MARINE ALSF SCIENCE REVIEW : AGGREGATE RESEARCH IN UK WATERS

Annual Research Review
MARINE AGGREGATE LEVY SUSTAINABILITY FUND
2005

Prepared for

The Department for Environment, Food & Rural Affairs (Defra)

by

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STATEMENT

This Science Review was carried out at the request of the Department for Environment, Food & Rural Affairs (Defra) Marine & Waterways and the Rural Partnerships Division. It forms part of the responsibilities of the marine Science Co-ordinator for the Aggregates Levy Sustainability Fund (ALSF). Any brief overview of such a large and complex range of research studies is likely to over-simplify the issues. We therefore wish to emphasise that the views expressed here are those of the marine ALSF Science Co-ordinators rather than necessarily those of the individual scientists involved in the projects, or those of the Delivery Partners. We note that several of the latter have commissioned independent Audits of individual research projects that have already been completed with support of the ALSF, so our comments are confined to an overview of what we consider to be 'known' and where additional financial support may be needed to meet the objectives of the ALSF.

CONTENTS

EXECUTIVE SUMMARY

This Science Review comprises an overview of the objectives of the marine Aggregate Levy Sustainability Fund (ALSF), together with a synopsis of projects funded on marine aggregate research in recent years. This is followed by a summary of the current status of marine aggregate research in UK waters and an assessment of the extent to which the current work has met key Policy objectives of the ALSF. The Report contains details of all projects funded through the ALSF, together with Progress Reports (Appendix 1) as well as a summary of relevant research from non-ALSF sources (Appendix 2), projects supported by the industry - BMAPA (Appendix 3), the US Government Minerals Management Service (Appendix 4) and relevant projects funded by the European Union (Appendix 5).

Our Science Review of projects related to marine aggregate dredging up to 31st March 2005 suggests the following:-

1. We have a relatively good understanding of the nature and scale of impacts of marine aggregate dredging on coastal processes, benthic biological resources and seabed habitats as a result of the significant investment in R&D in recent years.

2. Localised impacts on a relatively small area of seabed are regarded as an inevitable consequence of marine aggregate dredging. The key questions that have been addressed by current R&D programmes define the likely nature and scale of the "footprint" of impact on sediment composition and associated benthic biological communities. Further studies are required to validate predictions derived from current models of impacts and subsequent recovery processes.

3. This work can assist in the rational management of marine aggregate resources and in the protection of environmental resources including biological communities of conservation significance and resources of archaeological importance.

4. The provision of a sound science base for both regulatory purposes and for the prudent management of marine aggregate dredging in UK waters is considered to be an important achievement of marine aggregate research in recent years.

5. Whether there is a "need" for additional studies to further inform the regulatory process in relation to the question of impacts on environmental resources and recovery processes needs to be addressed by Defra and the ODPM. In our view the nature and scale of impacts and recovery processes are sufficiently well understood to adequately inform the regulatory process.

6. We have much less understanding of how impacts of marine aggregate dredging and subsequent recovery processes interact through the marine food web with significant economic resources such as fish. This is partly because the tropho-dynamics of marine ecosystems is poorly understood. We see an important need for further investment in well-targeted marine research to establish potential impacts at high levels in the marine food-web. This should include trophic interactions and potential impacts on habitat preferences of commercially significant species. It implies that significant further funds will be required for research on the impacts of marine aggregate dredging on ecosystem function – particularly in relation to food-webs supporting economically significant resources such as shellfish and fish.

7. Most of the R&D on marine aggregate dredging has focussed on improving our understanding of the nature and scale of "impacts" of marine aggregate dredging on environmental resources of conservation and economic significance. This is expected to form the basis of future work directed towards minimising these impacts. Appropriate management of dredging activities and mitigation measures will need to be developed to assist the process of recovery of biological resources and the food-webs that depend on them. We foresee a need for a close interaction with the industry to develop, where possible, appropriate dredging methodology to reduce the impacts of marine aggregate dredging[1].

8. There remain however, serious gaps in our understanding of the nature and distribution of resources of conservation significance in UK coastal waters. This makes it difficult to assess the "significance" of impacts of marine aggregate dredging within the relatively small area of seabed that is dredged. We foresee a need for significant further funding in marine biotope and habitat mapping so that the impacts of marine aggregate dredging established from recent research can be placed in context with the wider distribution of resources of conservation and economic significance in UK coastal waters.

9. Major advances in understanding of issues related to marine aggregate dredging have been achieved in recent years as a result of investment in R&D from many sources. However the results of the R&D have not in general been made available in a readily accessible form to other stakeholders including scientists working on marine aggregate research programmes. Insufficient attention has been given to presenting this information in an objective and impartial fashion to the wide range of stakeholders who are involved in the consultation process for marine aggregate licence applications.

10. In other words, it is not so much the 'knowledge-base' but Public perception that is limiting decision making in relation to marine aggregate dredging and this needs to be addressed as a higher priority than can be achieved through dissemination from individual projects.

[1] The projects reviewed in this document are those that have been funded up to 31.03.05. Several of those approved for funding under the current round of marine ALSF projects include ones aimed at developing appropriate mitigation measures to minimise impacts on marine resources, especially those of historic or archaeological significance

A. BACKGROUND TO THE FUND

A.1. ALSF Objectives

The Aggregate Levy Sustainability Fund (ALSF) provides a source of financial support for projects related to aggregate extraction from both land and marine sources. It is derived from a levy placed by the UK Government on material derived from aggregate mining and was started in 2002. It's four main objectives are:-

1. ***Minimising demand for primary aggregates***
2. ***Promoting environmentally friendly extraction & transport***
3. ***Addressing the environmental impacts of past aggregates extraction***
4. ***Compensating local communities for the impacts of aggregates extraction***

In all, approximately £30m per year is made available by Defra through the ALSF, of which about 10% is allocated to projects relating to the marine environment – reflecting the proportion of the UK aggregate requirements derived from marine sources. The remaining 90% of the fund is allocated to terrestrial-based projects.

The ALSF marine programme falls under the second objective of the ALSF, and so the overarching aim of the ALSF marine programme is to promote environmentally friendly extraction in the marine environment.

Defra allocates funds to four delivery partners to fund this work in the marine environment, they are:

- The Centre for Environment Fisheries & Aquaculture Science (CEFAS).
- The Office of the Deputy Prime Minister (ODPM) whose funds are administered by the Mineral Industry Research Organisation (MIRO)
- English Nature (EN).
- English Heritage (EH).

The rest of this section briefly outlines what the ALSF funds other than work in relation to marine aggregates.

The first objective which deals largely with increasing the supply of and demand for recycled and secondary aggregates is delivered by the Waste and Resources Action Programme (WRAP).

The second objective has two further strands in addition to work in the marine environment, these are: promoting environmentally friendly extraction on land (this work is delivered by ODPM, MIRO and English Heritage) and promoting environmentally friendly transport of aggregates which is delivered by the Department for Transport.

The third objective deals with the legacy of terrestrial sites that have not been restored and is delivered by a Partnership of the Countryside Agency and English Nature and by English Heritage.

The fourth objective funds community projects in areas subject to the impacts of aggregates extraction and is delivered by local authorities with the highest levels of aggregates production.

Further details are available on the Defra ALSF website:-

http://www.defra.gov.uk/environment/waste/aggregates/moreinfo.htm

A.2. Delivery Partner Priorities

CEFAS

CEFAS' allocation under the ALSF forms the Marine Environment Protection Fund (MEPF).

The objectives of the MEPF are to ensure that the ALSF is used to procure projects which deliver programmes that:-

- Promote environmentally-friendly practices for the extraction of marine aggregates
- Undertake strategic research into the environmental consequences of marine aggregate extraction
- Reduce the local effects of marine aggregate extraction
- Reduce the environmental impacts of using marine aggregate in coastal protection schemes

The MEPF is administered by CEFAS (e-mail contact: k.r.francis@cefas.co.uk. Tel: 01502-524361).

ODPM

The main focus of marine projects funded from the ALSF by ODPM is centred on the general question of:-

- Impacts of aggregate dredging on the marine environment

Further information can be obtained from the ODPM (e-mail contact: William.Mackenzie@odpm.gsi.gov.uk. Tel: 020-944-866). A review of all projects funded by MIRO on behalf of the ODPM in Round 1 of the ALSF, together with the management structure for administration of the Fund is given in the Annual Report 2004-5 ALSF Sustainable Land-Won & Marine Dredged Aggregate Minerals Programme. The Final Reports for projects carried out between 2002-4 under Round 1 of the ALSF from funds distributed by MIRO is available both as hard copy summaries and on CD from MIRO:- www.odpmaggregatefund.co.uk and www.miro.co.uk

English Heritage

The main focus of marine projects disbursed from the ALSF by English Heritage[2] is on the marine historic environment:-

- baseline information and characterisation of the resource
- techniques of prediction and evaluation
- mitigation strategies
- training, awareness and information exchange
- It includes the following main areas:-
  - Developing the capacity to manage aggregate extraction landscapes in the future
  - Delivering to public and professional audiences the full benefits of knowledge gained through past work in advance of aggregates extraction
  - Reducing the physical impacts of current extraction where these lie beyond current planning controls and the normal obligations placed on minerals operators
  - Addressing the effects of old mineral planning permissions
  - Promoting understanding of the conservation issues arising from the impacts of aggregates extraction on the historic environment

[2] English Heritage also supports terrestrial projects under the ALSF scheme so some of the programmes shown relate to land-won aggregate activities.

Details on marine research priorities, information on current projects and application guidelines can be obtained from the following website:- www.english-heritage.org.uk/server/show/nav.1315

Further information can be obtained from English Heritage (e-mail contact: jill.hummerstone@english-heritage.org.uk. Tel: 020-7973-3107).

English Nature

The focus of marine ALSF funds disbursed by English Nature is on the following priorities:-

- The nature, understanding and awareness of the biodiversity resource of marine sand and gravel habitats, together with the protection and recovery of the resource prior to, during and after aggregate extraction
- Addressing the social and environmental legacy of marine aggregate extraction
- Seabed features of geological and geomorphological interest which are affected by marine aggregate extraction

Further information can be obtained from English Nature (e-mail contact: alsfgrants@english-nature.org.uk Tel: 01476-584821).

A.3. The Role of the Marine Science Co-ordinator

Partly because of the increase in number of Delivery Partners, and the large number of project proposals received by them for studies related to Marine Aggregate research, Defra has identified a need for an independent Marine Science Co-ordinator to support co-ordination and evaluation of all marine research projects funded through the ALSF.

The Marine Science Co-ordinator is required to provide an overview of the research work undertaken through each of the ALSF programmes with the following objectives:-

- Ensure that Defra and ALSF Delivery Partners are made aware, and kept informed of past and present aggregate sector research and development activity external to ALSF programmes
- Ensure that where there is a risk of duplication that researchers are aware of other work either under the ALSF or elsewhere
- Identify opportunities for adding value by combining, clustering or cross-linking research projects
- Make suggestions about dissemination of results generally and about how to promote take-up of results
- Ensure that Defra and other government stakeholders are aware of the research as appropriate
- Contribute to identifying future research priorities

Among the tasks allocated to the Marine Science Co-ordinator are to:-

- Establish and maintain regular communication with industry representative organisations and other stakeholder groups engaged in establishing research priorities
- Receive and review all proposals for research projects from all ALSF Delivery Partners engaged in funding research
- Attend research proposal review meetings and marine aggregates steering committee meetings
- Co-ordinate Co-project Officer activities for projects within ALSF Marine Environment Protection Fund (MEPF)
- Prepare a review of marine research projects undertaken during the first two years of the ALSF, and an annual research report for submission to Defra

The following Report comprises an Annual Research Review for the period ending 31st March 2005. It includes a synopsis of completed marine projects that were funded in Round 1 during the first two years of the ALSF, together with information on marine projects that are in progress through each of the Delivery Partners from funds allocated for the year beginning 31st March 2004. We have also included reference to some relevant projects that have been funded from sources other than the ALSF in UK waters in recent years. Full details of ALSF projects, together with Progress Reports where these are available, have been included in Appendix 1 of our Report.

B. OVERVIEW OF MARINE AGGREGATE RESEARCH POLICY DRIVERS & PRIORITIES

The main priorities for the marine ALSF Delivery Partners have been summarised above. Essentially the ***Fund Goal*** of the ALSF as a whole is to deliver environmental benefits to areas affected by aggregates extraction on land and sea.

The ***Fund Objective*** of projects allocated from the marine component of the ALSF is:-

- ***To promote more environmentally friendly aggregates extraction in the marine environment***

To some extent this objective reflects stakeholder concerns about potential impacts of aggregate extraction on environmental resources in the sea. Licences for marine aggregate extraction are currently awarded by the ODPM following an application from the operating Company that is supported by a comprehensive ***Environmental Statement (ES).*** The ES is prepared to Terms of Reference that are approved by the ODPM following a consultation process that includes a wide range of statutory consultees and other stakeholders. It includes details of the boundaries of the Licence Application Area, together with a description of the geological, archaeological and biological resources of economic and conservation significance and other issues relevant to the proposal. Potential sources of impacts on these resources are assessed, and proposals made for mitigation and monitoring where impacts are predicted.

The Environmental Statement then goes out for further consultation, during which the views of both statutory consultees and members of the Public are sought before a 'Government View' is given by the ODPM on the Application for a Licence, and the Conditions for monitoring and mitigation that might be attached to the Consent.

Areas of concern that are commonly raised by stakeholders during this consultation process include a range of issues relating to the 'need' for marine aggregates in relation to demand and supply from other sources, including those on land. Other issues relate to potential impacts on seabed resources of geological, biological or archaeological significance, including impacts on coastal processes and economic activities such as fisheries and shipping. Concerns are often expressed on whether such resources are capable of 'recovery' over time, and whether these processes can be enhanced by suitable mitigation measures. The extent to which an extractive industry such as marine aggregate mining can be carried out in an 'environmentally friendly' fashion is largely determined by a thorough understanding of how such impacts can be reduced, and the rate of recovery of renewable resources such as benthic biota and fisheries can be promoted by appropriate remedial and mitigation technologies.

These concerns can be framed as a series of questions that will be addressed as part of our evaluation of the research carried out on marine aggregate dredging in recent years. They include the following main themes:-

1. Need

- What is the 'need' for the aggregate in relation to that available from other sources (including recycled materials) and what are the amounts of material likely to be removed from the seabed over time?

2. Seabed Resources – Mapping

- What are the geological resources that are likely to be affected by aggregate dredging – and are these of conservation significance for geodiversity?
- What are the biological resources that are likely to be affected by aggregate dredging – and are these of conservation and/or economic significance?
- What are the archaeological resources that are likely to be affected by aggregate dredging – and are these of conservation significance?

3. Impacts

- What are the impacts on seabed topography and geology, and will such impacts have an effect on wave height and seabed transport processes? Will the removal of significant quantities of seabed material have an effect on coastal erosion?
- What are the impacts on biological resources on the seabed, and how far outside the boundaries of the Licence Area do such impacts extend?
- What are the impacts on resources of archaeological and historic importance, and how far beyond the boundaries of the dredge site do such impacts extend?
- What are the socio-economic impacts of dredging on other legitimate uses of the sea, including fisheries, leisure-tourism and dependent activities on land?

4. Socio-Economic Impacts

- What are the socio-economic impacts of aggregate dredging on activities such as fishing and dependent activities ashore?
- Are there impacts on visual amenities, leisure and tourism associated with aggregate dredging, processing and transport of material ashore?
- What is the balance of economic gain and environmental and other losses associated with marine aggregate dredging compared with other sources of aggregate necessary to support the UK economy?

5. In-Combination & Cumulative Impacts

- What are the impacts of multiple dredging licenses in proximity to one another. Is the sum of impacts greater than that for individual Licence Areas?
- What are the impacts when combined with other infrastructure developments such as wind-farms, as well as activities such as spoils disposal and commercial fishing?
- What are the Cumulative effects over time?

6. Recovery

- Bearing in mind that aggregate dredging involves removal of a non-renewable resource from the seabed, to what extent is the geology of the seabed capable of 'recovery'?
- Are the biological resources capable of 'recovery', and if so, how long does it take for recovery of species diversity and community structure in sands and gravels?

7. Mitigation – Remediation

- Are there any measures that can be taken by the industry to minimise the impacts of aggregate dredging on the marine environment?
- Are there any measures that can be taken to enhance the processes of recolonisation and recovery of biological resources following cessation of dredging?

8. Dissemination

- How can the results of research on marine aggregate dredging be disseminated to provide a basis for informed debate with stakeholders and the public on issues related to marine aggregate dredging?
- Can we 'predict' the impacts of marine aggregate dredging on coastal erosion, and resources of economic and conservation significance with sufficient confidence to provide a basis for Environmental Assessment of marine aggregate dredging, both for individual Licence applications and in combination and cumulative impacts over time.

The ALSF was set up to provide information that can be used to both inform the regulatory process on these issues, to assist the industry in developing management methodologies to reduce impacts once these have been defined, and to develop appropriate mitigation and remedial technologies.

C. RANGE OF PROJECTS FUNDED BY THE ALSF TO DATE

A complete list of marine projects funded by each of the ALSF Delivery Partners is given in ***Appendix 1***, together with contact details for the project leader(s), the scale of funding and the scope of the project and progress reports where available.

Projects that are relevant to the objectives of the ALSF have been given a code reference in red that defines the Theme Number (as defined above) and the source of funding (A=Defra; B=Defra + ODPM and others; C=Dredging Industry; D=the European Union; E=the ALSF). Thus a Reference Code of 5.E indicates a project on In-Combination or Cumulative impacts supported by the ALSF. These codes are carried through to Table 1 which summarises the funding allocated to each of the eight themes from the five sources of funding[3].

C.1. Projects funded by the Centre for Environment, Fisheries & Aquaculture Science (CEFAS) from the Marine Environment Protection Fund (MEPF)

See Appendix 1 for full details of all projects supported through the Marine Environment Protection Fund (MEPF).

[3] Many of the projects fall into more than one of our assigned categories, partly because some of them have a GIS or mapping component. English Heritage projects in particular can be assigned to either seabed mapping (Theme 2) or to mitigation (Theme 7). The coding used in Table 1 is shown in red in appendices 1-5. English Heritage consider that many of the projects assigned to Theme 2 in our review should more properly be assigned to Theme 7 (mitigation) reflecting the importance EH attaches to appropriate protection of the marine historic environment.

C.2. Projects funded through the Minerals Industry Research Organisation (MIRO)

C.2.1. Sustainable Land-Won & Marine Dredged Aggregate Minerals Programme (SAMP).

The Minerals Industry Research Organisation (MIRO) were appointed in 2002 to act on behalf of the Office of the Deputy Prime Minister (ODPM) as a Delivery Partner to manage the minerals sector research programme known as ***SAMP*** (***Sustainable Land-Won and Marine Dredged Aggregate Minerals Programme***). The SAMP programme provides funding for marine aggregate minerals research that is consistent with the objectives of the ALSF and is broadly in line with the construction aggregates component of the ODPM Planning Research Programme. It provides funds for R&D projects related to the ALSF target of assessing the '*Environmental Consequences of Marine Aggregate Extraction*'.

Full details of all projects supported under the SAMP programme are given in Appendix 1.

C.2.2. The Mineral Industry Sustainable Technology Programme (MIST).

MIRO also administer a second programme for distribution of funds from the ALSF. This is the ***Mineral Industry Sustainable Technology Programme (MIST)***. It provides a basis for implementation of focussed research and development activity aimed at supporting achievement of ALSF objectives. The programme provides funding support for R&D projects that address priorities defined in the second objective of the ALSF namely '*Promoting environmentally friendly aggregate extraction and transport*'.

The objective of MIST is '*to reduce the environmental effects of mineral extraction through development, promotion and implementation of sustainable technologies*.'

Research and development funds are made available in five key areas of activity related to mineral extraction:-

- Environmental assessment procedures and tools
- Impact mitigation and management
- Site design, operation and closure
- Knowledge and technology transfer
- Optimising resource value.

All projects funded under MIST require match funding in the form of cash and/or in-kind contributions from project consortia. MIST provides funding up to a maximum of 50% of total project costs.

Full details of all projects supported under the MIST programme are given in Appendix 1.

C.3. Projects Funded through English Nature (2004-2005)

Full details are available for each of the projects funded by English Nature are given in Appendix 1.

C.4. Projects Funded Through English Heritage

English Heritage have been appointed by Defra to allocate ALSF support to projects related to the historic environment. The core objectives of the English Heritage marine ALSF programme is to reduce the impacts of aggregate extraction on the historic environment. Full details of marine ALSF projects funded through English Heritage up to 31.03.05. are summarised in Appendix 1.

The English Heritage ALSF Projects OnLine provides access to details of all projects funded by EH through the scheme:-

www.english-heritage.org.uk/server/show/nav.1315

D. RELEVANT RESEARCH FUNDED FOR UK WATERS FROM NON-ALSF SOURCES

D.1. Defra Marine Environment R&D Programme 2004-2005

Marine Research & Development projects funded by the Department for Environment, Food and Rural Affairs (Defra) relevant to marine ALSF projects are grouped into 4 main Programmes with identification codes as follows:-

- ***ME11. Managing marine activities: Deposits.***
- ***ME12. Managing marine activities: Aggregate Extraction.***
- ***ME14. Managing marine activities: Integrated Management.***
- ***ME41. Monitoring and Assessment.***

Further information on these and projects funded by Defra, ODPM & The Crown Estate are summarised in Appendix 2. See also the Defra website:-

www.defra.gov.uk/research/project_data/Default.asp

D.2. Projects Funded by the British Marine Aggregate Producers Association (BMAPA) & the Construction Industry Research and Information Association (CIRIA)

The British Marine Aggregate Producers Association (BMAPA) and the Construction Industry Research & Information Association (CIRIA) has funded a number of research projects directly related to the marine aggregate industry. These are summarised in Appendix 3.

D.3. Projects funded by the US Government, Department of the Interior, Minerals Management Service

Several studies on the impacts of marine aggregate dredging in UK waters have been funded by the US Government, Minerals Management Service (MMS). This work has been aimed at providing information for planned sand extraction off the east and south-east coasts of the USA, based on data collection from aggregate extraction sites in UK waters. This has been followed by a number of studies funded by the MMS in the USA. A list of relevant projects funded by the US Government Minerals Management Service is given in Appendix 4.

D.4. Related Research Programmes funded by the European Union

There are several major research programmes relevant to the Marine Aggregate Industry supported by the European Union under Inter-Regional Aid (INTERREG III) funds. Details of these projects are summarised in Appendix 5.

Table 1. Sources of Funding and Breakdown of Areas of Expenditure on Aggregate Research in U.K. Waters from 2000-2005. Based on data in Appendices 1-5.

	SOURCE OF FUNDING					
THEME	**(A)** DEFRA	**(B)** DEFRA& ODPM & Others	**(C)** Industry (BMAPA/MMS)	**(D)** EU	**(E)** MALSF	**Total (£)**
1.Need						**0**
2.Seabed Resource Mapping						
2.a Geology	£976,391				£1,463,001	**£2,439,392 8.2%**
2.b Biology	£1,407,850			£6,635,020	£280,581	**£8,323,451 28.0%**
2.c Archaeology			£7,500		£2,122,883	**£2,130,383 7.2%**
3.Impacts						
3.a Geology	£961,554	£699,885	£129,230	£3,500,000	£763,686	**£6,054,355 20.4%**
3.b Biology	£1,354,478		£285,000		£593,420	**£2,232,898 7.5%**
3.c Archaeology					£219,480	**£219,480 0.7%**
4.Socio-Economic						**0**
5.In-Combination Effects/Cumulative Impacts		£674,628	£63,000			**£737,628 2.5%**
6.Recovery	£80,000	£527,087			£602,152	**£1,209,239 4.1%**
7.Mitigation/Remediation (Advice to Industry)	£531,379		£1,505,000		£234,000	**£2,270,379 7.6%**
8.Dissemination (Advice to Regulators)	£2,674,386	£435,459			£1,076,942	**£4,186,787 14.1%**
Total	**£7,986,038 26.9%**	**£2,337,059 7.9%**	**£1,989,730 6.5%**	**£10,135,020 34.1%**	**£7,356,145 24.7%**	**£29,803992**

E. ALLOCATION OF RESEARCH FUNDS

The projects that have been summarised in our Research Review have been grouped into 8 main Themes (1-8) and have also been coded in the appendices according to the sources of funding for each project. This allows the reader to identify which research projects have been included, and how the figures shown in Table 1 have been derived. The information allows some assessment of (i) how much money has been spent on marine aggregate research in UK waters over approximately the past 7 years (ii) the relative expenditure in different research areas and (iii) the relative contribution of funding from Government R&D (Defra and ODPM), directly from the marine aggregate industry (BMAPA & the MMS), from the European Union and from the Aggregate Levy Sustainability Fund (ALSF).

Several factors should be borne in mind in arriving at these figures:-

- The figures are based on total grants cited in our text, but where the work depends on data collected by others, these figures generally exclude the large costs of data collection – often funded by the aggregates industry as part of the costs of Environmental Impact Assessment and monitoring. In other words, the input from outside sources including the dredging industry, Fisheries and other projects is higher than that implied from Table 1.
- Many other research projects not included in our overview may have an indirect relevance to marine aggregate dredging in UK waters. That is, our figures probably represent minimal amounts spent on marine aggregate research in recent years.
- Whilst some of the projects relate to work funded back to 1998, most relate to work in the period 2000-2005, and in the case of the marine ALSF projects, these were initiated in 2002. That is, there is an increase in the relative importance of the ALSF as a source of funding compared with sources A-C in recent years.

With these caveats in mind, some interesting features on the relative importance of funding from different sources emerge from Table 1 as follows:-

1. *A total expenditure of **£29,803,992** from all sources is accounted for by the projects reviewed here for marine research related to the aggregates industry since 1998.*
2. *Of this sum, approximately £10.3m has been sourced from R&D projects funded from Defra and ODPM. This is approximately 35% of the total expenditure on marine aggregate research in the UK.*
3. *The remaining sources of funding include direct grants of approximately £1.9m from the aggregates industry (6.5% of the total expenditure), approximately £10.1m from the European Union through INTERREG III Programs (34.1% of the total expenditure) and approaching £7.4m from Defra through the ALSF (24.7% of the total expenditure).*

The relative allocation of funds to the broad categories assigned to projects summarised in our Research Review is also of interest. Table 1 shows the following main features:-

1. There appears to have been no allocation of funds specifically directed to assessment of ***the 'need' for aggregates*** derived from marine sources compared with those from land. This may reflect the way the marine ALSF is structured, and implies that the objectives of the marine ALSF may need to be widened to include issues of supply sources. Interaction with projects funded through the terrestrial ALSF is also clearly of importance (see the Waste & Resources Action Programme: WRAP. Section A1 of this report). The question of the balance of costs of supply from different sources, and the environmental consequences, needs to include an assessment of the costs of sourcing from marine aggregates in UK coastal waters.

2. The total funds allocated to ***seabed resource mapping*** amounts to as much as £12.9m or 43.4% of the total £29.8m allocated to marine aggregate research in recent years. This figure includes approximately 8.2% of the total expenditure allocated to Geological resources, 28.0% to Biological resources including seabed habitat mapping, benthic biological resources and fisheries, and 7.2% to Archaeological resources.

3. The total funds allocated to ***impacts of marine aggregate dredging*** amount to approximately £8.6m or 28.6% of the total £29.8m allocated to marine aggregate research in recent years. This figure includes as much as 20.4% of the total marine research budget allocated to impacts on Geological resources, including coastal processes. Approximately 7.5% of the total budget was allocated to assessment of impacts on biological resources and only 0.7% to impacts on Archaeological resources.

4. Funding of assessment of the ***socio-economic effects*** of marine aggregate dredging has received no funding to date from any of the sources we have reviewed.

5. Potentially important issues that include assessment of the ***long-term 'cumulative' effects of marine aggregate dredging, and the 'in-combination' impacts*** with adjacent dredge sites and other maritime activities such as fishing and infrastructure projects such as wind farms have also received relatively small funding of £757,628 or 2.5% of the total aggregate research expenditure to date.

6. Projects that relate to the ***nature and rate of 'recovery' processes*** for both seabed sediments and biological resources account for £1.3m or 4.1% of the total expenditure on marine aggregate research.

7. Significant funds have been allocated to development of ***mitigation and remediation options*** to reduce the impacts of marine aggregate dredging. These amount to a total of £2.3m or 7.6% of the total funds allocated to marine aggregate research in the UK in recent years[4].

8. A major allocation of approximately £4.2m (14.1% of the total funds distributed to marine aggregate research) has been allocated to development of ***Policy Advice to Regulators*** and dissemination of information to other stakeholders. This figure does not include funds allocated within individual projects for dissemination of the results to stakeholders. Almost all of the marine ALSF Delivery Partners require specific proposals on how the results of projects will be disseminated to stakeholders.

In general, the most noticeable feature of the research funding is that the question of 'need' for marine aggregates and the wider socio-economic implications of marine aggregate dredging have been largely ignored as projects under the marine ALSF scheme. This may be because they are more appropriately considered under other programmes such as the Waste & Resources Action Programme (WRAP). It is also noteworthy that despite a specific objective of the ALSF to reduce the impacts of marine aggregate dredging by suitable mitigation and management, the only serious funding for this has come from the industry itself and from Defra R&D projects.

[4] This science review covers projects in progress or approved up to 31.03.05. It should be noted that a number of projects approved in the current ALSF round of applications include elements of mitigation and remediation. English Heritage, in particular, have emphasised the objectives of providing practical solutions to industry and robust scientific advice to the regulators. The project portfolio fulfils these objectives by studying ways in which the impacts of aggregate extraction on the marine historic environment can be reduced, resulting in practical solutions disseminated in the form of guidance notes.

F. OVERVIEW OF CURRENT STATUS OF RESEARCH

Any brief overview of such a large and complex range of research studies is likely to over-simplify the issues, and we wish to emphasise that the views expressed here are those of the marine ALSF Science Co-ordinators rather than necessarily those of the individual scientists involved in the projects, or those of the Delivery Partners. We note that several of the latter have commissioned independent Audits of individual research projects that have already been completed with support of the ALSF, so we are confining our comments to an overview of what we believe is 'known' and where additional financial support may be needed to meet the objectives of the ALSF.

Our overview is grouped, for convenience, into the eight main categories shown in Table 1.

F.1. The 'Need' for Marine Aggregates

The whole question of where the aggregates required to support the UK economy are sourced from is a complex one that includes a wide range of Policy issues, socio-economic factors as well as a balance of interactions with environmental issues. As far as marine aggregate dredging is concerned, it is simplistic to view 'impacts' solely in relation to the marine environment without addressing other issues including the reduction of environmental impacts achieved by bulk transport of material from marine sources by ship, and the reduction in complex environmental issues related to transport of land-won materials by road and rail.

To date no funds have been allocated from the marine ALSF to a holistic assessment of all aspects of the balance of economic gain versus environmental losses for aggregate supplied from marine and terrestrial sources. Few assessments of the impacts of marine aggregate dredging include the full economic interactions including impacts on fisheries, dependent industries on land, amenity interactions with leisure-tourism and socio-economic issues such as wealth generation from maritime activities that may be affected by marine aggregate dredging compared with comparable impacts from land-won aggregate supplies.

Recommendation:

We see a need for a socio-economic assessment of aggregate sourcing from land- and marine-based resources to address the balance of economic gain and environmental and other losses for different options, including all issues – resource supply and demand, socio-economic and environmental. We suggest that the marine ALSF should consider inclusion of wider objectives that include the question of the balance of gain & losses through different sources of aggregate supply. Such a study would need a serious input from Industry representatives to assess the costs-benefits issues and likely sources of supply of marine and terrestrial aggregates for the next several decades.

F.2. Seabed Resource Mapping

The total funds allocated to ***seabed resource mapping*** amounts to as much as £12.9m or 43.4% of the total £29.8m allocated to marine aggregate research in recent years. This figure includes approximately 8.2% of the total expenditure allocated to Geological resources, 28.0% to Biological resources including seabed habitat mapping, benthic biological resources and fisheries, and 7.2% to Archaeological resources.

It is generally true to say that the location of the majority of exploitable sand and gravel deposits in UK waters is well-known to the Industry. The distribution of exploitable material is determined mainly by the location of palaeo-deposits that include riverine terrace and outwash areas from glacial river systems and beach deposits that have been inundated by relative changes in the sea level compared with the land.

Such deposits are relatively widespread. The situation is complicated as far as commercial aggregate extraction is concerned, by the fact that many gravel deposits that may be suitable for marine aggregates are inaccessible due to an overburden of sands and muds. In other cases the seabed deposits may be of a suitable quality for aggregate dredging, but are too far from end-users to be commercially viable at current cargo values for marine aggregates.

The result of these factors is that most commercial aggregate extraction is located in relatively small parts of the seabed where aggregate resources are suitable for commercial purposes, are in sufficiently shallow water to dredge (30-50m), and are sufficiently close to major customers to allow a commercially viable activity. The area actually dredged at any one time is typically only a small proportion of the area licensed for dredging although the seabed resources of the entire licence areas are defined in some detail as part of the Environmental Impact Assessment required as part of the licensing procedure.

The main problem with such assessments of seabed resources, and predicted impacts of marine aggregate dredging within defined Licence areas is that they give very little information of the 'significance' of impacts within the proposed dredge area, compared with the distribution of resources well outside the boundaries of the dredge site. In other words the 'context' of impacts on seabed resources such as topography, geodiversity, biodiversity and fisheries can be assessed only in relation to some knowledge of seabed resources over a relatively wide area outside the areas likely to be affected by dredging. If the seabed resources within a proposed dredge site are unique or unusual, then any impacts are likely to be of more 'significance' than those on resources that are widespread and abundant outside the boundaries of the Licence Area.

Significant sums of research funds have therefore been allocated to defining the seabed resources that occur in UK waters, especially in areas that are subject to potential impacts from marine aggregate dredging and infrastructure projects such as ports and wind-farms.

F.2.1. Seabed Geological Resources.

Geological resources on the seabed have been studied for many years as part of the work carried out by the British Geological Survey among others. Recent studies include £976,391 R&D funds from Defra and £1.5m for a Broad Scale Habitat Map of the eastern English Channel and other sites that includes some seabed biological sampling to correlate acoustic and bathymetric data with biological community composition. The total sum allocated to these projects amounts to £2.4m or 8.2% of the funds allocated to marine aggregate research in recent years.

In general, maps of the seabed sediments are relatively well-developed compared with those for Biological and Archaeological resources. However the rapid development of remote sensing techniques for definition of seabed habitat types, and their association with marine biotopes, is a field that requires significant additional investment. Some integrated information to allow seabed Habitat Maps to be developed is emerging for the outer Bristol Channel and the Eastern English Channel from projects currently funded by the marine ALSF, but significant additional funds will be required if this approach is to be extended to other parts of the seabed in UK coastal waters.

There is also a need to integrate the results of these studies with other broad scale mapping projects supported for the North Sea and English Channel by EU INTERREG III funds.

F.2.2. Seabed Biological Resources.

The amount of funds allocated to mapping of biological resources is considerably higher than that for geological resources in recent years. As much as £1.4m has been allocated from R&D funds by Defra, mainly to support work carried out by CEFAS. A further £6.6m has been allocated to a major Channel Habitat Atlas Resource Map part supported by the EU under INTERREG III funding to a consortium of UK scientists headed by the St Augustine College and the University of Kent at Canterbury in collaboration with the French Fisheries Institute (IFREMER), University

scientists from France and from CEFAS. Funds of £280,581 have also been allocated from the ALSF for biological resource mapping in UK waters.

The total expenditure on Biological resource mapping from these sources amounts to as much as £8.3m or 28.0% of the total expenditure on projects related to the marine aggregates industry. This largely reflects major funding from EU sources for mapping of fisheries resources, rather than funds specifically allocated to projects associated with the marine aggregates industry.

Despite this relatively large expenditure of mapping of Biological resources on the seabed, it remains true that we have only the most broad scale definition of the types of communities that occur over wide areas of the UK coastal waters that require management. Most of the information available is derived from Fisheries surveys and data for resources of economic significance. Seabed mapping projects tend to be expensive both in survey vessel time and manpower, as well as in subsequent analytical costs and this is reflected in the relatively large sums that have been spent to date. So far, the most detailed Biological Resource maps suitable for marine spatial planning requirements have been developed for the Irish Sea, Bristol Channel and (from projects currently funded) the Eastern English Channel.

Even for these areas, the level of definition is very coarse and is unlikely to be suitable for conservation requirements that include identification of offshore marine Special Areas of Conservation (SACs) as required under the EU Habitats Directive.

F.2.3. Seabed Archaeological Resources.

Mapping of seabed archaeological resources includes a wide spectrum of resources from palaeo-deposits of significance for remains of early man, through to historic shipwrecks and more recent artefacts. Although there are well-known examples of historic shipwrecks that have been successfully located and conserved, the location and identification of traces of early man and seabed anomalies that may be of archaeological interest is in its infancy compared with geological and biological resource maps.

Significant funds have been made available only recently for this work from the aggregate industry (£7,500) and a larger sum of over £2m from the ALSF distributed mainly through English Heritage and MIRO on behalf of the ODPM. This has resulted in significant advances in development of techniques for rapid assessment of seabed anomalies that may be of archaeological interest, and in our understanding of the size of exclusion zones that may be required to prevent damage to archaeological material by aggregate dredging. The funding has also resulted in development of a code of practice to assist the industry in identification and management of seabed archaeology. Recent studies funded through the ALSF have resulted in significant advances in our understanding of the palaeo-geography of the North Sea basin and in prediction of potential sites of palaeo-historic importance.

There is no doubt that this work will result in an enhancement of our understanding of the distribution and significance of palaeo-historical artefacts and archaeological material on the seabed in UK coastal waters. The development of methods for the rapid assessment of such sites, and the use of data acquired from geo-surveys of the seabed sediments at depth by the oil industry to enhance our understanding of the palaeo-geography of the North Sea and its habitation by early man will assist in the development of archaeological resource maps of value in offshore resource management.

Because of the localised nature of archaeological material, broad-scale mapping projects are unlikely to be of assistance in management and protection of marine archaeological resources. It is also certain that data for archaeological resources will be available for only relatively limited areas of the sea-bed in the immediate future, even if significant additional funds are assigned to seabed mapping of maritime artefacts. In our view, therefore, the most beneficial use of funds from the ALSF might be to prioritise funding to areas of sea-bed of particular significance for marine archaeological resources with the object of developing geo-referenced database maps for areas subject to disturbance from marine aggregate dredging.

Amongst the achievements of the marine ALSF projects funded through English Heritage are:-

- *Significant maritime archaeological assessment methodologies have been developed and tested*
- *Many additional stakeholders (Government, industry and advisors) and the general public have been made aware of the historic environment in, and adjacent to, marine aggregate extraction areas*
- *Productive partnerships have been developed including organisations outside the heritage sector*
- *Specialist maritime archaeological capacity has been enhanced*

Recommendation:

It is self-evident that we are unable to make rational decisions on management of the sea bed in relation to marine aggregate dredging, or infrastructure projects such as wind-farms and ports without some knowledge of the resources we are aiming to manage and protect. At present, apart from relatively small areas of seabed, we have insufficient information to provide a scientific basis for decisions on the following:-

- What are the geological resources of significance as far as 'geodiversity' of marine deposits on the seabed are concerned?
- What is the distribution of key habitat types and their relation to biological resources?
- What are the biological resources of conservation significance that we are attempting to 'manage'? If effect, with the exception of some areas such as the outer Bristol Channel, and near-shore deposits of the Irish Sea, we do not have sufficient information on marine biotopes, or the distribution of species and habitats of conservation significance to identify offshore marine SACs, or to asses the 'significance' of impacts on resources in a relatively small area of seabed within the confines of areas licensed for aggregate extraction.
- What are the resources of economic significance such as fish and the non-target prey species upon which they depend, and to what extent are aggregate dredge sites important in the context of the food resources, breeding areas and other environmental resources supplied by deposits outside the dredge areas?
- What are the resources of archaeological significance in areas that require conservation and management in relation to marine aggregate dredging and other potential sources of disturbance?

In our view, significant additional funding is required to support a major geo-referenced seabed resource mapping exercise for UK coastal waters in general, and for areas likely to be affected by marine aggregate dredging and other infrastructure projects in particular.

Given that some areas such as the outer Bristol Channel, the eastern English Channel and parts of the southern North Sea are target areas for marine aggregate dredging, these areas should be prioritised for an integrated approach to the development of a marine spatial plan that includes seabed resources of geological significance, biological resources of conservation and economic importance, and those of archaeological significance.

F.3. Impacts of Aggregate Dredging

The total funds allocated to ***impacts of marine aggregate dredging*** amount to approximately £8.6m or 28.6% of the total £29.8m allocated to marine aggregate research in recent years. This figure includes as much as 20.4% of the total marine research budget allocated to impacts on Geological resources, including coastal processes. Approximately 7.5% of the total budget was allocated to assessment of impacts on biological resources and only 0.7% to impacts on Archaeological resources.

F.3.1. Impacts on Geological Resources.

The impacts of marine aggregate dredging on geological resources such as seabed topography, sediment dispersion and transport, as well as impacts on coastal processes including coastal erosion have been widely studied for many years. At the risk of over-simplification, the general consensus view may be summarised as follows:-

- *Aggregate dredging by static (anchor) dredger can result in major depressions in the seabed. Because particles of more than a few mm diameter are not mobilised at depths of 30-50m, such depressions caused by the removal of sand and gravel tend to infill with fine particles capable of being mobilised by seabed transport processes in the particular dredge site. In general, most dredge sites use a moving (trailer) dredger which may either dredge over a relatively wide area within the licence area, or (more commonly) restrict dredging to managed dredge lanes that are intensively dredged before being relinquished for recolonisation and recovery of biological resources.*
- *Some dredgers take an 'all-in' cargo of material as dredged from the seabed. More usually, however, the sand:gravel content of the cargo is adjusted to meet customer requirements. This commonly involves screening the dredged material and returning significant quantities of sand to the seabed before a cargo is taken aboard the dredger. This process takes about 5h of dredging for a typical 5000te dredger operating in 30-50m water depth.*
- *Most of the material rejected during the screening process falls to the seabed relatively rapidly – within 300-500m astern from the dredger. This settlement is known as 'passive settlement' and depends on the size and density of the rejected material. A second 'dynamic phase' of plume dispersion also occurs during the dredging processes. This is caused by the dense plume of reject material striking the seabed and dispersing along the axis of transport of material on the tidal currents at the dredge site.*
- *Both the passive and the dynamic phases of plume settlement and dispersion are well-understood and have been successfully modelled. Recent studies funded by the ALSF for actively-dredged sites in the North Sea fully support the predictions based on models of plume dispersion. They show that the 'footprint' of impact of dredging and screening is associated with an increase in the proportion of fine sands within the dredge site and for a distance of up to 2-3km along the axis of seabed transport at sites where seabed transport is strong. Where transport is weak, the 'footprint' of impact on sediment composition is smaller.*
- *At one site (Area 106 in the North Sea) and at some sites in the eastern English Channel, there is evidence of an additional 'benthic boundary plume' that may extend for as much as 1 tidal excursion from the dredge site. Similar boundary layer plumes have been initiated by beam trawlers working in the same area. Little is known of these boundary layer plumes, except that they do provide a potential mechanism for transport of sediments for longer distances than predicted and confirmed from conventional settlement and dispersion profiles. One possibility is that benthic boundary plumes may be analogous to self-propagating turbidity currents in parts of the seabed where the slope is sufficient to sustain plume generation.*
- *Despite the removal of relatively large quantities of aggregates from the seabed, especially in areas where there are multiple licence areas, there is very little evidence that marine aggregate dredging is implicated in coastal erosion in the southern North Sea or English Channel. Major studies on sediment budget and transport for these areas suggest that sediment transport is parallel with the coast and that the linkage between offshore sediments at potential dredge sites and sediments at the shoreline is weak. In other words, material required to support existing shorelines is derived from elsewhere along the coast, not offshore.*

- *We do not have sufficient information to prepare 'geodiversity' maps analogous to those on land. Hence the potential impacts of aggregate dredging on the 'geodiversity' of marine deposits is unknown.*

F.3.2. Impacts on Biological Resources.

A much smaller sum has been allocated to studies on the impacts of marine aggregate dredging on Biological resources. Hence it is not surprising that there are more areas of uncertainty in assessing the often complex interactions between dredging and biological resources. However we do have a fairly good understanding of the nature and scale of impacts on at least those benthic biological resources that occur in gravels and which can be quantitatively sampled. We can summarise our current understanding as follows:-

- *Removal of material by the dredger results in a loss of 30-90% of the species, numbers of individuals and biomass of marine invertebrates depending on the intensity of dredging.*
- *This reduction in 'biodiversity' coincides with the 'footprint' of dredging on sediment composition. It may extend for up to 3km outside the boundaries of the dredge site in areas where seabed transport is strong and is associated with an overlay of fine sediment mobilised by the dredging (and screening) process.*
- *There is some evidence that release of organic matter entrained with the deposits processed by the dredger may result in an enhancement of benthos on the seabed surrounding the dredge site.*
- *We have very little information that allows us to assess the 'significance' of these losses from a relatively restricted part of the dredge site within the Licence Area. This is because we rarely have sufficient information on the biodiversity of deposits over a sufficiently wide area of seabed for which management decisions are required.*
- *Very little is known of secondary impacts of dredging on the marine food web and the higher trophic levels (such as fish) that depend on them. We have insufficient information on the tropho-dynamics of marine food webs to assess how a suppression of potential food availability in a small part of the seabed is likely to affect mobile opportunistic predators such as fish.*

F.3.3. Impacts on Archaeological Resources.

The impacts of aggregate dredging are (as in the case of benthic biological resources) likely to be severe within the actively-dredged area. Furthermore, unlike biological resources, archaeological and historic resources are non-renewable. Most expenditure on marine archaeological research has therefore been directed towards identifying sites of importance, and in preparing proposals for protection of those sites in areas likely to be impacted by aggregate dredging. Several points are worth making in relation to archaeological resources on the seabed:-

- *Most of the more recent historic shipwrecks and artefacts have a component of iron. This makes them possible to detect as 'seabed anomalies' using a magnetometer as part of baseline environmental surveys. However all of the earlier palaeo-historic artefacts are non-ferrous and essentially cannot be detected by these methods. This makes them vulnerable to damage by marine aggregate dredging – especially when evidence of early hominoids is associated with riverine terraces of the type that are favoured for aggregate extraction.*
- *Support from the ALSF to projects distributed by English Heritage has resulted in some significant advances in methods for assessing the significance of seabed deposits for marine archaeology. These survey methods are likely to be used in the future to better define the archaeological resources in the vicinity of marine aggregate dredge sites and to ensure their protection from inadvertent damage.*
- *Studies on the extent of physical impacts of marine aggregate dredging both within the dredge site and outside are of importance in assessing the 'risk' to archaeological resources posed by aggregate dredging and the size of 'exclusion zones' that might be applied surrounding known sites of archaeological significance close to dredge sites.*

- *There has in general been a good co-operation between the aggregates industry and those responsible for protection of archaeological resources. This has resulted in an agreed Code of Conduct to minimise damage to archaeological resources should these occur in aggregate dredge sites.*

Recommendation:

This very brief overview of 'what we know' about impacts of marine aggregate dredging on environmental resources suggests that we have a fairly good understanding of both the nature and scale of impact of aggregate dredging on seabed resources of geological, biological and archaeological importance.

Such information has not come cheaply. A total of £8.6m or 28.6% of the total aggregate research budget has been spent on assessing 'impacts' particularly on coastal processes such as erosion, and on resources of economic significance such as fisheries. Most of this has come from Defra R&D budgets and from the European Union (INTERREG III) rather than from the ALSF.

We have had direct experience of the advice given both by CEFAS (as advisors to Defra) and from the staff of Defra on Environmental Assessment of marine aggregate dredge sites in UK coastal waters. In general we have found that the advice is well-informed and fully reflects current understanding of the nature and scale of impacts associated with marine aggregate dredging. Whilst there is always scope for additional studies, our view is as follows:-

Impacts on Physical Resources:

- We probably have sufficient understanding of the physical impacts of aggregate dredging to make sound judgements on marine aggregate licences based on robust scientific evidence. However there is a wide gap between this consensus view and Public perception of the risks posed by aggregate dredging to coastline stability, seabed habitats of importance to fisheries and other issues. In other words, whilst the scientific understanding appears to be good, the stakeholder awareness is very poor.

- We therefore recommend that far more resources should be put into building confidence in the reliability of impact assessment on the physical environment. As a start, we suggest there ought to be an independent assessment or audit of the whole question of impacts of aggregate dredging on coastal processes. This may need to be carried out by an overseas scientist of suitable qualifications who could issue an independent assessment of all issues of concern relating to impacts of aggregate dredging on the coastal environment.

This document would need to identify the degree of uncertainty attached to currently-used predictive models, and their role in arriving at environmental assessment of impacts on coastal processes. Note that the recent results of a major EU-funded SANDPIT project does not inspire confidence in sole use of predictive models. The independent Report would need to identify what additional work (if any) is required to build Public confidence that the basis for impact assessment on coastal resources is robust and reliable.

Impacts on Biological Resources:

- We have a good understanding of the nature and size of impacts on benthic biological resources. The advice from both CEFAS and Defra fully reflect recent research, and has been successfully incorporated into both baseline and monitoring survey requirements.

- We know very little about the 'significance' of these impacts in relation to the nature and distribution of resources on the seabed outside areas likely to be dredged for marine aggregates. The whole question of impacts needs to be put into 'context' or perspective through a geo-referenced habitat and biotope mapping project for key areas of UK coastal waters.

- We have very little information on whether the known impacts on benthic invertebrates translates into an effect on the marine food web and higher trophic levels such as fish of economic significance. This is partly because fish are opportunistic feeders and are mobile outside the boundaries of a dredge site. They are therefore affected by factors outside the dredge site and moreover show marked fluctuations in breeding success and population density, quite apart from the effects of exploitation from fishing. This makes impacts on fish and the marine food web difficult to ascribe to aggregate dredging. Nevertheless this is an area of concern to a major stakeholder group (the fishermen) and resources ought to be made available from the ALSF for suitable well-targeted research to address these issues.

Impacts on Archaeological Resources:

- Marine archaeology is at a fairly early stage of development. At this stage we consider that the most appropriate use of the ALSF will be to develop suitable methods for the location and identification of sites and features of archaeological and historic importance, and to use these to prepare geo-referenced maps that can be integrated with other mapping projects for marine spatial planning purposes.

F.4. Socio-economic Impacts

It is a matter of some surprise that there appears to have been no proposals supported by the marine ALSF that address the issue of the wider socio-economic impacts of marine aggregate dredging. Such issues include a holistic assessment of the economic gain associated with the industry and the environmental and socio-economic implications of impacts on fisheries, sport fishing, leisure and tourism. Impacts on infrastructure such as port facilities and road transport of processed material, and the wealth creation associated with on-shore activities all form part of an equation that is not addressed in other research projects.

Recommendation:

We recommend that one or more projects addressing these socio-economic issues should be considered for funding by the ALSF and would provide information of potential benefit for planning and regulatory purposes. Such information needs to be integrated with land-based studies including those delivered by the Waste & Resources Action Programme (WRAP).

F.5. In-combination & Cumulative Impacts

Potentially important issues that include assessment of the ***long-term 'cumulative' effects of marine aggregate dredging, and the 'in-combination' impacts*** with adjacent dredge sites and other maritime activities such as fishing and infrastructure projects such as wind farms have received relatively small funding of £757,628 or 2.5% of the total aggregate research expenditure to date. This funding is mostly from R&D expenditure through Defra, ODPM and others with a small contribution from the industry (the US Government Minerals Management Service).

Although a good deal is known of the potential impacts of dredging within a particular dredge site, much less is known of the significance of 'cumulative' impacts of marine aggregate dredging over time and 'in-combination' impacts from adjacent dredge sites, infrastructure projects, fishing and other activities. This partly reflects the immense complexity of issues surrounding interactive effects of this type and the fact that we have only just developed an understanding of likely impacts of individual sources of perturbation, let alone how they might interact between one another and over time.

It would be misleading to suggest that we have sufficient understanding of the marine ecosystem to make a robust assessment of either 'cumulative' or 'in-combination' impacts of marine aggregate dredging based on reliable scientific information for more than a few dredged sites. Most assessments (as required under EU Environmental Impact Assessment regulations) are informed judgements based on experience.

The scientific basis for our current understanding of the potential cumulative and in-combination impacts of marine aggregate dredging has been developed from only two studies in recent years. One of these was a desk-top evaluation of the sources of impacts and approaches to assessing how such impacts might affect environmental resources close to aggregate dredge sites. The other was an experimental study of sites in the North Sea and eastern English Channel to assess the nature of cumulative and in-combination effects at dredge sites over time.

Marine aggregate dredging licence applications are currently assessed mainly on a basis of the individual licence application, although in areas where there are other activities such as aggregate dredging and infrastructure developments such as oil and gas installations and wind farms, some assessment is generally made of the likely in combination and cumulative impacts over time. Unfortunately it is very difficult to place these assessments on an objective basis, especially as one of the main contributory impacts is likely to be from heavy bottom gear used in fishing – about which there is far less known than for the impacts of marine aggregate dredging.

Recommendation:

We recommend that an integrated study of in-combination and cumulative impacts should be supported by the marine ALSF in future funding rounds. In particular we recommend that the impacts of heavy bottom gear used by beam trawlers should be assessed as a potential contributing factor to in-combination effects on both the physical and biological resources of the seabed in the vicinity of marine aggregate dredge sites.

F.6. Recovery of Physical & Biological Resources

Projects that relate to the ***nature and rate of 'recovery' processes*** for both seabed sediments and biological resources account for £1.3m or 4.1% of the total expenditure on marine aggregate research. This is a relatively small proportion of the total research funding devoted to aggregate research in recent years. Nevertheless we do have an overall conceptual framework for the nature and speed of recovery of biological resources, based in part on studies related to impacts of organic enrichment and other anthropogenic effects. Significant funds have also been set aside from the marine ALSF in the current round of projects to assist in the prediction of impacts and recovery in a broad range of habitat types.

Our current understanding of the nature and rate of 'recovery' processes may be summarised as follows:-

F.6.1. Physical Resources.

- *Despite Government policy directives to promote 'sustainable development', it has to be recognised at the outset that marine aggregate dredging is not a 'sustainable' activity in the sense that it involves removal of seabed material that is not replaced. Coarse deposits are geological features laid down by fluvial or coastal processes, and have been subsequently submersed by a rise in sea level relative to that of the land.*
- *Because current strengths at 30-50m depth are insufficient to move particles larger than a few mm diameter, any pits or grooves formed on the seabed by the draghead are infilled by fine material mobilised by waves and bottom currents. Together with the deposition of fine material derived from the rejection of sand during screening, the end result of dredging is a progressive increase in fine sand in deposits towards the end of a working dredge licence area.*
- *Dredge scars and pits from dredging may be persistent features of the seabed in areas of low sediment mobility, but can disappear rapidly in other areas. Clearly the impacts of dredging on the topography and bathymetry of the seabed is variable from site to site, depending above all on the natural sediment mobility and transport for the particular site.*
- *Seabed dredging is not particularly efficient at removing all of the coarse components, so some form of restoration of particle size composition is possible by removal of the fine sand over time, leaving residual coarse material exposed on the surface of the dredged area. This process of 'winnowing' of the residual dredged deposits is not well-described, but does appear to be a recognised feature of dredged areas following cessation of dredging.*
- *Bearing in mind the importance of particle size composition in controlling the nature of the biological resources that can colonise the seabed, it is clearly important that additional resources are allocated to the whole question of whether 'recovery' of particle size composition is possible following cessation of dredging, and the rate at which this occurs.*

F.6.2. Biological Resources.

'Recovery' of biological resources is a complex issue due in part to the definition of what is meant by 'recovery' of a component that can vary greatly in space and time even in the absence of disturbance by man. Despite these difficulties of definition, we have sufficient understanding of the nature and speed of recovery of biological resources to make some general assertions that can assist in management of aggregate licence applications:-

- *The nature of the organisms and the rate of recolonisation are heavily dependent on the type of deposits. In general, sandy deposits are characterised by small mobile 'opportunistic' species with a rapid rate of recolonisation and growth. They are well-adapted to life in mobile deposits and can recover species diversity and population density within weeks of disturbance by dredging. In most cases the biomass recovers rapidly because the resident organisms are small and fast-growing with a lifestyle suited to recolonisation.*
- *In contrast, coarse deposits including boulders and stones are characterised by a larger species inventory and comprise organisms that have a slow rate of reproduction and growth. This means that*

it takes longer for initial restoration of biodiversity, and a long time for those organisms to grow to full size. Restoration of biomass may take decades in the case of the most long-lived components of such communities, even if the deposits are suitable for recolonisation shortly after cessation of dredging. It should be emphasised, however, that the majority of the species composition of sands and gravels that are exploited commercially for marine aggregates are likely to recolonise within 4 years after cessation of dredging.

- *Most direct studies on the recovery of benthic organisms following cessation of dredging have been confined to the initial stages of recolonisation up to 5y after cessation of dredging. Other studies have re-visited sites several years after cessation of dredging and have attempted to construct a time frame for recovery. The results of these studies have mostly emphasised the great site-to-site variability of recovery, and the fact that large variations in community structure in undredged sites over time obscure assessment of variations associated with dredging within dredged areas.*
- *Recent projects supported by the ALSF include development of a comprehensive 'model' that attempts to relate physical impacts with those on biological resources in different habitat types, and to include assessment of the probable recovery times for species diversity, population density and biomass over time in relation to habitat type. Other studies involve examination of the 'lifestyle' of typical sand and gravel communities with a view to predicting the time required for recolonisation and growth of a whole range of biota. The object of this project is to assist prediction of the recovery of species diversity and biomass based on baseline information on the resident species in the deposits prior to dredging.*
- *Neither of these projects has been completed, but it is clear that some progress is being made towards development of simple predictive models that allow some inferences to be made on the nature and rate of recovery processes in different deposit types following cessation of dredging. Validation of such predictive models will be necessary to place statistical boundaries on the predictability of recolonisation and recovery. We consider that this is probably best achieved by analysis of the results of the detailed monitoring programmes that are generally imposed on marine aggregate dredging licences as part of current Consent procedures.*

Recommendation:

- In our view, there is already sufficient information on the nature and rate of recolonisation and recovery processes to provide a conceptual framework for management and monitoring purposes.
- Depending on the outcome of current projects, we envisage some predictive framework or model to be available by March 2007. This will then need validating against some site-specific studies – probably from data made available from the results of monitoring programmes carried out as part of marine aggregate licence Consent Conditions.
- There is a case for studying long-term recovery at sites at which dredging has ceased for a number of years, but complications over natural variability of biological communities in non-dredged deposits over long time periods make interpretation very difficult.
- Probably of more fundamental significance to the question of recolonisation and recovery of biological resources is whether physical processes allow restoration of coarse material on the surface of the seabed over time. This is likely to be a primary factor that controls whether recovery of the original biological community composition is possible, and needs to be studied.
- Some studies have been initiated to determine whether seabed placement of coarse material is a viable route to assist recolonisation by marine fauna. How this could be carried out cost-effectively, the thickness of material that would be required and the general feasibility of such a scheme needs to be evaluated.

F.7. Mitigation-Remediation – Advice to Industry

The key objectives of the Marine Environment Protection Fund (MEPF) relate to development of management practices that reduce the effects of marine aggregate dredging on the marine environment:-

- ***Promote environmentally-friendly practices for the extraction of marine aggregates***
- ***Undertake strategic research into the environmental consequences of marine aggregate extraction***
- ***Reduce the local effects of marine aggregate extraction***
- ***Reduce the environmental impacts of using marine aggregate in coastal protection schemes.***

Significant funds have been allocated to development of ***mitigation and remediation options*** to reduce the impacts of marine aggregate dredging. These amount to a total of £2.3m or 7.6% of the total funds allocated to marine aggregate research in the UK in recent years. Of this sum, 90% represents support from R&D funding by Defra and £1.5m directly from the aggregate industry. Only £234,000 about 10% of the budget has been allocated from the ALSF to support practical mitigation and remediation by the industry.

To some extent the ALSF has been concerned with assessing the nature and extent of impacts on environmental resources, the distribution of those resources in relation to dredge sites, and the extent to which recovery processes occur (ie objective 2 of the MEPF above). This is necessary before practical remediation and mitigation measures can be proposed.

However we caution against the natural tendency of science programmes to be self-propagating. At some stage we need to assess at what point we have 'enough information' to make informed decisions that meet a general management-related objective of the ALSF and other projects if they are to achieve value for money.

This management-related objective is quite distinct from those posed by research which may be more concerned with improving knowledge in a particular research area. It is:-

- *To provide **practical solutions to the industry** to assist in minimising impacts of marine aggregate extraction. In other words, the industry has a legitimate expectation as a 'customer' of the ALSF to receive some practical benefits from the significant sums that have been invested in the UK marine aggregate research programme.*

It has to be said that to date, few practical options for '*promoting environmentally friendly practices*', for '*reducing the local effects of marine aggregate extraction*' or for '*reducing the environmental impacts of using marine aggregate in coastal protection schemes*' have emerged as a direct result of funds made available through the ALSF. Funds from the industry through BMAPA have, however, supported a project that has resulted in the development of an appropriate Code of Conduct for reporting of archaeological material that may be encountered within dredged areas. This may assist the industry in providing better protection of seabed archaeological resources in the future. We also note that there is a consultation exercise being conducted by the US Government Minerals Management Service (MMS) to determine whether experience of marine aggregate dredging operations in some countries can be incorporated into Best Practice for sand dredging on the east coast of the United States. The outcome of this exercise is not yet available.

Recommendation:

The whole question of what we know about impacts on physical, biological and archaeological resources needs to be reviewed, and advice sought from the industry on whether, in the light of this information, there are any practical and cost-effective routes available to:

- Promote 'environmentally-friendly' practices for aggregate dredging
- Reduce the local effects of marine aggregate extraction
- Reduce the environmental impacts of using marine aggregates in coastal protection schemes*

This could probably be best achieved in the first instance by a workshop to assess whether these objectives have any practical meaning or benefit. If so, are they achievable and at what cost?

*BMAPA point out that the specification for the aggregates levy itself specifically excludes use for beach replenishment. On this basis, this theme is inappropriate to receive funding from the ALSF. The following guidance document provides information on this:-

http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageOnlineServices_ShowContent&propertyType=document&columns=1&id=HMCE_CL_001169

F.8. Dissemination – Advice to Regulators

A second key management-related output from marine aggregate research funded by Defra either through R&D programmes or (more recently) through the marine ALSF is:-

- *To provide comprehensive and **robust scientific advice to the Statutory Regulators** on issues related to marine aggregate dredging – notably the assessment of impacts, suitable mitigation proposals and practical cost-effective monitoring programmes.*

Themes 1-8 within the marine aggregate research programme have been mainly concerned with providing a science base for evaluating the resources that require management and protection, and with an assessment of what the sources of impact might be from marine aggregate dredging. This approach has provided a robust science base to advice given to Regulators and other stakeholders including the Public and underpins much of the R&D allocation from Defra as well as from the industry and from the ALSF.

A major allocation of approximately £4.2m (14.1% of the total funds distributed to marine aggregate research) has been allocated to development of **Policy Advice to Regulators** and dissemination of information to other stakeholders. This figure does not include funds allocated within individual projects for dissemination of the results to stakeholders. Almost all of the marine ALSF Delivery Partners require specific proposals on how the results of projects will be disseminated to stakeholders.

We consider that perhaps the most valuable end-product of the aggregate research summarised in this Science Review is that it has yielded a fairly comprehensive understanding of the nature of the impacts from marine aggregate dredging, and of appropriate monitoring and assessment programmes that are required to assist protection of environmental resources. We have been impressed by the quality of scientific advice offered both by CEFAS (as advisors to Defra) and by the level of scientific

comments received directly from Defra as part of the Statutory consultation process required for marine aggregate dredging licence applications. In general these show a high level of appreciation of current research – indicating that the output from aggregate dredging research has been successfully incorporated into Policy advice.

Significant efforts have also been made as part of expenditure on marine aggregate research, to develop systems to better inform the Public and other stakeholders on the issues and solutions raised as part of the major investment into research on marine aggregate dredging. We regard these efforts as being considerably **less successful** than the primary research resulting in Policy advice to Government.

Recommendation:

- One of the objectives of this Science Review is to assess whether public concerns are based on a lack of reliable information or a lack of communication of that information in a succinct and believable way to Third Parties who may be both misinformed and deeply prejudiced in their views.
- Our opinion is that at least part of the Public Perception problem is because insufficient attention has been given to methods of better informing the Public on the outcome of major investment in marine aggregate research in recent years.
- There is a real difficulty that there are deeply entrenched single-issue views that need to be challenged without confrontation and by persons who have an independence from either environmentalist, or fisheries or industrial views.
- We recommend that Defra or others give serious consideration to production of proper information leaflets that present the issues and possible solutions in a clear and objective fashion. Such information could perhaps be aimed particularly at issues which include:- coastal erosion, impacts on fishing and impacts on resources of conservation significance – among others.

G. VALUE FOR MONEY – IS THE EXPENDITURE ON AGGREGATE RESEARCH LEADING TO WORTHWHILE OUTCOMES?

Our Science Review of projects related to marine aggregate dredging in recent years suggests the following:-

1. We have a relatively good understanding of the nature and scale of impacts of marine aggregate dredging on coastal processes, benthic biological resources and seabed habitats as a result of the significant investment in R&D in recent years.

2. Localised impacts on a relatively small area of seabed are regarded as an inevitable consequence of marine aggregate dredging. The key questions that have been addressed by current R&D programmes define the likely nature and scale of the "footprint" of impact on sediment composition and associated benthic biological communities. Further studies are required to validate predictions derived from current models of impacts and subsequent recovery processes.

3. This work can assist in the rational management of marine aggregate resources and in the protection of environmental resources including biological communities of conservation significance and resources of archaeological importance.

4. The provision of a sound science base for both regulatory purposes and for the prudent management of marine aggregate dredging in UK waters is considered to be an important achievement of marine aggregate research in recent years.

5. We have much less understanding of how impacts of marine aggregate dredging and subsequent recovery processes interact through the marine food web with significant economic resources such as fish. This is partly because the tropho-dynamics of marine ecosystems is poorly understood. We see an important need for further investment in well-targeted marine research to establish potential impacts at high levels in the marine food-web. This should include trophic interactions and potential impacts on habitat preferences of commercially significant species. It implies that significant further funds will be required for research on the impacts of marine aggregate dredging on ecosystem function – particularly in relation to food-webs supporting economically significant resources such as shellfish and fish.

6. Most of the R&D on marine aggregate dredging has focussed on improving our understanding of the nature and scale of "impacts" of marine aggregate dredging on environmental resources of conservation and economic significance. This is expected to form the basis of future work directed towards minimising these impacts. Appropriate management of dredging activities and mitigation measures will need to be developed to assist the process of recovery of biological resources and the food-webs that depend on them. We foresee a need for a close interaction with the industry to develop, where possible, appropriate dredging methodology to reduce the impacts of marine aggregate dredging.

7. There remain however, serious gaps in our understanding of the nature and distribution of resources of conservation significance in UK coastal waters. This makes it difficult to assess the "significance" of impacts of marine aggregate dredging within the relatively small area of seabed that is dredged. We foresee a need for significant further funding in marine biotope and habitat mapping so that the impacts of marine aggregate dredging established from recent research can be placed in context with the wider distribution of resources of conservation and economic significance in UK coastal waters.

Recommendation:

- The research is expensive mainly because it requires extensive use of research vessels. It is likely to require significant further funding if marine spatial planning issues are taken into account in the coming years. We view this as an important and necessary element in the management of coastal resources in UK waters, including marine aggregate mining.

- The research has led to a robust science base to underpin Policy Advice to Government as 'customer' for the research. In other words, we regard the expenditure to date as being fully justifiable and necessary for regulation of marine aggregate dredging now and in the future.

- Whether there is a "need" for additional studies to further inform the regulatory process in relation to the question of impacts on environmental resources and recovery processes needs to be addressed by Defra and the ODPM. In our view the nature and scale of impacts and recovery processes are sufficiently well understood to adequately inform the regulatory process. Additional funding is required however to assess the "significance" of such impacts and to better inform stakeholders of the advances that have been achieved in our understanding of the impacts of aggregate dredging on marine environmental resources.

- The research has (in our view) been far less successful in providing practical solutions to the industry to meet the objectives of the ALSF and MEPF in reducing the impacts of marine aggregate extraction on environmental resources.

- A Technical Workshop was held in June and November 2003 to assist in definition of research priorities for 2004. The impacts of marine aggregate dredging are better understood as a result of the significant investment in marine aggregate research in recent years. We therefore think it would be useful and informative to hold a technical workshop with representatives of the industry to seek their views and advice on whether there are practical options to reduce the impacts of aggregate dredging as we currently understand them to be.

- We question whether the industry would currently regard the ALSF as 'money well-spent' from their own particular point of view as 'customers' of the ALSF, if it has not so far resulted in any practical solutions to the question of how impacts can be minimised. However the fact that the nature and scale of impacts are placed on a factual basis is, we believe, generally welcomed by the industry because it assists strategic management decisions based on robust Policy advice.

- Our understanding is that the industry is fully supportive of studies that result in an objective evaluation of all aspects of impacts by the industry, and that they are generally satisfied with the outcome of research to date. Our view is that potential solutions should now be addressed once the R&D programmes started in 2004 reach a conclusion.

- Major advances in understanding of issues related to marine aggregate dredging have been achieved in recent years as a result of investment in R&D from many sources. Insufficient attention has however been given to presenting this information in an objective and impartial fashion to the wide range of stakeholders who are involved in the consultation process for marine aggregate licence applications. In other words, it is not so much the 'knowledge-base' but Public perception that is limiting decision making in relation to marine aggregate dredging and this needs to be addressed as a higher priority than can be achieved through dissemination from individual projects.

H. COMMISSIONING PROCEDURES

We have little to add to the information that is available on commissioning and application procedures on the web sites for the main Delivery Partners. Additional information is also likely to become available through the Defra website and as a geo-referenced meta-database on marine research in UK coastal waters supported by the MEPF (Project 04/07).

We have the following comments that makes the task of applications and evaluation of project proposals easier for all concerned:-

Recommendation:

- It is generally helpful if the Delivery Partners make it quite clear what general range of proposals they wish to consider, so that applicants can approach the correct Delivery Partner to support their proposal. Currently there is some overlap between projects that might be submitted to English Nature and the MEPF. Considerable confusion exists on whether MIRO considers applications for biological research (as in Round 1) or whether they now support mainly physical studies. The remit of English Heritage is entirely clear.

- English Heritage have a system in place that we regard as exemplary and which may have some components that should be considered by other Delivery Partners. The procedure is set out clearly on their website but essentially involves:-

    - Examination of a Draft Project Proposal. If this is of interest, a Project Officer is assigned from EH staff to assist the proposal to meet all of the ALSF and EH requirements.
    - If the proposal is acceptable in Draft, the proposer is invited to prepare a full costed proposal. Necessary costs amounting to up to £3,000 are paid for this work which is carried out in discussion with EH. The result is a proposal that meets the objectives of the Funding Body, which has been developed in discussion with them, and which is likely (though not necessarily) suitable for support. This process avoids the expenditure of a large effort on inappropriate proposals, and reduced time and costs for both the proposers and the evaluators.
    - After acceptance the project is assigned a Project Officer who maintains a close dialogue with the Project Leader. In effect this is a Project Co-ordinator appointed from within the Delivery Partner.
    - At intervals during the course of the projects, there is a series of Work in Progress meetings at which participants are encouraged to have an open discussion on the successes (and failures) in the project, and to invite discussion of modification of the project as appropriate. We view this as an important interactive exercise that could be adopted by other Delivery Partners. It does not replace an Annual ALSF Technical Conference, but is more interactive and responsive to short term developments that are important for co-ordination between related projects.

- Some Delivery Partners have an independent 'Audit' of projects that have been completed with funds from the ALSF. The results of these have not been made available to us, neither have the Terms of Reference, so we cannot comment at this stage on whether this exercise is useful and cost-effective. Nevertheless in principle it is important that Project Leaders are aware that the results of their projects are likely to be evaluated by a scientific 'Peer Review' process and that the outcome of this process may have implications for future research applications by them to the ALSF.

Finally, the reader will note that the task of marine Science Co-ordinator is not an easy one. It may intrude on both Policy views of Government and the interests of individual scientists, their organisations and the Delivery Partners. We hope that you will accept that any views expressed here are based on the fairly difficult task of reviewing numerous research outputs and summarising these succinctly. This will inevitably have led to some over-simplification of issues, and there are others we may have overlooked. We hope you will in any case find our summary of current marine aggregate research of value, and that you will forgive any oversights or omissions that we have made in the short time available to compile this Research Review.

I. CONCLUSIONS

1. This Science Review comprises an overview of the objectives of the marine Aggregate Levy Sustainability Fund (ALSF), together with a synopsis of projects funded on marine aggregate research in recent years. This was followed by a summary of the current status of marine aggregate research in UK waters and an assessment of the extent to which the current work has met key Policy objectives of the ALSF. The Report contains details of all projects funded through the ALSF, together with Progress Reports (Appendix 1) as well as a summary of relevant research from non-ALSF sources (Appendix 2), projects supported by the industry - BMAPA (Appendix 3), the US Government Minerals Management Service (Appendix 4) and relevant projects funded by the European Union (Appendix 5).

2. The following key points emerge from our Review of work completed or commissioned up to March 31st 2005:-

- A total expenditure of **£29,803,992** from all sources is accounted for by the projects reviewed here for marine research related to the aggregates industry since 1998. This sum has been derived from Table 1 based on projects summarised in Appendices 1-5.
- Of this sum, approximately £10.3m has been sourced from R&D projects funded from Defra and ODPM. This is approximately 35% of the total expenditure on marine aggregate research in the UK.
- The remaining sources of funding include direct grants of approximately £1.9m from the aggregates industry (6.5% of the total expenditure), approximately £10.1m from the European Union through INTERREG III Programs (34.1% of the total expenditure) and approaching £7.4m from Defra through the ALSF (24.7% of the total expenditure).

3. The relative allocation of funds to the eight broad categories or themes summarised in our Research Review is summarised in Table 1. This shows the following:-

- There appears to have been no allocation of funds specifically directed to assessment of ***the 'need' for aggregates*** derived from marine sources compared with those from land. Clearly the question of the balance and costs of supply from different sources, and the environmental consequences, needs to include an assessment of the costs of sourcing from marine aggregates in UK coastal waters. The need for marine aggregates compared with land-based sources is something the Defra economists may wish to consider in the future, but current R&D has been directed towards environmental impact assessment.
- The total funds allocated to ***seabed resource mapping*** amounts to as much as £12.9m or 43.4% of the total £29.8m allocated to marine aggregate research in recent years. This figure includes approximately 8.2% of the total expenditure allocated to Geological resources, 28.0% to Biological resources including seabed habitat mapping, benthic biological resources and fisheries, and 7.2% to Archaeological resources.
- The total funds allocated to ***impacts of marine aggregate dredging*** amount to approximately £8.6m or 28.6% of the total £29.8m allocated to marine aggregate research in recent years. This figure includes as much as 20.4% of the total marine research budget allocated to impacts on Geological resources, including coastal processes. Approximately 7.5% of the total budget was allocated to assessment of impacts on Biological resources and only 0.7% to impacts on Archaeological resources.
- Funding of assessment of the ***socio-economic effects*** of marine aggregate dredging has received no funding to date from any of the sources we have reviewed.
- Potentially important issues that include assessment of the ***long-term 'cumulative' effects*** of marine aggregate dredging, and the ***'in-combination' impacts*** with adjacent dredge sites and other maritime activities such as fishing and infrastructure projects such as wind farms have also received relatively small funding of £757,628 or 2.5% of the total aggregate research expenditure to date.

- Projects that relate to the ***nature and rate of 'recovery' processes*** for both seabed sediments and biological resources account for £1.3m or 4.1% of the total expenditure on marine aggregate research.
- Significant funds have been allocated to development of ***mitigation and remediation options*** to reduce the impacts of marine aggregate dredging. These amount to a total of £2.3m or 7.6% of the total funds allocated to marine aggregate research in the UK in recent years.
- A major allocation of approximately £4.2m (14.1% of the total funds distributed to marine aggregate research) has been allocated to development of ***Policy Advice to Regulators*** and dissemination of information to other stakeholders. This figure does not include funds allocated within individual projects for dissemination of the results to stakeholders. Almost all of the marine ALSF Delivery Partners require specific proposals on how the results of projects will be disseminated to stakeholders.

4. In general, the most noticeable feature of the research funding is that the question of 'need' for marine aggregates and the wider socio-economic implications of marine aggregate dredging have been largely ignored as projects under the marine ALSF scheme. It is also noteworthy that despite a specific objective of the ALSF to reduce the impacts of marine aggregate dredging by suitable mitigation and management, the only serious funding for this has come from the industry itself and from Defra R&D projects.

5. At some stage Defra and the ODPM need to assess at what point they have 'enough information' to make informed decisions that meet two key aims of undertaking research in the aggregates dredging sector if they are to provide value for money. These management-related objectives are quite distinct from those posed by research which may be more concerned with improving knowledge in a particular research area.

These objectives are:-

- To provide comprehensive and ***robust scientific advice to the Statutory Regulators*** on issues related to marine aggregate dredging – notably the assessment of impacts, suitable mitigation proposals and practical cost-effective monitoring programmes.
- To provide ***practical solutions to the industry*** to assist in minimising impacts of marine aggregate extraction. In other words, the industry has a legitimate expectation as a 'customer' of the ALSF to receive some practical benefits from the significant sums that have been invested in the UK marine aggregate research programme.

6. It has to be said that to date, few practical options for meeting the key MEPF objectives of '*promoting environmentally friendly practices*', for '*reducing the local effects of marine aggregate extraction*' or for '*reducing the environmental impacts of using marine aggregate in coastal protection schemes*' have emerged as a direct result of funds made available through the marine ALSF. Work funded from all sources has however established a firm science base to our understanding of the impacts of marine aggregate dredging. This is of undoubted value to the industry in assisting the rational management of dredging and monitoring operations. Work carried out with support from the Aggregate Industry through BMAPA has also resulted in the development of a Code of Practice for reporting of archaeological material should these be encountered during dredging operations. This may be of practical benefit in the improved identification and protection of archaeological resources in the future.

7. Our Science Review of projects related to marine aggregate dredging in recent years leads to the following main conclusions:-

- The research is expensive mainly because it requires extensive use of research vessels and is likely to require significant further funding if marine spatial planning issues are taken into account in the coming years. We view this as an important and necessary element in the management of coastal resources in UK waters, including marine aggregate mining.

- The research has led to a robust science base to underpin Policy Advice to Government as a 'customer' for the research. That is, we regard the expenditure to date from the ALSF and other sources as being fully justifiable and necessary for regulation of marine aggregate dredging now and in the future. In this sense, we consider that the expenditure on aggregate research represents good 'value for money' as far the Statutory Regulatory customer is concerned.

- Whether there is a "need" for additional studies to further inform the regulatory process in relation to the question of impacts on environmental resources and recovery processes needs to be addressed by Defra and the ODPM. In our view the nature and scale of impacts and recovery processes are sufficiently well understood to adequately inform the regulatory process. Additional funding is required however to assess the "significance" of such impacts and to better inform stakeholders of the advances that have been achieved in our understanding of the impacts of aggregate dredging on marine environmental resources.

- The research has (in our view) been far less successful in providing practical solutions to the industry to meet the objectives of the ALSF and MEPF in reducing the impacts of marine aggregate extraction on environmental resources.

- A technical workshop was held in June & November 2003 to assist in definition of research priorities for 2004. The impacts of marine aggregate dredging are better understood as a result of the significant investment in marine aggregate research in recent years. We therefore think it would be useful and informative to hold a technical workshop with representatives of the industry to seek their views and advice on whether there are practical options to reduce the impacts of aggregate dredging as we currently understand them to be.

- We question whether the industry would currently regard the ALSF as 'money well-spent' from their own particular point of view as 'customers' of the ALSF, if it has not so far resulted in many practical solutions to the question of how impacts can be minimised. The fact that the nature & scale of impacts have been placed on a robust basis is, we believe, generally welcomed by the industry because it assists strategic management decisions based on robust Policy advice.

- Our understanding is that the industry is fully supportive of studies that result in an objective evaluation of all aspects of impacts by the industry, and that they are generally satisfied with the outcome of research to date. Our view is that practical solutions should now be addressed once the R&D programmes started in 2004 reach a conclusion.

- Major advances in understanding of issues related to marine aggregate dredging have been achieved in recent years as a result of investment in R&D from many sources. However the results of the R&D have not in general been made available in a readily accessible form to other stakeholders including scientists working on marine aggregate research programmes. Particular attention needs to be given to making the results of R&D both from the ALSF projects and those funded from other sources available either as formal peer-reviewed publications or as full reports containing all relevant information.

- Insufficient attention has been given to presenting this information in an objective and impartial fashion to the wide range of stakeholders who are involved in the consultation process for marine aggregate licence applications.

- In other words, it is not so much the 'knowledge-base' but Public perception that is limiting decision making in relation to marine aggregate dredging and this needs to be addressed as a higher priority than can be achieved through dissemination from individual projects.

R.C.Newell & K.A.Reeds
17th June 2005

J. APPENDICES

Appendix 1: RANGE OF PROJECTS FUNDED BY THE ALSF TO DATE

CONTENTS

A complete list of marine projects funded by each of the ALSF Delivery Partners is given below, together with contact details for the project leader(s), the scale of funding and the scope of the project and progress reports where available.

Projects that are relevant to the objectives of the ALSF are summarised below, together with a code reference in red that defines the Theme Number (as defined above) and the source of funding (A=Defra; B=Defra + ODPM and others; C=Dredging Industry; D=the European Union; E=the ALSF). Thus a Reference Code of 5.E indicates a project on In-Combination or Cumulative impacts supported by the ALSF. These codes are carried through to Table 1 which summarises the funding allocated to each of the eight themes from the five sources of funding.

1.1CEFAS/Marine Environment Protection Fund (MEPF)

1.1.1 MEPF 04/00 Assessment of the Rehabilitation of the Seabed Following Marine Aggregate Dredging (6.E)

Contractor: CEFAS
Grant: £186,000 FY 04/05
Timescale: Ends 31st March 2005
Contact: Keith Cooper Tel:01621 787238, Fax:01621 784989
E-mail: K.M.Cooper@cefas.co.uk

Proposal details
This proposal details plans for the utilisation of intramural funding from the Aggregates Levy Sustainability Fund (ALSF) Marine Environmental Protection Programme. It comprises two components. Firstly, the creation of a standalone website. This website will be established to publicise the Marine Environmental Protection Programme (e.g. advertise calls for proposals) and also to disseminate the results of research funded through the scheme. The second, and major area of work, aims to extend research conducted under C1103 (CEFAS reference), 'Rehabilitation of the seabed following aggregate dredging' (funded by the ODPM, Defra and The Crown Estate).

C1103 progressed our understanding of the ecological effects of marine aggregate extraction and allowed, for the first time, an examination of the likely factors responsible for observed differences in the recovery of licensed extraction sites. Results indicated that whilst there was evidence for re-establishment of benthic invertebrates at some extraction sites within a period of 6-7 years following the cessation of dredging, at others the fauna remained in a perturbed state.

This proposal seeks to augment the existing time-series of data, by one year, at four contrasting extraction areas in order to provide further information on the time-scales for physical and biological recovery following cessation. The results will thereby strengthen the quality of ongoing scientific advice to Government Departments (i.e. ODPM, Defra and the Crown Estate), the marine aggregate extraction industry and other stakeholders. In addition, the outcome may usefully contribute to the future assessment of the feasibility of deriving physical and ecological 'quality standards' for site-specific application in UK waters. Such an approach would anticipate developments within OSPAR and the EU towards an 'ecosystem level' approach to marine environmental management.

The main objectives of this project are:

Website Development

- To develop a standalone website in order to publicise the Aggregates Levy Sustainability Fund (ALSF) Marine Environmental Protection Programme. This website has been completed and can be found at www.alsf-mepf.org.uk

Time-series extension

- To understand the rate at which the seabed recovers following marine aggregate dredging and;
- To investigate whether different historical levels of dredging intensity affect the subsequent rate and nature of benthic recolonisation at marine aggregate extraction sites after the cessation of dredging.
- To further disseminate results from C1103 in the peer-review literature.

Work Conducted in Reporting Period

(Final Report to be published 31st July 2005)

1.1.2. MEPF 04/01 Eastern English Channel Large-scale Seabed Habitat Map (2.a/b.E)

Contractor: British Geological Survey
Grant: **FY 04/05** £95,732
FY05/06 £736,426
FY06/07 £235,153
Total £1,067,311
Timescale: 3 years
Contact: Ceri James (BGS),
Tel: 0115 9363467, email: jwcj@bgs.ac.uk

Proposal Details

This aim of the project is to provide integrated broadscale habitat maps for an extensive area within the central part of the eastern English Channel in order to support the sustainable management of offshore resources. The maps will be based on an inter-disciplinary approach, integrating geological, geophysical and biological data and interpretations, including new surveys using modern high-resolution geophysical systems, ground-truthed with sampling and video. The immediate driver is the discovery of substantial aggregate resources in this area and the requirement to manage the sustainable development of this resource and minimise potential impacts. The area of resource needs to be assessed within the broader context of the eastern English Channel. The government wishes to promote effective stewardship of the marine environment through a policy of integrated management, balancing the requirements for development with nature conservation and legislation. The implementation of the EU Habitats directive requires a significant knowledge of the nature of the seabed and the project will act as a demonstrator for the mapping methodologies which are required for effective implementation. The results will be made available in GIS format and used by government, nature conservation bodies and the aggregate industry to inform the planning process. It will also be a valuable tool for fisheries management. Main aims of the project are to:

- Critically review all the pertinent scientific data for the eastern English Channel and identify gaps in knowledge over the region.

- Collect additional data through the conduct of new geophysical, sediment and biological surveys in the eastern English Channel to target knowledge gaps.
- Integrate new and existing geological, geophysical and biological data to provide comprehensive maps of the distribution of marine species and habitats within the eastern English Channel. This output will also assist in providing additional information on the distribution of any sensitive species or habitats.
- Test causal relationships/correlations between the physical environment and associated fauna.
- Provide additional geophysical, geological and biological data to support the integrated management of offshore resources in the eastern English Channel and to provide a better basis for marine spatial planning.
- Produce products that will be used to better manage marine offshore activities now and into the future and which will also resolve conflicts regarding seafloor use.
- Disseminate interpreted data, maps and new knowledge directly to stakeholders via the World Wide Web, reports, scientific publications, multimedia and other means.

Work Conducted in Reporting Period

- Because of contractual issues the project was not able to start in earnest until 2005. The first start up meeting was held at Burnham-on-Crouch on the 24th January. An amended work plan for the current financial year was discussed at the meeting and the project partners were asked to draw up revised plans and expenditure estimates for shorter timeframe now available in 2004-2005 to meet the above milestone.

- Planning for the May/June 2005 geophysical survey began in November 2004 with the drawing up of documentation for the Official Journal of the European Union seeking expressions of interest (EOI) from geophysical contractors. Ten contractors expressed an interest at the EOI deadline. Tender documents and specifications for multibeam, sidescan and sub-bottom seismic surveys were prepared and sent out for return by 26 April 2005.

- An FTP site for the project was set up on a BGS server at Keyworth to allow the easy storage and transfer of datasets between project partners. The framework of the GIS in ArcMap was designed and the project partners began to review and collate all the relevant existing data.

- The datasets with relevant metadata which has been reviewed, has been placed on the project GIS.

1.1.3 MEPF 04/02 Predictive Framework for Assessment of Recoverability of Marine Benthic Communities Following Cessation of Aggregate Dredging (6.E)

Contractor: Marine Ecological Surveys Limited
Grant: **FY 04/05** £68,384
FY05/06 £200,884
FY06/07 £146,884
Total £416,152
Timescale: 3 years
Contact: Dr. Jamie Robinson (Lead Scientist).Tel:01225 442211
Fax:01225 444411, email: Jamie@seasurvey.co.uk

Proposal Details

The main objective of the study will be to provide a framework for prediction of recoverability of biodiversity and community structure of marine benthos following cessation of dredging. This project will be quite different from traditional site-specific studies of 'recovery' over time. The latter are of importance for documenting restoration of physical and biological resources at specific dredge sites, but have proved to be of limited value in predicting the nature and timing of recovery in seabed deposits elsewhere, and moreover need to be continued for (unpredictable) lengthy periods until 'recovery' is judged to be complete.

This proposal outlines that knowledge of the species inventory, combined with data on the recruitment and growth of the organisms that characterise the community, will allow prediction of the rate of recovery of species diversity, population density and biomass for different deposit types, at a

greatly reduced cost compared with repeated surveys over time at sites where dredging has ceased. Provided that the composition of the seabed deposits is restored, or remains generally similar to that prior to dredging, this work will allow (for the first time) prediction of the long-term risk to marine biodiversity posed by marine aggregate dredging in different habitat types. It will also allow prediction of the sequence and timing of recovery processes based on the species inventory and life-styles of the community prior to dredging.

The output will form an important source term for any model that may be developed within the framework of project MEPF 04/04 to describe the impacts and recovery of marine benthos following dredging. It will be relevant to assessment of long-term 'risk' to biodiversity from marine aggregate dredging. The data will provide a tool for prediction of likely recovery rates for species diversity, population density and biomass in marine deposits following cessation of dredging. It is anticipated that the results will be used for assessment of sustainability issues related to the impacts of marine aggregate dredging and will provide one of the source terms required for development of a risk assessment framework under project number MEPF 04/03 for differing deposit types, including those from multiple Licence Areas in the eastern English Channel.

This will be the first study to integrate analysis of population dynamics and growth data into the widely used multivariate analysis of community composition used in benthic studies in UK waters.

Objective 1:
To collate data from the Marine Ecological Surveys Limited extensive database of species data collected from aggregate extraction areas in the eastern English Channel and at other sites around the U.K. and to gather published data on recruitment, growth rate and population dynamics of benthic invertebrate taxa identified as forming important components of coastal communities.

Objective 2:
To establish the species inventory and quantitative significance of the characterising species in deposits exploited for marine aggregates. We propose to establish the relationship between community composition and biodiversity in a broad range of habitat types including sands and gravels, and the coarse cobble deposits that form part of the resources to be exploited in the eastern English Channel. This will involve quantitative analysis of the benthos at 20 different sites representing at least 4 broad habitat types, and relating these community types to sediment composition.

Objective 3:
To establish the recruitment rate and growth rates (production) of the characterising species for each of the habitat types whose community composition has been defined under Objective 2. This will involve a 'layered' sampling programme suitable for collection of sufficient material to analyse the population structure of the macrofauna. It will include assessment of the population dynamics and growth: age relationships of both hard- bodied (Mollusca, Echinodermata, Crustacea) and soft-bodied (e.g. Polychaeta) components of the benthic communities that characterise sands and gravels.

Objective 4*:*
To develop a predictive framework that relates the time for recovery of biodiversity, population density and biomass of the benthic macrofauna to habitat type along a gradient of environmental stability. From our current understanding (Ref 1,4), we anticipate being able to demonstrate a relatively rapid capacity for recovery of biodiversity and population density and a somewhat slower rate of recovery of biomass (by growth of the colonising individuals) for the communities of mobile sandy deposits. We anticipate that the same sequence will apply to the communities that occur in coarse stable deposits of the Eastern English Channel, but that the whole process of 'recovery' of biodiversity and biomass may extend over several (or many) years, reflecting the increase in proportion of slow-growing 'equilibrium' species that characterise the community. The main objective of this part of the project will be to provide sufficient information on recolonisation rates and growth of the components that comprise communities in differing habitat types to allow a realistic prior prediction of the rates of recovery of biodiversity and population structure in marine deposits that are likely to occur following cessation of dredging.

Work Conducted in the Reporting Period

- 24/11/04. Project start-up meeting at Plymouth Marine Laboratory, those present were: Jamie Robinson, Nicola Simpson, Richard Warwick, Paul Somerfield and Bob Clarke.

- 17/12/04. Project coordination meeting at MESL offices, those present were: Richard Newell, Kate Reeds, Jamie Robinson and Nicola Simpson.

- 04/02/05. Project meeting at Plymouth Marine Laboratory, those present were Jamie Robinson, Nicola Simpson, Richard Warwick and Paul Somerfield.

- Assimilation of relevant historical data sets into a practical electronic format. This involved the gathering of all benthic data sets from sand, gravel and cobble areas from the Marine Ecological Surveys archives and re-entering data held in 'paper' format into a more accessible electronic database (ongoing).

- Available data from sand, gravel and cobble habitat types was then analysed by multivariate techniques in order to identify the most important taxa (in terms of abundance and/or biomass). This has been completed for all usable data held by MESL. It is our intention to carry out further analyses for data held by the aggregates industry (ongoing).

- A literature search for information on the life history traits of the key species identified by multivariate analysis (ongoing).

- Construction of 'life history' table, containing information such as Developmental Mechanism, Generation time, Dispersal potential and life span (ongoing).

A survey is due to be undertaken from the 21st May to the 14th June. A total of 20 sites (weather permitting) will be surveyed using a variety of sampling techniques.

1.1.4 MEPF 04/03 Development of a risk assessment framework (8.E)

Contractor: HR Wallingford Ltd.
Grant: **FY 04/05** £62,853
FY05/06 £62,267
FY06/07 £54,880
Total £180,000
Timescale: 3 years
Contact: Paul Sayers (Group Manager) Tel: 01491 822344, Fax: 01491 835311, email: pbs@hrwallingford.co.uk

Proposal Details

To develop a practical risk assessment framework and associated guidance for assessing the risks caused by the exploitation of marine minerals. The approach will consider both the nature of the impact and probability in determining the significance of different risks and will utilise both quantitative and qualitative methods. A key aspect of the risk framework will be to recognise the importance of uncertainties and to provide guidance on appropriate strategies to deal with uncertainty within the decision-making process. The framework will be developed in a generic fashion and trailed. To ensure the risk framework supported an integrated appraisal of the risks it will be capable of dealing with several components of the biological or physical environment and will include species and habitats, coastal processes, and other human impacts.

The tools generated by this work will provide Defra with a firm basis upon which to assess the individual and in combination effects of aggregate extraction, and will contribute to any future regional or strategic evaluation of the UK's aggregate resource.

The scope, detailed in HR Wallingford's proposal, outlines three tasks, which have been combined into two phases for the purpose of clearly defining distinct stages in the technical work of the project. Phase 1 - Conceptual Research, seeks to define and develop the underpinning concepts of the risk framework, and involves four tasks:

- Task1 - Literature review
- Task 2 - Develop risk indicators
- Task 3 - Develop initial framework
- Task 4 – Consultation in parallel with above tasks

Phase 2 Development of Tools and Techniques and Trialling, involves converting the generic framework into practice through implementation on pilot studies. Phase 2 involves:

- Task 1 - Refinement of framework
- Task 2 - Development of approximate reasoning methods
- Task 3 - Handling of uncertainty
- Task 4 - Piloting and trial

Work Conducted in Reporting Period

HR Wallingford has begun work on Phase 1 by collating and reviewing information to contribute to the literature review. The aim of this review is to establish the existing organisational framework and benchmark scientific knowledge so there is a clear definition of what the project has to build upon and where the Risk Assessment Framework can support good decision making.

There are five elements of information management that this initial research is addressing:

- *Data and Information*: Outlining the data on the marine environment that is typically collected. Impacts are assessed from the information available for the parameters under consideration, so this will show where impacts can already be assessed and will highlight areas where information is sparse.
- *Roles and Responsibilities*: outlining the roles and responsibilities of all stakeholders including governing organisations, the dredging industry and the fishing industry.
- *Processes and procedures*: establishing what processes and procedures already exist for assessing any element of risk, in particular, looking at how Environmental Impact Assessment is carried out for dredging applications. Understanding the existing process for planning aggregate extraction.
- *Enabling technologies*: recording the technology that is currently used to collect data and achieve the processes and procedures.
- *Audit and control*: understanding the existing methods for validating data and recording decisions.

This approach draws on Business Elements Theory (Mayon-White & Dyer, 1997), which provides a method for managing and achieving the tasks on a project. This initial research will feed into the development of the risk indicators and the initial framework.

The consultation task under Phase 1 will determine how the significance of risk is perceived. The project will produce guidance to identify how the process of stakeholder involvement can be improved to ensure that risks that are perceived as highly significant are adequately assessed and the results disseminated effectively.

1.1.5 MEPF 04/04 Coupling physical and ecological models: A new approach to predicting the impacts of aggregate extraction on biological recoverability (3.b.E)

Contractor: ABP Marine Environmental Research Ltd and Partners
Grant: **FY 04/05** £66,000
FY05/06 £69,000
FY06/07 £65,000
Total £200,000
Timescale: 3 years
Contact: Ian Townend (Managing Director), Tel: (023) 8033 8100, Fax: (023) 8033 8040, email: itownend@abpmer.co.uk

Proposal Details

Central to Defra's strategy for the sustainable development and management practices of marine aggregate extraction activities is the need to enable regulars and managers to better assess impacts to the seabed and their consequences to sensitive biological receptors. Presently, however, there are no robust or reliable models sensitive enough to predict these impacts and their consequences. As a result, current licensing procedures remain over precautionary.

Recognising the need to improve existing regulatory management practices, the objective of this study is to develop a new approach to predicting the impacts of aggregate extraction on the benthic environment. More specifically, the approach will (for the first time) model the complex biological responses of recolonisation and recoverability to the physical processes associated with extraction activities (e.g. sediment transport, deposition and plume dispersion).

The proposed research is intended to improve current assessment methods and provide new insights into the current state of knowledge. This is particularly relevant as the potential impacts to sensitive biological receptors are currently assessed by inferences drawn from conceptual models describing a zone of influence or impact footprint (1). This is despite the use of numerical models to characterise seabed processes such as sediment transport, plume dispersion and wave climates. It is acknowledged that further development and refinement of such models will not add significantly to what is already known and that a large gap presently exists between these modeling capabilities and the level of sophistication needed to model the resulting biological response. Moreover, conceptualisation is not robust enough to account for wider effects to biology that extends beyond the impact footprint (e.g. those associated with the dispersal of organic material).

Recommendations proposed under the SAMP Project 1.022 (2) highlighted the need to use existing biological information as source-terms to characterise existing modeling practices. There is now sufficient detailed information available on the recolonisation and recoverability of benthic organisms following extraction activities to enable these responses to be coupled with physical processes models. This approach will form the basis for developing and testing a grid-based cellular automata model that will predict the spatial and long-term dynamics between seabed alteration/transport and species recoverability.

Cellular models have been used effectively to predict complex systems and processes to generate a spectrum of very complex patterns of behaviour out of sets of relatively simple underlying rules. They are able to capture many essential features of complex behaviour typically observed in real systems. Information about the physical environment (generated from numerical models) will be coupled with information on the function and life history strategies of benthic species (e.g. body traits, fecundity, recruitment, longevity, habitat requirements, sensitivity etc) in order to parameterise the cellular model.

The project includes the dissemination of the results and it is anticipated that the new approach will provide a platform for continued research endeavors in this area and, if the results are favorable, they could help shape future assessment and legislation requirements for aggregate extraction activities. The project will involve the development of discrete sub-models that capture changes in the physical conditions of the seabed and its consequences for spatial and long-term interaction responses of the benthic community. The biological responses to physical changes will be characterised using existing field data and current scientific understanding, and tested against existing numerical models.

The project includes for the wide dissemination of the results. Following this it is anticipated that the tools will provide a platform for continued research endeavor in this area and, if the results of this phase are favorable, they could be used to establish new guidelines for assessment and legislation. In order to deliver the aim of the study the project has been organised into 6 objectives as follows:

Objective 1. Physical-biological model conceptualisation: Define the physical and biological boundaries, constraints and level of detail required to set-up and characterise the overall model, and draft the framework strategy for model development and implementation (comfirm at project team workshop). Review current modeling approaches that integrate physical and biological data, with a view to writing new guidelines for applying such approaches to marine aggregation extraction activities in objective 5. Conceptualisation will determine the detailed framework for the development of the model and the project delivery. Therefore, it is essential that incorporation of the projects inception process is included in this stage. *[Led by ABPmer with input from partners]*

Objective 2. Transition rules and cellular characterisation: Generate characterisation and source-terms that clearly define predictive responses associated with biological recoverability and physical changes in the seabed such as sediment deposition and transport, and plume dispersion. This will include a workshop (to be held in the Spring, 2006) for stakeholders to provide feedback and validation to the overall model approach and rules developed.
[Led by ABPmer with input from UCL and MES]

Objective 3. Development of cellular automata and sub-models: Develop a cellular grid-based model to predict the complex spatial and temporal dynamics of the impact footprint and the receiving biological environment. Cell states will represent the seabed impacts associated with aggregate extraction (as defined in objective 1) and their effect on benthic organisms.
[Led by UCL with input from ABPmer and MES]

Objective 4. Case studies and model validation: Conducted at two study sites to test the effectiveness of the cellular-based model in capturing the impact footprint and the consequence of biological re-colonisation and recovery. In addition, a number of key requirements for assessing extraction impacts will be examined, namely, (i) site specificity in relation to extrapolating/applying impact and recovery trends, (ii) practicality and cost benefit of restoration/rehabilitation, (iii) determination of 'acceptable levels' of recovery on **a site-by-site** basis, (iv) clearer understanding of timescale in recovery, and (v) examination of extraction site size to optimise re-colonisation post extraction.
[Led by ABPmer with input from MES and ICES]

Objective 5. Dissemination: Dissemination of project results to regulators and industry, and to research groups presently developing conceptual-based models of the impact footprint**, to obtain** feedback. It is intended that the results will provide a focus for a number of workshop presentations to demonstrate the model approach and how it will improve existing predictive capabilities and better inform policy and management practices (two workshops will be held to consider key developments in the modeling approach and implementation). The new guidance terms for modeling integrate physical-biological models for marine aggregate extraction impacts will be made available via website.
[Led by ABPmer with input from other partners]

Objective 6. Peer review: Peer review at critical stages, namely objective 2 (transition rules and cellular characterisation) and 3 (development of cellular automata and sub-models) as these stages represent the most significant breakthroughs in the development of a new predictive tool and ultimately its acceptance by regulators and industry. Final review of project findings will allow sufficient time to revise and consider recommendations before handing reports to Defra.
Dr. Stuart Rogers (CEFAS) has agreed to act as Co-Project Officer to provide guidance at key stages during the life of the project.
[Led by ABPmer with input from partners]

Work Conducted in Reporting Period

It should be noted that the dates and target milestones for the project had to be modified following a request by CEFAS to bring forward the project deadline for the first year to the 31st March 2005. Under the Defra & CEFAS ALSF MEPF Research Requirements terms-of-reference (June 2004) there was no indication that projects must conform to this March deadline. Consequently, the planning of the project and subsequent submission of the proposal included a full program of development for a year starting in October 04 and ending in September 05.

To accommodate these changes a revised Gantt chart of the overall project milestones and timescales are presented in the full project report (See Appendix 2). Milestones for the revised 1st financial year are as follows

- Agree conceptualisation framework with CPO;
- Complete technical specification of model source terms;
- Review literature on physical-biological models;
- Conceptualisation workshop.

All milestones for the project-reporting period have been met. Moreover, advances have also been made with the 2nd objective (development of rules for model) and 3rd objective (development of model) although these are far from being completed.

1.1.6 MEPF 04/05 Marine ALSF Science Co-ordinator (8.E)

Contractor: Marine Ecological Surveys Limited
Grant: £50k per year maximum for each FY = Total £150,000
Timescale: 3 years
Contact: Dr Richard Newell (Managing Director), Tel: 01225 442211
Fax: 01225 444411, email: Richard@seasurvey.co.uk

Proposal Details

Provide "independent" science input to the whole procedure to oversee commissioning of appropriate research and monitoring progress to meet ALSF objectives.

Cross distribution body co-ordination of science activity (avoiding duplication and promote co-operation, matched funding) to ensure that best use of marine ALSF funds is achieved to meet the ALSF objectives.

The primary objectives of the role are to:

- Ensure that Defra and ALSF Delivery Partners are made aware and kept informed of past and present aggregate sector research and development activity external to ALSF programmes.
- Ensure that where there is risk of duplication that researchers are aware of other work either under the ALSF or elsewhere,
- Identify opportunities for adding value by combining, clustering or cross-linking research projects
- Make suggestions about dissemination of results generally and about how to promote take-up of results,
- Ensure that Defra and other government stakeholders are aware of the research as appropriate,
- Contribute to identifying future research priorities.

Work Conducted in Reporting Period

Due the nature of the Science Coordinators role, many of the primary objectives have proved to be ongoing commitments. Essentially the following milestones have been achieved to date:

- Investigations into the suitability of a database for Round 2 project information have been made and a decision reached, that the Defra website would be the most appropriate repository for such information
- Science Coordination meetings have been held with all of the MEPF project teams and also with MIRO/SAMP Projects 2.24, 2.25 and 2.43. In addition communications have been established with the ALSF teams within the Delivery Partners. Technical workshops and Evaluation panel meetings have also been attended
- Links have been well established with projects outside of the ALSF but relevant to ongoing research.
- New project proposals submitted to the MEPF, MIRO/SAMP, English Heritage and English Nature have all been fully reviewed by the Science Coordinator.
- The programme and arrangements for the 2005 MALSF conference has been devised in collaberation with Defra and the Conference organisers.
- Advice to Defra has been ongoing in providing a dissemination of marine research to date and recommendations on the future direction of the Marine ALSF have been made.

1.1.7 MEPF 04/06 Marine ALSF Annual Conference (8.E)

Contractor: CMS- Coastal Management for Sustainability
Budget: **FY04/05** £15,000
FY 05/06 £25,000
FY06/07 £25,000
Total £65,000
Timescale: 3 years
Contact: Bob Earll, Tel: 01531 890415,
email: bob.earll@coastms.co.uk

Proposal Details

To provide suitable facilities for an annual two or three-day conference on the scientific research supported by the Marine ALSF or other funding mechanisms.

Work Conducted in Reporting Period

Arrangements have been made for the 2005 Marine ALSF Conference to be a one-day technical conference held at SOAS (The School of Oriental and African Studies) London. A full budget report and Conference programme have been prepared.

1.1.8 MEPF 04/07 Marine Aggregate Levy Sustainability Fund (ALSF) Offshore Geographical Information System (8.E)

Contractor: ABP Marine Environmental Research Ltd.
Grant: **FY 04/**05 £68,791
FY05/06 £61,062
FY06/07 £35,780
Total £165,633
Timescale: 3 years
Contact: Ian Townend,(Managing Director).Tel: (023) 8033 8100, Fax: (023) 8033 8040, email: itownend@abpmer.co.uk

Proposal Details

Marine Aggregate dredging is one sectoral activity in an environment which finds competing pressure from many other sectoral interests, be that offshore windfarms, fishing activity, shipping, marine disposal, pipelines and cables, etc. A centrepiece of Government policy is to promote sustainable development by making sure we work together to manage the marine environment responsibly.

Research related to marine aggregates is available from a variety of sources with DEFRA now funding projects through ALSF. To ensure this research provides maximum benefit in support of their policy needs a project is proposed to improve 'knowledge management'.

A web-based facility is proposed to hold a live register of research studies structured as a spatial database and, where available, providing direct links to research outputs. This research may be directly related to marine aggregates or associated to another sectoral interest, it may offer a UK context or be developed from an overseas study. The database would recognise planned, current and past activities with associated funding bodies and research institutes. The use of GIS will be included to provide a means of assisting search facilities and determining areas which may be data rich or data poor. We consider the facility to be suited to addressing the web related dissemination requirements of other current projects; MEPF 04/01 to 04/04.

The intended project deliverable is aimed more at improving the management of information. As a direct consequence of providing the database tool a further support vehicle will be available to assist wider dissemination from other ALSF and non-ALSF funded research with the overall benefit of improved take up of all the research.

In order to deliver the aims of the study the project has been organised into 7 objectives as follows:

Objective 1. Project inception ***[Led by ABPmer with input from GeoData]***

The initial stage of the project is to ensure that the ideas presented in this document are consistent with those of the funding body. Project definitions will be agreed with the Co-Project Officer and/or steering group. These will include timescales, milestones and deliverables.

Project inception will also be used to validate the likely end-users of the database and validate their requirements. Consultation with a wide body of users, from industry, regulatory and policy makers will be relevant to the design and query capabilities of the system. The output requirements, data export, printing and summary requirements will also be explored as part of this objective.

Objective 2. Finalise design of project database and internet access tools ***[Led by GeoData with input from ABPmer]***

The output from the project inception will form a specification for the database. Technical aspects of the database including data import, structure and backup/recovery solutions will be addressed. The specification of the web-enabled GIS viewer will be defined. This will incorporate tools for querying the database and navigating the results. Key layers of base-mapping for the viewer and the range outputs will also be reviewed.

The hardware and operating system required for the project will be considered at this stage. The precise specification of these will be derived through the user review undertaken during Objective 1, and are therefore not available at this time. However it has been established that the hardware and operating system used in this project will based on the Open Source model. The means that there will be no cost for software packages, server or client licences, support or upgrades.

The range of metadata information required for the database will also be established at this stage. This development will work towards the International Organization for Standardization[1] (ISO) 19115 guideline for geographic information metadata standard.

Objective 3. Database development and webGIS implementation [GeoData]

At this stage the project design will be implemented. Internal beta-testing will occur and the system will be created ready to populate with data.

The following system architecture is proposed for the development: DBMS - One of the most important components of the system will be a spatially enabled DBMS. We propose to use the Open Source PostgreSQL1[2] database with PostGIS[3] spatial extensions. These are industry standard applications conforming to standards published by the Open GIS Consortium[4] (OGC), though they could be exchanged with commercial alternatives such as Oracle and SDE (Oracle Spatial Data Engine).

GIS Libraries - The manipulation and display of spatial data in the GIS application will be implemented using the Open Source MapServer5 GIS component library. This also integrates a collection of other Open Source software libraries for manipulating and transforming a very wide range of spatial data types. The MapScript[6] scripting extension enables the use of MapServer within the PHP scripting language.

Web Application - The above technologies will be brought together by the main web interface, which will be constructed using the Open Source PHP[7] web scripting language. Standards for HTML[8] and CSS[9] (style sheets) will be used in conjunction with content management modules to enable separation of application, content and design.

Web Server - The Open Source Apache[10] Web Server will be used to execute the web application and deliver web page output to users. No special client-side technologies will be required at the browser end. Apache is an industry standard for serving industrial strength web applications. However, any alternative HTTP server, such as Microsoft Internet Information Server, could be deployed if required.

Objective 4. Collation of available R & D project information *[ABPmer]*

This stage will be used to collate all of the available and relevant contemporary (post 2000) research for the database. Information will be collated to populate the key metadata fields established as part of Objective 2. Spatial location of the research projects will also be recorded in order to provide visual search facilities within the webGIS viewer.

The core focus will be marine aggregate R & D projects within English waters, however it is planned that appropriate UK, EU and overseas studies are also included as well as relevant non-aggregate projects. Other information captured will include links to project websites and digital project deliverables.

When the data has been collated it will be loaded into the project database. This process will continue for the majority of the project life cycle with the database being continually updated. Towards the end of the project new updates will be completed by external project teams using a website to modify and enter new project metadata. This process should ensure that the database remains as a contemporary resource after this project has been completed. It is planned that the initial stages of this objective will be completed in parallel with Objective 3.

Objective 5. Host pilot database ***[Led by GeoData with input from ABPmer]***
On completion of Objectives 3 & 4 a pilot version of the database will be launched for a selection of users to comment and provide feedback. Comments and suggestions generated by the pilot study will be incorporated to finalise the database.

Users will be encouraged to use the online data entry facility to register R & D projects as they are completed. It is suggested that this online registration becomes a prerequisite for future ALSF R & D projects in order to capture live metadata and keep the proposed metadatabase system up to date.

Input will be made via web based forms in which the user will be asked to provide standard information about the R&D project including a spatial extent. The creation of a data entry interface ensures that the database can be updated in future

Objective 6. Further testing and finalise Database ***[Led by GeoData with input from ABPmer]***
The database will be finalised and opened for public access. Monitoring the use of the web interface will be undertaken via web statistics to provide summaries of the usage of pages and particularly useful items. Where data downloads are undertaken it is possible to assess and categorise the downloads, (e.g. academic, government, agency private etc) to allow for the charting of the value of the data.

Objective 7. Disseminate ***[Led by ABPmer with input from GeoData]***
The project deliverables will be disseminated. This will include the technical report and publication in appropriate academic literature. The completed R & D database and GIS web-viewer will be completed and ready to be supplied to a host organisation.

Work Conducted in Reporting Period
Three key documents have been produced during the first year of the project, namely:

- User Specification -This document has been presented to the Marine ALSF community and other potential users of the database for comment. Feedback is currently being collated using a website forum and potential users have been invited to log comments about the specification. The document outlines the functionality of the system and will incorporate relevant feedback from the website forum upon completion.
- Technical Specification - The user specification forms the basis of this technical document in which detailed aspects of the development are presented. This specification is a technical design plan for the development of the metadatabase and web-enabled GIS. Utilizing the user specification as the basis for this document will focus the development in year two of the project towards meeting user requirements.
- Scoping of potential links with other databases -The contents of a series of databases were investigated and a shortlist produced. The potential of different levels of interoperability was investigated in detail for the identified databases. The result of the scooping report will be an investigation into potential data exchange links to other databases and a recommendation about developing these links as part of the current project.

The specification documents are currently available on the Marine GIS website: www.marinealsf.org.uk

The full progress report follows in Appendix 2.

1.2 ODPM/MIRO/SAMP Round 1 Projects 2002-2004

1.2.1 SAMP 1.001 Seabed Characterisation and the Effects of Soil Structure on Benthos and on Benthos Recolonisation Caused by the Impact of Marine Aggregate Dredging (3.a.E)

Contractor: Andrews Survey
Grant: £185,000
Timescale: 2002-2004 **Project Completed**
Contact: Roy Jarman. Tel. 01493-332111
Email: royjarman@andrews.co.uk

Proposal Details
This project was intended to evaluate innovative techniques to characterise the seabed deposits and near-bed water column in and adjacent to aggregate dredge sites. The techniques included:-

- Seabed mounted acoustic Doppler current profiler and current meter
- Sediment penetration camera and towed camera and video sledge
- Cone penetration studies of seabed consolidation
- Analysis of seabed topography and bathymetry

The work was carried out at the same study sites used by Marine Ecological Surveys Limited in project SAMP 1.022. Apart from new data collected to characterise the seabed in the survey areas, material from grab samples and box-cores collected in the Marine Ecological Surveys Ltd project was used to interpret the sediment transport regimes in relation to marine aggregate dredging at the survey sites.

Summary Of Work Completed
Using a range of instruments and criteria it is possible to characterise the seabed within and in the vicinity of dredging operations.

The most significant effect of dredging is the lowering of seabed levels and the removal of seabed sediments. This will result in an alteration of seabed topography, sediment composition and structure. This is a long term or permanent alteration and is readily detectable from bathymetric and swath technology, particle size distribution studies and CPT operations. The finest details of these alterations can be examined with seabed profiling cameras. At a site where dredging operations have been carried out in regular zones it is readily possible to date events and monitor decay of dredge furrows. The removal of the substrate leads to the partial or perhaps ultimately to the destruction of the benthic biota. Seabed camera evidence indicates that patches of seabed at least geologically similar to the predredge seabed survive even in intensely dredged areas. The cumulative effect of dredging can only be assessed at the end of the extraction phase but features like minor sandwaves if present initially, appear to either survive through the dredging activities or become established immediately after operations have ceased. This suggests a seabed resilience and a positive restoration of an altered equilibrium as soon as external conditions allow. Within the aggregate extraction zone if the deposit is worked using screening techniques the seabed can become oversanded resulting in the burial of both original seabed structures and the continual reduction in the gravelliferrous content of the deposit. This can be a medium or long term alteration. (PSD and camera studies) Beyond the dredge site, plumes generated by the dredging operations may extend a considerable distance beyond the worked area. At a screened site the seabed plume footprint could be detected on sedimentological evidence for a distance double its apparent effect on the benthic community (4 kilometres as opposed to 1750 metres MES 2004). The footprint of a plume was successfully detected by PSD techniques at a screened site and it was established that the seabed plume footprint could have resulted from as few as 100 cargoes. An overspill only plume footprint could not be detected at a non-screened site. No evidence could be detected of an earlier plume footprint a matter of weeks after dredging had ceased, suggesting that the features are geologically at least transient
phenomena.

Full Report available at

www.odpmaggregatefund.co.uk/themea/samp_1_001.pdf

1.2.2 SAMP 1.022 Impacts of Overboard Screening on Seabed and Associated Benthic Biological Community Structure in Relation to Marine Aggregate Extraction (3.b.E)

Contractor: Marine Ecological Surveys Ltd.
Grant: £393,420
Timescale: 2002-2004 **Project Completed**
Contact: Richard Newell. Tel. 01225 442211
Email: marine@seasurvey.co.uk

Proposal Details

The primary objective of this project was to establish the fate and distribution of material rejected by screening during dredging, and the extent to which this is associated with changes in sediment composition and biological communities in space and time outside the boundaries of dredge sites in different coastal areas. The work provided information on the sequence and time-course of recovery of biodiversity of benthic communities following cessation of dredging in different deposit types.

Two different dredge sites were selected in the southern North Sea as suitable study areas, where the water depth and the proportion of dredged material rejected after screening differed. The first of the study sites was Area 430, off Southwold, and the second study site was Area 106, off the Humber estuary.

Summary of Work Completed

The results of this study are summarised both as an interactive electronic version of the main Report, a print-ready pdf version and as a Non-Technical summary. The main conclusions from this study and those of others are as follows:-

- Despite wide variations in habitat type and associated benthic communities in dredged areas, the dredging process results in a 30-70% reduction in species variety, a 40-90% reduction in the number of individuals, and a similar reduction in the biomass of benthic invertebrates in the dredged area.
- Sand from screening is deposited as an ellipse of approximately 200m width and extending for up to 600m in each direction along the length of the tidal stream. However, when the net sediment flux is asymmetrical, the 'footprint' of impact on sediments and associated biological resources may extend 2-3km along the axis of net sediment transport.
- The process of removal of coarse material and the return of sand-sized particles to the seabed can result in long-term changes in particle composition of dredged deposits. Where this occurs, it is associated with a suppression of species variety, population density and biomass as well as changes in community composition to one that is dominated by polychaete worms.
- The initial process of recolonisation by some mobile 'opportunistic' species can occur within months of cessation of dredging. Restoration of biomass is achieved by growth of these and other colonising species. This is always slower than the initial restoration of species diversity and population density. Generally, a time of 4-6 years is characteristic of restoration of biomass in sandy gravels. In deep water stable habitats, substantial recovery is achieved within 4-6 years, but restoration of the biomass of the slowest growing members of the community may take 15-20 years.

The Report ends with a review of potential mitigation measures to minimise the extent of the 'footprint' of impact of marine aggregate dredging on benthic biological resources and to enhance the processes of Recolonisation and recovery following cessation of aggregate dredging.

Full Report available at

www.odpmaggregatefund.co.uk/themea/samp_1_022.pdf

1.2.3 SAMP 1.031 Best Practice Guide to Assessing the Impacts of Aggregates Dredging (8.E)

Contractor: Posford Haskoning Ltd.
Grant: £156,830
Timescale: 2002-2004 **Project Completed**
Contact: Ms Sian John. Tel. 01733-334455
Email: s.john@royalhaskoning.com

Proposal Details
This project had the following objectives:-

- To improve the consistency of impact assessment in the marine environment, through consideration of good practice in data collection and collation, and the definition of robust assessment criteria and techniques, and impact mitigation.
- To support the improvement of environmental management practices
  To ensure that decisions and actions taken at the strategic level are cognisant and reflective of good working procedures and issues at the project level
- To widely disseminate best practice to stakeholders and encourage participation
- To enable sound decisions to be made that minimise the impact of aggregate extraction on the marine environment and ensure the future sustainability of the physical and biological resource.

Summary of Work Completed
The project was based on a series of themed workshops and resulted in production of a 'Best Practice Guide' on assessing the impacts of aggregate extraction on the marine environment, including key criteria, a series of assessment tools and a framework intended to assist decision-making.

Full Report available at

www.odpmaggregatefund.co.uk/themea/samp_1_031.pdf

1.2.4 SAMP 1.042 Seabed Prehistory: Gauging the Effects of Marine Aggregate Dredging (3.c.E)

Contractor: Wessex Archaeology
Grant: £219,480
Timescale: 2002-2004 **Project Completed**
Contact: Stuart Leather. Tel:01722-326867
Email:S.leather@wessexarch.co.uk

Proposal Details

This project had the following principal objectives:-

- To better understand the extent and character of prehistoric seabed deposits
- To develop new methodologies for assessing and evaluating prehistoric seabed deposits in the course of licence applications
- To guide industry, regulators and public towards better understanding, conservation and appreciation of seabed deposits implicated by marine aggregate dredging

The survey area chosen for the study was the Owers Bank, approximately 10km south of Littlehampton, off the coast of Sussex. In all, a total of 20 vibrocores, 108 seabed grab samples and 245km of seabed seismic survey data were collected over a 3.5x 1km survey area, most of the sites being located in a central 1 sq km area around a buried palaeo-channel feature.

The results were used to assess the suitability of survey methodology for archaeological studies, and were used to generate a Draft Technical Advice Note that is included as an Appendix to the main Report for this project.

Full Report available at

www.odpmaggregatefund.co.uk/themea/samp_1_042.pdf

1.2.5 SAMP 1.044 Outer Bristol Channel Marine Habitat Study (R1) (2.a.E)

Contractor: British Geological Survey
Grant: £201,814
Timescale: 2002-2004 **Project Completed**
Contact: Ceri James (BGS), Tel: 0115 9363467,
email: jwcj@bgs.ac.uk

Proposal Details
Undertake a marine habitat, biodiversity and geodiversity survey in the outer Bristol Channel, providing baseline data for the sustainable development of seabed resources and inform the planning and regulatory process with regard to marine conservation and the public at large as stakeholders in the marine environment.

The project will integrate geological and biological information gathered through geophysical and benthic surveys into a comprehensive interpretation of marine habitats.

The study will incorporate new survey data gathered through modern techniques, including multibeam, sidescan and reflection seismics with the historical records held in the archives of the National Museum of Wales and the British Geological Survey. Through co-operation with other organisations the project will actively seek to include, any multibeam, geophysical and biological data available in the Outer Bristol Channel.

The project will produce detailed bedform, sediment and faunal distributions, and interpretations, as well as comprehensive interpretations of marine species, habitats and biodiversity distributions within the study area. This will provide physical, geological and biological data as baseline criteria for the sustainable development of seabed resources, including fisheries, aggregates and wind farms, and inform the planning and regulatory process with regard to marine conservation, and national and EU legislation. As well as providing data and interpretations through maps, reports and publications the project aims to make its results available to a wider audience through a bilingual multimedia CD-ROM, web pages, museum exhibition, and outreach awareness sessions of its results at education institutions (Universities, colleges, schools), societies and interest groups.

Summary of Work Completed

Full Report available at

www.odpmaggregatefund.co.uk/themea/samp_1_044.pdf

MIST MA/3/1/003. Towards Establishing a Tool to Provide Baseline Data on Fisheries Within Sussex Fisheries District (2.b.E)

Contractor: Sussex Sea Fisheries Committee.
Grant: £6991 (from MIST) of total £7962.50
Status: **Project Completed**
Contact: Robert Clark, Sussex Sea Fisheries District Committee, Unit 6, Highdown House, Shoreham Airport, Shoreham-by-Sea, West Sussex. BN43 5PB. Tel, 01273 454407. Email, rclark@sussex-sfc.gov.uk

The objective of this project was to develop a tool to provide information on fishing activity in the area for which the Committee has competence in a transferable, quantitative format and to communicate this information to stakeholders. The project was developed with 50% funding through the ALSF and the remaining 50% from the Sussex Sea Fisheries District Committee.

Full Report available at

www.mi-st.org.uk/call1/reports/final_report_ma-1-1-003.pdf

MIST MA/3/1/005. Towards Developing Best Practice for Sussex Sea Fisheries in the Acquisition of Data for Marine Resource Management (8.E)

Contractor: Sussex Sea Fisheries District Committee.
Grant: £3981 (from MIST) of total £13,982
Status: **Project Completed**
Contact: Robert Clark, Sussex Sea Fisheries District Committee, Unit 6, Highdown House, Shoreham Airport, Shoreham-by-Sea, West Sussex. BN43 5PB. Tel, 01273 454407
Email, rclark@sussex-sfc.gov.uk

The objectives of this project were:-

- To hold a 2-day workshop on the collection and exchange of information on inshore fisheries within the Sea Fisheries Districts, and to present the results of a programme on 'Towards establishing a tool to provide baseline data on fisheries within the Sussex Sea Fisheries District' to the 12 Sea Fisheries Committees of England & Wales.
- To provide a manual for the collection and dissemination of fishery activity data in GIS format, and to provide details of fishing activity in Sussex in a web-based format.
- To disseminate information on the project on the internet.

The Workshop was held in November 2003 and was attended by 17 persons including representatives from the Sea Fisheries Committees and CEFAS. The project received 50% funding from the ALSF with the remaining 50% from the Sussex Sea Fisheries District Committee.

Full Report available at

www.mi-st.org.uk/call3/reports/final_report_ma-3-1-005.pdf

1.3 ODPM/MIRO/SAMP Round 2 Projects 2004-2007

1.3.1 SAMP 2.06 Outer Bristol Channel Marine Habitat Study – Geophysical and Video Surveys (2.a.E)

Contractor: British Geological Survey
Grant: £78,864
Timescale: 18 months
Contact: Ceri James (BGS), Tel: 0115 9363467, email: jwcj@bgs.ac.uk

Proposal Details
The project will integrate geological and biological information gathered through geophysical and benthic surveys into a comprehensive interpretation of marine habitats.

The study will incorporate new survey data gathered through modern techniques, including multibeam, sidescan and reflection seismics with the historical records held in the archives of the National Museum of Wales and the British Geological Survey. Through co-operation with other organisations the project will include, other multibeam, geophysical and biological data available in the Outer Bristol Channel

The project will produce detailed bedform, sediment and faunal distributions, and interpretations, as well as comprehensive interpretations of marine species, habitats and biodiversity distributions within the study area. This will provide physical, geological and biological data as baseline criteria for the sustainable development of seabed resources, including fisheries, aggregates and wind farms, and inform the planning and regulatory process with regard to marine conservation, and national and EU legislation. As well as providing data and interpretations through maps, reports and publications the project aims to make its results available to a wider audience through a bilingual multimedia CD-ROM, web pages, museum exhibition, and outreach awareness sessions of its results at education institutions (Universities, colleges, schools), societies and interest groups

Responsible stewardship requires an understanding of the way the marine environment functions and how the sea bed may respond to human activity. It also means involving stakeholders as an integral part of policy making. The results from the project have been designed to supply robust science for responsible stewardship and also provide information, through innovative media, to the public at large as stakeholders in the marine environment

Work Conducted in Reporting Period

The geophysical survey cruise was completed Three types of geophysical equipment – multibeam, sidescan and boomer were run. The weather for much of the survey period was not ideal with strong winds and large sea swell and waves. However, survey was only delayed two nights due to the weather. Multibeam and sidescan continued although the sea conditions did at times affect the resolution and quality of the data. The cruise enabled completion of almost all the original planned multibeam survey coverage with the inclusion of the data collected in November 2003. This is not the case with the sidescan coverage, only about 70% of the planned survey coverage has been obtained. This shortfall in sidescan coverage was due to the fact that there had been problems with the Edgetech sidescan system in November 2003 which was not deployed over as wide an area as the multibeam. There was not enough time on this geophysical survey cruise to complete the planned coverage of sidescan. A different sidescan on this survey was deployed– a Klein 5000. This ran the whole time without any problems and produced good data especially with regard to the sea conditions.

The boomer system is sensitive to sea conditions; rough seas create noise on the records and make them unusable. It needs smooth seas for optimal quality. There was only one 24-hour period when the boomer could be deployed to get acceptable records. Within this period only 3 of the 11planned lines were taken. This is an improvement on the one boomer line acquired in November 2003, but the minimal boomer coverage means there is still lack information on the from and thickness of sediment and rock beneath the sea bed over a large part of the study area.

There may be an opportunity to run the boomer at night during the planned video survey in May 2005. This was not in the original plan for the video survey and no funds have been set aside for a night time boomer survey. Practicalities and sources of funding for the addition of a boomer to the video survey are being looked at.

Processing of all the multibeam data from both cruises has been completed. About 80% of the sidescan data from both cruises has been processed. These two datasets are currently being integrated to enable analysis of the character and morphology of the sea bed.

1.3.2 SAMP2.24 Dredging Lane Management – CFD Simulations (3.a.E)

Contractor: The Centre for Environment, Fisheries and Aquaculture Science
Grant: £96,054
Timescale: 18 months
Contact: John Rees, Tel:01502 524383,
email: j.m.rees@cefas.co.uk

Proposal Details

It is increasingly common for aggregate extraction operators to develop a dredging plan in which areas or "lanes" within a dredging licence area are managed in order to: 1) supply the resource to the specification required and; 2) to assist re-colonisation of the seabed after the licence is relinquished. Inside these lanes, the draghead from typical trailer-suction dredgers causes "furrows" on the seabed with dimensions of approximately 3-4 m wide and 0.5 m deep. The side walls of the lanes can be a few metres high. Within such environments of large vertical scales in comparison with the horizontal, the hydrostatic approximation used in standard coastal engineering models of tidal flow breaks down, such that a full Navier-Stokes solution based on a Computational Fluid Dynamics (CFD) approach is required to effectively describe flow in and around furrows. Importantly, this approach will correctly model the secondary flows associated with the furrow cross-section. This project constitutes fully independent work, but can be linked effectively to CEFAS's modeling proposal under ALSF MEPF 04/04 for "Improvements to Predictive Modeling".

The project will modify an existing model of turbulent flow over seabed features, and apply it to the case of a dredging furrow in order to investigate the processes of sediment transport within a dredging lane and close by (see Figure 1). Of particular interest is the impact on natural sediment transport of potential particle trapping by secondary flows within the furrows and the dependence of this on the orientation of the furrows to the tidal ellipse and changed bed roughness. All these factors form an impact on the benthos which will link with CEFAS's ALSF MEPF 04/02 proposal for "Recoverability of affected ecosystems after cessation of marine aggregate extraction", a copy of which is attached for information.

With input from industry, regulators and other stakeholders, a series of management scenarios will be developed. These could include investigations into the size and shape of dredging lanes, their orientation to the tidal flows, the sequence of using dredging lanes, and mitigation options (e.g. raking, seeding with fresh gravel etc.). Once established these scenarios will then be assessed using the CFD code to determine the potential effects on sediment transport and, if possible, the benthic environment. Qualitative ranking of the various scenarios will be made, with respect to impacts on sediment transport, benthic ecology, rate and nature of re-colonisation and other associated aspects. A communication strategy has been developed in order to disseminate the results from this project.

The various dredging/environment scenarios will be tested using the CFD code and the potential impacts determined on the sedimentary environment. From this impacts could be assessed regarding the benthic ecology. The results are envisaged as the form of "Industry Best Guidance" but could also lead to further work to develop predictions.
If the CEFAS's MEPF 04/04 bid is approved, these results will also feed back into the decision-tree approach for predicting the effects on the benthic community.

Work Conducted in Reporting Period
The project is moving forward rapidly with several iterations of the model now providing a sound basis on which to move forward. The development of the model is key in delivering this contract and as such getting the CFD code working accurately is essential. Significant progress has been made in delivering this goal. Links with the stakeholders continue but at a lesser pace.

1.3.3 SAMP 2.25 Building GIS and Environmental Data Management Capabilities of the Sea Fisheries Committees (2.b.E)

Contractor: The Centre for Environment, Fisheries and Aquaculture Science
Grant: £35,366
Timescale: 18 months
Contact: Paul Eastwood, Tel: 01502 524536, email: p.d.eastwood@cefas.co.uk

Proposal Details
Knowledge of the location and intensity of fishing effort is critical to the assessment of potential conflicts between fishing and aggregate licensing. Defra are responsible for monitoring fisheries outside of 6 nautical miles (nm), whereas Sea Fisheries Committees (SFCs) monitor activity within 6 nm. Offshore surveillance data from the Defra fisheries monitoring programme is collected and stored in digital format and can be readily converted into estimates of fishing effort. Environmental consultants routinely use this information to evaluate potential conflicts between fishers and proposed aggregate licences. By contrast, comparable data for inshore fishing activity (i.e. within 6 nm) is not readily accessible, as SFCs collect and store fisheries surveillance data on paper logs and not in digital format. The aggregate industry continues to show interest in exploiting nearshore resources, and in doing so faces strong opposition from local fishing interests (e.g. area 372/2 to the east of the Isle of Wight). Access to an objective source of information on inshore fishing effort is therefore critical if potential conflicts between the various stakeholders are to be resolved to the satisfaction of all sides.

Recent efforts by Sussex Sea Fisheries Committee (SFC), with support from the MIST component of the Aggregate Levy Sustainability Fund (MA/1/1/003), led to the development of a Geographic Information System (GIS) for the management, analysis and visualisation of inshore fishing activity information within the Sussex district. In a subsequent MIST-

funded initiative (MA/3/1/005), Sussex hosted a workshop for all SFCs with the aim of disseminating the outcomes of this project and encouraging best practice in the acquisition and management of fishing activity data. The workshop concluded that a concerted effort was now needed to further develop GIS capacity within the SFCs and to harmonise the management, analysis and visualisation of fishing activity information. The aim of this project is to build on the 2 previous GIS projects by coordinating and harmonising the development of GIS and environmental data management capabilities across a broader number of SFCs as a pilot project. Committees willing to participate in this pilot are Sussex, Southern, Devon, Cornwall, North Eastern, and Northumberland (i.e. 6 of the 12 SFCs).

Work Conducted in Reporting Period

All GIS software has been distributed. Base marine GIS data from SeaZone Solutions will be distributed pending completion of the licence agreement by the Association of Sea Fisheries Committees. All participating SFCs are now fully operational in their GIS capability. CEFAS has provided technical support by phone and email to facilitate GIS implementation. The GIS workshop has been completed.

Participating SFCs have submitted suggestions for how fishing effort estimation can be standardised. These will be consolidated during this quarter and then discussed with individual SFCs during the programme of on-site visits in April and May '05

Defra Sea Fisheries Inspectorate have taken an interest in this project and have agreed in principle to provide fisheries surveillance recording software to all SFCs. This will greatly facilitate the standardisation of sightings records and provides tremendous added value to the project. Discussions with SFI will take place in April/May '05 regarding the practical implementation of the surveillance software, during which time we will also scope the linkages with the GIS database and fishing effort estimation methods developed during the GIS workshop.

1.3.4 SAMP2.43 Seabed Prehistory 2: Archaeology and Marine Aggregates in the North Sea and English Channel (2.c.E)

Contractor: Wessex Archaeology
Grant: £482,517.90
Timescale: 30 months
Contact: Stuart Leather, Tel:01722 326867,
email: s.leather@wessexarch.co.uk

Proposal Details

This proposal arises directly from the success of *Seabed Prehistory: gauging the effects of marine aggregate dredging*, which was an ALSF project focussing on the palaeo-Arun off Sussex, administered under this programme by MIRO in Round 1 - see www.wessexarch.co.uk

In Round 2 we intend to take the advances made in Round 1 to aggregate dredging areas in the East English Channel and Humber, which both have clear potential to contain prehistoric artefacts and deposits in close association with marine aggregate resources. However, it is equally clear that the processes that resulted in marine aggregates being present, and which caused archaeological material to be associated with them, are different in each of these two regions, and to the Arun studied in R1.

In addition to site-specific insights, it is expected that the project will result in an understanding of archaeology and marine aggregates that is more sensitive to regional variation in formation processes. In so doing, the project should enable the development of frameworks for assessment, evaluation and mitigation that can also be applied away from the palaeo-valleys of the South Coast, upon which most attention has focussed to date.

While the extension to new areas is a key element of this project, further methodological enhancement is also an important strand. In particular, we wish to carry out further processing of the very dense data acquired from the Arun in R1, and to start developing computer-modelled visualisations of the prehistoric landscape as a means of integrating, interrogating and exploring the implications of geophysical, geotechnical, palaeo-environmental and archaeological data from the seabed.

The project will secure scientifically robust baseline information about the sediment architecture, formation, date, palaeo-environment and prehistoric archaeology of the East English Channel, of the Humber and Owers dredging zones, and the North Sea and English Channel more generally. Through its website, Steering Group, presentations, lectures and publications, the project will collate and disseminate accurate information on marine dredging issues and practices suitable for a wide range of stakeholders.

By investigating the presence, extents, character and possible importance of prehistoric material in dredging zones, the project will better establish the direct environmental impacts of marine aggregate dredging, and their mitigation. The results of the project will be directly applicable to improving dredging conditions and the process of Environmental Assessment, both for individual applications and regionally. The project will also facilitate the development of improved predictive models, particularly with respect to their sensitivity to regional factors affecting site formation and survival.

Expected Results

- Interpreted suites of sub-bottom, vibrocore and grab data, synthesised with the results of palaeo-environmental analyses and scientific dating, for the Arun (enhanced from R1), East English Channel and Humber.
- A computer-modeled visualisation of the prehistoric landscape of the Arun.
- Yearly project reports.
- Text and illustrations for three published articles on the archaeological results of the investigations.
- Dissemination and outreach events and materials, to include presentation and participation in seminars and conferences, and public lectures.

Work Conducted in Reporting Period

The Arun Visualisation will be completed by the end of the March. This phase of the project has proved to be very successful. A computer animation of life in the Arun valley in 9120 BP has been created. The animation shows a landscape comprising a river channel, salt marsh and woodland that is now c.30m beneath the sea. All the information used to create the scenes came from data collected in the R1 project and from general archaeological knowledge of this period. The process of creating this landscape has proved to be an effective, instructive and rigorous way of integrating and interpreting the different data sets. The animation itself has brought the area to life and shows what life and the landscape may of been like during this period, making the archaeology live.

A portion of the marine surveys for the East English Channel will be commissioned by the end of the month. The survey schedule has been planned from the desk-based review started in the third quarter and completed in this quarter. The survey will not take place until there is a high probability of good weather.

An ALSF technical meeting hosted by English Heritage is being held on the 29th March. This meeting will be attended by representatives from industry, as well as bodies undertaking research projects in similar areas as seabed prehistory and Wrecks on the seabed whether funded though the ALSF or other grant agencies.

Rescheduling of staff time and subcontractor costs has taken place this quarter.
A portion of the second phase of marine survey fieldwork in the East English Channel has been brought forward into this quarter and the staff time for processing the marine geophysical survey data has been carried over into the next financial year. The publication of the Journal article has also been carried over into the next financial year.

The final claim for this financial year remains the same.

1.4 English Nature Marine and Coastal Projects 2004-2007

1.4.1 Marine Aggregates and biodiversity in both 2 and 3 dimension context (2.b.E)

Contractor: EMU Ltd.
Grant: £224,013
Timescale: for completion in March 2005 **Project Completed**
Contact: Simon Shaw, EMU Ltd, 1, Mill Court, The Sawmills, Durley, Hampshire, SO32 2EJ. Tel: 01489 860050
www.emulimited.com

Proposal Details
Investigating the link between superficial habitat, subsurface geology and benthic biotopes.

The project aims to discover whether benthic communities on thick gravel deposits are unique or are part of a more widely occurring community. Results will be published in appropriate journals.

Meets the MoU criteria: Promoting environmentally friendly aggregate extraction, conserving marine biodiversity.

Summary of Work Completed
Two fundamental questions were asked:

- Does the underlying depth of substrata relate to the faunal communities in the superficial sediments?
- Do deep aggregate resources support benthic communities unique to those areas?

Several relatively clear communities related to characteristic habitat types were described following analysis using PRIMER (Classification and Ordination). Outputs from community analysis were overlaid on BGS sediment depth data. It was apparent from early analysis that answers to the first question were not clear. However, it was found that in shallow sediments of less than 1m, communities may develop that are potentially only found in such areas. These communities corresponded with the coarse gravels and small cobbles, stable in nature and with structural diversity. These habitats support communities high in abundance and diversity by nature and characterised by a taxonomically diverse range of species including a significant epifaunal component. These communities had not been found in association with deeper sediments. The critical depth of sediment beyond which these communities exist has not yet been determined, but appears to be less than 1m depth.

In contrast, it was found that communities found over deeper sediments could also be found over shallow sediments, including those found in unstable conditions. The current conclusion to the second question posed, appeared to be that deep aggregate deposits do not support unique biological communities, although 'edge effects' related to topography may occur. A set of further analysis has been outlined in order to identify interactions between key species, spatial distributions of key species and relationships between individual characteristic species and substrata/depth type.

The full report is available upon request to EMU Ltd. Contact details as above.

1.4.2 Conservation of Marine Sand and Gravel Biotopes in South-East England (8.E)

Contractor: Hampshire and Isle of Wight Wildlife Trust
Grant: £173,190
Timescale: for completion in March 2005 **Project Completed**
Contact: Lisa Browning, Hampshire and Isle of Wight Wildlife Trust, Beechcroft House, Vicarage Lane, Curdridge, Hampshire, SO32 2DP. 01489 774400
www.hwt.org.uk

Proposal Details
Addressing areas of concern regarding the impact of extraction, promoting and developing Marine Spatial Planning, promoting biodiversity conservation and raising public awareness.

The project will work with the industry and other stakeholders to address issues of concern over the impact of extraction on biodiversity, it will engage the industry in the promotion and development of MSP. The project will promote marine biodiversity conservation at a Regional level. The project will raise public awareness of marine biodiversity and provide the means for public involvement in marine conservation.

Meets English Nature criteria: Increasing biodiversity, promoting environmentally friendly aggregate extraction, projects in local communities

Summary of Work Completed
Not yet available

1.4.3 South Coast Skates and Rays: Assessing the impact of Aggregates Extraction (2.b.E)

Contractor: The Shark Trust
Grant: £13,240
Timescale: for completion in March 2005 **Project Completed**
Contact: Ms Ali Hood, The Shark Trust, National Marine Aquarium, Rope Walk, Coxside, Plymouth, PL4 0LF. 01752 672008. www.sharktrust.org

Proposal Details
Trial techniques to assess the impact of extraction on skate and ray populations.

Analysing past changes and catch reports, involving angling clubs and the public at large, encouraging public understanding and informing scientific debate.

Meets English Nature criteria: Increasing biodiversity, promoting environmentally friendly aggregate extraction.

Summary of Work Completed
Not yet available

1.5 English Nature Marine and Coastal Projects 05-07

(These projects have only recently been awarded therefore progress reports are not yet available. They have not been included in Table 1 and are therefore not coded)

1.5.1 Marine Biodiversity and Aggregate Dredging in both a 2 and 3 Dimensional context

Contractor: EMU Ltd.
Grant: £112,878
Timescale: 2005-2006
Contact: Dr Simon Shaw, Head Office, 1 Mill Court, The Sawmills, Durley, Southampton, Hampshire SO32 2EJ. Tel: 01489 860050.
Email: mail@emulimited.com

Proposal Details
A project to investigate the link between superficial habitat, subsurface geology and benthic biotopes, to discover whether benthic communities on thick gravel deposits are unique, or whether they are part of a widely occurring community which also inhabits thin veneer deposits. This project links on from the Round one project.

Work Conducted in Reporting Period
Not yet available

1.5.2 Development of a Multi-Use Managed Marine Reserve

Contractor: University of Portsmouth Higher Education Corporation
Grant: £107,969
Timescale: Apr 05 -Mar 07
Contact: Ms Diana Tingley, CEMARE, University of Portsmouth, Boathouse 6, College Rd, H.M. Naval Base, Portsmouth, Hampshire, PO1 3LJ. Tel: 023 9284 4283
email: dianatingley@port.ac.uk

Proposal Details
The project aim is to develop a management framework for a stakeholder-run Multi-use Marine Managed Reserve (MMMR) promoting the sustainable use of marine resources, whilst ensuring that key conservation and biodiversity features are protected and monitored. The aims of the project reflect emerging policy directions in marine resource management. It seeks a practical assessment of the approaches to marine site management that will be key in developing consensual UK management policy.

The project will focus upon a trial area known as The Overfalls, located to the east of the Isle of Wight. The site has been identified as being suitable for several key reasons:

- regionally uncommon habitats of potential conservation significance
- an important commercial and recreational bass fishery
- the location of some recreational diving
- the location of important, potential aggregate resource

The site provides an opportunity to explore management options for the natural resource and issues of resource sustainability and conflict management between key uses and users of the site.

Phase 1 (Apr 05-Mar 06) will involve consultation with stakeholders to determine use of the resource and aspirations for potential involvement in the creation of a trial MMMR. A Protocol will be developed to outline 'best practice' for establishing an MMMR. An iterative process will be used to arrive at a consensual and practical Protocol and proposed MMMR Framework. All Phase 1 activities will be fully documented. Depending on the results of Phase 1, Phase 2 will be undertaken (Apr 06 – Mar 07). Objectives include facilitating the establishment of a trial MMMR, designing and applying a monitoring and evaluation framework, reviewing the protocol as practical problems are encountered, establishing how the MMMR can become autonomous and self-financing and disseminating Phase 2 activities and outcomes. 'Best practice' recommendations will be drawn from both phases.

Work Conducted in Reporting Period
Not yet available

1.5.3 Sand Banks and Offshore River Channels: Examples of Geodiversity from Aggregate Industry Sites

Contractor: Chris Evans
Grant: £25,520
Timescale: Apr 05-Feb 06
Contact: Christopher David Rys Evans, Bryeos, Llangoedmor, Cardigan, Ceredigion, SA3 2LB. Tel: 01239 612247
Email: bryneos@btinternet.com

Proposal Details
Hanson Aggregates-Marine have geological data on the blocks which they license in UK waters. Most of data are not in the public domain, have not been placed in a wider scientific context, and cannot be examined when marine geodiversity is being considered. Data from sand banks and river channels will be collated for this project using data from five sites. The aim is to make this information easily accessible to all those interested in marine geology.

Work Conducted in Reporting Period
Not yet available

1.5.4 Marine Wealth-Seabed Health

Contractor: Marine Biological Association of the UK
Grant: £67,725
Timescale: Jul 05-Sept 06 (PLANNED)
Contact: Dr Keith Hiscock, Marine Biological Association, The Laboratory, Citadel Hill, Plymouth, PL1 2PB.
Tel: 01752 633352.
Email: k.hiscock@mba.ac.uk.

Proposal Details
The project has two main elements:

1. to continue to bring together and interpret information collected as a part of surveys related to aggregate extraction, and

2. to use that information with other material to provide an interactive learning training experience based on aggregate extraction and on use of the information from surveys to identify environmental protection issues and solutions. Data access and interpretation will use the experience and skills of the MarLIN team at the Marine Biological Association and expand on work already undertaken with aggregate industry data. Further information, including images, acoustic survey results and monitoring studies will be sought in collaboration with CEFAS. The interactive learning experience will be developed for Web pages and CD-ROM in association with the National Marine Aquarium – also providing a part of the £3.6 million ExplorOcean gallery due to be completed in December 2005. NMA exhibits will include interactive models.

Work Conducted in Reporting Period
Planning stage

1.5.5 Best Methods for Identifying and Evaluating Biogenic and Cobbley Reef

Contractor: JNCC (Joint Nature Conservation Committee)
Grant: £304,706
Timescale: Apr 05- Mar 07
Contact: Tracey Edwards, JNCC, Dunnet House, 7 Thistle Place, Aberdeen, AB10 1UZ. Tel: 01224 655707
Email: tracy.edwards@jncc.gov.uk
www.jncc.gov.uk

Proposal Details
This project will review all existing information available on *Sabellaria spinulosa* 'reef' and cobble habitats. It is then intended to undertake a critical evaluation of a selection of existing and 'state of the art' seabed mapping techniques in order to establish their suitability for use in areas where EU Habitats Annex I reef habitats are suspected, particularly *Sabellaria spinulosa* 'reef' and stony reef. A report will document a thorough evaluation of the scope and limitations of available techniques through a review process and a programme of practical testing, and this will lead to more efficient assessment procedures and increase our knowledge of the biological resource that is associated with marine sand and gravel habitats.

Work Conducted in Reporting Period
Not yet available

1.5.6 Use of Shell to Speed Recovery of Dredged Aggregate Seabed

Contractor: University of Southampton
Grant: £35,400
Timescale: Jun 05- Mar 07
Contact: Dr Ken Collins, University of Southampton, School of Ocean and Earth Science, Southampton Oceanography Centre, SO14 3ZH. Tel: 023 80596010
Email: kjc@soc.soton.ac.uk
www.soton.ac.uk

Project Details
Shells and shell fragments are a significant component of undisturbed seabed and a key factor in the biodiversity of sand and gravel seabed habitats. Dredging aggregate extraction removes this surface of biogenic material, which if replaced, will accelerate its restoration to the pre-disturbance ecosystem. The project has two aims (i) to study at small scale the biological significance of the shell fraction (ii) to undertake an experimental demonstration project laying thin layers of shell on recently dredged seabed to the east of the Isle of Wight.

Work Conducted in Reporting Period
Not yet available

1.6 English Heritage Marine ALSF Project Portfolio R1 (2002-2003)

Final reports are to be made available digitally via the EH website. Details of all projects funded by EH through the ALSF scheme can be obtained from the following website:-

www.english-heritage.org.uk/server/show/nav.1315

1.6.1 Greater Thames Survey of Mineral Extraction Sites (2.a.E)

Contractor: Essex County Council
Grant: £115,012
Timescale: 2002-2003
Contact: www.essexcc.gov.uk

Proposal Details

This project is concerned with the establishment of up-to-date information on mineral extraction sites within the Thames Estuary area, embracing primarily the Thames Gateway sections of the historic counties of Kent and Essex (including the unitary authorities of Medway and Thurrock). It aims to inform current and future land-use proposals, and education and leisure initiatives. It will examine past, present and proposed mineral extraction sites and will identify known extraction sites, map them and, using the geological and planning records, establish what was being worked on each site. Once eligible sites have been identified, it will then assess the geological and archaeological potential of each site to inform further work in the area.

The survey area comprises primarily the Thames Gateway sections of the Thames Estuary area in the historic counties of Kent and Essex. In Essex, the mineral extraction sites in the Unitary Authority of Thurrock will be surveyed. In Kent, sites within the Unitary Authority of Medway will be surveyed. The Thames Gateway is seen as a priority area for regeneration and this project will contribute to the planning process for this development in an area that is rich in archaeological heritage.

- The table below details how the project aims to inform current and future land use proposals, and education and leisure initiatives.
- Creation of a GIS map base for the Greater Thames area of past, current and future mineral extraction sites and related buildings and features.
- Mapping areas where quarrying has destroyed archaeological deposits
- Considering the continuing value of the various quarry sites, and any associated surviving structures, for Palaeolithic and later archaeology including industrial archaeology
- Creation, based on the GIS, of 3-dimensional models for selected mineral extraction sites
- Considering the geological value of the various quarry sites.
- Assessing the archaeological potential of current and potential mineral extraction sites and identifying future threats to archaeological or geological deposits
- Provision of accurate and up-to-date information to the SMRs within the Greater Thames area for input to spatial planning and specific development proposals
- Feedback of the results into English Heritage's Monuments Protection Programme (MPP) programme
- Contribute to raising the profile of heritage issues and enhancing the image of the historic environment in the Greater Thames area
- Use of the information as part of the planning process in both current and future spatial planning proposals in the Greater Thames area
- Develop further archaeological decision-making and methodologies relating to spatial planning at a trans-national level within North West Europe, in conjunction with the Interreg IIIB funded

Summary of Work Completed

Not yet available

1.6.2 Multi-Beam Sonar on Wrecks (2.c.E)

Contractor: Wessex Archaeology
Grant: £11,012
Timescale: 2002-2003
Contact: Stuart Leather, Tel: 01722 326867
Email, s.leather@wessexarch.co.uk
www.wessexarch.co.uk

Project Details

Wessex Archaeology has undertaken a project that assesses multi-beam sonar survey (also known as swath bathymetry) and its application to the archaeological evaluation and recording of wreck sites on the seabed. This project runs hand in hand with the ALSF project: Wrecks on the Seabed: Assessment, Evaluation and Recording (3324) which includes provision for an assessment of the application of side-scan sonar, magnetometer, sub-bottom profiler and single-beam bathymetry survey techniques for the recording of wrecks.

The need for the project has arisen from communication with the aggregate industry that has indicated multi-beam sonar survey will become standard practice at the Environmental Impact Assessment stage of aggregate dredging licence applications. The adoption of this new technology provides an opportunity for the archaeological community to incorporate the assessment of this new data-source into the process of evaluating and recording submerged wreck sites.

Four Designated Historic Wreck Sites were added to those that are being surveyed as a variation on 3594 so that the assessment of archaeological applications of multi-beam sonar technology will also relate to sites designated under the Protection of Wrecks Act 1973.

Multibeam sonar is essentially the next step from using single beam sonars (i.e. ordinary echosounders) which gather more widely spaced single point depths in a line beneath the survey vessel as it moves along. Unlike sidescan sonar, multibeam data provides full bathymetric (depth sounding) data for every patch of seabed that is ensonified, allowing three dimensional digital terrain models to be created very easily. As with sidescan sonar depressions and features projecting from the seabed can be displayed.

The objectives of the project are as follows:

- To develop and test a structured system for acquiring, annotating, storing and referencing multi-beam survey data;
- To assess the incorporation of multi-beam sonar survey data into the process of assessing, evaluating and recording wreck sites using other methods.

In line with the Wrecks on the Seabed project, the following objectives will also be addressed:

- To initiate and maintain a dialogue with industry, regulators and contractors regarding the use of multi-beam survey data for the assessment, evaluation and recording of wrecks on the seabed;
- To support the development of skills and experience in the archaeological profession;
- To engage in academic debate nationally and internationally regarding the use of multi-beam survey data for the assessment, evaluation and recording of wrecks on the seabed;
- To inform the public of the value of investigating wrecks on the seabed within the context of marine aggregate licensing.

Deliverables for the project include:

- an enhanced dataset relating to each site subject to multi-beam sonar investigation, to be copied to the National Monument Record and relevant Sites and Monument Records;
- Inclusion of a section covering the archaeological and methodological results of multi-beam sonar survey within the Wrecks on the Seabed year 2 report;
- Inclusion of a section covering the archaeological and methodological results of multi-beam sonar survey within the consultation draft of guidelines on assessing and evaluating wreck sites;

- Inclusion of a section covering the archaeological and methodological results of multi-beam sonar survey within the consultation draft of guidelines on recording wreck sites;
- Inclusion of the results of the multi-beam assessment within the seminar programme, public lecture series and web pages, as outlined within the Wrecks on the Seabed project design.

Summary of Work Completed
Not Yet Available

1.6.3 Submerged Palaeo Arun and Solent Rivers: Reconstruction of Prehistoric Landscapes Pt 1 & 2 (2.c.E)

Contractor: Imperial College
Grant: £121,629
Timescale: 2002-2003
Contact: Dr. Sanjeev Gupta & Dr. Jenny Collier, Department of Earth Science & Engineering, Imperial College, Exhibition Road, LONDON SW7 2AZ,
Email: s.gupta@ic.ac.uk, jenny.collier@ic.ac.uk
www.ic.ac.uk

Proposal Details
This project is using high-resolution geophysical imaging sonars to investigate the geomorphology of submerged and buried landscapes on the northern English Channel shelf. Here submerged fluvial valley systems form important, but poorly understood, palaeo-landscapes on the shelf. Pleistocene sedimentary bodies associated with these valley systems hold considerable potential as aggregate resources, and also contain unique information on the palaeoenvironmental evolution of the region. Moreover, because onshore extensions of these valley systems contain some of the finest records of early human occupation in Britain, palaeo-land surfaces and sedimentary units in their offshore counterparts are likely to contain important archaeological data to help constrain the history of early human migration into Britain. *Thus, there is a critical need to assess the archaeological significance of these offshore fluvial systems, prior to extensive aggregate extraction.* The new data and technical developments provided by this study will contribute to the emerging field of prehistoric marine archaeology, in particular with regard to developing protocols to assess archaeological resource potential in offshore areas, and to the development of conservation strategies.

The aim of this project is to determine the morphology and internal stratigraphy of the relict fluvial valley systems of the offshore extension of the Arun river, off the south coast of Sussex. This is being achieved partly by the application of a new suite of high-resolution marine geophysical imaging sonars recently funded by JREI. We are working closely with Hanson Aggregates Marine Ltd. (principal contact: Dr. Ian Selby) and United Marine Dredging Ltd (principal contact: Dr. Andrew Bellamy), the two main aggregate industry companies operating in the region, who have provided extensive seismic and vibracore datasets to the project.

The insights gained from an integrated geophysical/ geomorphological/ sedimentological investigation of these fluvial systems will enable the development of concepts that will allow submerged land surfaces and fluvial facies variations in the subsurface *that have extensive potential to contain archaeological resources* to be understood and predicted.

Important questions to be addressed include:

- What are the palaeogeomorphic elements on the present seafloor and sub-surface?
- What is the sequence of erosional and depositional events in the valley systems?
- Which palaeogeomorphic elements of the submerged landscape hold potential for archaeological resources?
- Which sedimentary architectural elements in the valley-fill stratigraphy hold potential for archaeological resources?
- What techniques contribute most to the identification of potential prehistoric remains on the seabed?

The study is divided up into separate projects.

Project 1 is focused on acquiring and interpreting new marine geophysical data utilising the new JREI-funded equipment pool. Specifically, we are collecting, processing and interpreting geophysical swath bathymetry data from the lower (unfilled) portion of the Arun system and sub-bottom profiling data from the filled upper portions

Project 2 is focused on analysis and interpretation of the existing dataset of analogue boomer seismic and vibrocores collected for commercial exploration of aggregate resources in the study area. These data are being provided by our aggregate industry collaborators, Hanson Aggregates Marine Limited and United Marine Dredging Ltd.

Summary of Work Completed
Not Yet Available

1.6.4 Paleolithic Archaeology of the Sussex/Hampshire Coastal Corridor (2.c.E)

Contractor: University of Wales, Lampeter
Grant: £94,525
Timescale: 2002-2003
Contact:

Proposal Details
The Sussex/Hampshire Coastal Corridor (SHCC) is an area of considerable importance for both Quaternary studies and Palaeolithic archaeology. A range of deposits can be found in the area including marine and estuarine sediments, periglacial slope and fluvial deposits and wind blown silt that contain floral, faunal and archaeological material. These sequences have been studied intermittently during the last 200 years and the last 10 years have seen an increasing interest in the area

In order to understand more fully the nature of the archaeological record and the sedimentary sequences, the current project is being undertaken. It has a number of different objectives:

- **Geological mapping.** Refining knowledge and understanding of the distribution of major Middle and Late Pleistocene sediment units in the area
- **Sediment dating and interpretation.** Determining the environments of deposition and age of major Middle and Late Pleistocene sediment units in the project area
- **Geological correlation.** Refinement of the sequence of deposits in different parts of the study area, followed by integration of the sequences from the two areas
- **Hominid settlement history.** Establishing the history of hominid colonisation and settlement of the area through the Middle and Late Pleistocene
- **Palaeolithic cultural change/patterning.** Characterising and explaining material cultural change through the Middle and Late Pleistocene in the project area**6**
- **Palaeolithic resource distribution.** Mapping the distribution of Pleistocene sediments of potential Palaeolithic archaeological significance
- **Palaeolithic resource approach.** Determining appropriate evaluation and/or mitigation approaches to the Pleistocene sediments in the project area
- **Public dissemination/outreach.** To work with Southampton Museum Service in providing information on, and results of, the project suitable for a) enhancing existing Prehistory displays and b) developing a digital resource to facilitate local studies

Summary of Work Completed
Not Yet Available

1.6.5 Wrecks on the Seabed: Assessment, Evaluation & Recording (2.c.E)

Contractor: Wessex Archaeology
Grant: £92,090
Timescale: Jul 2002- Mar 2004
Contact: Stuart Leather, Tel, 01722 326867
Email, s.leather@wessexarch.co.uk
www.wessexarch.co.uk

Proposal Details
The aim of Wrecks on the Seabed is to provide industry, regulators and contractors with guidance on the archaeological assessment, evaluation and recording of wreck sites.

The project is addressing three levels of investigation, using both geophysical and diver-based techniques:
- Rapid in-situ recording
- Field assessment
- Non-intrusive evaluation

Methodologies are being developed on a sample of known (but generally unidentified) wreck sites off the coasts of Hampshire and Sussex, UK. The wrecks include both metal and wooden-hulled vessels, and aircraft. They were selected from an initial list of 44 sites, with the intention of conducting fieldwork on 14 wrecks in Year 1 and seven wrecks in Year 2.

The Year 1 geophysical investigations included sidescan and magnetometer surveys of 17 sites. In Year 2, detailed magnetometer, sub-bottom and multibeam surveys are to take place. Diving investigations in Year 1 included assessment of nine sites, using surface-supplied divers equipped with video, digital still cameras and underwater tracking

Summary of Work Completed
Not Yet Available

1.6.6 England's Shipping (8.E)

Contractor: Wessex Archaeology
Grant: £31,710
Timescale: 2002-2003
Contact: Stuart Leather, Tel, 01722 326867
Email, s.leather@wessexarch.co.uk,
www.wessexarch.co.uk

Proposal Details
The project aims to develop ways to make better use of the vast quantities of information that exists in the historical record about the movements and activities of ships in the past.

The project output is principally designed to support seabed developers, their archaeological advisors and heritage curators in assessing maritime archaeological potential on the seabed during the preparation of dredging work proposals. However, English heritage intend to make the information results and search facilities available to the general public through the National Monuments Records search facilities. Although the project is designed to run for two years, the gathering of information relating to England's Shipping is intended as an ongoing task. The project is currently being structured around a series of case study areas drawn from concentrations in the pattern of dredging activities in English waters.
The project aims agreed with English Heritage are as follows:
- Map the intensity and other characteristics of pre-1730 shipping in UK waters
- Collate information about shipping patterns in an accessible format
- Develop a database which can contain data reflecting the multiple facets of shipping related data
- Map the data using a GIS format to enable the user to query the data
- Provide an Outreach schedule to disseminate results

In order to meet ALSF requirements to engage the wider public in the importance of the marine historic environment and in order to facilitate access to the data, it is anticipated that the content of the digital atlas will be made available to users via the NMR. For further information on the

planned outreach schedule, please click here or email a request to info@wessexarch.co.uk

Summary of Work Completed

The project successfully resulted in the creation of a system, which could contain extensive amounts of data recorded from archival sources, and the development of a methodology for representing historical data spatially whilst mitigating against the uncertainty of locating events.

The difficulties of interpreting historical archives and the biases in shipping recorded over time meant that it was not possible to map shipping movements to a degree which would allow the prediction of archaeological potential on the seabed. However, it was possible to provide a representation of the character of England's Shipping and the relationship between ports and nations using the network of ship routes as a model for representing trends in shipping traffic.

Initial querying of the data showed that the system was working effectively and that trends in the initial dataset could be identified. Three case-study dredging areas were also chosen to test the sample data collated during the project. The analysis of the three areas showed additional data available on battle events, the some information on the nature of trade traveling through the area, and the relative importance of local ports during different centuries. Although the data entered in the database would have been biased towards the areas for which more information was available, further population of the database would inevitably reduce these biases.

The querying of data for traffic density entering and leaving ports provided a better representation of traffic density for the approaches to locations. Although it could not be extended further to sea, a reflection of the size and importance of a port, the nature of trade and its military importance would provide a representation of the likely density of traffic traveling through the area. Further population of the database could improve our ability to quantify and characterise the unknown potential for archaeology on the seabed, based on the importance of ports and the character of traffic relations

1.6.7 Artefacts from the Sea (8.E)

Contractor: Wessex Archaeology
Grant: £32,897
Timescale: Oct 02-Mar 04
Contact: Stuart Leather, Tel, 01722 326867
Email, s.leather@wessexarch.co.uk
www.wessexarch.co.uk

Proposal Details

The aim of the project is to collate information arising from previous discoveries of artefacts from the sea in a manner that improves understanding, conservation and appreciation of the marine historic environment.

The project is addressing findspot and related records at sea and on the coast, up to high water/cliff top, but encompassing a wide enough area to include relevant records with imprecise grid references. Although prompted by previous studies of early Prehistoric material, the project encompasses all pre-Modern artefacts from the sea (other than wreck), to allow a fuller understanding of the context of marine finds

Summary of Work Completed

In Year 1, attention has been directed to documentary sources, to the National Monuments Record (NMR) and to local authority Sites and Monuments Records (SMRs). As well as developing a project recording system, two case study areas have been selected – namely the Solent-Sussex coastline and the Humber-Tees coastline – based on the availability of records, proximity to dredging areas, and known areas of archaeological potential. In Year 2, the intention is to further enhance findspot records, to include data arising from artefacts held in museum and private collections.

1.6.8 High Resolution Sonar for the Archaeological Investigation of Marine Aggregate Deposits (2.c.E)

Contractor: Southampton University
Grant: £20,000
Timescale: 2002-2003
Contact: Dr. Justin Dix, (School of Ocean and Earth Sciences and Department of Archaeology, University of Southampton).
Tel: 023 8059 7817
Email: J.K.Dix@soton.ac.uk
www.soton.ac.uk

Proposal Details
This project design aims to test and optimise new acoustic techniques expressly designed to identify objects and structures within these acoustically complex environments. If successful, these techniques should enable the archaeologist to not only further our understanding of submerged archaeological sites but also glean invaluable insights to terrestrial contexts that have to date been difficult to interrogate. The primary aims of this project are:

- To identify an optimum Chirp pulse for the penetration of coarse grained (sand and gravel) deposits whilst maintaining typical decimetre resolution and high SNR imagery.
- To demonstrate the capabilities of this Chirp II source for the archaeological investigation of coarse grained aggregate deposits.
- To demonstrate the capabilities of the SOES 3D-Chirp system for the mapping and characterisation of an archaeological site within an aggregate licensing area.
- To disseminate the results of the research project to the academic community, the aggregates industry and the general public.
- The first three aims will be achieved through the surveying of a series of archaeologically significant localities which have been chosen specifically to satisfy a series of secondary aims pertinent to the agenda of the ALSF:
- To identify if the "Solent River System" represented a single or multiple drainage systems, and the implications of drainage morphology for our understanding of the Upper Palaeolithic and Mesolithic archaeology of the area.
- To establish the internal stratigraphy of a single terrace deposit, in order to further constrain the time-depth history of these secondary contexts.

Summary of Work Completed
Not Yet Available

1.6.9. A Reassessment of the Archaeological Potential of Continental Shelves (2.c.E)

Contractor: Southampton University
Grant: £21,1560
Timescale: 2002-2003 **Project Completed**
Contact: Dr. Justin Dix, (School of Ocean and Earth Sciences and Department of Archaeology, University of Southampton).
Tel: 023 8059 7817
Email: J.K.Dix@soton.ac.uk,
www.soton.ac.uk

Proposal Details
The aims of this project directly correspond to the key research themes identified below as being essential to our understanding of the archaeology of continental shelves, they are as follows:

- To re-appraise the methods used to construct palaeogeographic maps for the contextualisation of submerged continental shelf archaeology.
- To provide a state of knowledge review of the submerged archaeology (primary, secondary and tertiary contexts) of continental shelves, with particular emphasis on the NW European Continental shelf.
- To assess the potential impact of the physical processes associated with marine transgressions and regressions on the archaeological deposits and associated environments of continental shelves.
- To achieve a more realistic understanding of the submerged archaeological potential of continental shelves and to facilitate the development of predictive models.

- To disseminate the results of the research project to the academic community, the aggregates industry and the general public.
- To generate a ten-year research agenda for this sub-discipline.

In order to tackle these 4 key themes for submerged archaeological studies this project aims to undertake a wide-ranging literature review, in terms of both space and time. This work will interrogate extant literature from research disciplines including archaeology, anthropology, ethnography, oceanography, geology, biogeography and geophysics.

It is an aim of this project that the results will be disseminated to the academic community, the aggregates industry and the general public. This is to be accomplished via the production of a final report by March 2004 and the submission of papers relating to the various themes to internationally refereed journals and conferences. An abstract has already been submitted to, and accepted by the Marine and Coastal Geoarchaeology Symposium at the World Archaeological Congress 2003. A project website will also be updated on a regular basis as research progressed.

Summary of Work Completed

Full report available at

www.arch.soton.ac.uk/Research/Aggregates//shelve-report.htm

1.7 English Heritage Marine ALSF Project Portfolio R3 (2004/05/06)

1.7.1 Solent Aggregates to Outreach (8.E)

Contractor: Hampshire & Wight Trust for Maritime Archaeology
Grant: £8,000
Timescale: due for completion in April 2005
Contact: Julie Satchell, Archaeological Officer. Tel, 023 8059
Email, Julie.satchel@hwtma.org.uk.
www.hwtma.org.uk

Proposal Details

This project seeks to assess and develop integrated Presentation and Teaching Packs based around aggregates and the marine historic environment as an information resource for schools, home educators, local archaeology groups and community groups

Work Conducted in Reporting Period

The project is progressing well, it has received a positive response from all the individuals and organisations contacted. The project is on schedule for completion within the proposed timescale

Project meetings and/ or phone contacts have been undertaken with:
Ian Selby (Hansons Aggregates)
Mark Russell (BMAPA)
Andrew Bellamy (UMA)
Sarah Louise Colman (Hampshire Field Club & Archaeology society)
Alison Hamer (Hounsdown School)
Norma skinner (Special needs teacher)
Mark Dunkley (English Heritage Maritime Team)
Mike Wallis (HR Wallingford)
Ken Collins (Southampton Oceanography Centre Marine Biologist)

Meetings have been scheduled with the following:
Cynara Davies EH SE Outreach Officer

Justin Dix (University of Southampton)
Foundry Lane Primary School

1.7.2 Beach Replenishment and Derived Archaeological Material (2.c.E)

Contractor: Museum of London Archaeology Service
Grant: £20,000
Timescale: 12 weeks, due for completion August 2005
Contact: Dick Malt Tel: 020 7410 2200
E-mail: dickm@molas.org.uk
www.molas.org.uk

Proposal Details
This evaluation study comprises a desk-based assessment to examine the relationship between beach replenishment schemes and the historic environment in an innovative way by exploring the deposition of archaeological material on replenished beaches in association with its former offshore context.

Work Conducted in Reporting Period
Not Yet Available

1.7.3 Enhancing Our Understanding: Navigational Hazards (8.E)

Contractor: Bournemouth University
Grant: £100,000
Timescale: due for completion early 2007
Contact: David Parham, School of Conservation Science, Bournemouth University, Talbot Campus, Fern Barrow, Poole, Dorset, United Kingdom BH12 5BB. Email: d.Parham@bournemouth.ac.uk
www.bournemouth.ac.uk

Proposal Details
The overall aim of the project will be to assess the suitability of historical and scientific data relating to specific aspects of the marine historic environment surrounding navigational hazards for use in the environmental assessment of marine aggregate dredging proposals. Source analysis is likely to assist in the greater understanding and detection of hitherto unknown sites. The project is also likely to create a bespoke indicative predictive map of pro-active management strategies through linkages formed with other ALSF projects.

Work Conducted in Reporting Period
Not Yet Available

1.7.4 Modeling Exclusion Zones for Marine Aggregate Dredging (7.E)

Contractor: University of Southampton
Grant: £234,000
Timescale: Due for completion early 2007
Contact: Dr. Justin Dix, (School of Ocean and Earth Sciences and Department of Archaeology, University of Southampton).
Tel: 023 8059 7817
Email: J.K.Dix@soton.ac.uk
www.soton.ac.uk

Proposal Details
This project aims to make a preliminary assessment of dredging on archaeological materials, focussing particularly on wreck material. The work will bring together expertise across archaeology, oceanography and marine engineering with the potential to impact on not only archaeological science but also marine science.

Work Conducted in Reporting Period
Not yet available

1.7.5 Marine Historic Landscape Characterisation (HLC) (2.c.E)

Contractor: Wessex Archaeology
Grant: £144,000
Timescale: due for completion in early February 2006
Contact: Deanna Groom Tel, 01722 326867
E-mail: d.groom@wessexarch.co.uk
www.wessexarch.co.uk

Proposal Details
The project aims to adapt the methodology of Historic Landscape Characterisation (HLC) to England's inter-tidal and marine zone. Anticipating a key role in framing responses to aggregates extraction, the adaptation will be trialled through an initial pilot in NW England. This will inform four further, separate, pilots to confirm the method's validity in other main types of coastal context, ensuring a robust characterisation methodology to inform the assessment of aggregates extraction licence applications. It will complement the current national programme of County-based HLC projects which, through desk-based GIS mapping and analysis, seek an archaeological understanding of the historical and cultural development of the present landscape. Project delivery & reporting comprises digital datasets, web pages and a scholarly article.

The project has direct relevance to DEFRA's Programme of Research into Marine Spatial Planning. For further information, see the *Landscape Character* pages of English Heritage's web-site.

Work Conducted in Reporting Period
Not Yet Available

1.7.6 Severn Maritime Assessment (2.c.E)

Contractor: Museum of London Archaeology Service
Grant: £25,000
Timescale: due for completion in June 2005
Contact: Dick Malt, Tel: 020 7410 2200
E-mail: dickm@molas.org.uk
www.molas.org.uk

Proposal Details
This project seeks to assess the current state of knowledge relevant to the historic environment in relation to aggregate extraction in the Severn Estuary and make recommendations for further work

Work Conducted in Reporting Period
Not Yet Available

1.7.7 Seabed Prehistory R2 (2.c.E)

Contractor: Wessex Archaeology
Grant: £299,000
Timescale: due for completion late 2006
Contact: Stuart Leather, Tel, 01722 326867
E-mail, s.leather@wessexarch.co.uk
www.wessexarch.co.uk

Proposal Details
The aim of this *Seabed* fieldwork module is to inform best practice for the assessment and evaluation of prehistoric deposits on or beneath the seabed in the course of the aggregate dredging license application process, and to provide baseline data on the prehistoric archaeological potential of dredging areas around the coast of England. The intention is to carry out two fieldwork elements: geophysical survey, off Great Yarmouth and extensive grab sampling in the Palaeo-Arun, off Sussex. Both elements will run concurrently.

Information about the project will be disseminated to the wider public through project web pages. The completion of this project will assist in the development of guidance for the regulation of dredging for sand and gravel.

This project complements the MIRO funded Seabed Prehistory R2: Archaeology and Marine Aggregates in the North Sea and English Channel project.

Work Conducted in Reporting Period
Not Yet Available

1.7.8 Wrecks on the Seabed R2 (2.c.E)

Contractor: Wessex Archaeology
Grant: £557,000
Timescale: Due for completion October 2006
Contact: Anthony Firth,
Email: a.firth@wessexarch.co.uk
www.wessexarch.co.uk

Proposal Details
Submitted as a modular project, investigations currently commissioned under 'Module 1' comprise the refinement and development of methodologies related to area survey methods and the survey of ephemeral sites through the acquisition of substantial and purposely collected geophysical datasets that represent relevant and independent 'compare and contrast' scenarios for side scan sonar surveys. Such scenarios will enable clear 'demonstrable' guidance on the most appropriate geophysical survey specification to meet archaeological objectives. Specifically, the module is intended to standardise the approach to reviewing typical geophysical datasets and when defining whether an acoustic signal is anomalous or not.
A Project Design covering the entire project is anticipated and will comprise further modules. Project delivery & reporting will be confirmed within a fuller Project Design, but is expected to include web-site development and additional guidance notes on the evaluation & recording of wreck sites.
As a continuation of an R1 project, the completion of this project will assist in the development of guidance for the regulation of dredging for sand and gravel.

Work Conducted in Reporting Period
Not Yet Available

1.7.9 Innovative Approaches to Rapid Archaeological Site Surveying and Evaluation in the Maritime Environment Transitional Zones (2.c.E)

Contractor: University of St Andrews
Grant: £204,000
Timescale: Due for completion late 2006
Contact: Dr. Richard Bates,
Email: crb@st-andrews.ac.uk
www.st-andrews.ac.uk

Proposal Details
The principal aim of this project is to exploit the potential of geophysical, remote survey equipment to allow rapid detailed investigation of submerged archaeological sites and their immediate surroundings. A secondary aim is establish the optimum configuration of acoustic instruments to obtain the maximum resolution necessary for high quality archaeological work, although the project's details have yet to be finalised. However, has been earmarked.

Work Conducted in Reporting Period
Not Yet Available

1.7.9.1 On the Importance of Shipwrecks (8.E)

Contractor: Wessex Archaeology
Grant: £30,000
Timescale: due for completion August 2005
Contact: Stuart Leather, Tel: 01722 326867
Email, s.leather@wessexarch.co.uk,
www.wessexarch.co.uk

Proposal Details
The aim of the project is to develop and trial a framework for ascribing importance to shipwrecks suitable for use in the Environmental Assessment of marine aggregates dredging proposals. The project will also seek to address the following priorities for the EH ALSF Programme:

- developing capacity to manage aggregate extraction landscape in the future;
- promoting understanding of the conservation issues arising from the impacts of aggregates extraction on the historic environment.

At the heart of this project design is the need to create an easy-to-use evaluation system which can be shown to reliably differentiate 'importance' across a range of ship types, functions, and periods (dates) of build. Hence, the objectives of the project are;

- To review relevant literature relating to the importance of shipwrecks;
- To develop a process-based methodology for ascribing importance to shipwrecks in which individual wreck assessments are consistent, comprehensive, transparent and contestable;
- To develop sets of factors and/or lexicons that can be readily applied to key characteristics of wrecks in UK waters, and are understandable to environmental consultants, developers, regulators and the public, as well as archaeologists.
- To conduct trials of framework on wrecks and sources typical of marine aggregates EAs.

The project deliverables include:

- A workshop on the application of the framework;
- Materials to support the workshop;
- A project report in hardcopy and digital form (.pdf).

The final report will be in three parts:

- Literature Review;
- Initial Framework and Methodology;
- Results of Trials.

Appendix 2. RELEVANT RESEARCH FUNDED FOR UK WATERS FROM NON-ALSF SOURCES

2.1. Defra Marine Environment R&D Programme 2004-2005

Marine Research & Development projects funded by the Department for Environment, Food and Rural Affairs (Defra) relevant to marine ALSF projects are grouped into 4 main Programmes with identification codes as follows:-

- ***ME11. Managing marine activities: Deposits.***
- ***ME12. Managing marine activities: Aggregate Extraction.***
- ***ME14. Managing marine activities: Integrated Management.***
- ***ME41. Monitoring and Assessment.***

Further information on these and related projects can be obtained from the Defra website:-

http://www2.defra.gov.uk/research/project_data/Default.asp

ME11. Managing Marine Activities: Deposits.

The objectives of this programme include investigation of the impacts of developments such as capital maintenance dredging and windfarms on the marine environment. The purpose is to enable Defra to address coastal zone management issues relating to dredging, disposal and offshore developments based on the scientific understanding of environmental impacts.

AE0260. Large scale use of muddy dredged material for sustainable flood defence and habitat management **(7.A)**
Contractor: HR Wallingford Ltd.
Project Total: £531,379
Status: 4yr project Started 01.12.02.

The objectives of this study are to build on previous studies and undertake field measurements of key variables (such as waves and tidal currents) which influence the behaviour of muddy material on intertidal ecosystems. Develop a suite of models that can be used to predict the fate of muddy dredged material, placed nearshore for beneficial purposes. Produce a manual on best practice for regulators and other potential users.

The key customer purpose is to assist Defra in assessing the potential benefits that can accrue from using muddy dredged material, such as for coastal protection and habitat conservation. Enable the UK to support international and regional conventions that involve dredged material disposal and biodiversity issues.

AE0261. Development of indicators environmental quality relating to dredging and disposal in the marine environment **(8.A)**
Contractor: CEFAS
Project Total: £523,263
Status: 4yr project started 04.01.02.

The objectives of this project are to identify a suite of biological, physical and chemical measures and conduct a statistical evaluation to determine their potential as indicators of environmental health in terms of scientific robustness and suitability as a management tool. Undertake field sampling and provide guidance on appropriate sampling strategies such as scale and frequency.

The key customer purpose is to assist Defra refine its national approach to Environmental Quality Objectives and the setting of Environmental Performance Indicators in line with developments at OSPAR and ICES. Provide enhanced transparency in evaluations of the environmental consequences of dredged material disposal and marine aggregate extraction.

ME 12. Managing Marine Activities: Aggregate Extraction.

AE0908. Mapping of Gravel Biotopes and an Examination of the Factors Controlling the Distribution, Type and Diversity of their Biological Communities **(2.b.A)**

Contractor: CEFAS.
Project Total: £1,407,850
Funding: Defra
Status: 3yr project starting 01.04.98

The objective of this project was to assess the utility of seabed mapping techniques for surveying habitats, and to examine the environmental influences affecting gravel biotope communities. The study was based on the following scientific objectives:-

- To characterise the seabed in an area of the eastern English Channel using various physical and geophysical techniques.
- To incorporate biological, sedimentological and hydrographic information along with existing environmental and fisheries data into a geographical information system, in order to evaluate the functional role and importance of the gravel biotope relative to other substrate types, and for use in licensing procedures for the area surveyed.
- To determine the causes of biological variation and of observed patchiness and to devise appropriate sampling strategies to allow for this variation. This work was to take particular account of the dynamic aspects of the environment in which the benthic communities have developed.
- To establish the utility of seabed mapping techniques for surveying habitats. To examine broad-scale fishery-independent beam trawl survey data for the eastern English Channel. Describe the range of assemblages sampled using dominance of commercially fish and macrobenthic invertebrate by-catch, and where possible explain the ecological rationale for observed patterns in species affinities.
- To evaluate the susceptibility of gravel biotope benthic communities to anthropogenic disturbances in contrasting areas, particularly by dredging. This involved the testing of established and novel methods for describing and quantifying biological status and sensitivity.
- To report on the significance of the findings for the management of extraction activities.

A summary of the work completed for this project is summarised in Marine Aggregate R&D Review: 10th November 2003 (Defra, ODPM and the Crown Estate).

References:

Brown, C.J., Cooper, K.M., Meadows, W.J., Limpenny, D.S. & Rees, H.L. 2002. Small-scale mapping of seabed assemblages in the eastern English Channel using sidescan sonar and remote sampling techniques. *Estuarine, Coastal and Shelf Science* ***54*** (2), 263-278.

Brown, C.J., Hewer, A.J., Meadows, W.J., Limpenny, D.S., Cooper, K.M, Rees, H.L. & Vivian, C.M.G. 2001. Mapping of gravel biotopes and an examination of the factors controlling the distribution, type and diversity of their biological communities. *Science Series Technical Reports*. CEFAS Lowestoft 114, 43 pp.

Brown, C.J., Cooper, K.M., Meadows, W.J., Limpenny, D.S. & Rees, H.L. 2000. An assessment of two acoustic techniques as a means of mapping seabed assemblages in the eastern English Channel. ICES Annual Science Conference. ICES CM 2000/T:02.

Foster-Smith, R.L., Brown, C.J., Meadows, W.J., White, W. & Limpenny, D.S. 2001. Ensuring continuity in the development of broad-scale mapping methodology – direct comparison of RoxAnn and QTC technologies. SeaMap/CEFAS Report. 113 pp.

Hewer, A.J., Brown, C.J., Meadows, W.J., Limpenny, D.S., Cooper, K.M. & Rees, H.L. 2002. Mapping gravel biotopes: an integrated approach. ICES Annual Science Conference. ICES CM 2002/K:01.

AE0916. A strategic evaluation of the impacts of aggregate extraction on marine fauna **(3.b.A)**

Contractor: CEFAS
Project Total: £1,303,523
Status: 5yr project starting 01.04.03

The objectives of this project are to use the results of field-based studies, modelling and field-based research to examine the spatial relationship between biological resources and marine aggregate reserves. To assess the sensitivity of fish and macro-benthic invertebrates to extraction, and to evaluate the potential for remediation in high priority areas.

The key customer purpose is to assist Defra and other government departments and the industry to determine more clearly the environmental consequences of marine aggregate extraction. The project uses a UK regional seas approach to provide scientifically robust advice on the sensitivity of habitats and their restoration.

A summary of progress to date has been given in Marine Aggregates R&D Review: 10th November 2003 (Defra, ODPM and the Crown Estate).

Key References:

Boyd,S.E. (compiler) 2002. Guidelines for the conduct of benthic studies at aggregate dredging sites. Department for Transport, Local Government and the Regions & CEFAS Lowestoft. DTLR Product Code 02DPL001. 117 pp.

Boyd, S.E. & Rees, H.L. 2003. An examination of the spatial scale of impact on the marine benthos arising from marine aggregate extraction in the Central English Channel. *Estuarine, Coastal and Shelf Science* ***57***, 1-16.

Boyd, S.E., Limpenny, D.S., Rees, H., Meadows, W. & Vivian, C.M.G. 2002. Review of current state of knowledge of the impacts of marine sand and gravel extraction. ***In***: *Dredging Without Boundaries*. Proceedings of CEDA Conference 22-24th October 2002. Casablanca, Morocco.

Boyd, S.E., Rees, H.L., Vivian, C.M.G. & Limpenny, D.S. 2003. Review of current state of knowledge of the impacts of marine sand and gravel extraction – a UK perspective. ***In***: *European marine sand and gravel – shaping the future*. EMSAGG Conference 20-21st February, Delft University. The Netherlands.

Related References:

Brampton, A.H. & Evans, C.D.R. 1998. Regional seabed sediment studies and assessment of marine aggregate dredging. CIRIA, London.

John, S.A. (2000). Scoping the assessment of sediment plumes from dredging. CIRIA, London.

Posford Duvivier Environment & Hill, M.I. 2001. Guidelines on the impact of aggregate extraction on European marine sites. Countryside Council for Wales (UK Marine SACs Project).

Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (eds) 2001. ICES Co-operative Research Report No. 247. *International Council for the Exploration of the Sea, Denmark.*

AE0253. A procedure to assess the effects of dredging on commercial fisheries **(8.A)**

Contractor: CEFAS
Project Total: £80,181
Status: Completed 2002

The main aim of this project was to develop a standard protocol for the assessment of the effects of dredging on commercial fisheries and fish resources. The protocol identifies threshold levels of disturbance for commercially important species, where these are known. Where data on specific responses are not available, risks are assessed on a basis of a defined impact hypothesis.

The method is based on an Environmental Risk Assessment (ERA) process which formalises the approach to impact assessment and provides greater clarity and consistency in the decision-making process.

Reference:
Rogers, S.I. & Carlin, D. 2002. A procedure to assess the effects of dredging on commercial fisheries. Final report of Defra CSG Contract A0253. CEFAS Lowestoft. 84 pp.

ME1202. Assessment of the rehabilitation of the seabed following Marine Aggregates Dredging (CDEP 84/5/289) **(6.A)**

Contractor: CEFAS
Project Total: £80,000
Status: 4.2yrs project starting 04.01.00

The objective of this project is to provide better understanding of the processes leading to the rehabilitation of the seabed following gravel extraction in order to provide an indication of the likely timescale involved for different areas of the seabed. Also to identify dredging patterns/methods which optimise the potential to return the seabed to its pre-dredging conditions within an acceptable time scale.

The key customer purpose is to assist Defra and the ODPM to develop management strategies for minimising the environmental impacts of ongoing dredging activity and assessing the recovery of areas of the seabed from marine aggregate extraction.

References:
Boyd, S.E., Limpenny, D.S., Rees, H.L., Cooper, K.M. & Campbell, S. 2003. Preliminary observations on the effects of dredging intensity on the recolonisation of dredged sediments off the south-east coast of England (Area 222). Estuarine, Coastal and Shelf Science 57, 209-223.

Kenny, A.J., Rees, H.L., Greening, J & Campbell, S. 1998. The effects of gravel extraction on the macrobenthos at an experimental dredge site off North Norfolk, UK (results 3 years post-dredging). ICES Annual Science Conference. ICES CM1998/V, 14, 1-7.

ME14. Managing Marine Activities: Integrated Management.

AE1148. Integrated Science for Integrated Management – Developing the Capacity for Adaptive Ecosystem Management **(8.A)**
Contractor: CEFAS
Project Total: £1,528,859
Status: 6.6yr project starting 01.09.03

The objectives of this project are to use a thematic approach to evaluate emerging methodologies and the use of ecosystem quality objectives (EcoQO) under various environmental scenarios. To provide advice on how to obtain a significant reduction in the loss of biological diversity by 2010 and recommendations for establishing representative networks of Marine Protected Areas by 2012.

The key customer purpose is to assist Defra's commitments to undertakings in Europe, OSPAR and the UN in applying the ecosystem approach for the sustainable development of the marine environment.

AE1224. The ecosystem consequences of seabed disturbance **(3.a.A)**
Contractor: CEFAS
Project Total: £961,554
Status: 4yr project started 01.04.01

This project is based on fieldwork and laboratory studies. The objectives are to compare the physical disturbance of the seabed from dredging, fishing and construction with natural changes. Improved understanding of the biogeochemical function of the seabed ecosystem will be used to formulate a model that will compare the bioavailability of pollutants produced by man-made disturbance with algal species.

The key customer purpose is to support Defra's aim to sustain and enhance the marine environment, provide advice on seabed disturbance in relation to the Biodiversity, hazardous substances and Eutrophication Strategies of OSPAR, particularly because of the forthcoming 'ecosystem approach' to management and in respect to Special Areas of Conservation (SAC) under the Habitats Regulations.

ME41. Monitoring and Assessment.

AE1033. The role of seabed mapping techniques in environmental monitoring **(2.a.A)**

Contractor: CEFAS
Project Total: £976,391
Status: 4yr project starting 01.04.01

The objectives of this project are to evaluate the cost-effective use of physical and geophysical seabed mapping techniques such as side-scan sonar, acoustic ground discrimination systems and sediment profiling cameras at sites used for dredging and fishing. Produce guidelines for the use of these techniques for a wide range of sediment types for a wide range of sediment types to aid environmental management and monitoring of ecosystems.

The key customer purpose is to improve assessment techniques of environmental disturbance in response to international obligations from the OSPAR Commission and EU Habitats Directive. Enable Defra, the Crown Estate. The ODPM and others to comments on the suitability of such techniques in UK waters.

References:

Brown,C.J., Hewer, A.J., Meadows, W.J., Limpenny, D.S., Cooper, K.M., Rees, H.L. & Vivian, C.M.G. 2001. Mapping of gravel biotopes and an examination of the factors controlling the distribution, type and diversity of their biological communities. *Sci. Ser. Tech. Rep., CEFAS Lowestoft*, ***114***, 43 pp.

Limpenny, D.S., Boyd, S.E., Meadows, W., Rees, H.L. & Hewer, A. 2002. The utility of sidescan sonar techniques in the assessment of anthropogenic disturbance at aggregate extraction sites. ICES Annual Science Conference. ICES CM 2002/K:04.

AE1041. Marine and Coastal Data Network **(8.A)**

Contractor: CEFAS
Project Total: £393,283
Status: 5yr project starting 01.07.03

The objectives are to develop an easily accessible, coherent and harmonised maritime data information system to facilitate interoperability with other coastal and marine data gathering organisations. Provide a tool to support assessment of cumulative environmental impacts and ecosystem change.

The key customer purpose is to improve the ability to respond to national and international requests for environmental data as well as enhance the manipulation and integration of information for legislative purposes eg., in relation to the Water Framework Directive, Quality Status Reports and OSPAR requirements.

ME4108. State of the Seas Assessment – 2: Marine Nature Conservation and Biodiversity Input (MARP 46) **(8.A)**

Contractor: Marine Joint Nature Conservation Committee
Project Total: £63,800
Status: 1.2yrs starting 19.09.03

The objectives are to prepare the JNCC's contribution to the State of the Seas Report, including finalising the development of indicators of biodiversity of UK seas based upon data from monitoring under the management of JNCC and presenting these in enumerated form ready for inclusion in the report.

ME4111. State of the Seas Assessment – 3: Integrated Regional Assessment (MARP 80) **(8.A.)**

Contractor: Not Stated.
Project Total: £35,000
Status: 0.6yrs starting 01.04.04

The objectives were to produce a State of the Seas report by the end of 2004. The Report to contain integrated assessments of regional seas judged against various parameters and to develop indicators for marine processes and climate, marine habitats, marine life and human impacts with a view to taking forward the ecosystem approach.

The key customer purpose is to enable Defra to meet the commitment made in Safeguarding our Seas report to produce by the end of 2004 an integrated assessment of UK waters in the form of a State of the Seas report. The research will help to show the extent to which the seas around the UK meet the goal of being sustainable, healthy and productive, and identify management issues needed to work further to achieve this goal.

ME4112. Support for the National Marine Monitoring Programme (NMMP) Database – III (MARP 86) **(8.A)**

Contractor: Environment Agency (Bristol).
Project Total: £50,000
Status: 2yr project starting 01.04.04

The objectives of this project are to develop software and data management routines to enable the NMMP database to be flexible so that data can be stored and exported easily and interface efficiently with current and emerging reporting requirements, such as the EC Marine Strategy and Water Framework Directive.

The key customer purpose is to enable UK national and international reporting commitments on the marine environment to be met in a timely and efficient way and enable simple data transfer to other databases and reporting systems.

AE0914. Preliminary Investigation of the Sensitivity of Fish to Sound Generated by Aggregate Dredging and Marine Construction **(3.b.A)**

Contractor: CEFAS
Project Total: £50,955
Status: 3yr project starting 01.04.00

The object of this work was to assess the nature of sound generated by certain marine activities, and the likely sensitivity of fish to the sound generated. The main scientific objectives were:-

- To carry out a literature review of the sensitivity to sound of a range of marine fish.
- To develop an understanding of the sound climate associated with certain marine activities, based on the literature review.
- Collect field measurements of ambient sound levels and sound generated by certain activities potentially causing disturbance in the sensitivity range of fish and other animals, concentrating on aggregate dredging.
- Review the sound disturbance caused by aggregate dredging, and the species likely to be sensitive to this disturbance, and recommend areas of future research.

The results of this project are summarised in Marine Aggregate R&D Review: 10th November 2003 (Defra, ODPM and the Crown Estate).

2.2. Projects Funded by Defra and ODPM/Crown Estate

AE0903. Cumulative Environmental Impacts of Marine Aggregate Extraction **(5.B)**

Contractor: CEFAS
Project Total: £674,628
Funding: Defra & Crown Estate.
Status: 4yr project starting 01.01.98

The main focus of this project is to investigate the potential for cumulative environmental effects arising from marine aggregate extraction. This was achieved through a combination of field and desk study over a period of four years. The objectives were as follows:-

- To identify the scope for cumulative effects of multiple dredging activity on the seabed environment and fisheries, initially with special reference to licensed areas off Lowestoft and the Isle of Wight.
- To describe the current environmental status of these regions, with particular attention to the biological communities and the factors controlling them.
- To plan and execute a programme of scientific sampling of key biological and environmental measures relevant to the assessment of cumulative impacts, including definitions of the appropriate spatial scales for benthic sampling in order to identify any biological effects.
- To quantify the spatial scale of physical and biological impact arising from aggregate dredging within selected localities, and its potential significance, especially for commercial fisheries, and variability with time.
- To develop a predictive capability, allowing the consequences of any future extension of dredging activity to be evaluated at the licensing stage.
- To help to define the circumstances under which cumulative effects studies may become necessary in other areas, and to develop a generic framework for such studies.
- To report on findings, with particular emphasis on information beneficial to the assessment of licence applications.

A summary of scientific progress to date is given in Marine Aggregates R&D Review: 10th November 2003 (Defra, ODPM and the Crown Estate).

Reference:
Boyd,S.E. &Rees, H.L. 2003. An examination of the spatial scale of impact on the marine benthos arising from marine aggregate extraction in the central English Channel. *Estuarine & Coastal Shelf Science*, ***57,*** 1-16.

AE0910. A Computer Modelling Tool for Predicting the Dispersion of Sediment Plumes from Aggregate Dredging Activities **(3.a.B)**

Contractor: CEFAS
Project Total: £699,885
Funding: Defra and ODPM
Status: 3yr project starting 01.04.98

The objectives of this project are:-

- To provide a critical review of existing knowledge on dredge plume dispersal to underpin the approach and specification to modelling.
- To assess the availability of, and provide a comprehensive database of bathymetry and high resolution tidal and wind driven flows for use with the model and covering regions of likely aggregate extraction.
- To gain an enhanced understanding of the far field behaviour and impact of sediment plumes generated by aggregate extraction. To express this understanding in a form suitable for model validation.
- To deliver a fully validated modelling tool, with comprehensive high-resolution tidal database. This model to incorporate enhanced knowledge of sediment plume behaviour.

The modelling package allows an assessment of dredger impacts to be made based in site-specific data from a high resolution dataset of tidal information. This dataset covers all UK south coast sites, and all sites within

about 20km of the shore on the east coast, to a resolution of approximately 1km. The ability to specify an arbitrary size distribution of particles means a wide range of aggregate extraction sites and dredging methods can be accommodated. Principal limitations are that a degree of expert knowledge is required to set the initial conditions, particularly if a dynamic plume phase is thought to be important. This is a general requirement that has yet to be fully resolved in any existing model of this type.

A summary of progress to date is given in Marine Aggregate R&D Review: 10th November 2003 (Defra, ODPM and the Crown Estate).

AE0915. Rehabilitation of the seabed following marine aggregate extraction **(6.B)**

Contractor: CEFAS
Project Total: £527,087
Funding: ODPM, Defra & the Crown Estate.
Status: 4yr project starting 01.04.00

The objectives of this research programme are:-

- To assess the rate at which the seabed recovers following marine aggregate extraction
- To identify measures to enhance the potential for the rehabilitation of dredged areas.
- To investigate whether different historical levels of dredging intensity affects the subsequent rate of recolonisation of benthic fauna at marine aggregate sites after cessation of dredging.

The key customer purpose is to assist Defra and the ODPM to develop management strategies for minimising the environmental impact of ongoing dredging activity and assessing the recovery of areas of the seabed from marine aggregate extraction.

An executive summary of progress to date is given in the Marine Aggregate R&D Review: 10th November 2003 (Defra, ODPM and the Crown Estate).

Reference:
Boyd,S.E., Limpenny,D.S., Rees, H.L, Cooper,K.M. & Campbell, S. 2003. Preliminary observations of the effects of dredging intensity on the re-colonisation of dredged sediments off the southeast coast or England (Area 222). *Estuarine & Coastal Shelf Science***. 57**, 209-223.

ME3107. Marine Life Information Network 'MarLIN' **(8.B)**

Contractor: Marine Biological Association of the UK
Project Total: £185,459
Status: 3yr starting 05.11.01

The objective of this project is to identify locations of nationally important benthic species and habitats, at particular risk from pollution from accidental oil spills, develop links between sensitivity and survey data and utilise GIS technology to increase functionality and speed of access to data. Additional research on species and habitats considered as keystone, characterising or indicators as listed under the OSPAR prioritisation process.

The key customer purpose is to contribute to the application of sensitivity information to marine environmental protection, especially by promoting approaches developed in UK in Europe.

ME3111. Marine Life Network (MARLIN) – III **(8.B)**

Contractor: Marine Biological Association
Project Total: £250,000
Status: 4.4yr project starting 01.11.04

This project is a continuation of financial support to the Marlin project, with the same terms of Reference and project objectives defined under phase 1.

Appendix 3: PROJECTS FUNDED BY THE BRITISH MARINE AGGREGATE PRODUCERS ASSOCIATION (BMAPA) & THE CONSTRUCTION INDUSTRY RESEARCH AND INFORMATION ASSOCIATION (CIRIA)

The British Marine Aggregate Producers Association (BMAPA) and the Construction Industry Research & Information Association (CIRIA) has funded a number of research projects directly related to the marine aggregate industry. Projects that have direct relevance to ALSF objectives include:-

Scoping the Assessment of Sediment Plumes arising from Dredging **(3.a.C)**

Contractor: Posford Duvivier Environment, HR Wallingford & CEFAS.
Project Total: £10,000
Status: Report published in 2000.

Reference:
John, S.A., Challinor, S.L., Simpson, M., Burt, T.N. & Spearman, J. 2000. Scoping the assessment of sediment plumes from dredging. CIRIA publication C547. ISBN 0-86017-547-2.

Eastern English Channel – Regional Environmental Assessment **(8.C)**

Contractor: Posford Duvivier Environment heading team of consultants.
Project Total: £1,500,000 (including data acquisition)
Status: Final Report completed February 2003.

This project covered regional scale issues related to licence applications for marine aggregate dredging sites in the central part of the eastern English Channel. It included a description of the existing environment, physical impacts (waves, tides, sediments), plume effects, marine biology, fish resources, fishing activity, shipping, navigation and marine archaeology. The Regional Environment Assessment concluded with a series of management and mitigation recommendations, as well as identifying areas of uncertainty where further research was necessary.

Reference:
Posford Haskoning Ltd. 2003. Regional Environmental Assessment for Aggregate Extraction in the Eastern English Channel. Report prepared for the East Channel Association.

Further information is available on www.eastchannel.info

A Mass Balance Study for a Dredger in the North Sea **(3.a.C)**

Contractor: Coastline Surveys and Marine Ecological Surveys Ltd.
Project Total: £10,000
Status: Completed in 1998.

This study measured the losses from a dredger during the screening process during loading of a cargo in the North Sea. It included measurements of the organic matter entrained in the dredging process and some estimates on whether this could account for the visibility of the dispersing plume associated with dredging operations. The results confirmed studies carried out at the Owers Bank and at the North Nab dredge sites. They suggested that the concentration of organic matter lost in the outwash from operating dredgers is compatible with that available from invertebrates entrained with the sediments and fragmented with the dredging and screening processes.

Reference:

Newell, R.C., Hitchcock, D.R. & Seiderer, L.J. 1999. Organic enrichment associated with outwash from marine aggregates dredging: a probable explanation for surface sheens and enhanced benthic production in the vicinity of dredging operations. *Marine Pollution Bulletin* ***38*** (9), 809-818.

Analysis of the Relationship between Sediment Composition and Biological Community Structure **(3.a.C)**

Contractor: Marine Ecological Surveys Limited.
Project Total: £31,230
Status: Completed in Reports for 1999 and 2001.

This work involved analysis of the relationship between biological community composition of marine benthos and the particle size composition of the deposits at several marine aggregate licence sites. The study showed some correlation between benthic community composition and particle size distribution of the deposits, but at the sites studied there were evidently other environmental factors as well as particle size involved in controlling community composition.

References:

Seiderer, L.J. & Newell, R.C. 1999. Analysis of the relationship between sediment composition and benthic biological community structure in coastal deposits: implications for marine aggregate dredging. *ICES Journal of Marine Science*, ***56***, 757-765.

Newell, R.C., Seiderer, L.J. & Robinson, J.E. 2001. Animal:sediment relationships in coastal deposits of the eastern English Channel. *Journal of the Marine Biological Association U.K.* ***81***, 1-9.

Impact of Marine Aggregate Dredging and Overboard Screening on Benthic Biological Resources in the Central North Sea **(3.b.C)**

Contractor: Marine Ecological Surveys Limited.
Project Total: £85,000
Status: Completed 2002.

This project was carried out in 2001 and extended the results obtained for a non-screened aggregate dredge site at North Nab to a heavily screened site in the central North Sea. The area was well away from other Production Licence Areas so that the influence of other dredge sites could be excluded. Records of the dredging activities within the dredge site then allowed estimates of the impact of dredging on the physical nature of the seabed and associated biological communities both within the dredge site and along the axis of transport of material discharged during the screening process.

References:

Newell,R.C., Seiderer, L.J., Simpson, N.M. & Robinson, J.E. 2002. Impact of Marine Aggregate Dredging and Overboard Screening on Benthic Biological Resources in the Central North Sea: Production Licence Area 408, Coal Pit. Marine Ecological Surveys Ltd Technical Report No. ER1/4/02 to the British Marine Aggregate Producers Association. 72pp.

Robinson, J.E., Newell, R.C., Seiderer, L.J., and Simpson, N.M. 2005. Impacts of aggregate dredging on sediment composition and associated benthic fauna at an offshore dredge site in the southern North Sea. *Marine Environmental Research* ***60***, 51-68.

Marine Aggregate Dredging: A review of current procedures for assessing coastal processes and impact at the coastline **(8.C)**

Contractor: University College London.
Project Total: £5,000
Status: Completed 2001.

This project was initiated in response to public and consultee concerns that had been raised in the Bristol Channel, on the south coast and on the east coast of England over the assessment of coastal processes and coastal impact.

The report investigated the UK licensing procedures for marine aggregate dredging, with specific reference to the potential impact of dredging on coastal processes and the shoreline. The approaches used to assess coastal impacts were reviewed, and comparisons made between the licensing and assessment procedures adopted within the UK and those in other countries. The report concluded with a number of recommendations, including improved communication between the industry and public/stakeholders, the presentation of coastal models and the use of risk assessment techniques to consider the level of unacceptable impact at the coastline.

Marine Aggregate Dredging and the Historic Environment, and associated research **(2.c.C)**

Contractor: Wessex Archaeology.
Project Total: £7,500
Status: Completed 2003.

This project was initiated with English Heritage as partner with BMAPA in response to consultee concerns over the potential for new aggregate licence applications to damage features of archaeological significance. As well as the consideration of the potential for sites of archaeological interest occurring in aggregate resources offshore, a key part of the project was to prepare a Guidance Document to assist the consideration of marine archaeological issues in new licence applications.

The Guidance Document defines a Best Practice approach for consideration of marine archaeology by developers, and was prepared in partnership with both the developer and the regulator.

Appendix Table 3.1. BMAPA Involvement in Research Projects: 1996 to 31.03.05.

Project	Involvement		
	Steering Group	**Data**	**Funding**
CIRIA 1996, Beach recharge materials demand & resources, report 154	X	X	
BGS 1998, Inshore Seabed Characterisation of selected sectors of the English Coast	X	X	
CIRIA 1998, Marine Aggregates in North West Europe, a scoping study	X		
CIRIA 1998, Seabed Sediment Study West of the Isle of Wight, Report PR65 (DETR/CE)	X	X	£10k
CIRIA 1998, Regional Seabed Sediment Studies and Assessment of Marine Aggregate Dredging, C205	X		Linked to above.
CIRIA 1999, Maximising the use and exchange of coastal data, CP77	X		
CIRIA 2000, Scoping the assessment of sediment plumes arising from dredging, C547 (DETR, BMAPA, English Nature, Federation of Dredging Contractors, MAFF, Rijkswaterstadt)	X		£10k
ABP/Posford Duvivier 2000, Bristol Channel marine aggregate resources and constraints study (NAW/DTLR)	X	X	
MARLIN, 2001, web-based database of benthic information			£5k/year - 3 years
University College London 2001, A review of Coastal Impact Study techniques (BMAPA/SCOPAC)	X		£5k
Hants & Wight Trust for Maritime Archaeology, 2001, Submerged landscapes and prehistory in the Solent			£2k
HR Wallingford in prep, Southern North Sea sediment transport study, Phase 2 (ACAG/DEFRA/EA et. al.)	X	X	£10k
Marine Ecological Surveys in prep, The biological impact of marine aggregate dredging in a screened licence area (BMAPA)	N/a	X	£85k
Wessex Archaeology in prep, Archaeological Guidance Note and research into the archaeological potential of dredging areas (BMAPA/RCHME)	X		£7.5k
CEFAS in prep, Assessment of the potential for cumulative impacts from marine aggregate dredging (DEFRA/CE/DTLR)		X	
CEFAS in prep, The rehabilitation of seabed following marine aggregate dredging (DTLR/DEFRA/Crown Estate)	X	X	
CEFAS in prep, Procedural guidelines for benthic surveys (DTLR)	X		£3k
CEFAS in prep, Assessment of noise generated by marine aggregate dredging (DEFRA)	X		
CEFAS in prep, Assessment of noise generated by marine aggregate dredging (DEFRA)	X	X	£1k
Symonds Group in prep, Comparative impact assessment of supply options for fine aggregate supply in South Wales (NAW)	X	X	
Baird Associates in prep, Model development or modification for analysis of dredge plume generation, dispersion and sedimentation (MMS)	X	X	
Posford Haskoning in prep, Scoping Study for a Marine Development Plan (DTLR)	X		

Appendix Table 3.2. Research Projects involving individual BMAPA Members

Project	Involvement		
	Steering Group	**Data**	**Funding**
HR Wallingford 1993, South Coast Seabed Mobility Study		X	
MAFF/Crown Estate 1992-1997, North Norfolk trial dredging and benthic recovery			X*
ABP/SUDO/ACAG 1996, Southern North Sea sediment transport study, Phase 1 – Literature review & conceptual sediment transport model	X		X
HR Wallingford 1996, Dispersion studies at Owers Bank		X	
Coastline Surveys 1998, Marine aggregate mining benthic and plume study (MMS)		X	
Marine Ecological Surveys/Coastline Surveys 1999, The biological impact of marine aggregate dredging in an unscreened licence area (MMS)		X	
Marine Ecological Surveys 1999, Analysis of the relationship between sediment composition and benthic community structure in coastal deposits: implications for marine aggregate dredging		X	X
Marine Ecological Surveys in prep, Animal/sediment relationships in coastal deposits of the eastern English Channel, off Folkestone, Kent		X	

* Funding in kind – vessel time

Seabed Sediment Study, West of the Isle of Wight
CIRIA Report PR65, 1998

Originator and Principle Funders:
CIRIA originated and administered the project, with the DETR and the Crown Estate as principle funders.

This project (and the parallel C505 report) followed on from an original seabed sediment study undertaken to the east of the Isle of Wight by HR Wallingford (Report EX2795, 1993), which was largely funded by Coastal Authorities.

Study Team:
HR Wallingford and the British Geological Survey.

Objective:
To investigate seabed sediment transport processes between St Catherines Point (IOW) and Durlston Head (Dorset).

BMAPA Contribution:
A total of £10k was made available for this and the accompanying Regional Seabed Sediment Study report (C205) completed in parallel with this project. In addition, BMAPA was represented on the projects steering group and BMAPA members made available prospecting data where available.

Conclusions:
Inshore of a line between the Needles and Durlston Head, sediments are regularly transported by tides and waves. Any dredging would require careful study of waves, tides and sediment mobility and would probably require substantial monitoring. Offshore of this line, the seabed sediments are immobile, therefore dredging will not affect sediment supply to coastlines, although waves and tides still need to be considered.

Regional Seabed Sediment Studies and Assessment of Marine Aggregate Dredging CIRIA Report C505, 1998

Originator and Principle Funders:
CIRIA originated and administered the project, with the DETR and the Crown Estate as principle funders.

Study Team:
HR Wallingford and the British Geological Survey.

Objective:
To provide a definitive guide to the requirements, objectives and scope of seabed sediment studies necessary to assess the implications of proposed marine aggregate dredging.

BMAPA Contribution:
A total of £10k was made available for this and the accompanying Seabed Sediment Mobility Study (PR65) completed in parallel with this project. In addition, BMAPA was represented on the projects steering group.

Conclusions:
Tidal flows, wave conditions and sediment mobility should always be investigated, and methods for doing so are described. The rigour of each study will depend on the location of the proposed dredging area.

The report also concluded that the storage and analysis of seabed and coastal data should be improved, and that a meta-database (information about information) is needed to list what data exists and who holds it. The aim being to improve understanding of seabed dynamics through existing information wherever possible, in order to permit better informed decisions on activities that may affect it.

Scoping the assessment of sediment plumes arising from dredging CIRIA Report C547, 2000

Originator and Principle Funders:
CIRIA originated and administered this project.

Funding was provided by DETR, BMAPA, English Nature, the Federation of Dredging Contractors, MAFF and the Rijkswaterstadt

Study Team:
The study team was led by Posford Duvivier Environment, with HR Wallingford and CEFAS as sub-contractors.

Objective:
The overall objective was seen as a scoping report to developing a structured approach to the assessment of the effects of sediment plumes arising from dredging, that could be used by developers and regulators alike.

This not only included aggregate dredging, but also capital and maintenance dredging.

BMAPA Contribution:
A contribution of £10k was made to the project.

Additionally, BMAPA was represented on the steering group.

Conclusions:
The report provides a review of research work undertaken on the plumes arising from various dredging operations, and examines current knowledge on environmental impacts.

Through this review process, it considers the current understanding of dredging plumes and identifies gaps in knowledge (specifically the lack of sufficient source term/dispersion information (examples of actual data measurements) to plug into/validate existing numerical models). Recommendations are then made to fill these gaps and to develop a comprehensive framework for assessment.

Southern North Sea Sediment Transport Study – Phase II
HR Wallingford, 2002 (in prep)

Originator and Principle Funders:
Members of ACAG/Members of HECAG/Crown Estate /BMAPA/English Nature/ Environment Agency. MAFF grant aid also obtained

Study Team:
HR Wallingford – Project management
Posford Haskoning
CEFAS
UEA
Dr Brian D'Olier

Objective:
To obtain an improved understanding of the Southern North Sea sediment transport system and its links with the eastern English coastline between Flamborough Head and the River Thames. To include:-

- Identification of sediment sources, transport pathways, volumes of sediment transport and areas of deposition, across the complete range of particle sizes and temporal scales.
- Identification of the location, size, variability and evidence of offshore features, and their influence on and interaction with waves and tidal current climates.
- Provision of the information that is required for the updating of SMPs and which enable a more informed assessment to be made of the influence of off shore dredging on the eastern coast of England

BMAPA Contribution:
£10K plus data.

Conclusions:
The report concludes that the assessment of sediment issues along a substantial length of the east coast has enabled an overview of the main issues. These in turn have been able to be linked at the regional scale rather than being examined in isolation. The results produced by the study and the new site-specific field data collected in the study will be of lasting value for comparison against future studies.

Marine Aggregate Dredging: A review of current procedures for assessing coastal processes and impact at the coastline
Simons, R. and Hollingham, S., University College London, 2001

Originator and Principle Funders:
BMAPA initiated this project, in response to public and consultee concerns that had been raised in the Bristol Channel, on the South coast and on the East coast over the assessment of coastal processes and coastal impact. The Standing Conference on Problems Associated with the Coastline (SCOPAC), a coastal group centred on the Isle of Wight was approached to partner the scheme.

Study Team:
The Civil and Environmental Engineering Department of University College London was approached to undertake the project, with a Master's student undertaking most of the data collection.

Objective:
The report investigates the UK licensing procedures for marine aggregate dredging, with specific reference to the potential impact of dredging on coastal processes and the shoreline. The approaches used to assess coastal impact were reviewed, and comparison was made of the licensing and assessment procedures adopted in the UK with those in other countries.

BMAPA Contribution:
BMAPA contributed £5k to the project, which was matched by SCOPAC. BMAPA also project managed and administered the project.

Conclusions:
The report concluded that the licence procedures in place were for the most part world-leading, though there was potential for improvement during the consultation stages and in the presentation of results from coastal models used in Coastal Impact Studies. The need for more effective dialogue and feedback during the application process was also highlighted.

Methods of coastal impact assessment were considered to be consistently applied, though concerns were raised over the reliance upon the modeled wave conditions generated by reference to wind records, without validation against local wave conditions. The choice of 'acceptable change' criterion (2-3%) was also discussed against the limits of numerical model accuracy.

The report concluded with a number of recommendations, including improved communication between industry and public/stakeholders, the presentation of coastal models and the use of risk assessment techniques to consider the level of unacceptable impact at the coastline.

Impact of marine aggregate dredging & overboard screening on benthic biological resources in the central North Sea (Area 408)
Robinson, J.E., Newell, R.C., Seiderer, L.J. & Simpson, N.M. 2005. Impacts of aggregate dredging on sediment composition and associated benthic fauna at an offshore dredge site in the southern North Sea. *Marine Environmental Research*, **60:** 51-68

Originator and Principle Funders:
BMAPA originated and was the sole funder for this project.

The work was a natural progression from a project undertaken to the east of the Isle of Wight, funded by the American Minerals Management Survey, in that it considered a relatively intensively trailer dredged area

that employed screening. The earlier work considered the effects of static, all-in dredging and was thus less representative of the majority of UK marine aggregate production.

Study Team:
The project was undertaken by Marine Ecological Surveys Ltd, with the survey work completed in conjunction with routine monitoring work. A separate report on seabed sediments was completed by Coastline Surveys Europe Ltd, as an annex to the main research.

Objective:
To assess the impact of marine aggregate dredging and screening on benthic biological resources, and to consider the nature and scale of potential 'far field' effects resulting from the return of sediment through the screening process. The nature of dredging in the study area also provided the opportunity to consider the recovery of the seabed and benthos once dredging ceased.

BMAPA Contribution:
BMAPA provided all the funding for this work, including data collection, vessel hire, analysis and reporting. Hanson Aggregates Marine supplied additional physical information (sidescan sonar data), and absorbed the mob/de-mob costs for the survey.

Conclusions:
Species numbers and diversity were unaffected in and around actively dredged areas, although biomass was significantly depressed. Recovery appeared to be substantially complete within 12 months of dredging ceasing.

Important evidence of potential enhancement effects outside of the actively dredged area was identified, together with 'far field' effects extending 2-4km downstream, believed to be an effect of the screening. This is the first time these effects have been accurately quantified at a production licence area.

Marine Aggregate Dredging and the Historic Environment, and Associated Research
Wessex Archaeology, 2002 (in prep)

Originator and Principle Funders:
BMAPA instigated the project, and contacted English Heritage (the regulator designate) to proceed on a partnership basis. This was in response to an increase in consultee concerns over the potential for new applications to damage features of archaeological heritage.

Study Team:
Wessex Archaeology, supported by Francis Wenban-Smith from Southampton University.

Objective:
To consider the implications of marine aggregate dredging on the historic environment, in terms of flooded landscapes and maritime heritage (wrecks etc.). Internationally, this is a developing issue.

As well as the consideration of the potential for sites/features of archaeological interest occurring in aggregate resources offshore, a key part of the project was to prepare a guidance document to aid the consideration of marine archaeological issues in new licence applications.

BMAPA Contribution:
BMAPA contributed £7.5k to the project, which was match funded by English Heritage. Additionally, BMAPA administered the project, and conducted the consultation necessary.

Conclusions:
The guidance document defines a best practice approach that sets a marker for consideration of marine archaeology by developers, prepared in partnership with the developer and the regulator. This is certainly nationally leading, and potentially internationally leading.

The wider research undertaken that considers the potential for marine aggregate deposits to contain features of archaeological interest is also ground-breaking.

Guidelines for the conduct of benthic studies at aggregate dredging sites
DTLR, 2002

Originator and Principle Funders:
DTLR funded and managed this project.

Study Team:
CEFAS undertook this project.

Objective:
Guidelines for conducting benthic surveys in support of aggregate dredging applications were considered necessary in order to promote a consistent and comprehensive approach to the assessment of the seabed environment as part of the pending statutory planning process.

BMAPA Contribution:
BMAPA were members of the steering group.

Although not funding the project directly, with the approval of the steering group BMAPA contracted three environmental consultancies to technically review and comment on the draft guidance document. This cost £3k.

Conclusions:
The guidance provides advice on survey design and survey techniques for regulators, developers and consultants, particularly with respect to the consideration of potential cumulative and in-combination effects.

Marine Life Network (MARLIN)

Originator and Principle Funders:
Marine Biological Association, in conjunction with English Nature, DEFRA, the Crown Estate, UKOOA and BMAPA.

Study Team*:*
Managed by the Marine Biological Association.

Objective:
To develop a meta-database (information about information) of marine biological survey information around the coastline of the United Kingdom. This can be accessed and interrogated through the web.

BMAPA Contribution:
Funding of £5k/year over three years was agreed from 2001, to assist in the development of this project.

Individual company members have also begun to provide information about baseline and monitoring biological surveys for inclusion in the database.

Conclusions:
The project has developed to pull together all available biological survey information around the coastline of the UK, to provide a reference database. The intention is to maximise the available information by centralising the type, extent and timing of all surveys, so that interested parties can see what has already been done. Potentially, this can reduce duplication of survey effort, and maximise the benefit of available information, which may have more than one use.

Rights to survey information remain with the owner, and prospective users have to come to an agreement for access to any specific data on a case-by-case basis.

Submerged Landscapes and Prehistory in the Solent
Hants and Wight Trust for Archaeology, 2001

Originator and Principle Funders:
Hampshire and Wight Trust for Archaeology have been running a programme on marine archaeology for a number of years, supported by funding from various organisations, including English Heritage, DCMS, the Crown, SCOPAC and Hants County Council.

Study Team:
Hants and Wight Trust.

Objective:
Two projects are evolving, considering the prehistory of the Solent and a survey of the same area. Both seek to further the understanding about the submerged landscapes to be found in the area, and to consider the evolution of sea level rise to help explain the separation of the Isle of Wight and the drowning of the river valleys of the Hampshire coast.

BMAPA Contribution:
£2k.

Conclusions:
The project is ongoing, but numerous papers have been produced.

Assessment of noise generated by marine aggregate dredging
CEFAS, 2002 (in prep)

Originator and Principle Funders;
DEFRA have funded this project, in response to issues raised through several ongoing production licence areas where the noise of aggregate extraction is claimed to have resulted in behavioural changes in commercial fish stocks.

Study Team;
CEFAS undertook to complete the work in conjunction with QinetiQ (previously the Defence Research Agency – DERA).

Objectives;
To obtain measurements of the noise generated by aggregate extraction, and to consider the potential implications to commercial fish species.

BMAPA Contribution;
Initially, BMAPA offered contribution in kind, by making dredgers available to allow measurements to be made while loading took place. BMAPA was also represented on the steering group.

However, funding ran out for the project before measurements were obtained. BMAPA therefore offered to pay for 1-days boat time (linked to an ongoing survey) to ensure that the data was collected, at a total cost of £1k.

Conclusion;
Results are still being analysed, and a final report has not been issued yet.

Appendix 4. PROJECTS FUNDED BY THE US GOVERNMENT, DEPARTMENT OF THE INTERIOR, MINERALS MANAGEMENT SERVICE (MMS)

Several studies on the impacts of marine aggregate dredging in UK waters have been funded by the US Government, Minerals Management Service (MMS). This work has been aimed at providing information for planned sand extraction off the east and south-east coasts of the USA, based on data collection from aggregate extraction sites in UK waters. This has been followed by a number of studies funded by the MMS in the USA. Information on relevant projects funded by the MMS can be obtained from the following website:-

www.mms.gov/sandandgravel

Relevant studies in UK waters are as follows:-

Investigation of Benthic and Surface Plumes Associated with Marine Aggregate Dredging Activities **(3.a/b.C)**

Contractor: Coastline Surveys & Marine Ecological Surveys Ltd.
Project Total: £78,000
Status: Completed October 1998

This project comprised a study of plumes associated with marine aggregate dredging off the Owers Bank on the south coast of England. The project was based on 162 continuous Backscatter Profiling (CBP) transects across plumes generated by trailer suction dredgers operating at a licence site where material was returned to the seabed by screening. The Report includes a review of the potential impacts of marine aggregate dredging on benthic biological resources and an assessment of the main sources of impact of the dredging and screening processes.

References:

Hitchcock, D.R., Newell, R.C. & Seiderer, L.J. 1998. *Investigation of Benthic and Surface Plumes associated with Marine Aggregate Dredging in the United Kingdom – Final Report. Contract Report for the U.S Department of the Interior, Minerals Management Service.* Contract Number 14-35-0001-30763. Coastline Surveys Ltd Ref. 98-555-03 (Final). 168 pp.

Newell, R.C., Seiderer, L.J. & Hitchcock, D.R. 1998. The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the sea bed. *Oceanography and Marine Biology: an Annual Review* 1998, ***36***, 127-178.

Study of the Cumulative Effects of Marine Aggregate Dredging **(5.C)**

Contractor: Oakwood Environmental Ltd
Project Total: £63,000
Status: Completed 1999.

This project comprised a literature review of the cumulative effects of marine aggregate dredging. The Report is available on the Minerals Management Service website Reference OCS Study 2000-054.

Integrated Study on the Impact of Marine Aggregate Dredging on Physical and Biological Resources of the Seabed **(3.a/b.C)**

Contractor: Coastline Surveys & Marine Ecological Surveys Ltd.
Project Total: £200,000
Status: Completed 2002.

This study was principally carried out at the North Nab dredge site to the east of the Isle of Wight where aggregates are dredged without return of screened material to the seabed. Additional analysis of plumes associated with dredging and screening at Owers Bank to the east were included in the

Report. The results showed the impact of dredging at different levels on benthic infauna within the dredge site, and also showed evidence of an enhancement of numbers and biomass of filter-feeding invertebrates in the deposits surrounding the dredge site. The reasons for this were not established, but were thought to include release of organic matter from material discharged overboard by the dredger, and released by disturbance of the deposits during dredging. Analysis of plumes associated with dredging suggested that there may be a benthic boundary layer of mobilised sediment that extends beyond the boundaries of the passive settlement of material from the dispersing plume.

References:

Hitchcock, D.R., Newell, R.C. & Seiderer, L.J. 2002. *Integrated Report on the Impact of Marine Aggregate Dredging on Physical and Biological Resources of the Sea Bed*. U.S Department of the Interior, Minerals Management Service, International Activities and Marine Minerals Division (INTERMAR), Washington, DC. OCS Report Number 2002-054. Contract Number 14-35-01-99-CT-30980. 242 pp.

Newell, R.C., Seiderer, L.J., Simpson, N.M. & Robinson, J.E. 2003. Impacts of marine aggregate dredging on benthic macrofauna off the south coast of the United Kingdom. *Journal of Coastal Research* ***20*** (1) 115-125.

Status of Marine Minerals Environmental Studies (As of April 4, 2005)

4.1 Completed Projects/Generic

Title	Awarded Amount
West Florida Shelf Benthic Repopulation Study (OCS Report 95-0005, Sept. 1996)	$425,000
Synthesis of Hard Mineral Resources on the Florida Panhandle Shelf (Final Report completed Sept. 1998)	$149,782
A Numerical Modeling Examination of the Cumulative Physical Effects of Offshore Sand Dredging for Beach Nourishment (MMS Study 2001-098, March 2003)	$200,000
Development of Criteria to Evaluate Wave Refraction Models (OCS Study 99-0096, Oct. 1999)	$60,000
Design of a Monitoring Protocol/Plan for Environmentally Sound Management and Development of Federal Offshore Sand Borrow Areas Along the United States East and Gulf of Mexico Coasts (OCS Study 2001-089,Oct. 2001)	$351,296
Model Development or Modification for Analysis of Benthic and Surface Plume Generation and Extent During Offshore Dredging Operations (Final model delivered December 2003)	$200,000
Worldwide Analysis of Shipwreck Damage Caused by Offshore Dredging: Recommendations for Pre-Operational Surveys and Mitigation to Avoid Adverse Impacts (OCS Study 2004-0005, Feb. 2004)	$123,327
Review of Existing and Emerging Environmentally Friendly Offshore Dredging Technologies	$176,664
Total of Completed Generic Efforts	**$2,081,069**

4.2 Completed Projects /Site-Specific

Title	Awarded Amount
Environmental Surveys of OCS Sand Resources off Virginia (OCS Report 97-0025, January 1998)	$420,000
Wave Climate Modeling and Evaluation Relative to Sand Mining on Ship Shoal, Offshore LA, for Coastal and Barrier Islands Restoration (OCS Study 96-0059, Oct. 1996)	$396,171
Environmental Surveys of OCS Sand Resources Offshore Alabama (OCS Study 99-0051, Sept. 1999)	$498,943
Environmental Report: Use of Federal Sand Resources for Beach and Coastal Restoration in New Jersey, Maryland, Delaware and Virginia (OCS Study MMS 99-0036**,** November 1999) ***Note: This was not funded using ESP dollars.***	$450,000
Surveys of Sand Resource Areas Offshore Maryland/Delaware and the Environmental Implications of Sand Removal for Beach Restoration Projects (OCS Study 2000-055, August 2000)	$384,241
Environmental Surveys of OCS Sand Resources Offshore New Jersey (OCS Study 2000-052, Dec. 2000)	$599,048
Wave Climate and Bottom Boundary Layer Dynamics with Implications for Offshore Sand Mining and Barrier Island Replenishment, South-Central Louisiana (OCS Study 2000-053, Dec. 2000)	$393,671
Collection of Environmental Data Within Sand Resource Areas Offshore North Carolina and the Environmental Implications of Sand Removal for Coastal and Beach Restoration (OCS Study 2000-056, Sept. 2003)	$499,969
Environmental Surveys of Potential Borrow Areas Offshore Northern New Jersey and Southern New York and the Environmental Implications of Sand Removal for Coastal and Beach Restoration (OCS Study 2004-044, November 2004)	$500,000
Environmental Surveys of Potential Borrow Areas on the East Florida Shelf and the Environmental Implications of Sand Removal for Coastal and Beach Restoration (OCS Study 2004-037, January 2005)	$550,000
Total of Completed Site-Specific Efforts	**$4,692,043**

4.3 Completed Projects /Aggregate Studies

Title	Amount Awarded
Investigation of Benthic and Surface Plumes Associated With Marine Aggregate Dredging Activities (OCS Study 99-0029, July 1999) www.mms.gov/sandandgravel/PDF/JCR%20Volume%2020/JCR%20MMS%20Theme%20Section_Aggregate_Physical.pdf	$140,000
Study of the Cumulative Effects of Marine Aggregate Dredging (OCS Study 99-030, Feb. 1999)	$100,000
Integrated Study of the Biological and Physical Effects of Marine Aggregate Dredging (OCS Study 2000-054, October 2002) www.mms.gov/sandandgravel/PDF/JCR%20Volume%2020/JCR%20MMS%20Theme%20Section_Aggregate_Bio.pdf	$320,000
Total of Completed Aggregate Dredging Efforts	**560,000**

Total Expended for all Completed Efforts:$7,333,112

4.4 Ongoing Projects/Contracted

Title	Amount Awarded
Environmental Investigation of the Use of Shoals Offshore Delaware and Maryland by Mobile Benthos and Finfish Species (Site specific /Generic/Versar) ***Note: All field work has been completed; data analysis ongoing.***	$500,000
Analysis of Potential Biological and Physical Dredging Impacts on Offshore Ridge and Shoal Features/Engineering Alternatives and Options to Avoid Adverse Environmental Impacts (Generic/Continental Shelf Associates)	$400,000
Worldwide Survey of Dredging Impacts on Commercial and Recreational Fisheries and Analysis of Available Mitigation Measures to Protect and Preserve Resources (Generic/EMU, Limited) ***Note: First dredge observation and interviews was aboard Bean dredge Meridian, offshore Morehead City, NC, December 6, 2004. Second observation planned for offshore Brevard County, Florida, April 14, 2005.***	$249,849
Total Ongoing Contracted Projects	$1,149,849

4.5 Ongoing Projects/Cooperative and Inter-Agency Agreements

Title	Amount Awarded
Winter Waterbird Survey of Offshore Shoals From Northern New Jersey to the Virginia/North Carolina Border (Interagency Agreement with Fish and Wildlife Service)	$25,000
Field Testing of a Physical/ Biological Monitoring Methodology for Offshore Dredging and Mining Operations (Generic/Site-specific – being conducted at Sandbridge Shoal, offshore Virginia (Cooperative Agreement with Virginia Institute of Marine Science) *(Phase 1: $58,000; Phase 2: $611,821)(Site-Specific/Generic)* ***Note: Cooperative agreement extended to allow for additional biological data collection postdredging***	$669,821
Environmental Investigation of the Long-Term Use of Ship Shoal Sand Resources for Large-Scale Beach and Coastal Restoration in Louisiana (Cooperative Agreement with Louisiana State University) (Co-funded with Louisiana Department of Natural Resources)	$600,000 (MMS $)***(LDNR providing additional $600,000 – total project cost is $1.2 million)***
Total Ongoing Cooperative and Inter-Agency Agreements	**$1,149,849**

4.6 Ongoing Studies/MMS/LSU Coastal Marine Institute

Title	Amount Awarded
Wave-Bottom Interaction and Bottom Boundary Layer Dynamics in Evaluating Sand Mining at Sabine Bank for Coastal Restoration, Southwest Louisiana	MMS: $345,172 (LSU Match: $349,671)
Ship Shoal, Louisiana: Sand, Shrimp, and Sea trout Investigation MMS	$145,778 (LSU Match: $145,877)
New WAVCIS Ocean Observing System on Ship Shoal, Louisiana	MMS: $500,000
Total, Ongoing MMS/LSU CMI (MMS only)	**$990,950**

4.7 Additional Ongoing Study Efforts (Non-ESP)

Title	Amount Awarded
Study to Address the Issue of Seafloor Stability and the Impact of Sand Dredging Activities on Oil and Gas Infrastructure in the Gulf of Mexico (Baird and Associates)	$109,912
Total Additional Ongoing Study Efforts	**$109,912**

4.8 Ongoing Marine Mineral Environmental Study Efforts Being Conducted by USGS Biological Resources Division

Title	Amount Awarded
Focused Analysis/Review of Benthic Assemblages on Ridge and Shoal Features of the U. S. East and Gulf of Mexico Coasts (Generic)	$210,000
Investigation of Finfish Assemblages and Benthic Habitats Within Potential Borrow Areas in Federal Waters Offshore Southeastern Texas and Southwestern Louisiana (Site-Specific) ***Note: Detailed cruise report available at http://www.mms.gov/sandandgravel/PDF/TX%20Sand%20Cruise%20Report.pdf***	Total BRD $ over 3 years: $1,020,000
Utilization of Benthic Communities by Fish Populations on Ridge and Shoal Features (Ship Shoal) Total BRD $ over 4 years:	$540,000
Total Ongoing Marine Mineral Environmental Study Efforts Being Conducted by USGS Biological Resources Division	**1,770,000**

Appendix 5. RELATED RESEARCH PROGRAMMES FUNDED BY THE EUROPEAN UNION

There are several major research programmes relevant to the Marine Aggregate Industry supported by the European Union under Inter-Regional Aid (INTERREG III) funds.

Eastern Channel Habitat Atlas for Marine Resource Management (CHARM) **(2.b.D)**

Contractor:	Canterbury Christ Church University College, University of Kent at Canterbury with multiple partners in France.
Funding Source:	EU INTERREG IIIB North West Europe (NWE) programme
Project Total:	Phase 1- £1,335,020 (50% from EU Funds)
Status:	Phase I completed May 2005.

The aim of this project is to improve the management of the marine environment in the vicinity of the Dover Strait in terms of its biological resources. In addition to consideration of simple fisheries stock values, areas of reproduction and feeding areas consideration is also given to the food webs upon which they depend and the effects of abiotic factors, climatic and anthropogenic effects.

A Steering Group consisting of key stakeholders in the marine environment of the Dover Strait and adjacent waters has been set up. The objectives of the project are as follows:-

- To integrate diverse available marine environmental and biological data into an atlas of habitats, important species and marine living resources.
- To model scenarios for impacts to marine habitats and changes in levels of exploitation that can influence marine living resources.
- To develop a 'toolbox' to aid decision-making and planning in the marine environment of the eligible area.
- To evaluate current policy and legal frameworks in the context of the management of the marine ecosystem and to suggest possible improvements.
- To disseminate the atlas-based information widely within the eligible area, principally by on-line and other electronic media, in order to raise public awareness of the marine environment, its resources and habitats.

Further information can be obtained on this project from the following website:-

http://charm.canterbury.ac.uk/presentation/presentation.htm

Development of a Framework for Mapping European Seabed Habitats – MESH **(2.b.D)**

Contractors:	Joint Nature Conservation Committee (JNCC) with 11 partners
Funding Source:	EU INTERREG IIIB North West Europe (NWE) programme
Project Total:	£5,300,000
Status:	4yrs project starting May 2004. Reporting to ODPM.

The object of this project is to present seabed habitat maps covering all the marine waters of north-west Europe via the internet, and to develop internationally agreed standards for future seabed mapping campaigns. The project was proposed at the OSPAR Biodiversity Committee meeting in January 2003 and is intended to achieve the following objectives:-

- Facilitate spatial planning and decision-making in the marine environment
- Establish an ecologically-coherent network of marine protected areas
- Protect internationally-threatened marine habitats and species.

The MESH project will reach key stakeholders through a combination of printed material, a website and direct contact with stakeholders.

Further information on this project can be obtained from:-

www.searchMESH.net

EU Community Research Programme 'SANDPIT' **(3.a.D)**

Contractors: Consortium of Universities and Hydraulics Institutes led by Prof.Leo van Rijn.
Funding Source: EU INTERREG IIIB North West Europe (NWE) programme
Project Total: £3,500,000
Status: 3yr project. Final Report to be a Book published in July 2005.
http://sandpit.wldelft.nl/mainpage/mainpage.htm

The overall objective of the SANDPIT project is to develop reliable prediction techniques and guidelines to better understand, simulate and predict the morphological behaviour of large-scale sand mining pits/areas, and the associated sand transport processes at the middle and lower (offshore) shoreface and also in the surrounding coastal zone.

The project is funded through the 5th framework of the EU Community Research Programme and is also supported by funding from the joint Defra/Environment Agency flood and coastal erosion risk management R&D programme. Theme 1 – Fluvial, Estuarine and Coastal Processes (theme leader: Prof. Mike Thorne).
The original intention of SANDPIT was to construct a large experimental pit in the Dutch part of the North Sea, and to collect data to better understand sand transport processes within, and in the vicinity of the pit. This proposal was abandoned after permission to construct the pit was refused by the Dutch authorities. Instead fieldwork has focussed on existing pits and sand transport studies in large-scale laboratory facilities.

There are synergies between SANDPIT and two other projects that have a remit to develop guidance for the management of marine sand and gravel operations. These are:-

- An EU funded EUMARSAND programme (co-ordinated by Dr. Aldolo Uriate, AZTI, Spain). Details of this programme can be obtained from:- http://www.azti.es/eumarsand/eumarsand.htm
- The ICES WGEXT programme. Details of this programme can be obtained from:- http://www.ices.dk/reports/mhc/

The final output of the SANDPIT programme will be a 600 page book due for publication in July 2005. The outputs from the programme will be separated into two parts: (i) material suitable for end-users and (ii) technical papers describing the outcome of research. Sections of the book are already available on the SANDPIT website at:- http://sandpit.wldelft.nl/mainpage/mainpage.htm

K. GLOSSARY OF TERMS

Note that this glossary is more comprehensive than the Marine ALSF Science Review – 2005 might require. It does however cover a number of terms which appear in linked documents.

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Accretion	- process of sediment build-up
Acoustic backscatter	- a method of detecting discontinuities in the water, often used for current and turbidity measurements
Active dredge zone	- area within a licence area that is dredged
Aggradation	- reworking of the sediment by waves and currents
Aggregate	-the collective term for sand, gravel and crushed rock. They can be compacted to firmly fill a space and are often bound together with cement (to make concrete) or bitumen (for road surfacing)
Amphipod crustacean	- a group of small crustaceans eg., 'sand hoppers'
Annelida	- worms
Anthropogenic	-of or relating to the study of the origins and development of human beings
Appraisal	-A rapid reconnaissance of a site and records to establish whether a mineral extraction or other development proposal has known or potential archaeological potential requiring further investigation
Archaeological Contractor	-Archaeological organisation commissioned to carry out archaeological assessments, evaluations, excavations and other required mitigation works
Archaeological Curator	-A person or organisation with a statutory responsibility for the management and conservation of archaeological sites and archaeological evidence generally for a specific area. It includes national bodies such as English Heritage
Archaeology	- the study of historic and prehistoric communities
Artefacts	- objects of archaeological interest, often stone tools or other man-made objects
Ascidians	- generally soft-bodied animals sometimes forming colonies attached to stones and rocks - sea squirts
Attenuation	-Term used to describe the decrease in noise level. It is the opposite of amplification.
Barnacles	- small crustaceans encased in a calcareous shell, usually attached to shells and rocks on the seabed
Barrier islands	- offshore sandbanks that may, or may not be exposed at low tide and which protect a coast from prevailing wave action
Baseline	-the conditions existing before the commencement of mineral operations. This may not be the "natural" state, as there may be other impacts already operating
Baseline survey	- a survey of environmental resources carried out prior to a development
Bathymetry	- the topography of the seabed
Beach draw down	- removal of deposits from a beach by seabed transport
Beach recharge	- placement of aggregates on beaches to replace that lost by erosion (beach nourishment) or to protect coastal resources
Bedform	- sand sheets, ribbons and sand waves on the seabed
Bedload transport	- the transport of sediments along the seabed
Benthic boundary layer	- a zone at the seabed where sediment transport occurs
Benthic ecology	- the nature and distribution of organisms on the seabed
Benthic fauna	- animals that live on the seabed
Biodiversity	- the range of species that comprise a particular community or habitat
Biodiversity Action Plan (BAP)	Biodiversity Action Plan. This is a range of 59 broad activities for conservation work which were agreed at the UK Biodiversity Convention in 1993, held in response to the Rio summit in 1992, which called for the creation and enforcement of national strategies and action plans to conserve, protect and enhance biological diversity. www.ukbap.org.uk
Biogenic reefs/concretions	- aggregates of species that together form a hard substrate
Biomass	- the mass of organisms in a community
Biotope	- a distinctive community of interdependent organisms that characterise a particular habitat type.
Boundary layer currents	- currents at the sediment-water interface
Bronze Age	-in Britain the period approximately between 2000-700BC. Equated with the introduction of copper metallurgy.

Bryozoa	- mainly colonial animals that can form encrusting growths or leaf-like colonies attached to rocks and stones on the seabed
Catchment Area	-a land area where precipitation runs off into streams, rivers, lakes, and reservoirs. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large drainage basins, like the area that drains into the River Severn contain thousands of smaller drainage basins
Cetaceans	- whales and dolphins
Chart Datum	- a reference point to which water depths are referred
Chronology	- the relative timing of events
Coastal Impact Study	- a comprehensive study of all aspects of a project on the coastal morphology, bathymetry and coastal processes
Coastal squeeze	- narrowing of the upper shore from a combination of sea defences and rising sea level
Community composition	- the relative species variety, population density and biomass
Compensation	-the measures taken to offset or compensate for residual adverse effects that cannot be mitigated, or for which mitigation cannot entirely eliminate adverse effects
'Conditions'	- constraints or requirements imposed on a licence as part of the consent for aggregate dredging
Conservation status	- an assessment of the significance of an area for wildlife resources and habitats protected under conservation law
Consultees	- those consulted as part of the Environmental Impact Assessment process
Crown Estate	- the Body responsible for the commercial management of the seabed that is under the jurisdiction of the Crown
Crustacea	- shellfish such as crabs, lobsters and prawns
Cumulative effects	- the sum of effects from adjacent activities such as dredging and fishing, including spoils and waste disposal
Cut depth	- the depth of individual passes by the draghead
Deeps	- areas of seabed where the depth greatly exceeds that in the surrounding waters
Defra	-Department for Environment, Food and Rural Affairs. This is a government department whose aim is sustainable development. www.defra.gov.uk
Demersal fish	- fish that live on the seabed
Dendrogram	- a method of showing the similarity between samples
Density current jet	- a fast moving dense plume of suspended solids descending to the seabed from dredger reject chute discharge
Dependent species	- species that depend on the presence of other species for their occurrence in a particular habitat
Designated habitats	- habitats protected under Directive 92/43/EEC The Habitats Directive and Directive 74/409/EC the Birds Directive
Designated species	- species protected under Directive 92/43/EEC The Habitats Directive and Directive 74/409/EC the Birds Directive
Development Control	-the procedures that operate to ensure that the decision about whether to permit a particuar mineral application is made in the appropriate way
Development Plan	-a set of documents (text and maps) which contain the regional planning body and local planning authority policies and proposals for development, including minerals (Regional Spatial Strategies and Development Plan Documents)
Dispersion	-the atmospheric movement of suspended matter away from the source of the emissions
Doggerland	- habitable area on the North Sea plain prior to transgression by the sea
Dominance	- a method of expressing the relative contribution of different species to the population density of a community
Draghead	- dredging gear at the seabed, often with a centrifugal pump
Dredge pipe	- the pipe through which aggregates are sucked from the seabed into the hopper of the dredger
Dredge pit	- depression in the seabed associated with static dredging
Dredging area	- the area actually dredged as opposed to that Licenced
Dredging footprint	- the area of seabed that is affected by dredging
Dredging intensity	- the amount of material dredged from the seabed
Dredging lane	- a narrow strip of seabed chosen for dredging within the dredging area

Duration of Impact - the time over which an impact occurs - used as a component of risk assessment for environmental resources

Ebb dominance - the ebb tide is stronger than the flood tide in moving sediment
Echinodermata - organisms such as starfish, sea urchins and sea cucumbers
Ecological Quality Objective - objectives set to define environmental quality (EcoQO)
Elasmobranch fish - cartilaginous fish such as skates, rays and sharks
Environmental Assessment -the process of assessing impacts on environmental resources
Environmental Statement - A comprehensive review of the proposed project, environmental resources, potential impacts and mitigation measures required as part of the Licence Application process
Epibenthic - animals or plants that live on the surface of the seabed
Epifauna/epibiota - animals that live on the surface of the seabed
Equilibrium communities - complex communities with a slow rate of growth and reproduction ('k-strategists') that are often controlled by complex biological interactions
Erosion zone - area of seabed where the surface sediments are coarse, fine sediments having been winnowed out
Evaluation -A limited programme of non-intrusive and/or intrusive fieldwork designed to ascertain the presence or absence, nature and character of the archaeological component of a specific site or area.
Exclusion - prevention of use of an area by other vessels
Extent of Impact - the spatial area of environment over which impacts extend- used as a component of risk assessment for environmental resources
Extraction rate - the mass of marine aggregates removed from the seabed per unit time

Fauna - animals - both invertebrates and vertebrates
Fin fish - a general term to distinguish 'fish' from 'shellfish'
Fines - small particles such as sand and silt
Fisheries Associations - associations that represent the interests of regional fisheries
Fisheries catch - the weight (or value) of exploitable fish caught
Fisheries resources - all aspects of the nature and abundance of exploitable fish and shellfish
Flatfish - demersal fish such as plaice, sole and flounder
Flood dominance - the flood tide is stronger than the ebb tide in moving sediments
Floodplain -a strip of relatively flat and normally dry land alongside a stream, river, or lake that is covered by water during a flood
Food web - a term used to describe the food relationships between members of a community
Frequency range (Hz) - the wavelength of sound - measures in Hertz (Hz)

Geophysical anomaly - an abrupt change in the geophysical features of the seabed, potentially associated with wrecks and archaeological sites
Geophysics - the study of the physics of the earth. Geophysical survey techniques use physical properties themselves (e.g. magnetism) or apply properties to see how the earth affects them (e.g. radar), to determine something about the earth structure.
Glacial outwash - deposits of material washed out from glaciers
Glaciation - the presence of glaciers
Granulometry - the particle size composition of deposits
Groynes - breakwaters used to reduce the rate of transport of beach deposits

Habitat - the summed physical and biological features of an area that distinguish it
Hamon grab - a type of grab used for sampling of seabed deposits
Handaxe - stone age tool
Haul-out site - a site where seals come onto the shore or sandbanks
Heritage - historic or cultural associations
Hopper - the main hold of the vessel into which the aggregate is loaded
Hydrodynamic processes - processes associated with waves, tides and currents
Hydroids - small plant-like colonies of polyps that live attached to stones and shells on the seabed

Infauna - animals that live within the deposits on the seabed
In situ material - material in an undisturbed condition on the seabed
Intensity of sound - measured in decibels (Db)

Interglacial	- the warm periods between cold (glacial) interludes
'Interim Procedures'	- temporary arrangements in place that control the approval and issue of licences for aggregate dredging
Intertidal mudflats	- areas of seabed that are alternately covered and uncovered by the tide and which comprise sands and muds
Intolerance	- a measure of the ability of an organism to tolerate environmental stress
Invertebrates	- animals without backbones - worms, molluscs etc.
Iron Age	-in Britain the period approximately between 700BC and the Roman conquest. Equated with the introduction of iron technology.
Joint Nature Conservation Committee (JNCC)	-The Joint Nature Conservation Committee is the UK Government's wildlife adviser, undertaking national and international conservation work on behalf of the three country nature conservation agencies English Nature, Scottish Natural Heritage and the Countryside Council for Wales. www.jncc.gov.uk
Juveniles	- the young post-larval stages of animals
Key faunal species	- animal components considered to be of importance in defining the community
Knots	- a speed of one nautical mile (nM) per hour
Landings data	- reported fish landed at ports
Larvae	- stages that hatch from eggs
Licence Area	- area of seabed licenced by the Crown Estate for aggregate dredging
Littoral drift	- the net movement of material along the shore under the influence of prevailing waves and currents
Loading time	- the time taken for a dredger to load a cargo (approx 5-6h)
Lower Palaeolithic	- early prehistoric period ('old stone age')
Macrofauna	- larger animals generally defined as those retained on a 1mm mesh sieve
Magnetometer	-also known as a fluxgate gradiometer. A remote sensing instrument capable of identifying sub-surface archaeological features by measuring the difference in their magnetic properties against the surrounding soils
Mammals	- warm-blooded animals with hair eg., seals, whales, otters
Managed retreat	- areas where the sea is allowed to inundate sites formerly protected by sea defences
Marine Aggregates	- sand and gravel deposits on the seabed
Marine Protected Areas	- areas designated under the 1998 OSPAR Annex V on the Protection & Conservation of the Ecosystems & Biodiversity of the Maritime Area
Maritime sites	- sites of historic wrecks or maritime features of historic and archaeological interest
Mesolithic	- archaeological era between the 'old' and the 'new' stone age
Mineral Industry Sustainable Technology (MIST)	The Mineral Industry Sustainable Technology programme aims to deliver environmental benefit through development and demonstration of new technologies and approaches. It funds projects with money from the Aggregates Levy Sustainability Fund and is administrated by MIRO.
Mitigation	- measures to reduce or eliminate impacts
Mollusca	- a large group of animals including snails, bivalves and squid
Monitoring	- steps taken to measure process or impacts predicted in the Environmental Impact Assessment
Monitoring target	- the target against which the results of monitoring is to be assessed
Morphology of Plume	- the size and shape of a plume of sediment adjacent to an operating dredger
Multidimensional Scaling	- a method of ordination (MDS) that shows the similarity of groups of samples
Multiple Licence Areas	- groups of Licence Areas that are close to one another
Multi-variate analysis	- a statistical method to compare samples using many features in combination
Natura 2000	- a European network of SACs, SPAs and other protected sites
Nautical miles (Nm)	- a distance corresponding with 1 minute of arc on a meridian
Neap tide	- the minimum amplitude of the tide (each 14 days between the full and new moon)

Neolithic - later stone age period ('new stone age')
Net transport - the residual movement of sediment after its oscillatory movement on tidal currents, or under the influence of waves
Noise - defined as unwanted sound and is usually measured in dB(A)
Nursery ground - and area of importance for juvenile fish

Occupancy - the time spent in a particular area by a dredger
Office of the Deputy Prime Minister (ODPM) Office of the Deputy Prime Minister. This is the UK government office responsible for policy on housing, planning, devolution, regional and local government and the fire service. It also takes responsibility for the Social Exclusion Unit, the Neighbourhood Renewal Unit and the Government Offices for the Regions. www.odpm.gov.uk.
Opportunistic species - small fast-growing organisms with a high rate of growth and reproduction ('r-strategists') that rapidly recolonise deposits
OSPAR Convention - the Oslo & Paris Convention controlling the discharge of material at sea
Overburden - deposits (often sand) deposited on top of local sediments
Overfalls - areas of rough water where eaves are generated by sudden changes in seabed topography, such as sandbanks and deeps.

Palaeo-beach - a beach laid down in prehistoric times
Palaeolithic - archaeological era covering the 'old stone age'.
Palaeo-topography - topography of the land surface in prehistoric times
Palaeo-river valley - a prehistoric river valley
Passive phase - the period of dispersion and plume decay that occurs 2-3h after initial discharge
Pelagic fish - fish that live in mid-water
Phocidae - the family to which seals belong
Plankton - animals and plants that drift in the water column
Plume - the visible material settling to the seabed following discharge from a dredger
Plume morphology - the shape and configuration of dispersing sediment plumes associated with dredging
Polychaete - a group of marine worms with numerous bristle-like chaetae
Population density - the numbers of organisms in a community
Predation - use of food species (prey) by predators such as fish and seals
Predation pressure - the extent to which food resources are depleted by animals that prey on them
Prehistoric - a catch-all term for the pre-Roman periods
Primary production - fixing the energy of sunlight into carbon by plants
Production tonnage - the mass of marine aggregate removed from the seabed
Production zones - Company-specified dredging areas within the Licence Area
Productivity - the yield per unit area. In the case of Fisheries this is often expressed as the value per km² per year

Quantitative -this refers to something that can be measured in a precise way to give a definite result. This contrasts with qualitative, which is usually a more subjective assessment of the amount of something
Quaternary deposits - a geological term for deposits laid down in the Eocene, Oligocene, Meiocene and Pleiocene periods

Recolonisation - the re-establishment of marine communities by organisms
Recoverability - an assessment of the ability of a community to recolonise
Reef assemblage - a group of organisms that are interdependent and which are either attached to a rocky substrate or form one by accretion.
Regional transport pathway - a pathway of regional significance in the movement of sediments
Rehabilitation - the recovery and restoration of seabed sediments, topography and biological communities
Reject chute - chutes attached to screening towers through which material rejected during the sorting process is returned to the seabed
Replacement tonnage - aggregates that are intended to replace those dredged at another site
Risk assessment - a process of assigning 'risk' to resources
Roman - the period of Roman influence and occupation of Britain between AD43 and c.AD450. The term Romano-

British is often employed in reference to the contemporary native population

Rough ground - areas of seabed where there are boulders or biogenic reefs

Routeing pattern - the distribution and frequency of use of shipping

Ross worm - common name of *Sabellaria spinulosa*, a species that forms biogenic reefs by accretion that in turn support a range of dependent species

Sand waves - seabed 'sand dunes' that may be static or move under the influence of waves and tides

Saturated slurry - the mix of aggregate and water that is pumped from the seabed to the screening towers

'Scoping' Document - survey of issues of legitimate concern to be taken into account in the Environmental Impact Assessment

Screening - adjustment of gravel content with mesh screens

Screening towers - on-board towers that house the screening and reject chutes

Seabirds - birds that spend a significant proportion of their time at sea

Sediment processes - processes that affect the movement of sediments

Sediment sink - a site where there is a net accumulation of sediment

Sediment transport - movement of sediment in the water column or on seabed

Seismic data - data derived from seismic surveys of the seabed

Sensitivity - a measure of response of organisms and habitats to impacts based on the intolerance and recoverability.

Serpulid worms - worms that live in a calcareous tube attached to stones and shells

Shellfish - a general term to include molluscs (whelks, scallops, mussels, cockles etc) from crustaceans (crab, lobster, shrimps)

Side scan sonar - a remote-sensing method of identifying seabed features

Significance of Impact - assessment of risk based on the scale and duration of environmental impacts

Similarity analysis - analysis of the similarity of samples

Site-specific issues - issues that relate to a particular licence application Area

Spatial variability - variations in space

Spawning habitat - areas or communities selected for release of eggs

SACs - Special Areas of Conservation (Habitats Directive)

SPAs - Special Protection Areas (Habitats Directive)

Spillways - openings through which displaced seawater is discharged when the hopper is almost full

Spring tide - the maximum amplitude of the tide (each 14 days corresponding with the new and full moon)

Static dredger - dredging by a stationary vessel

Static gear - fishing gear deployed at fixed sites on the seabed eg., trammel nets and pots

Storm surge - a major rise in sea level above the predicted range due to episodic events such as low pressure and high winds

Strategic Environmental Assessment (SEA) Strategic Environmental Assessment assesses the environmental impact of plans and programmes prepared by public bodies.

Substrate - the type of material on the seabed

Sustainable Development - a key objective of sustainable development is the need to secure an adequate supply of minerals to meet economic needs, whilst minimising the potential adverse effects of mineral extraction on the environment.

Sustainability Plan - a corporate plan designed to maximise efficient use of seabed resources, minimise waste and environmental impacts, and to maximise recovery of seabed resources

Taxon/taxa - a distinct category of organism such as species, genus or family

Temporal variability - variations with time

Terms of Reference - the range of issues addressed in the Environmental Statement

Tidal range - the amplitude of the tides in a particular area

Tidal stream atlas - a chart of an area showing the strength of tidal currents at different stages of the tide.

Tidal streamlines - movement of sediments on tidal currents

Trailer dredging - dredging underway. The draghead is trailed along the seabed

Trammel netting - static nets placed on the seabed

Transgression - warmer periods when the sea level rose and covered parts of the land

Trawl - a method of fishing using a towed net (trawl)

Trawlers - vessels engaged mainly in fishing by trawl (beam or otter trawl)

Trophic level - a step in the food web from one level to another

Trophic models - estimates of the flow of material (or energy) from on level in the food web to another

Turbidity - reduction in light penetration due to suspended solids

Vertebrates - animals with backbones - fish, birds and mammals

Vibrocore - a core sample taken of seabed sediments with a long tube attached to a vibrating motor - generally used for seabed sampling at depth for sediment analysis

Wave refraction - modification of the angle of waves by seabed features

Wave rose - a method of showing the size and direction of waves based on the frequency of occurrence in different quadrants of the compass.

Winnowing - removal of fine material from coarse ones by winds or currents

Worked-out Area - a Licence Area from which economic aggregate resources have been dredged.

Zoning - sub-areas within the Licence Area that are worked to minimise area of the seabed that is worked at any one time