the REA are addressed. For this reason, Conditions should require individual operators within the ECR to co-operate in fulfilling the regional objectives identified.

13.4.2 East Channel Region Licensees

With respect to both site-specific and the regional Conditions, individual operators will need to be responsible for ensuring compliance as required by their individual licence conditions. However, it is recommended that the ECR licensees instigate a co-ordinated regional approach.

To that end, it is recommended that the following tasks are recognised by the licensees at a regional scale:

- Co-ordinating compliance with the regional component of licence conditions, and liaising with regulatory authorities;
- Defining and agreeing the scope of regional mitigation and monitoring requirements;
- Co-ordinating regional liaison requirements (fisheries, navigation and trans-boundary liaison);
- Implementing and reporting the 'Industry Charter' (see the Industry Statement);
- Managing regional data collection and developing a 'partnership approach' to monitoring and research (see Section 13.4.3);
- Co-ordinating a 'technical review forum' (see Section 13.4.4);
- Public reporting of performance (compliance reporting) (see Section 13.4.5);
- Funding and managing the ECR GIS (see Section 13.4.6); and
- Maintaining a website detailing current active dredge areas, together with providing electronic copies of all monitoring and research reports.

13.4.3 A Partnership Approach to Monitoring

There are clear advantages to any ECR monitoring being undertaken jointly rather than separately under individual company initiatives – particularly where geographical overlapping occurs. Such an approach would allow for greater effectiveness through consistency in monitoring and survey methodologies, the regional interpretation of results, information dissemination and value for money. The comprehensive nature of the outputs would also provide more weight to results and help to define the most appropriate way forward through collaborative decision making.

Table 13.1 ECR Aggregate Extraction Mitigation Plan (Summary)

Parameter	Potential effect	Recommended Mitigation: Dredging within 5km by 2km to be restricted	Dredging to be tide parallel (NE/SW)	Screening to be minimised	Dredged area to be minimised (i.e. 10km²)	Resources to be worked to exhaustion	Designation of buffer zones	Seasonal/temporal restrictions in sensitive areas	Production areas to be limited, awaiting herring spawning data	Zoning to target resources with a lower sand content	Seabed sediment to remain similar	Loading times to be minimised	Fishing industry to be well informed of activities	Designated fisheries liaison officer	Dredging plans to be specified in detail	Trans-boundary liaison; broadcasts	Notices to Mariners, Navtex warnings, Charts	Good radar, AIS, visual coverage	Good communication with CNIS	No Dredge and Dredging Notification Zones
Physical Environment	Water quality effects from sediment plumes	✓	✓	✓	✓					✓										
	Deposition/transport of sediment from plumes	✓	✓	✓	✓	✓														
	Far field effects (waves and tides)																			
Biological Environment	Removal of habitat and species			✓	✓	✓	✓				✓									
	Effects of the sediment plume	✓	✓	✓	✓	✓	✓			✓										
Fish/shellfish resources	Biomass removal				✓	✓	✓	✓	✓											
	Effects of the sediment plume	✓	✓	✓	✓		✓	✓	✓	✓										
	Noise				✓							✓								
	Altered substrate topography				✓	✓					✓									

Parameter	Potential effect	Recommended Mitigation: Dredging within 5km by 2km to be restricted and tide parallel (NE/SW)	Slopes managed to avoid trawling interference	Screening to be minimised	Dredged area to be minimised (i.e. 10km²)	Resources to be worked to exhaustion	Designation of buffer zones	Seasonal/temporal restrictions in sensitive areas	Production areas to be limited, awaiting herring spawning data	Geophysical surveys should be used routinely	Provision to be made to model, survey, where necessary, and report	Adoption of a regional approach to archiving	Fishing industry to be well informed of activities (inc. activity warnings)	Designated fisheries liaison officer	Dredging plans to be specified in detail and published	Trans-boundary liaison; broadcasts	Notices to Mariners, Navtex warnings, details on Admiralty charts	Good radar, AIS transponder, electronic charting, visual coverage (3 people on bridge)	Good communication with CNIS (before arrival/departure)	In TSS, vessels to avoid waiting; dredgers to be parallel to traffic; 1nm horizontal visibility	No Dredge and Dredging Notification Zones / alarm zones around hazards
Fisheries activity	Reduction in catches	✓	✓	✓	✓	✓	✓	✓	✓				✓								
	Exclusion and disruption to vessels/gear		✓					✓					✓	✓	✓	✓	✓			✓	
Navigation	Ship collision risk												✓		✓	✓	✓	✓	✓	✓	✓
Archaeology	Palaeolithic and Mesolithic archaeology									✓	✓	✓				✓					✓
	Maritime archaeological heritage									✓	✓	✓				✓					✓
Other activities	Submarine cables														✓						✓
	Recreation (yachting/diving)														✓	✓	✓		✓		

Table 13.2	ECR Aggregate Extraction Monitoring Plan (Summary)																		
		Recommended Monitoring																	
Parameter	Potential effect	Survey of cumulative suspended sediment plumes (one-off)	Measurement of sediment deposition and transport (case studies, repetitive)	Bathymetry, sidescan sonar, seabed sediment sampling (on-going)	Records of dredging activity, loads and screening returns (on-going)	Seabed sediment composition (before and after dredging)	Benthic resources in and adjacent to dredging zones (overtime) – recovery rates	Records of site-specific plume distributions (occasional)	Records of the influence of other activities, i.e. fishing, cable laying etc. (on-going)	Defining the distribution of over-wintering female brown crabs (establish the baseline)	Locating favoured herring spawning areas (on-going)	Definition of the density of scallops (pre-works)	Records of responses to disturbance	General records of spawning and feeding patterns across the ECR	Self-monitoring of the fishing industry (log books)	ECA to maintain an up to date list of vessel details; passage plans to be developed	Geophysical surveys should be regularly reviewed re. archaeology (on-going)	No dredging zones to be enforced through the CE's EMS (continuous)	Records of measures taken to avoid environmental effects
Physical Environment	Water quality effects from sediment plumes	✓																	
	Deposition/transport of sediment from plumes		✓	✓	✓														
	Farfield effects (waves and tides)																		
Biological Environment	Removal of habitat and species		✓		✓	✓	✓		✓										✓
	Effects of the sediment plume		✓		✓		✓	✓	✓										✓
Fish/shellfish resources	Biomass removal								✓	✓	✓	✓		✓	✓				✓
	Effects of the sediment plume	✓	✓					✓					✓	✓					✓
	Noise												✓						
	Altered substrate topography			✓		✓	✓							✓					

Parameter	Potential effect	Recommended Monitoring: Survey of cumulative suspended sediment plumes (one-off)	Measurement of sediment deposition and transport (case studies, repetitive)	Records of dredging activity, loads and screening returns (on-going)	Seabed sediment composition (before and after dredging)	Benthic resources in and adjacent to dredging zones (overtime) – recovery rates	Records of site-specific plume distributions (occasional)	Records of the influence of other activities, i.e. fishing, cable laying etc. (on-going)	Defining the distribution of overwintering female brown crabs (establish the baseline)	Locating favoured herring spawning areas (on-going)	Definition of scallop densities (pre- and post-works)	Records of responses to disturbance (on-going)	Self-monitoring of the fishing industry (log books)	ECA to maintain an up to date list of vessel details; passage plans to be developed	CNIS to monitor dredging activity and liase with the French (continuous)	System to be established to record information on accidents and near misses	Geophysical surveys should be regularly reviewed re. archaeology (on-going)	No dredging zones to be enforced through the CE's EMS (continuous)	Records of measures taken to avoid effects / regular reviews
Fisheries activity	Reduction in catches	✓			✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓			✓
	Exclusion and disruption to vessels/gear												✓		✓				✓
Navigation	Ship collision risk													✓	✓	✓			✓
Archaeology	Palaeolithic and Mesolithic archaeology																✓		✓
	Maritime archaeological heritage																✓		✓
Other activities	Submarine cables																	✓	✓
	Recreation (yachting/diving)														✓	✓			

13.4.4
A Technical Review Forum

Responsibility for defining and agreeing the scope of mitigation and monitoring requirements should rest with the operating companies, the Regulator (ODPM) and the various statutory consultees (DEFRA, EN). However, it would be helpful to review the effectiveness of these measures on a regular basis.

It is recommended that a forum be set up to review the results of monitoring and to suggest any changes to the future monitoring or mitigation regime that may be considered necessary, for consideration by the licensees and the Regulator. The forum could also discuss the results of recent research that might have a bearing upon the proposed activities in the ECR and the associated mitigation and monitoring programme.

It is proposed that the review forum would consist of the following representatives:

- relevant members of the industry with expertise within specific areas, e.g. fisheries, benthos and other activities (navigation, archaeology);
- regulatory agencies including DEFRA, ODPM and CEFAS; and
- scientific experts with relevant expertise, as appropriate.

Meetings would take place on a regular basis to review the results of monitoring and where necessary their linkage with the mitigation measures in place.

The forum would be responsible for discussing various parameters of the monitoring, including the objectives, thresholds, specific survey methodology and frequency of review. The results of the forum discussions would need to be publicly available and reported on a regular basis.

Where suggestions or further recommendations are made within the forum, the operating companies and the Regulator should discuss and agree an open response to confirm what additional action (if any) will be taken.

13.4.5
Public Compliance Reporting

It is recommended that the operators within the ECR produce an annual compliance report which sets out both the extent and location of the dredging operations, the mitigation measures in place, and the progress and results of the various monitoring programmes underway. This report should be publically available.

The following areas would be reported:

- Compliance of the dredging industry with the Conditions of the various licences;

- The results of the Crown Estate EMS which reports on ship location, dredge pump on/off status and whether active dredging is taking place;

- The extent of overall activity within the ECR in the context of the mitigation measures recommended. This would include:

  - area dredged within the previous year;
  - grading data and cargo production reports (quantity and quality of material extracted);
  - screening activity, including time and total loads;
  - measures taken to minimise the effects of the sediment plume;

- The progress and results of monitoring undertaken to date and any action taken following interpretation of the monitoring results;

- The level of achievement of agreed objectives;

- The effectiveness of recommended measures to minimise actual effects;

- Any collisions at sea or near misses;

- Any archaeological finds; and

- Recommendations for future work.

13.4.6
The GIS Database

An important output from the REA has been a MapInfo GIS database, to store, update, analyse and integrate the data collated on the physical, human and natural environment. The objective of this initiative was to ensure the continuity of the REA, as the scale of information, knowledge and activity develops over time.

The GIS should be kept up to date, providing the mechanism for the collation (and dissemination, where appropriate) of all relevant data in the future. The GIS will aid the efficient design of monitoring programmes as well as provide an ideal tool for helping to verify predicted impacts.

A catalogue of metadata ('data about data') has been created as part of the REA. This includes data on the owner; format; date of creation; copyright; availability; accuracy; errors; contact person; and source of all of the information held. All future data sets should be entered into the system using the NGDF (National GeoSpatial Data Framework) which has become a British Standard, and is compatible with EU standards. Metadata are stored in XML (Extendible Mark-up Language), a universal standard language for easy transfer of information between organisations and other institutions. This information is effortlessly transferred to other formats and it is ready for Internet publication.

Maximum benefits will be obtained from the GIS if all operating companies participate in its future development. This would require the provision of resources for data entry and management and the nomination of a central data entry point. Its future development and use should be overseen by the ECR licensees, and shared access to the data and the easy exchange of information ensured. The development and maintenance of an ECR website could be managed in the same way. Thereby ensuring a co-ordinated approach to information management and the dissemination of information on the extraction of aggregate across the East Channel Region and its implications for the physical environment, biological resource and human activities.

appendix 1

Summary of Consultation Responses

Organisation and Address	Contact Name and Job Title	Comments
The Crown Estate Marine Estates 16 Carlton House Terrace London SW1Y 5AH	Dr A Murray Asset Manager Offshore (also replied on behalf of Mr Bright and Mr Parrish).	• CE welcome the initiative, and see it as an essential step in developing a robust management scheme for the resources in the area and for the management of existing extraction licenses and applications already with the DTLR or being prepared for submission. • Believe that the resources of the Eastern Channel provide a major opportunity to secure the long-term sustainable supply of marine aggregates. • Location of the resources in relatively deep water and offshore eliminates effects on the coastline. • Scale of the resource should allow extraction to take place to avoid significant cumulative impacts from disturbance of the seabed, dispersion of dredging plume and interference with other users of the seabed. • Should not be necessary to permit more than 60 sq. km as a first stage, of which only a proportion would be used at any one time. • Industry has indicated that if licences were issued on this basis, they would expect to surrender substantial numbers of existing licences which are nearing the end of their commercial lives. Would also prioritise current applications, which should result in a major reduction in workload for the regulatory authorities. • These resources are probably the last major untapped source of marine aggregates off southeast England. Essential that access should be planned on a strategic basis. If development of this resource not handled carefully, the future of the marine aggregate industry in the UK could be bleak and the consequences for the wider environment would be unfortunate.
The Countryside Agency South East & London Region Sterling House 7 Ashford Road Plan Marine Maidstone Kent ME14 5BJ	Fiona Fraser Boulton Countryside Officer	• No formal comments to make regarding this matter. This is an expression of priorities and does not imply a lack of interest, or support or objection for the proposed assessment. • The proposed site lies offshore from the Sussex Heritage Coast which runs between Seaford and Beachy Head, and lies within the Sussex Downs AONB. A Heritage Coast Management is being prepared. This area of coastline is also designated as the Seven Sisters Voluntary Conservation Area. Suggests contact with Sussex Downs Conservation Board for information on management strategies. • Issues of water quality and sedimentation are being tackled by Coastal Zone Management Plans being planned by the EA and Coastal Defence Authorities. Contact with these bodies advised.

Organisation and Address	Contact Name and Job Title	Comments
National Monuments Record Centre Great Western Village Kemble Drive Swindon SN2 2GZ	S A Waring Maritime	• Highlighted necessity for a cautious approach to be undertaken as little is known about the archaeological resource in the area and similarly in the offshore zone. The NMRC records only go out to the 12-mile limit with a cut off date of 1945. • Suggest that the 'Code of Practice for Seabed Developers' is applied and is a good starting point towards archaeological mitigation. • The REA should include an archaeological mitigation statement, which should include the following conditions: - A watching brief should be maintained for archaeological artefacts, and wrecks in the area should be avoided by the use of an exclusion zone - Sidescan sonar and bathymetric surveys should be interpreted using archaeological expertise to identify possible areas of interest. Where areas of archaeological interest are found to lie in areas to be dredged, the position should be passed on to the National Monuments Record and consideration given to implementation of a dredging exclusion zone or seabed inspection and subsequent implementation of a dredging zone as appropriate - For known archaeological sites, NMRC recommend a dredging exclusion zone of minimum 100m radius to ensure negligible risk of disturbance. Attempts should be made to confirm the positions of all known wrecks during bathymetric survey work, and positions passed to the National Monuments Record - Any artefacts raised should be reported to the Receiver of Wreck under the 1995 Merchant Shipping Act, chapter 20 - The relevant competent archaeological authorities should be informed within 48 hours of the discovery of any significant archaeological feature, or artefact recovered from the seabed • The likelihood of dredging encountering archaeological remains is hard to predict. However, if appropriate measures are implemented (as detailed above) the residual impact on archaeology will be minimised. • A search of the proposed dredging area revealed a total of 162 records, falling into three categories: - 14 are known wrecks which should be charted - 48 are features and obstructions termed fishermen's fastenings which, though unidentified, are of interest in that they could prove to be vessel remains - 98 are Casualties. These are known, documented shipping losses whose remains have not been located and whose precise position of loss is not known. - The channel area may also contain submerged landscapes and possible palaeolithic and mesolithic archaeological material. • An industry led document giving guidance to assessing, evaluating, mitigating and monitoring the archaeological effects of marine aggregate dredging is in the process of being prepared by Wessex Archaeology on behalf of the British Marine Aggregate Producers Association (BMAPA) and the Royal Commission on the Historical Monuments of England (RCHME). • Included an index listing of all records of the proposed dredging area – full report available if required.

Organisation and Address	Contact Name and Job Title	Comments
English Nature Northminster House Peterborough PE1 1UA	Paul Gilliland	• EN is currently working on a project called Maritime Natural Areas. Have not yet dealt with the ECR but have been sent data (Anatec on ship routing and cables, CEFAS on fisheries information). EN has provided designation information to Anatec. • No designated areas due to distance offshore. JNCC are working on a project for DEFRA looking at designating areas beyond 12 miles. Unlikely to be subtidal sandbanks due to depth but may be an issue with reefs. • JNCC also hold latest information on seabird vulnerability. The important bird areas volume by Birdlife International is useful as this is used as a surrogate for offshore SPA's. • EN holds no relevant data themselves. No relevant records on the MNCR database. • France is unlikely to have designated any offshore regions yet.
South East England Regional Aggregates Working Party (SEERAWP) 22 Sittingbourne Road Maidstone Kent ME14 5LW	John Kilford Chairman	• SEERAWP welcome the prospects for supplies extending into the long term from the ECR. Would like to assist in any way to bring forward the decisions to release supplies at the earliest opportunity to maintain the level of supply to this region. • Understand that of the ECR, extraction from only some 1 – 2% would be sufficient to maintain the whole of the marine aggregate supplies to the South East. Ask that this context is reflected in the amount of depth to which the REA goes in order to identify the scope for such limited areas subject to minimal or least impacts in this extensive area. Are anxious that the REA does not lead to delay in license applications being granted. • SEERAWP concerned with the proximity of the ECR to the median line in the Channel being a potential cause for delay.
Maritime and Coastguard Agency Bay 2/29 Spring Place 105 Commercial Road Southampton SO15 1EG	Joe Collins Principal Marine Surveyor	• MCA has held a number of meetings with commercial dredging companies to discuss navigational safety aspects. Would be consulted by the DTLR (their parent department) to give advice on navigational matters as part of the Government View procedure. • A significant part of the ECR is covered by the Channel Navigation Information Service (CNIS), operated by the MCA through the Coastguard station at Dover. Information on traffic movements through the Dover Straits would therefore be available, by prior arrangement, to assist in any collision risk assessment.
RSPB South East England Regional Office 2nd Floor, Frederick House 42 Frederick Place Brighton East Sussex BN1 4EA	Carrie Temple Conservation Officer	• RSPB support a strategic approach to environmental assessment of marine aggregate extraction in the East Channel. Their marine bird data for this region is extremely limited, so are unable to provide any additional information to support this project.

Organisation and Address	Contact Name and Job Title	Comments
Kent and Essex Sea Fisheries Committee The Ice House Military Road Ramsgate Kent CT11 9LG	Mrs Joan Taylor Office Manager	• As the areas concerned are some 40+ miles distant from the Kent coastline the KESFC have no comment to make at this time. If further dredging work is proposed nearer to the Kent coast, would like to be contacted again. • Feel that the REA will be a useful exercise provided that it includes sufficient assessment of the cumulative impact on fish stocks. • The impact both short and long term on marine habitat and benthic species should be considered taking into account the fact that extraction of aggregates will permanently alter seabed depth and type.
Europilots 53 West Ella Road Kirk Ella Hull E Yorkshire HU10 7QL	Captain JD Robinson	• Interest would be concerned with the safety of navigation, and would presume that there has already been a study of the traffic flows in the area, particularly with regard to the crossing traffic in areas 464-2, 473, 458, 474, 475 and 461. • Given the high traffic density, it would probably be desirable to provide a 'Guard ship' during any dredging operations. • Dredging operations off the East Anglia Coast are conducted in an area with a lower volume of traffic than the East England Channel. VHF radio warnings to fishing vessels seem to be sufficient off the East Anglian Coast, while the East Channel Area has much deeper water and traffic with much deeper draughts.
DEFRA	Angus Radford	• Details of fisheries contacts have been passed to Richard Banks (Posiedon). Have discussed the project with Stuart Rogers of CEFAS and feel at this stage that they have little further information to provide. • Overflight and boarding data is available for the area.
DEFRA Room 128 17 Smith Square London SW1P 3JR	Miss Margaret Wemys Marine Environment Branch	• DEFRA has already commented in relation to Area 461, and on the pre scoping statements and scoping statements for some other applications in the East English Channel area. • CEFAS laboratory has a great deal of extensive information on fisheries, benthic, physical and chemical data both in spatial and temporal terms.
DEFRA European Wildlife Division Temple Quay House 2 The Square Temple Quay Bristol BS1 6PN	John Kingston	• Within the Coastal Environment Study Area – Beachy Head to Dungeness – the following are SPA/Ramsar/SAC sites – Pevensey Levels Ramsar site, Dungeness to Pett Level SPA and possible Ramsar site, Dungeness candidate SAC and Hastings Cliffs candidate SAC. • DEFRA do not want to comment at this stage. Suggest that we contact JNCC and EN.
British Shipping Tony.Hall@british-shipping.org	Tony Hall	• The Chamber fully supports the approach being taken. • Main area of interest is to ensure that safety of navigation will continue and not be compromised. • Will be particularly interested to see relevant parts of the report at the public consultation stage.

Organisation and Address	Contact Name and Job Title	Comments
The Wildlife Trusts Woodside House Woodside Road Eastleigh Hants UK SO50 4ET	Lisa Browning Marine Conservation Officer	• Commend the ECA on instigating a REA for the ECR. Strategic management of sand and gravel seabeds – both as exploitable resources and as wildlife habitats - is impossible without a regional (and national) overview of both aspects. The REA will be an invaluable tool in assessing the significance of individual and combined projects within the region. The Wildlife Trusts hope that the ECR REA will lead the way for the application of this approach in other regions and nationally. • The approach being taken to the development of the REA appears to be comprehensive. EIAs for individual licence applications have tended to be weak in the cumulative impacts area, and hope that the REA will go some way to addressing this weakness. • Disappointed that the assessment will draw solely on existing data which is likely to limit its scope quite substantially. • Widely acknowledged that there are gaps in the understanding of gravel biotopes, and had hoped to see some gaps closed prior to commencement of aggregate exploitation in the East Channel Region. Without knowledge of the significance of the targeted areas for biodiversity, it is not possible to assess the impacts of exploitation.
Comité Régional des Pêches Maritimes et des Elevages Marins de Haute-Normandie Rue Georges Robbe 76200 Dieppe France	Dominique Masson President of the CRPMEM de Haute-Normandie	• The fishermen of this committee unanimously give an unfavourable report concerning the extraction on these zones. • This type of sedimentary structure (homogenous sandy sediments with an absence of silts) is favourable for benthic species and also the reproduction of pelagic species such as cod. This area is also a nursery zone. • The impact of dredging on this zone will have direct effects on the biological richness of the site, and also the whole of the Channel and the North Sea. • Due to the fishing restrictions already in place in this area, opening the zone to dredging would further limit access to the resource. • Because of its siting between Boulogne and Dover, this zone is a concentrated area of fish migration. Therefore it is also a concentrated zone of fishing. • This zone is trawled at least once each tide for benthic and pelagic animals.
Maritime and Coastguard Agency MRCC Dover HM Coastguard Langdon Battery Swingate Dover CT15 5NA	Eric Musson Operations Manager	• HM Coastguard Dover’s concerns are with the safe navigation of vessels operating within the Dover Strait Traffic Separation Scheme. It is essential that any vessel working in the designated area maintain regular contact with Dover Coastguard.

Organisation and Address	Contact Name and Job Title	Comments
WWF Panda House Weyside Park Godalming Surrey GU7 1XR	Christopher Berry Acting Offshore Activities Officer	• WWF recognise that marine aggregate extraction carries with it the potential to produce significant direct and indirect impacts upon both the physical and biological components of the marine environment. WWF/The Wildlife Trusts believe that a Strategic Environmental Assessment should be undertaken as a key mitigative measure, prior to the consideration of potential aggregate extraction projects. They therefore welcome the undertaking of a Regional Environmental Assessment. • WWF feel that it is particularly important for consideration to be given to interactions with other marine users given the safety implications associated with carrying out dredging activity in such a busy area for shipping. • WWF trust that our intention will be to undertake work to address any gaps that may be identified with regard to the existing environment, in order to ensure that the assessment is as complete as possible.
Préfecture Maritime de la Manche et de la Mer du Nord Division "Action de l'Etat en mer"	Vice-amiral Hubert Pinon	• Prefecture Maritime feel that the impact of the environmental assessment is difficult to measure and question whether or not the consequences of the assessment will prove harmful to the important fishing resources in this geographical zone. Further information about the exact nature of the study, explaining the approach and any results already obtained were requested. • PMMMN represent the French government at sea and are responsible for the proposed development area and also the preservation of the maritime environment in this area. Hubert Pinon is responsible for the area in question and is also responsible for the control of traffic. He believes that the project will cause security problems for the flow of traffic in the area.
Ministére de l'Equipement des Transports explaining et du Logement, Affaires maritimes 7 Place des Capucins 629 62321 Boulogne-sur-mer Cedex France	Philippe due Couëdic de Kergoaler Directeur interrégional Nord	• Require further information (report/proposal) giving the exact nature of the project, approach and any current results in order to make any final comments. The impact is difficult to measure and poses the question as to whether important fishing B.P. resources in this geographic zone will be harmed.
Chargé de mission Secrétariat général de la mer, 16 Boulevard Raspail 75007 Paris	Christophe Le Visage	• They have very little information on this project (areas to be dredged, volumes, nature of materials, schedules) and therefore have no clear view about the REA. Requested further information.

appendix 2 REA Technical Workshop

During the course of the REA preparation an interim Technical Workshop was held in November 2001, during which specialists, stakeholders and regulators discussed the background, progress and initial findings of the REA and provided a steer for the remainder of the Report preparation.

The workshop comprised a series of presentations from the ECA, Posford Haskoning and the specialist team, followed by breakout groups, which discussed the following subject areas:

- REA objectives and process;
- Benthic biological resources;
- Fishery resources and fishing activity;
- Geology, sediment transport and coastal processes; and
- Shipping and navigation.

The key conclusions of the Technical Workshop are presented below:

REA Objectives and Process

- The REA is a voluntary process that should remain transparent and objective.
- Interaction should occur between the REA and the site specific EIAs, with a flexible approach adopted to take account of new findings.
- There is a need to set licence conditions through the use of defined criteria/ thresholds (which control/limit risk) but that allow flexibility in decision making and management planning.
- The REA should be a "living" document that recognises uncertainty and is updated as new information becomes available.

Benthic Biological Resources

- Change in sediment composition is a key area of concern for benthic biological resources. If dredging causes a change in the sediment type, for example, from sandy gravel to gravelly sand, then the community diversity will change from rich to impoverished, with indirect effects for the fishery.
- There is an important requirement for robust models to predict changes in sediment composition spatially, in relation to individual dredge sites and the area as a whole, and over time.

Fisheries Resources and Fishing Activity

- Assessment of the short-term impacts on fish and shellfish resources needs to look at species-specific avoidance reactions, with the objective of establishing the required nature of spatial and temporal buffer zones around dredging activities.
- Reduction in access to fisheries resources by the fishing industry is recognised to be the main issue likely to be raised frequently and disproportionately by fishing organisations.
- It was recognised that there is a geographically tiered scale from the outer margins of the study area (2ºW and 51ºN) to the dredge sites in the intensity of impact, but it is also important to consider the sensitivity of species to dredging, weighted by commercial value. Herring, scallop, sole and plaice are at the top of the list.
- Monitoring must continue to take account of the changing dynamics of fishing activities and respond to these in terms of adaptive mitigation.

Geology, sediment transport and coastal processes

- The REA should show the complexity of the deposit and variability of the sediment and the surface.
- There is a very low chance of dredging significantly changing the sediment dynamics close to the English and French coastlines, but the impact on nearshore banks also needs to be considered.

Shipping and Navigation

- It is recommended that companies adopt a collective approach to Risk Management Procedures and adhere to one operational document.

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