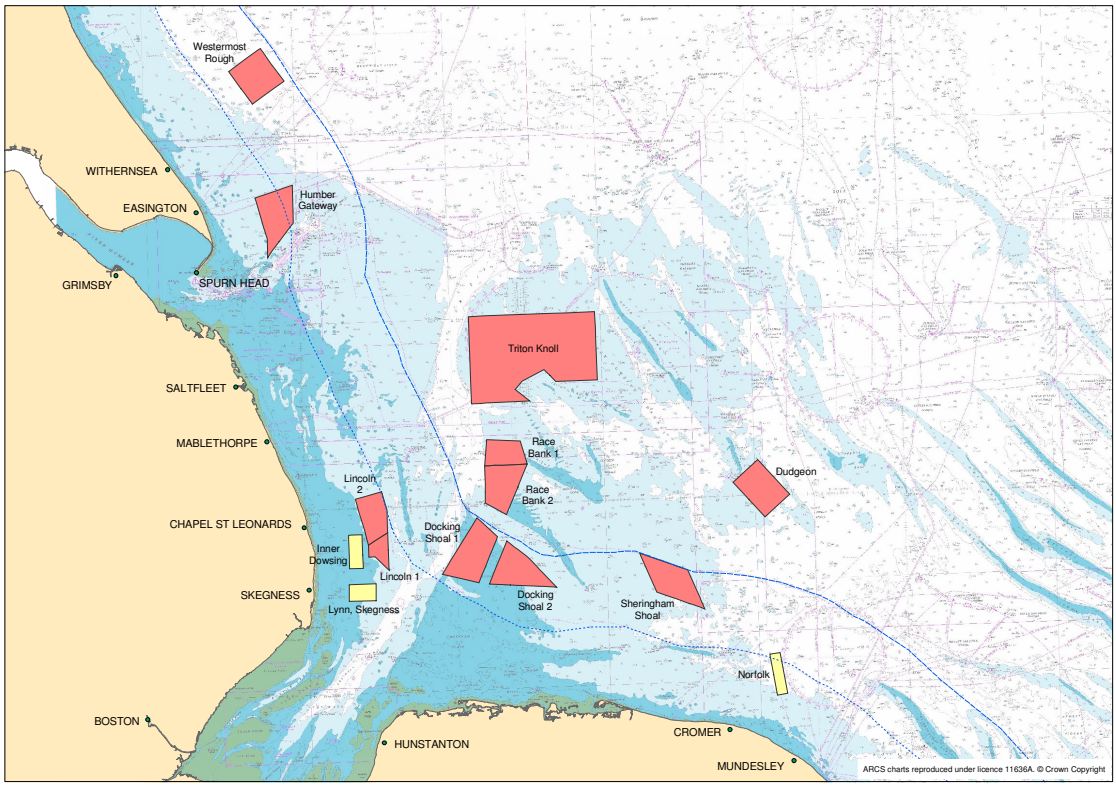

Greater Wash Round 2 Offshore Wind Farms: Cumulative Effects

Scoping Report

Wash Developers

September 2004

Final Report

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1 INTRODUCTION

1.1 BACKGROUND

Over recent years there has been increased awareness and interest in cumulative impacts and their assessment. The Environmental Impact Assessment (EIA) Directive 85/337/EEC, as amended by 97/11/EC, and the Strategic Environmental Assessment (SEA) Directive 2001/42/EC require consideration of the cumulative effects of wind farms with other projects progressed (or to be progressed) in the past, present or foreseeable future. In addition, the Habitats Directive (92/43/EEC) requires 'appropriate assessment' of plans or projects that may have a significant effect on *Natura 2000*[1] in combination with other plans or projects.

In December 2000, the Crown Estate announced the first tender round for UK offshore wind farm development (Round 1). Round 1 aimed to provide the UK with a demonstration round, enabling prospective developers to gain the necessary technological, economic and environmental expertise within projects limited by size.

All the proposed Round 1 windfarm sites are in water depths of less than 20m and no further than 12 km offshore. The Crown Estate procedure also limited the area of seabed to be developed in Round 1 to 10km², a maximum of 30 turbines and a minimum installed capacity of 20MW.

In July 2003 the Crown Estate announced its tender round for Round 2 sites, compared to the Round 1 sites, the proposed Round 2 developments are:

- greater in spatial extent;
- in closer proximity to each other; and thus,
- have the potential for broader scale impacts.

The assessment of cumulative impacts is, therefore, a much more significant issue in Round 2 (where this view was confirmed at the DTI/CEFAS Workshop, March 2004).

The developers responsible for taking forward proposals for Round 2 offshore wind farm sites within the Greater Wash SEA area, collectively known as the Wash Developers, recognise the importance of ensuring that the effects are fully addressed. As such, Posford Haskoning has been commissioned by the Wash Developers to undertake an initial assessment of the potential cumulative (and in-combination) effects associated with the wind farm developments proposed in the Greater Wash area (illustrated on Figure 1.1). In undertaking this review Posford Haskoning has worked with relevant specialists in this field, namely their own Environment and Coastal Process teams, supported by Anatec and IECS (Institute of Estuarine and Coastal Studies, University of Hull).

[1] the European Union-wide network of sites designated as Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), including candidate or proposed sites

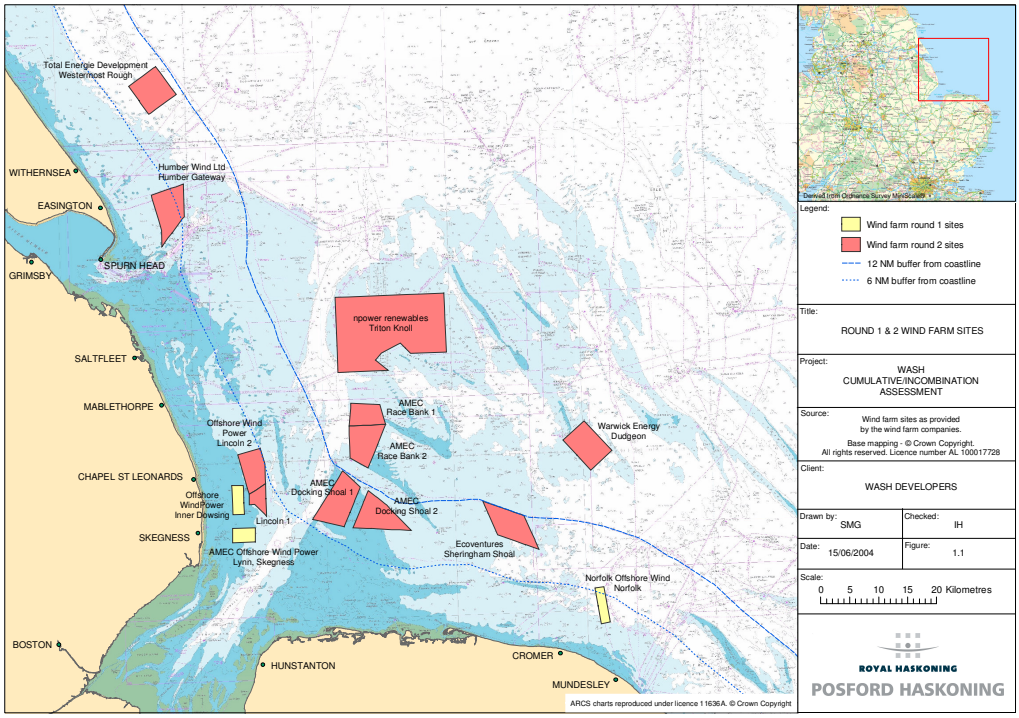

Figure 1.1 Round 1 and 2 Wind Farm Sites in the Greater Wash area

1.2 SCOPE OF THE STUDY

The focus of this initiative has been on considering, for each relevant environmental parameter, the potential for a cumulative effect to arise due to the establishment of a number of wind farms in the Greater Wash area and, subsequently, how those effects should be assessed.

The starting point is a discussion of all parameters that would normally be considered in an Environmental Impact Statement (EIS) and the identification of those parameters where a cumulative (or in combination) effect may arise. That is:

- marine benthos and epibenthos
- **cetaceans and marine mammals**
- **coastal processes and geomorphology**
- marine archaeology
- **landscape and visual character**
- **navigation**
- military and aviation
- **natural fishery resource**
- **ornithology**
- water and sediment quality
- noise and vibration
- tourism and recreation
- **commercial fisheries.**
- **socio-economic effects**

Those parameters where the potential for a cumulative effect to arise is considered to exist (emboldened above) are then taken forward and a clear justification provided as to the reasons why the other parameters have been 'scoped out', for example, because temporal or spatial interactions do not arise.

For those issues that remain within the scope of the assessment (such as ornithology, navigation and fisheries) the potential effects are set out and the principles of the proposed methodologies for assessing the cumulative effects discussed are outlined. This includes a discussion, for each parameter, of the key issues, the data requirements and the proposed method of assessment.

It is the intention of the Wash Developers that this document is used as the basis for discussion with the relevant Licensing Authorities that is DTI and MCEU and their advisors, such that an agreed approach can be taken forward. It is anticipated that the Licensing Authorities will expect to see cumulative effects investigated as part of the consents application process for Round 2.

1.3 CUMULATIVE (AND IN-COMBINATION) EFFECTS

Cumulative environmental effects can be defined as:

"The effect on the environment which results from the effects of a project when combined with those of other past, existing and imminent projects and activities. These may occur over a certain period of time and distance." (Canadian Environmental Assessment Agency, 1999)

A further definition adapted from the above as part of a European Commission research initiative, is:

"Impacts that result from incremental changes caused by other past, present or reasonably foreseeable future actions together with the project." (Hyder Consulting, 1999)

A number of cumulative impact investigations have also been undertaken in relation to the UK marine aggregate industry and Draft Marine Minerals Guidance Note 2 (DETR, 2001) defines impacts as *"effects on the environment, either from the summation of individually minor but collectively significant impacts, or as a result of the interaction of impacts from one or more sources"*.

In combination effects derive from the Conservation (Natural Habitats, &c.) Regulations 1994 which require competent authorities to make an appropriate assessment of any plan or project which either alone or *in combination* is likely to have a significant effect on a European site. Guidance issued by English Nature (EN 2001) sets out the scope of the "other plans or projects" to be considered under the "in combination" test (para 2.3 & 2.4) and goes on to include other plans or projects, activities and natural processes which the term "cumulative effects" can be commonly used to include (para 2.6).

Thus, in the context of offshore wind farms, cumulative effects might occur as a result of the development of an offshore wind farm at a single site, from multiple sites in close proximity, or in combination with effects from other human activities, such as aggregate extraction, marine disposal, dredging operations, fishing, pipeline construction, oil installations, natural processes and also other uses of the sea.

The term cumulative effect has been used throughout this document, where this also encompasses in combination effects as a sub set of cumulative effects.

Cumulative impacts can be either interactive or additive and can vary in terms of their temporal effect, scale and/or spatial extent. From the guidance available it is clear that the key aspects for consideration are:

- the temporal and geographic boundaries of the influence of activities;
- the interactions between the activities and the overall ecosystem;
- the environmental effects of the project, in conjunction with past and future (proposed) projects and activities; and
- the thresholds of sensitivity of the existing environment (Posford Duvivier Environment (PDE) & Hill, 2001).

Guidance on methods of cumulative impact assessment prepared for the UK Marine SACs project (PDE & Hill, 2001) promotes the following tasks as part of the scoping stage (adapted for wind farm developments):

i. Define the temporal and spatial boundaries of the features affected by the proposed development(s).
ii. Undertake consultation with other agencies, organisations and individuals who may have an interest, or have responsibility for other activities or projects, in the area.
iii. Identify the pathways through which the environmental effects of the proposed development(s) are expected to occur.
iv. Identify relevant past and existing projects and activities and their impacts on the environment of the development(s).
v. Identify future proposed projects and activities and their potential link to the wind farm development(s).

A number of techniques useful at both the scoping and assessment stage can be used to predict and represent impacts in cumulative assessment (PDE & Hill, 2001). This scoping exercise has utilised expert knowledge, available data, matrices and GIS to enable the identification of potential interactions between activities and individual environmental parameters and to indicate spatial boundaries in order to visually depict the extent of influences.

2 IDENTIFICATION OF POTENTIAL EFFECTS

2.1 INTRODUCTION

In terms of the assessment of cumulative effects in the three strategic areas of concern with respect to offshore wind farms (including the Greater Wash area), the questions that need to be asked were outlined at a DTI/CEFAS Round 2 workshop (12 March 2004), namely:

- What issues should be addressed in each strategic area?
- At what scales – strategic area or sub-areas? and
- Over what periods of time?

The first stage in identifying potential cumulative effects is, therefore, to identify those environmental parameters where an interaction or pathways of interaction could reasonably be expected to occur. This 'scoping in and out' of parameters was undertaken by listing and considering the environmental parameters that would be assessed in a typical EIA for a wind farm project. The outcome is set out in Sections 2.2 and 2.3 below.

However, it should be noted that the outcome of the scoping exercise is not absolute and the status of certain issues could change. That is, although some issues have been 'scoped out' at this stage (see Table 2.1), the influence of ongoing research could promote their importance with respect to potential cumulative effects in the future (e.g. electromagnetic and noise effects). In addition, although they may have been excluded from the wider assessment of cumulative effects (i.e. across the Greater Wash area) interactions between individual initiatives could still arise (e.g. in the case of MOD concerns) which individual developers may need to respond to. With respect to issues 'scoped in', the potential for the opposite effect to occur also exists. That is, it is not the case that cumulative effects will arise in all instances (e.g. cetaceans). However, where sufficient concern exists that cumulative effects may occur, these parameters have been considered in the further assessment.

2.2 PARAMETERS 'SCOPED OUT'

Table 2.1 below indicates those parameters that are not considered, at this stage, to be likely to experience significant cumulative effects due to the progression of a number of wind farm initiatives in the same SEA area.

Table 2.1 Environmental parameters unlikely to experience cumulative effects

Environmental Parameter	Reason for being "scoped out"
Marine benthos and epibenthos	In most cases, wind farm construction is unlikely to lead to any significant change in sea bed substrate or sediment type, only short term disturbance effects will be experienced and recolonisation by the surrounding infauna and epifauna can be expected to take place rapidly during the following spring. This is validated by benthic data collected from other wind farm sites and offshore projects. The exception could be large finds of particular species of concern, such as biogenic *Saballaria* reefs, or other Biodiversity Action Plan (BAP) species and habitats, which ordinarily would be dealt with on a site specific basis. Electromagnetic field (EMF) effects from underwater cables on elasmobranchs (and other electrosensitive species) have been the subject of research (COWRIE). This demonstrated that there is a differential effect in terms of the behavioural response of elasmobranchs to simulated electric fields emitted by prey and those from undersea power cables. Further study has been recommended and it will be appropriate to take this into consideration when published. Decisions on the location and number of export cable routes (or the use of one or more hubs) are yet to be taken. At this stage, it is not considered that the effect is likely to lead to extensive cumulative effects.
Underwater Noise and Vibration	Research and studies are ongoing in this field which will be taken into account as our understanding increases. Currently, it is not considered that significant interaction between projects will take place and it is predicted that the issue should remain site specific. Consideration will however, be given to potential cumulative effects during the construction phase.
Marine Archaeology	Preserved landscapes of very early (Palaeolithic and early Mesolithic) date may exist offshore, leading to potential disturbance of insitu material, depending on the sediment type and depth of bedrock. However, this is likely to be a site specific effect, in the same way that historic wrecks and associated finds will be. It is anticipated that marine archaeology can be effectively assessed and mitigated (if necessary) on an individual basis; interactions with other wind farms are not expected to occur. Interpretation and review of the geophysical data would verify this conclusion.
Military and Aviation	See below.
Water and Sediment Quality	The offshore nature of most of the sites means that the potential impact associated with disturbance to and dispersion of contaminated sediments is likely to be minor and site specific. In addition, the dispersion of sediments (contaminated or clean) will be short term, arising during the construction phases of development. No interactions are anticipated.
Tourism and Recreation	It is recognised that there are potential benefits and disbenefits associated with wind farm development on tourism and land based recreation. The Yorkshire, Lincolnshire and Norfolk coastlines all boast tourism resorts and attractions (both natural and man made). It is considered that effects will be important site specific issues for the nearer shore sites, such as the Humber Gateway. However, cumulative effects on tourism and recreation (specifically) are unlikely to be significant due to the distances offshore (see also socio economic effects and landscape and visual character).

2.2.1 Military and Aviation

The MOD assesses proposals for wind farms on a case by case basis. Therefore, they are largely considered to be a site specific issue however there are impacts across several projects. Current discussions with the MOD (and other operators where relevant, such as helicopter operators) will continue and will involve other relevant wind farm developers where the potential for interaction exists. Studies are ongoing regarding wind farms and radar interference, the results of which will be taken into account.

2.3 PARAMETERS 'SCOPED IN'

Once those parameters that are unlikely to experience cumulative effects are excluded, the issues that remain include:

- Navigation and shipping
- Commercial fisheries
- Natural fishery resource
- Ornithology
- Cetaceans and marine mammals
- Landscape and visual character
- Coastal Processes and Geomorphology
- Socio-economic effects.

These issues are considered in turn in Section 3. For each parameter, the key issues, data requirements and proposed in principle methodology for assessing predicted cumulative effects are set out.

A matrix approach has been adopted to summarise how these effects should be taken forward with respect to the identification of their potential spatial and temporal influence.

For many of the parameters the spatial separation of the wind farm sites enables cumulative impact assessment to be undertaken in **sub areas** within the Greater Wash SEA area. In general, two sub areas exist relating to the sites in the northern Wash, namely Westernmost Rough and Humber Gateway, referred to as the **Yorkshire Coast sites or north Wash** and the remaining sites in the southern Wash, referred to as the **south Wash.** In addition, within these sub sets, further groupings may be required.

Matrix 2.1 Potential Cumulative Effects: scope, data requirements and method of assessment

PARAMETER	Scope / geographical area	Possible effects	Data requirements	Methodology for assessment
Navigation & Shipping	Determined by proximity to, or influence on, existing shipping routes and densities. Interactions due to potential changes to shipping routes as a result of wind farm development. Greater Wash wide assessment required in the first instance with possible sub divisions following further investigation.	Shipping route changes (longer voyage times/reduced clearance/increased costs/increased emissions). Potential funnelling of shipping routes. Collision risk.	Current maritime traffic survey [Anatec Study March 2004]. Site specific 28 day survey as required by MCA.	Desk top study (analysis of long term statistics) on activity, consultation and modelling (collision risk assessment). With coordinated mitigation recommendations.
Commercial Fisheries	Generally, different fishing vessels/groups operate in the Yorkshire Coast sites area and the south Wash. Significant commonality (in target species) exists, but the south Wash is more diverse. Broad scale assessment to approach the Yorkshire Sites and south Wash separately as EIA information becomes available.	Effects to the important potting (crab & lobster) fishery. Loss of and/or disturbance to fishing grounds. Displacement and concentration effects. Loss of gear. Effects on commercially targeted species.	Vessel landings. Catch returns. Overflight data. Sightings and survey data. Effort statistics [Sea Fisheries Committees, DEFRA/CEFAS].	Literature review, consultation, port visits and assessment of landings, quantification of activity. Broad scale assessment. Including socio-economic effects.
Natural Fishery Resource	General commonality across Greater Wash, however, the south Wash area is likely to be characterised by greater diversity. Broad scale assessment to approach the Yorkshire Coast sites and south Wash sites separately.	Localised effects anticipated including short term loss/disruption/smothering.	Epibenthic survey data; Fisheries information [Sea Fisheries Committees, DEFRA/CEFAS]	Desk top study and consultation. Limited quality data is available which is not generally site specific however a broad assessment is considered possible.

PARAMETER	Scope / geographical area	Possible effects	Data requirements	Methodology for assessment
Ornithology	The variety of bird species, habitats and uses of the Greater Wash means that assessment at a number of scales is required, i.e. at a large scale (to include all sites); separately for Yorkshire Coast and south Wash sites for a number of species (e.g. Sandwich Tern & Gannet). Also some attempt at assessment for species using both the Thames SEA area as well as the Greater Wash (e.g. Divers, Brent Geese & Scoter).	Disruption to habitat formation/displacement. Habitat disturbance/loss. Increased collision risk and change of migration patterns (additional energy expenditure/barrier effect). Influence on designated sites (SPAs).	Aerial and boat based surveys for each site and environs. (Species/group density data); Seasonal patterns and migratory rates; (Flight direction and heights) Existing data and research results. [WeBs data] [WWT Research 2003] Use of radar where feasible.	Collaborative study. Collation of aerial and site specific boat surveys. Analysis of data. A number of scales of assessment are applicable.
Cetaceans & Marine Mammals	Effects likely to be local to each site; although issues are generic. Possible issues during concurrent construction phases.	Disturbance and displacement. Collision risk. Reduction in water quality during construction. Increased pressure on the fishery.	Boat surveys (to coincide with bird surveys) Existing sightings and strandings. [SMRU, JNCC, Sea Watch Foundation data].	Analysis of data at a site specific level with cooperation between sites to compare data/assessment results (leading to possible "scoping out").
Landscape and Visual Character	Due to distance offshore most sites will not be visible from the coast in the majority of weather conditions. Cumulative assessment undertaken (if necessary) for interacting projects which are within a 30km range of an identified visual coastal receptor.	Combined visual/seascape impact at a variety of coastal receptor points.	Coastal characterisation. Coastal visual receptors identified. Zones of Visual Influence / wireframes & photomontages.	Standard cumulative landscape and visual impact assessment in accordance with CCW guidance.

PARAMETER	Scope / geographical area	Possible effects	Data requirements	Methodology for assessment
Coastal Processes and Geomorphology	Despite Round 1 experience indicating no far field effects, concern exists regarding potential adverse effects on sediment transport regimes and subsequent effects on nearby coastlines caused by the larger aggregations of sites. Sub division of the sites will be possible with those near the Lincolnshire & north Norfolk coastline likely to require cumulative assessment and verification of predicted effects.	Changes in wave, tidal currents and sediment regimes.	Metocean and physical data.	Combination of geomorphological interpretation and board scale wave and tidal modelling.
Socio-economic Impacts	Greater Wash area	CO_2 and related emissions (e.g. SO_2) avoided. Economic benefits (e.g. UK contracts, strengthening of industrial base & job creation).	Latest project specifications.	Use of published figures on economic return / benefit per MW installed.

3 CUMULATIVE EFFECTS

3.1 NAVIGATION AND SHIPPING

3.1.1 Key Issues

With respect to navigation, cumulative and/or in-combination effects associated with the proposed Round 2 offshore wind farms could be experienced by the following vessel types:

- Merchant ships (e.g. cargo, tanker, ferry, offshore);
- Fishing vessels;
- Recreational craft; and
- Other miscellaneous vessels (e.g. tugs, dredgers).

A detailed list of the key navigational issues that need to be addressed for each individual application site is provided in the draft Maritime Coastguard Agency (MCA) Marine Guidance Note (MGN) *Proposed UK Offshore Renewable Energy Installations (OREI) - Guidance on Navigational Safety Issues*. This includes key issues such as obstruction to vessel navigation, risk of collision and potential interference with marine communications, radar and positioning systems.

The mean positions of commercial shipping routes passing through the Greater Wash area are presented in Figure 3.1. This is provided as an example and it is acknowledged that other vessels are not shown such as those engaged in fishing, recreational or dredging activities.

From Figure 3.1 and Anatec's experience of marine risk assessment for the Greater Wash area, it is apparent that cumulative effects will arise for all of the Round 2 sites due to their proximity to navigational features such as:

- Ports / harbours;
- Traffic Separation Schemes (TSSs);
- Dredging licence areas;
- Anchorage areas;
- Shipping channels and established routes;
- Fishing grounds and transit routes;
- Marinas and areas of recreational sailing activity;
- Oil/gas installations and pipelines;
- Aids to navigation; and
- Beach replenishment areas.

For the purposes of predicting potential cumulative effects, it can be seen from Figure 3.1 (for example) that ships that have to revise their passage to avoid one site may also have to take into account an adjacent site, potentially leading to longer voyage distances/times, reduced clearance of other obstructions and shallow water. In addition, in some cases shipping routes may have to 'funnel' between adjacent developments, reducing the sea room available and increasing the risk of ship-to-ship encounters.

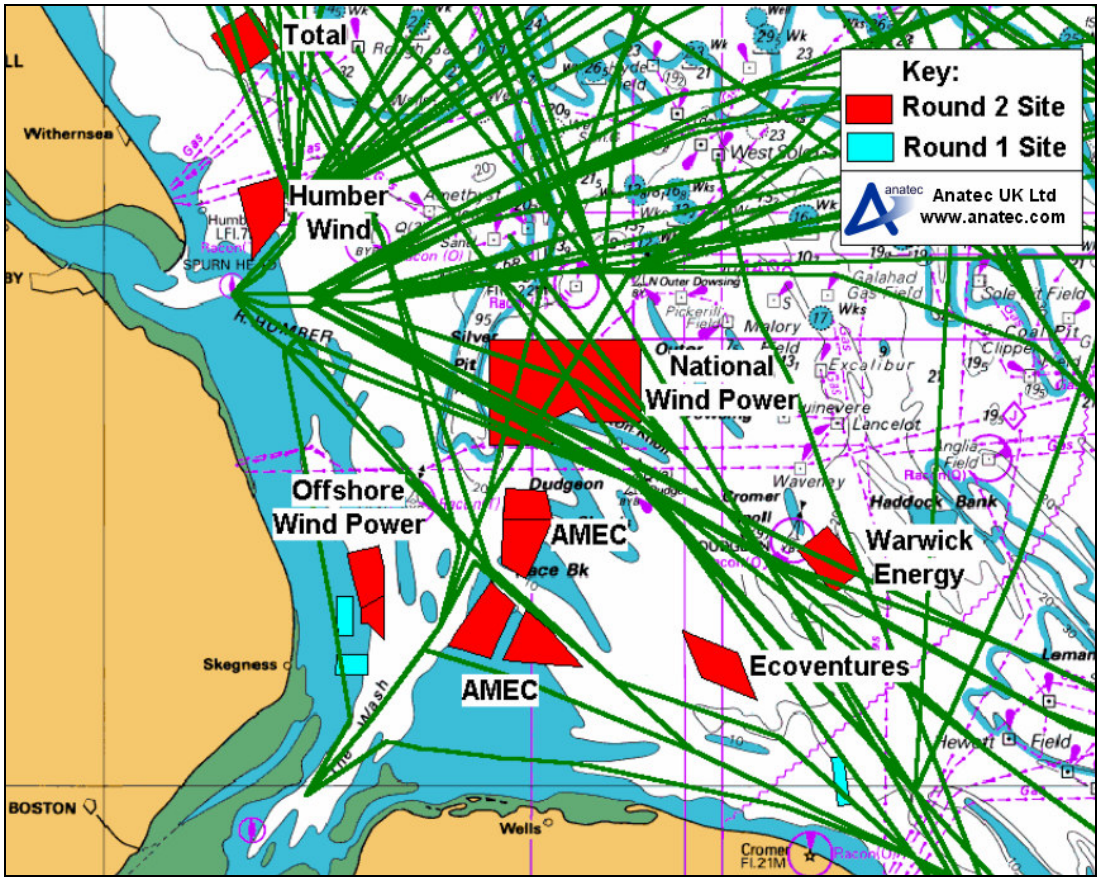

Figure 3.1 Mean Shipping Route Positions estimated from Anatec's ShipRoutes Database

Cumulative effects of this sort are generally only expected to arise where Round 2 sites are in relatively close proximity to one another or consented Round 1 sites. Therefore, the Humber Gateway and Westernmost Rough sites to the north may encounter cumulative effects with respect to each other, as might Lincoln 1&2 given their proximity to the existing Lynn and Inner Dowsing Round 1 sites further south. It maybe the case that there is little significant interaction (and, therefore, cumulative effects) between the northern and southern sites, however, Trinity House and the MCA suggest strongly that due to the effective use of the entire Wash area by shipping it is not necessarily feasible to split the Strategic Area.

3.1.2 Data Requirements

The main data requirement for assessing navigational issues, including cumulative and in-combination effects, is for an up-to-date maritime traffic survey of each of the proposed sites (to be undertaken as part of the EIA). The MCA specify that this should cover all vessel types and is likely to be of least four weeks duration, but should also take account of seasonal variations in traffic patterns. A requirement exists for each individual site to be fully surveyed, as well as the immediate surroundings, in order to detect any marine activity in close proximity to the site which could be affected.

The survey data should be supplemented by the analysis of longer-term statistical data on vessel activity in the Greater Wash area available from a variety of sources, such as:

- Shipping databases (incorporating port callings);
- Ferry timetables;
- DEFRA surveillance data;
- Coastguard incident records; and
- Dredger movements.

Consultation with local experts and users, such as harbour masters, vessel skippers, sailing clubs and the coastguard, will also assist in accurately identifying the potential impact of the proposed developments on navigation.

The Greater Wash developers should consider collating the survey data collected in a standardised format, within a GIS database. This would help to provide a global picture of vessel activity in the area and assist greatly in assessing the likely cumulative and in-combination effects.

3.1.3 Assessment of Cumulative Effects

A navigational risk assessment for each site will be undertaken (as part of the EIA) that considers the impact of the proposed offshore wind farms on all of the different users of the study area. This will be based on detailed analysis of the survey and statistical data as well as feedback obtained from the consultation stage. All of the key issues mentioned above and summarised in the MCA's Draft MGN will be assessed, where this will incorporate in-combination effects relating to ships, fishing vessels, yachts, dredgers, etc.

In addition (or as a combined initiative with those undertaken for the EIAs) cumulative assessments will be undertaken. It is suggested that the Wash can be sub-divided into the Yorkshire Coast sites and the south Wash sites. However, given comments from navigational interests (see above) it is anticipated that the whole of the Wash will be investigated in the first instance with sub divisions being made where these are identified as being reasonable, for example where projects can be grouped according to proximity to, or influence on, shipping routes and densities (see Figure 3.1). Cumulative assessments will be undertaken on a co-operative approach (if the timing of the EIA studies allow) or individually utilising existing data. The assessments will focus on:

- Qualitative review of the overall impact on vessel navigation;
- Increased voyage times / distances and the subsequent increase in fuel costs and emissions;
- Risk of vessel collision with wind farm structures (powered and drifting);
- Change in risk of vessel-to-vessel collision;
- Change in risk of vessel groundings;
- Consequences of an accident in terms of injury, death or loss of property both at sea and amongst the population ashore; and
- Potential interference with marine systems.

This co-operation will ensure consistency when considering appropriate mitigation measures for individual sites and those adjacent or in proximity. Typical mitigation measures include:

- Turbine layout;
- Navigational aids;
- Lights and marking;
- Burying of cables;
- Navigational warnings;
- Routeing measures;
- Contingency measures (pollution and marine casualties);
- Safety zones;
- Radar coverage; and
- Patrol vessel during construction.

3.2 COMMERCIAL FISHERIES

3.2.1 Key Issues

Scope and geographical area

The Greater Wash area is characterised by similar fisheries, including the potting shellfishery, whelks, ground fish trawling (such as cod), static gill netting offshore and intertidal bass netting. The southern Wash area shows a greater diversity and includes the significant brown shrimp beam trawling fishery and mussel dredging. In addition, the use of both of the sub areas by individual vessels is limited, although some overlap does occur at the peripheries on a seasonal basis, for example, shellfish operators based at Bridlington and other beach launched venues in the southern sector of the north Wash may deploy fleets of pots in the south Wash area; similarly, vessels operating from Grimsby will deploy both static gears and trawl gears within the boundaries of the north Wash and beyond.

Given the decline of fin-fish there has been a significant move towards shellfishing and this component dominates the fishery within the Greater Wash area. Whilst there is significant commonality between the two areas, the southern Wash fisheries are more diverse. As a consequence, any broad scale assessment of cumulative effects should approach the two areas separately.

Potential effects

In predicting the potential cumulative effects associated with the commercial components of the fishery, it is considered that the site specific effects are likely to be replicated to a large extent. The cumulative assessment will need to consider the additive effects of a number of wind farms. The in-combination effects of wind farm development and aggregate extraction will also be accounted for, although again it is likely that the effects will be the same, but on a greater temporal and spatial scale. This is also the case with respect to the loss of access to fishing grounds. However, not all grounds are profitable and, therefore, the potential exists for the commercial sector to be 'squeezed' as more sea bed is taken up.

The following paragraphs summarise potential effects as a result of both the construction and operational phases[2].

[2] Depending on the existence of safety zones and distance between turbines.

Commercial sector effects:

- Loss of access to fishing grounds during construction (static and mobile gear operators);
- Displacement to less profitable grounds;
- Concentration of fishing effort on remaining available grounds;
- As a result of the concentration of effort on remaining grounds, the possibility of conflict between operators of differing types of gear (static versus mobile);
- Potential conflict between static gear operators and dredgers if mussel beds become established within wind farm boundaries as a result of habitat creation;
- Increased travelling times to fishing grounds;
- Potential reduced CPUE[3] as a result of displacement to less profitable grounds;
- Elevated running costs; and
- Loss of gear through increased traffic
- Overall socio-economic effects.

3.2.2 Data Requirements

The available literature and fisheries data can be obtained from a number of sources, including the two Sea Fisheries Committees within the Greater Wash area, DEFRA and CEFAS. However, it is unlikely that these data will be site specific[4]; they are more likely to reflect stocks present, vessel landings and fishing effort within each Committee's jurisdiction. Data collected would, in general, be as part of the normal EIA work requirements.

Due to sea temperature increase and the over-exploitation of some fin fish stocks, over recent decades the fisheries within UK waters have changed considerably, this is especially prevalent along the English east and north-east coasts. A consequence of this is that much of the historical information is no longer representative of the present state of the fishery. Examples of such changes include the shift to shellfish, variability of whelk stocks, decline in cod and other fin fish species and expansion of the bass fishery. Much of the information available still relates to the importance of fisheries now in decline and makes no mention of important, expanding fisheries.

In order to collate and interpret comprehensive fisheries data for the north and south Wash areas respectively, and to allow an assessment of the potential for cumulative effects to arise, a multi-strand approach should be adopted. This may require:

- Analysis of Sea Fisheries Committee data (landings, patrol vessel sightings and effort statistics);
- Consultation with relevant Fishermens' Associations and individual fishermen;
- Potting effort surveys - these data can be input into GIS to produce fishing effort data maps;
- Analysis of DEFRA datasets (overflight data, catch statistics, etc.);

[3] Catch per unit effort

[4] data from NESFC on potting effort is site specific between Whitby and Spurn Head within the 6nm limit

- Port visits and assessment of catch/landings;
- Possible dedicated quantification (scientific evaluation) of catch aboard vessels deploying gears within specific development sites undertaken by observers;
- Evaluation of scientific and commercial reports relating to individual areas in order to identify potential mussel beds (likely to be specific to the south Wash area) - this is an important fishery within the Wash, however, offshore mussel beds tend to be transitory and dependent on successful recruitment.

3.2.3 Assessment of Cumulative Effects

Once this data collection exercise has been undertaken (as part of individual EIAs), the potential for the effects identified above to arise would be considered, in turn and separately, for the Yorkshire Coast sites and the south Wash, based on fishing effort and gear type as well as location of main fishing centres (which may allow further sub division). It is likely that developers within the respective north (Yorkshire sites) and south Wash areas will cooperate with data collection and analysis so that information is pooled in order to make an effective judgement on cumulative effects. This will be a progressive process with data being accumulated as the individual projects undertake their EIAs.

3.3 NATURAL FISHERY RESOURCE

3.3.1 Key Issues

The issues listed below are considered to be relevant to the assessment of potential cumulative effects on the natural fishery resource. They are essentially the same as those for site specific assessment, but the effects need to be considered on a broader scale.

It should be noted that in addition to the potential impacts set out below, benefits/enhancement to the natural fishery resource could arise due to the development of offshore wind farms. Such benefits could be associated with the new habitat conditions created and the restriction of fishing access.

The following paragraphs summarise potential effects as a result of both the construction and operational phases.

Construction (short term & reversible):

- Degradation of water quality locally due to elevated SSCs, affecting epi-benthos, larvae and fish present within the water column;
- Effects on Sabellaria; and
- Elevated noise during construction acting as a barrier to some fin fish species (e.g. Bass).

Operation[5]*:*

- Increased trawling effort within areas which previously may have seen limited effort (due to displacement or if mussel beds become established within wind farm boundaries);
- Increased fishing effort targeting epifaunal species;
- Disruption of commercial fin fish and shellfish nursery and spawning areas as a result of the instalment of turbines, cables and scour protection; and
- Possible enhancement of fishery.

The fish resources (assemblages) present in the Greater Wash are considered typical for this region (the Central North Sea), although the south Wash is likely to have a greater diversity due to the greater range of habitat types. As for the commercial fishery, it is considered that both geographical areas (i.e. the north and south Wash) will be assessed separately.

3.3.2 Data Requirements

There is limited natural resource data available, which should be complemented by fisheries data. EIAs from aggregate extraction applications will be an important data source; however, it is unlikely that these data will be site specific. A recurring problem often highlighted when assessing the natural resource is that the gears employed to collect data are neither efficient nor relevant to the seabed type and species inhabiting that particular area. Given this, any field based assessment should carefully consider deploying appropriate gears that will fully assess the natural fin fish and epifaunal resource as a whole.

As discussed in commercial fisheries above, due to changes in sea temperature and the over-exploitation of some fin fish stocks, the natural resources found along the coastal margins of the English east coast have changed considerably over a very short time scale. A consequence of this is that much of the literature relating to the natural resource is a limited representation of the present state of the resource. For example, the decline of some epifaunal species and growth in others (such as Velvet crabs), matched by the decline in cod and other fin fish species with a growth in bass and red mullet. Much of the information available still relates to the importance of fisheries now in decline.

In order to collate comprehensive natural resource data for the north and south Wash areas, a multi-strand approach will be adopted. This would require:

- Analysis of combined epifaunal and fish surveys using appropriate gears to acquire fish and epifaunal data simultaneously;
- Analysis of all available fisheries data, including EIAs from recent developments (aggregate extraction);
- Sea Fisheries Committee data (landings, patrol vessel sightings and effort statistics);
- Consultation with relevant Fishermens' associations and individual fishermen; and

[5] Potential effects are dependent on the existence of safety zones and distance between turbines.

- Evaluation of reports relating to potential areas of Mussel beds and Sabellaria.

There is likely to be a paucity of current data with regard to the natural fish resources present throughout the Greater Wash, and those data available will relate to species of commercial value, with less data available for non-target species (e.g. benthic fish species such as pogge, dragonet, sea scorpion, gobies, etc.). These species form the basis of community structures for fish assemblages and will be targeted for evaluation.

3.3.3 Assessment of Cumulative Effects

It is probable that the direct long term cumulative ecological effects on the natural resources within the north and south Wash as a result of the construction of offshore wind farms will be limited; in fact the developments may well have a beneficial effect. As for the commercial resource, short term effects are likely to be more significant but are likely to reverse.

Again, the cumulative effects are likely to replicate the site specific effects. With respect to the potential loss of access to profitable fishing grounds, the possibility that the commercial sector could be 'squeezed' could adversely affect the natural resource as a greater area would be disrupted by trawling vessels.

It is important to characterise fish communities in relation to specific sites and information collected can be used to characterise species diversity in relation to habitat type, sediment characteristics, depth and faunal community. Given the requirement for site specific data, it is likely that individual wind farm developers will initiate characterisation of their respective sites, feeding information into a generic document covering the north and south Wash development areas. This would provide both site specific data and a broad scale assessment of the natural resources present within the two areas and be the generic document would be used by developers to pull the relevant information on cumulative effects (associated with their site) into their EIA.

3.4 ORNITHOLOGY

3.4.1 Key Issues

There are a number of potential issues relating to offshore wind farms that could have a cumulative effect on bird populations. These largely centre around the following, and arise both on a site specific basis and at a strategic level:

- Habitat loss during construction - direct disturbance from construction work and ancillary activity;
- Habitat loss during operation - direct disturbance from the operation of the turbines as well as maintenance activity;
- Modification to migratory routes - involving increased energy consumption and, if the development forms a physical barrier, possible removal of adjacent feeding and roosting sites;
- Collision risk to birds - both for short range daily movements and long range migratory movements, including nocturnal movements and during bad weather; and

- Disruption to habitat function - displacement of feeding areas with increased predation or reduction in prey availability, disruption of movements to, from and within breeding-roosting-foraging sites.

In general, for coastal migration, it is understood that the majority of movements occur along the coastal margin, within c.3km of the shore. However, in addition to expected lateral coastal movements, there is the potential for offshore movements broadly perpendicular to the coast. The physical shape of the Greater Wash coastline means that movements within the development areas may be from a variety of directions. In addition, external factors (such as weather) will lead to variations in movements on an annual and even daily basis. Most nocturnal migrants are likely to fly above the rotor swept area (RSA), with collision risk occurring when birds are transiting through the RSA when taking off or coming in to land. However, concentrations of movements within the RSA may occur during periods of poor weather or strong winds. While coastal migration patterns are relatively well understood at a generic level, offshore movements are less well developed.

Excepting the collision risk issues, some of the main potential impacts from single or multi-developments will centre on displacement. In some instances, particularly for mobile rafting flocks, this may not have any significant implications, but for species potentially dependent on a defined site for foraging, impacts could be more profound. It is noted however, that mobile rafting flocks could be as vulnerable to increased mortality if displaced from feeding areas as less mobile species, if food availability is limiting population size.

3.4.2 Data Requirements

Due to the lack of data on offshore seabird concentrations it is acknowledged that it is necessary to undertake additional dedicated survey work. Recently commissioned survey work is being undertaken following the NERI/COWRIE guidelines which provide guidance on both boat and aircraft surveys. The Joint Nature Conservation Committee, with contributions from English Nature and CCW, has prepared information in addition to that provide by the COWRIE guidance.

Discussions are ongoing between the Wash Developers and English Nature regarding the exact requirements for surveys in the Wash and the problems regarding availability of resources (observers and planes for aerial surveys and larger boats for boat based surveys), consistent bad weather conditions and lack of proven technology (such as radar).

Both aircraft and boat based surveys are currently being employed on a single development basis, allowing detailed and wider spatial data to be collected and some information on migratory usage and collision prediction to be ascertained. Aircraft surveys are particularly suitable for large areas, providing a good indication of bird species in the area; and hence are useful in providing a baseline for cumulative impact assessment. The data does not, however, provide information suitable for assessing migratory routes and numbers or flight heights and, as such, cannot be used for the prediction of collision risk.

Boat based surveys will cover much less area than an aircraft survey, but may provide data on flight direction and height, as well as more detailed information on foraging. As

such, this information can be used for the identification of seasonal and diurnal migration routes and magnitude, and can feed into a prediction of collision risk, as well as a wider assessment of the impacts of habitat loss or disturbance.

3.4.3 Assessment of Cumulative Effects

A number of the cumulative impact issues will be best addressed over an area that includes all Greater Wash wind farm sites utilising site specific aerial and boat based data. It is clear that some issues may only have a partial or development specific effect, however, the potential exists for wider cumulative effects in the context of two or more of the development areas. In taking this forward it is proposed that while a top-down approach may have a high level screening application, a bottom-up approach to any cumulative assessment of effects on ornithology is more appropriate.

Greater Wash Sites

Existing data is well suited to a spatial assessment covering all Greater Wash sites and site information can be incorporated to gain an understanding of key foraging and resting areas, as well as main flight-lines between areas.

Documentary information on interactions of flocks is readily available, and it is likely that a medium level assessment could be achieved using existing information together with data derived from Round 1 and 2 EIAs. For instance, movements of tern flocks between foraging areas and breeding colonies can be identified, as can any route interactions from one or more wind farm sites and concentrations of wintering sea duck.

Activities that have the potential to cause in-combination effects to arise, such as aggregate extraction and intensive fishing, can be relatively easily determined at this scale. This is important in order to quantify habitat loss and potential disturbance levels.

Yorkshire Coast sites and south Wash sites

It is possible that for some species, and for some areas, cumulative assessments will only be necessary for a sub-set of the Greater Wash wind farms, due to their location (primarily, if they are remote from other sites). It is apparent, for example, that there are, for some species or groups, distinct differences in occurrence between those Yorkshire Coast sites and the other sites in the south Wash. For instance, the north Norfolk Coast can be regarded as the single most important breeding area for Sandwich Tern in the UK and, as such, the potential for impacts to the status of these colonies (through direct or indirect additive mortality or reduced foraging potential) is a key concern to be addressed by those sites which are within their foraging range. However, sites north of the Humber mouth would not have the potential to influence such breeding site related activity; whereas they would feature Sandwich Tern movements during passage periods and the proximity of the Yorkshire Coast sites to the Flamborough Head breeding colony means that species associated with this colony will have to be assessed in detail. Other examples include Gannet, for instance which will undertake foraging movements within the north Wash, where such movements are substantially less in the south Wash.

A similar approach might also be appropriate for sites located some distance offshore, although the absence of detailed knowledge on avifaunal usage in these areas and the complex coastal shape of the Greater Wash area may preclude this.

Thames Estuary SEA

Whilst not applicable for many species, there may be a degree of cumulative effects assessment required at an inter-strategic scale, within the UK, and in particular for the Thames Estuary SEA and Greater Wash SEA areas. Whilst most species using these areas will be relatively sedentary during the winter, there is the potential for some movement through areas, for instance by Divers, Brent Geese or Scoter to and from wintering grounds, as well as some wader species, and terns on passage. There may be difficulties in assessment, despite the data being available, however the issue should not be ignored and some assessment attempt should be made.

Proposed Approach

The variety of bird species, habitats and uses of the Greater Wash means that assessment at a number of scales is required, i.e. at a large scale (to include all sites); separately for Yorkshire Coast and south Wash sites for a number of species (e.g. Sandwich Tern & Gannet); and some attempt at assessment for species using both the Thames SEA area as well as the Greater Wash (e.g. Divers, Brent Geese & Scoter). Again, assessment would be undertaken as a progressive process whereby adjacent wind farm site information (e.g. from boat based surveys) will be considered as it becomes available with the aerial survey work which provides the Greater Wash context. Discussions are ongoing with local English Nature teams on the way forward on this issue for the different sites/sub areas.

The assessment of habitat disturbance and loss, together with disruption to ecological function, would be possible across all sites with the Greater Wash area, assuming data have been consistently collected according to COWRIE methods or equivalent. At a basic level, graphical species/group density data from each site could be incorporated with that from the aerial surveys and existing ESAS[6] data in order to identify seasonal patterns on a key species basis. These data could then be potentially used for population viability analysis (PVA), whereby collision information and associated effects on populations could be identified in combination with changes in foraging carrying capacity, additional energy expenditure and overall condition.

However, such an assessment would be subject to a number of caveats, not the least being a paucity of good data on collision risk and on carrying capacity thresholds. Having said this it would provide a form of assessment that would at least incorporate and address many of the issues outlined above. If such an assessment were possible on a species basis, then the derived information could be collated and incorporated with data from the Thames, giving some quantification of impacts at a Greater Wash level. The methodology for assessment will be the subject of further discussion and the advent of further survey data results.

As a starting point, the use of GIS to collate, manage and analyse data would be a prerequisite, with data from the various single site studies and any strategic data being

[6] European Seabirds at Sea

collated on a species/temporal basis, primarily using density data. Basic physical data on seabed type, depth and infauna would also be of value, as these are expected to be distribution drivers for many species of seabird, together with data on other sea bed uses. The derived information would then provide an indication of key areas of habitat on a species/seasonal basis, together with the key drivers for site selection. This would allow an assessment of the potential for cumulative habitat loss, disturbance impacts, loss of foraging area and habitat dislocation.

Additional layers could be adopted for banded flight heights and direction, in order to gain an understanding of the main flight-lines and heights around the Greater Wash area. Such information would then be of use in assessing the collision potential for key migratory species.

3.5 CETACEANS AND MARINE MAMMALS

3.5.1 Key Issues

Although generally observed in low numbers, 10 species of cetacean have been recorded in this region since 1980. The majority of sightings have either been along the coast or in near-shore waters (within 60km of the coast). However, this distribution may to some extent reflect the greater frequency of observers in the coastal margin. Only three of the 26 species of cetacean found in UK waters are either present in the region throughout the year or have been recorded annually since 1980 as seasonal visitors (Evans, 1999).

Offshore banks are also important for cetacean sightings. Although cetacean densities appear to be low throughout the region, there is some indication that harbour porpoises and white-beaked dolphins occur more frequently offshore over the Indefatigable Banks (60km north-east of Norfolk), and minke whales are sometimes seen in the area. (Evans 1999).

The coastal stretch between Flamborough Head and Great Yarmouth holds almost 7% of the UK's common seal population and the breeding population in the south Wash is the only significant population of this species in England and is one of the more important aggregations in Great Britain (Duck, 2001). Main areas include Donna Nook and Blakeney Point, with large aggregations in the Wash.

Along the coast of the Southern North Sea numbers of grey seal are probably similar to those of the common seal, but with concentrations of each species close to their respective colonies. The main haul out site for the grey seal in this region is Donna Nook at the mouth of the Humber on the Lincolnshire coast, this site being used throughout the year.

Based on the available literature, the following are perceived to be the main potential effects on marine mammals as a result of wind farms within the marine environment:

- Disturbance as a result of elevated construction and operational sound (disorientation);
- Avoidance as a result of increased shipping (construction and commercial);
- Increased collision risk due to construction traffic;

- Potential reduction of the feeding resource due to increased fishing effort and effects on prey due to elevated SSCs; and
- Conflict with commercial fisheries as a result of increased effort within smaller fishing areas.

Pipelines and cables head offshore both to the north and south of the Humber. Although it is thought that electromagnetic fields generated by cables have the potential to disorientate marine mammals, recent studies by OSPAR (2003) identified that for cables buried to a minimum of 1m, medium to high voltage AC cables had no negative effect on the marine environment. Oil and gas exploration in the area could contribute to noise, although Evans (1999) notes that this activity usually involves lower frequencies that are most likely to affect baleen whales (not resident or regular visitors to the area). Baines (1993) also suggests that porpoises can be affected.

3.5.2 Data Requirements

A number of research bodies collect and collate details on the occurrence and distribution of sea mammals around the UK coasts, including the Sea Mammals Research Unit (SMRU) and the Sea Watch Foundation. As with most coastal regions, information on the use of the area by marine mammals is at best only semi-quantitative, being based mainly on casual surface sightings and strandings and reliant on reporting by interested parties. Therefore, due to the manner in which data are collected for sea mammals, the true number of animals within the area probably exceeds the numbers actually recorded. Given the above, determining the extent of the impact of a specific activity on marine mammals is very difficult to quantify. Judging displacement is further complicated by long range movements either in search of food or on a seasonal basis.

The SMRU are currently working with the Joint Nature Conservancy Council (JNCC) and the Sea Watch Foundation to develop a standardised cetacean distribution database for effort related cetacean sightings data. It is proposed that this data will be the most suitable for use as baseline data. Historical strandings data is also available dating back to the early 1900s, although the quality of the data has been much improved since the early 1990s. Frequency of strandings can be used as an indication of stress and mortality of cetaceans in the area, but also gives an impression of the general distribution of species. This is particularly useful for recording species which spend most of their time beneath the surface of the water.

3.5.3 Assessment of Cumulative Effects

Overall, the potential effects on marine mammals from offshore wind generation within the region are considered to be relatively generic. However, taking into account the relatively low density and frequency of the majority of species, and allowing for the more frequent sightings of just a few species, it is considered that the optimal approach to assessment would be on an individual development (site specific) level, with developers sharing information in order to assess whether there is likely to be a cumulative effect with neighbouring sites. The site specific data may indicate that the parameter can be “scoped out”.

Given the predominance of seal populations in the southern Wash, any assessment should account for the importance of haul out sites and potential impacts as a result of disturbance. It is likely that the north Wash recordings will be individuals on feeding

sorties from breeding and haul out colonies within the south Wash area, as a consequence the major emphasis of assessment should concentrate on the populations within the south Wash area.

Results of ongoing studies and research will also be taken into account when available.

3.6 LANDSCAPE AND VISUAL CHARACTER

3.6.1 Key Issues

Key landscape designations in the area include:

- Spurn Head Heritage Coast;
- North Norfolk Area of Outstanding Natural Beauty (AONB);
- The North Norfolk Heritage Coast; and
- The North Norfolk Coast Path National Trail.

In addition, there are a number of coastal towns and resorts as well as other attractions, such as nature reserves (e.g. Gibraltar Point and Scolt Head Island) and open areas where views out to sea are an important element. A seascape study was carried out for the DTI's Strategic Environmental Assessment (SEA) Report in 2003. The main objective was to identify levels of sensitivity of seascape units to the offshore development of wind farms, based on a series of factors such as land use and presence/absence of areas possessing landscape designations. Minimum offshore distances have been established for each of the seascape units based on CCW guidance.

The Greater Wash coastline varies in sensitivity from Low (or 'of preference') to medium and high. In general, sensitivities range from high on the north Norfolk coast and medium along the Lincolnshire coast to both of preference and high on the Yorkshire coastline. Table 3.2 sets out the likely effects of wind farm developments located at various distances from these seascape units.

Table 3.2 Effects of proposed development for different seascape unit sensitivities

Seascape unit sensitivity	Significance of effect		
	Possible minor or no effect – Preferred Areas	Possible medium effects threshold	Possible major effects threshold
Low/no sensitivity	8km+ offshore	N/A	<8km offshore
Medium sensitivity	13km+ offshore	8-13km offshore	<8km offshore
High sensitivity	24km+ offshore	13-24km offshore	<13km offshore

Source: BMT Cordah (2003)

An analysis of this matrix is provided visually in Figure 3.2. This indicates the boundaries of the inner and outer seacape contours which vary along the coastline depending on the sensitivity of the seascape unit. The extent that each wind farm site

overlaps and, therefore, interacts in both landscape and visual terms is also illustrated. From this figure it is easy to see which wind farm developments may need to be included in any cumulative effects assessment for landscape and visual character if deemed to be visible from the coast. For example, Docking Shoal will be required to take into consideration the landscape and visual effects of Lincoln 1 and Sheringham Shoal when viewed from the Norfolk coast. It is considered that a maximum distance of 30km offshore is the limit of visual influence, and therefore it is not necessary for wind farm developments outwith this distance to be included in a cumulative impact assessment. In the same way, it is reasonable to make a further distinction between the Yorkshire Coast sites and those located in the south Wash. It is acknowledged that consideration will also be needed regarding the cumulative visual effects experienced from the sea.

3.6.2 Data Requirements and Assessment of Cumulative Effects

It is considered that cumulative landscape assessment is well understood and can be undertaken using usual landscape and visual impact assessment (LVIA) techniques, such as Zones of Visual Influence and photomontages, in accordance with CCW's *Guide to Best Practice in Seascape Assessment* (CCW *et. al.* 2001). It will be incumbent on the developers of the various 'interacting' wind farm sites to undertake joint LVIAs where this is deemed appropriate.

Overall, it is considered that for many of the developments the sites are of sufficient distance offshore not to be noticeable in the majority of weather conditions.

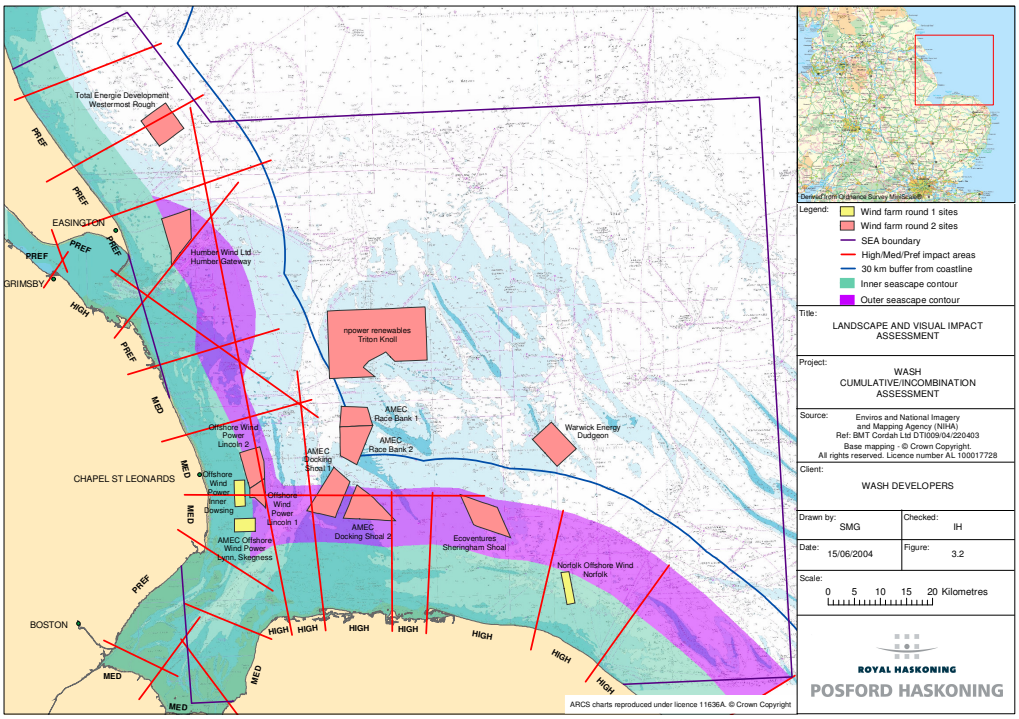

Figure 3.2 Landscape and Visual Impact Assessment

3.7 COASTAL PROCESSES AND GEOMORPHOLOGY

In terms of coastal processes, the Greater Wash area inside the 12nm limit comprises two littoral sediment cells, as defined by HR Wallingford (1994). Sediment cells are defined as a length of coastline that is relatively self-contained in terms of the movement of sand and gravel, where any interruption to the movement should not have significant effect on adjacent sediment cells. In the Greater Wash area, two major cells stretch from Flamborough Head to The Wash and The Wash to the Thames Estuary. These major cells are composed of sub cells which represent a practical sub division of the coastline into lengths that follow sediment cell principles. This enables suitably sized groups to be formed to consider coastal defence issues at the strategic level (DEFRA 2001).

To provide developers with further guidance on these issues the DTI is funding a study being undertaken by Neil Kenyon (Southampton Oceanography Centre) and ABPmer. A draft report has been issued to the SEA steering group (July 2004). Its main focus is in identifying net sediment pathways in relation to wind farm sites. Current indication of results as regards developments in the Wash Region are that, insofar, as coastal processes are concerned, the region could be subdivided into areas which can be considered independent. As such, the Yorkshire Coast sites could be considered independent from those to the south. Whether any further sub divisions are supported by the analysis will be clarified as the studies near completion.

The Southern North Sea Sediment Transport Coastal System (SNSSTCS) (HR Wallingford *et al*., 2002) provides information on broad scale transport in the offshore zone.

Cooper and Beiboer (2002) concluded that the changes to waves, tidal currents and sediment conditions caused by individual Round 1 wind farms are unlikely to be significant in the far-field, with only small changes in the near-field. This conclusion has largely been confirmed by the coastal process assessments subsequently completed for the Round 1 sites, e.g. Cromer, Lynn and Inner Dowsing assessments by Posford Haskoning (2002a, b, c). In addition, cumulative assessment of coastal processes undertaken for the Lynn and Inner Dowsing sites which are 4km apart showed no significant effects (Posford Haskoning 2002 b, c).

It is acknowledged, however, that the Round 2 sites are substantially larger than these Round 1 sites but by contrast they are further offshore. In addition, with the exception of sites at Race Bank and Docking Shoal, the proposed sites are to be constructed on firmer substrates with little tidally driven mobile sediment.

However, the concern remains as to whether the cumulative effect of the proposed developments will have a significant effect on the sediment transport regime, offshore and more importantly along the coast. Any changes in the sediment regime will come about through alteration of the physical processes (wave climate and tidal currents) that drive sediment transport.

Waves

When a wave propagating towards the coast impinges on a series of turbines in a wind farm a degree of diffraction of the wave around the turbines and reflection from the turbines will take place. These processes will cause the wave height and direction to change as it passes through the wind farm. This, in turn, has the potential to alter

sediment transport, both offshore and at the coast. The effect may be amplified if the wave passes through more than one wind farm site on its way to the coast. In the Greater Wash SEA, the main issues are likely to occur at the entrance to The Wash and along the east Lincolnshire and north Norfolk coastlines as a result of the cluster of sites in this area. To the north and east, the Humberside and north east Norfolk wind farms are considered cumulatively to have little impact on wave conditions, because their geographical relationship does not cumulatively impinge on wave approach to these coasts.

Tidal currents
The interference of tidal currents by wind farms may cause local variation in the flow and small-scale turbulence. This will impact locally around individual sites through the potential for scour at the base of the turbines. As with wave conditions, the assessment of Round 1 sites has shown that the impact of individual farms on tidal flows is generally localised and the effects do not extend a significant distance downstream of the site (Posford Haskoning, 2002a, b, c). Local changes in tidal currents may constitute an issue if the wind farm is constructed on a sand bank, where sediment transport pathways are controlled by tidal currents. In the Greater Wash SEA, the farms (with the exception of AMEC's site on Race Bank and Scroby Sands) are to be constructed on firmer substrates with little tidally-driven mobile sediment. Hence, on a broader scale the cumulative impact on the tidal current regime is likely to be minor, although assessment still needs to be carried out to prove this.

This summary indicates that the main issues are likely to be the alteration of wave conditions approaching The Wash, east Lincolnshire and north Norfolk coastlines and the potential changes to the sediment transport regime.

3.7.1 Data Requirements

Needs
In order to assess cumulative impacts on coastal processes, three main areas need to be investigated. These are sea bed form and composition (particularly mobile sediment distribution), physical processes (particularly tidal currents and wave climate) and shoreline geomorphological change.

Sea bed form and composition
Three main methods should be employed to characterise the sea bed; echosounder and side-scan sonar surveys and sea bed sampling. The echosounder provides detailed bathymetric data, whilst side-scan records allow the identification of sea bed texture and bedforms, which can be interpreted to determine sediment transport pathways. The sea bed samples ground truth the side-scan data and provide valuable information on sea bed mobility in their own right.

Physical processes
Wave characteristics can be measured using a variety of surface-mounted (wave rider buoys) and bed-mounted (pressure sensors) instrumentation. A minimum of 1 year of data collection is required to enable a reliable extrapolation of the data. However, data collection over this period may not be feasible within the scope of the EIA process and it is recommended that maximum use is made of existing data sources including the use of hindcast models (Meteorological Office). Tidal current velocities are best measured using Acoustic Doppler Current Profiler's (ADCP's). Current measurements taken close

to the sea bed can be compared with sea bed sediment distribution to assess offshore sediment mobility and transport direction.

Shoreline geomorphological change
Due to the potential cumulative physical impacts on adjacent coastlines, an understanding of how the coast functions is imperative, particularly how waves drive sediment transport along and across the littoral zone. Much of this information is readily available in previous reports (such as HR Wallingford, 1993 and HR Wallingford *et al.*, 2002) and a literature review is recommended. However, more detailed assessments can be made during a coastal walkover in combination with beach profiling and aerial photograph interpretation to gain an insight into coastal change over both the long-term (>10 years) and short-term.

Data Sources
Much of the data discussed above is or will be available through the EIA work undertaken for the individual sites and published sources. Where available, this information should be collated within this study to provide a comprehensive data set for the cumulative assessment. Where individual EIA study programmes mean that data will not be available to this study a separate data collection exercise may be required.

3.7.2 Assessment of Cumulative Effects

Methodology
It is proposed that the cumulative effects would be assessed through a combination of geomorphological interpretation of data and broad scale wave and tidal modelling. It is envisaged that sub divisions of the Greater Wash sites will be possible. These are likely to primarily be those near The Wash and Lincolnshire coast including Race Bank and Docking Shoal (such as, Lincoln 1 and 2, Inner Dowsing and Lynn and Docking 1 and 2 and Race Bank 1 and 2). The location of the Yorkshire coast sites in relation to the prevailing metocean conditions may mean that no interaction occurs, however this would need to be verified. Further discussions will be undertaken with CEFAS and the Environment Agency on the choice of groupings and methodology. Further feedback from CEFAS is awaited.

The need to include effects from nearby marine aggregates sites and effect on navigation channels must also be considered in the cumulative assessment.

Geomorphological Interpretation
One of the most important aspects of the data collection exercise is to accurately define the extent of the area over which data should be collected. This will be affected by water depth, proximity to coast, nature and sensitivity of coast and the proximity of offshore features (such as sand banks). With respect to the Greater Wash, the areas of most concern are those between the east Lincolnshire coast and 5 km offshore, and between The Wash and north Norfolk coast and 15-20 km offshore.

Collected data could be used to construct a conceptual model of how the offshore and coastal processes function. This conceptual understanding can then be used in conjunction with the numerical models (described below) to predict how sedimentary processes could potentially change upon construction of the wind farms. It is recommended that GIS provides a useful medium in which to store, manipulate and

interpret the data. The GIS would allow a comparison of data coverage, provide a means of comparing datasets and storage will assist data presentation.

Numerical Modelling
A broad scale wave and tidal model could be set up covering the identified groupings of wind farms. The model would replicate the impedance introduced by the individual wind farms and provide an assessment of the cumulative impacts. The level of impedance introduced in to the model would be based on large scale modelling completed for the individual sites. Where this information was not available, it could be deduced from existing large scale modelling results or from a separate modelling exercise to assess the impacts of small arrays.

Any model would be validated by running the model with only one wind farm included and comparing the results with those from the large modelling completed for the site. The model would provide an assessment of both the degree of interaction between the sites and the cumulative impacts at the coastline.

3.8 SOCIO-ECONOMIC EFFECTS

A range of beneficial economic impacts will result from all phases of the wind farm developments, including construction contracts, job creation, supply chain revenue, fabricators and distributors, as well as benefits to local businesses. Local infrastructure improvements, including port operations, are also likely to significantly benefit.

As well as economic benefits, obvious benefits to the nation arise through the development of renewable energy, including reductions in emissions and resource consumption.

The economic impact, both direct and indirect will be most significant during the construction phase, with less direct impact on the local economy during the operational phase. Given current programming for the development of sites, the economic impact will be spread over many years, and conceivably will extend up to 2015 and beyond.

As a rule of thumb it is considered that for every megawatt installed, c. £1M of economic expenditure occurs (DTI 2003 Future Offshore).

The cumulative socio-economic effects potentially experienced by the fishing industry and ancillary sectors will be addressed as part of the commercial fishing impact assessment (see Section 3.2).

3.9 EFFECTS FROM OTHER PLANS, PROJECTS OR USES

3.9.1 Key Issues

Effects from other plans, projects or uses of the sea are considered to include oil and gas installations, cables and pipelines, marine aggregates, offshore disposal, port developments and protected areas (conservation and heritage). Interactions will occur both during construction and operation, for those uses that continue to have active elements associated with them, for example, aggregate extraction.

The list of projects relevant to past (and still active), present and reasonably foreseeable projects include:

- Immingham Harbour Ro Ro Facility;
- Hull Container Terminal (2005);
- Humber Sea Terminal Phase 4;
- Offshore disposal grounds;
- Marine aggregate licence areas (see Figure 3.3);
- Marine aggregate licence application areas;
- Oil and gas activities;
- Coastal and flood defence schemes (including Lincshore);
- Proposed cables and pipelines; and
- Other wind farm construction programmes (which range from 2006 to 2015).

Assessment of these effects will be undertaken on a project specific basis as part of each offshore wind farm EIA.

3.9.2 Natura 2000 sites

Figure 3.4 illustrates the European sites that currently make up the network of designated sites known collectively as *Natura 2000*, that is Special Areas of Conservation (SACs) and Special Protection Area (SPAs). The JNCC is currently investigating likely qualification of offshore sites or extensions to existing sites for both SACs and SPAs. For SPAs, the seaward extension of breeding colonies is likely beyond the low water mark. Inshore areas used by non-breeding birds (divers and seaduck) and aggregations of seabirds away from the coast (for example for feeding) may also be identified.

In addition, further marine SACs could include sandbanks which are slightly covered by seawater all the time and reefs (including bedrock, stony and biogenic reefs); see Figure 3.4).

Under the Conservation (Natural Habitats, &c) Regulations 1994 (SI 1994/2716), known as the Habitats Regulations, which implement the EU Habitats Directive (92/43/EEC), the competent authority must consider the effect of a development on European sites when considering whether to grant an application for consent.

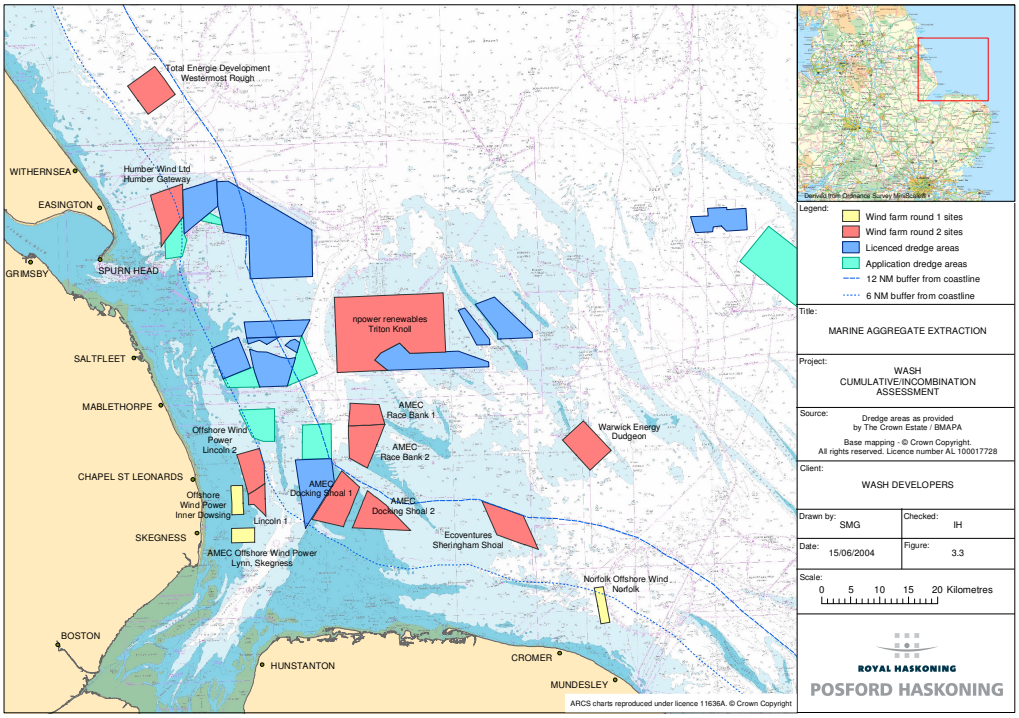

Figure 3.3 Marine Aggregate Extraction Licence areas

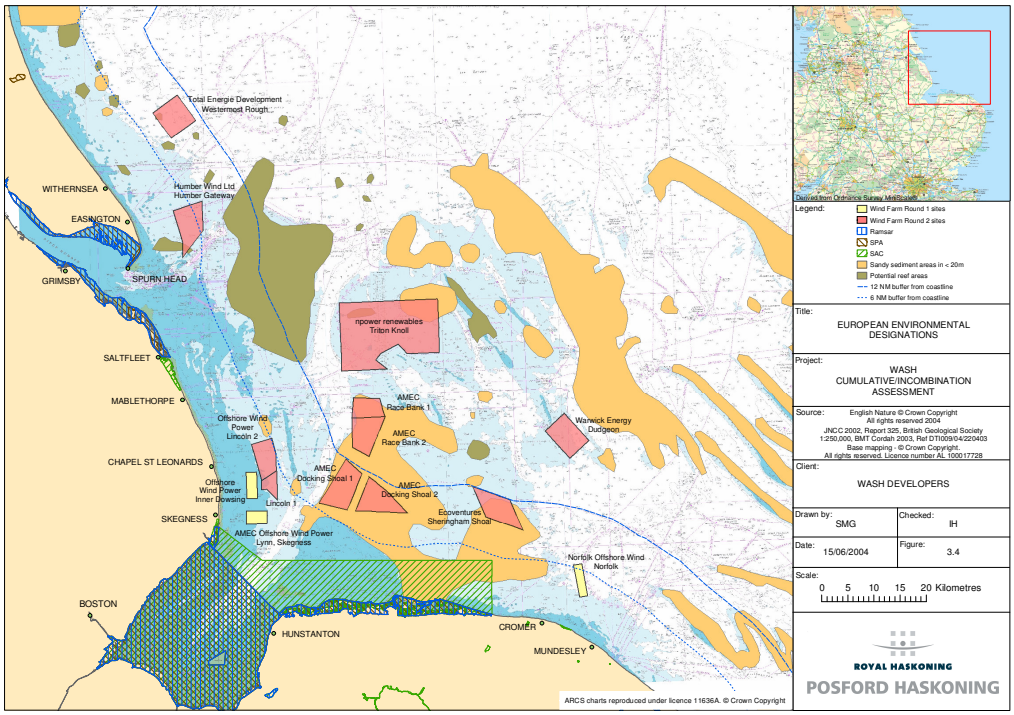

Figure 3.4 European Environmental Designations

Under Regulation 48 of the Habitats Regulations an ‘appropriate assessment’ must be undertaken by the competent authority in respect of any plan or project which:

(1) either alone or in combination with other plans or projects would be likely to have a *significant effect* on a European site, and
(2) is not directly connected with the management of the site for nature conservation.

The onus is on the developer to provide “Information for the Appropriate Assessment”. Much of this information will be collected and collated as part of the EIA, but particular reference must be made to the conservation objectives of the European site and to the site’s favourable condition tables. In addition, good liaison will be required with English Nature or the JNCC (beyond the territorial limit) on the requirement for an appropriate assessment, the extent of the study area to be included and the range of other projects or plans to be considered.

An *adverse effect* is likely to be one that prevents a European site from maintaining the same contribution to the favourable conservation status of the site’s relevant designated feature(s) as it did when the site was designated. The favourable conservation status of the site is defined through its *conservation objectives.* If, through the appropriate assessment process, it is concluded that the proposed development (inclusive of mitigation measures) would have an adverse effect upon the *integrity* of the designated site then the project can only proceed if there are no alternatives available and imperative reasons of overriding public interest (OPI) are considered to exist.

4 THE WAY FORWARD

4.1 CUMULATIVE IMPACT ASSESSMENT

Due to the complexity inherent in the interactions that characterise cumulative assessment it may not be possible to analyse impacts in detail. Impact prediction can involve high levels of uncertainty, more so in the maritime and coastal environment where there may be a lack of historical or up-to-date scientific data on which to base predictions. However, a disciplined and scientific approach will be followed where possible. In this respect it is likely that a number of clarifications may be applicable, including:

- the requirement to clarify assumptions about, for instance, the environmental impacts of activities;
- the importance of setting out predictions in terms of ranges rather than giving precise figures to reflect uncertainty;
- the need to base predictions on different scenarios which reflect possible future events and conditions;
- the use of worst case scenarios based on a precautionary approach; and
- a requirement to carry out sensitivity analyses to ensure that changing assumptions on which predictions are based does not overly influence the outcome of the predictions (PDE & Hill, 2001).

A pragmatic approach to the assessment of cumulative effects is therefore proposed (as set out in this document) such that robust data collection as part of normal EIA requirements is undertaken using comparable methods and that this information is then collated, shared and reviewed where potential interactions have been identified.

This document provides a commitment from the Wash developers to work together through the sharing of information and data to ensure that cumulative effects are adequately addressed.

As discussed it is proposed that the reporting of cumulative effects will be as part of each development's EIA. Separate published studies will not be prepared *per se* however, it is likely that studies will be commissioned to cover more than one site and in many cases to cover the sub areas namely, the Yorkshire Coast sites and the south Wash sites (and any further groupings within these sub areas). At this stage, it is not anticipated that any more original data will be collected over and above that required for each site's EIA. Existing information[7] regarding the Greater Wash area as a whole will be utilised to provide a wider context.

This has the benefit of pooling resources, avoiding double handling (and double or multiple counting) and assigning a consistent methodology to impact assessment and therefore cumulative assessment. Information from these studies will then be drawn upon by each developer for inclusion in their EIA to be submitted for consent applications. The following table sets out the essential steps for undertaking cumulative assessment.

[7] From other EIAs (such as marine aggregates), research and conservation studies and initiatives being undertaken.

Table 4.1 Cumulative Assessment

Basic EIA Steps	Tasks to complete for Cumulative Assessment
Scoping	• Identify issues of concern • Identify spatial and temporal boundaries to ascertain level of influence/interaction • Identify potential impacts due to actions and possible effects
Analysis of Effects	• Complete the collection of baseline data using comparable methodologies • Assess the magnitude of effects of proposed projects on identified parameters
Identification of Mitigation	• Recommend mitigation measures
Evaluation of Significance	• Evaluate the significance of residual effects • Compare results against thresholds or guideline criteria
Follow-up	• Recommend monitoring or effect management

(adapted from the Canadian Environmental Assessment Agency, 1999)

4.2 AN INCREMENTAL "BUILDING BLOCK" APPROACH

This scoping report has identified areas of interactions based on the spatial and temporal components of the various environmental parameters reviewed. The Wash Developers wish to proceed with the assessment of cumulative effects based on an incremental or 'building block' approach. This stems from the fact that Round 2 developers are proceeding with their data collection requirements at varying paces. It is clear that most of those Round 2 developers with sites within the 12nm territorial limit are advancing at a faster rate than those outside the limit.

Comparable data is the key to the assessment of cumulative effects and, without robust and scientific datasets, making a judgement on the significance of cumulative effects is extremely difficult and open to criticism. Given the Government's commitment to renewables and the investment of large sums of money by developers, it is not considered a realistic option to await the outcome of a cumulative effects study which covers all the Round 2 sites before individual applications are made and considered.

It is, therefore, proposed that cumulative effect studies are undertaken on a site specific basis and included as part of the EIA submission based on the criteria set out in this report. Due to the later start up of the Triton Knoll and Dudgeon EIA studies it is likely that the cumulative assessments undertaken by npower renewables and Warwick Energy, respectively, would build on the cumulative assessments already undertaken by those developers within the 12nm limit. These projects will have the benefit of considerably more data from the monitoring results of existing installations which should provide a greater understanding of effects.

The relevant regulators and stakeholders who attended the Greater Wash Offshore Developers Meeting held in Cambridge on 24th June 2004, indicated that this would be an acceptable way forward. The approach effectively maintains the renewable development impetus, whilst endeavouring to ensure that the cumulative effects of Round 2 are assessed. In contrast to recent studies in the Eastern English Channel on marine aggregate dredging, it is understood that the Licensing Authorities are not keen

to see a regional approach being taken. This is primarily because there is no legal basis for such an assessment, and awaiting information on all Round 2 sites in the Greater Wash prior to proceeding is not deemed to be reasonable, particularly in terms of the Government's renewable energy obligations and targets.

4.3 DATA SHARING

The mechanism for data pooling and sharing has been initiated by The Crown Estate as part of the Round 2 bid process, whereby developers are required under their lease agreement to include all data collected as part of the EIA, along with future monitoring data. The IACMST report on marine data portal which is expected soon (now in final draft) may well provide a protocol and standard for the future in this regard.

As data tend to be gathered on a development specific basis, there is an over-riding need for a large degree of standardisation of data collection techniques, in order to allow the existing data to be used for any cumulative assessment phase. These techniques need to be robust and fit for purpose, in that the data need to be collected using statistically valid methods which will meet the current and foreseeable needs for subsequent data analysis and information outcomes.

5 REFERENCES

Allan J, J Bell, M Brown, R Budgey & R Walls. Measurement of Bird Abundance and Movements Using Bird Detection Radar. CSL.

Baines, M.E. 1993. Marine mammal monitoring during the seismic exploration of block 107/21 in Cardigan Bay, Autumn 1993. Haverfordwest, Dyfed Wildlife Trust.

BMT Cordah Limited. 2003. Offshore Wind Energy Generation: Phase 1 Proposals and Environmental Report For Consideration by the Department of Trade and Industry.

Camphuysen CJ, TJ Fox, MF Leopold, & IK Petersen. 2003. Towards Standardised Seabirds at Sea Census Techniques in Connection with environmental Impact Assessments for Offshore Windfarms in the UK. COWRIE.

CEFAS 2004, Proceedings from DTI/CEFAS Round 2 Workshop (March 2004)

CCW 2001,Guide to Best Practice in Seascape Assessment

Cooper, B. and Beiboer, F. 2002. Potential effects of offshore wind developments on coastal processes. Report to ETSU.

Delaney M.J. 1985. *Yorkshire Mammals*. University of Bradford.

Department of the Environment, Transport and the Regions (DETR). 2001. Draft Marine Minerals Guidance Note 2: Guidance on the Extraction by Dredging of Sand, Gravel and Other Minerals from the English Seabed CONSULTATION PAPER

DEFRA 2001, Shoreline Management Plans: A Guide for Coastal Defence Authorities.

English Nature 2001, Habitats Regulations Guidance Note (HRGN 4).

Evans, P.G.H. 1999. *Coast and Seas of the United Kingdom* Electronic Platform (Phase 1) version 1.0., JNCC.

HR Wallingford, CEFAS/UEA, Posford Haskoning and D'Olier, B. 2002. Southern North Sea Sediment Transport Study Phase 2. Sediment Transport Report. HR Wallingford Report EX4526.

HR Wallingford. 1994. Coastal management – mapping of littoral cells. HR Wallingford Report SR328.

Joint Nature Conservation Agency Guidance on Offshore Windfarm Development – extract of draft guidance on bird survey techniques. 27 May 2004

Kuiken, T., Bennett, P.M., Allchin, C.R., Kirkwood, J.K., Baker, J.R., Lockyer, C.H., Walton, M.J., & Sheldrick, M.C. 1994. PCBs, cause of death and body condition in harbour porpoises Phocoena phocoena from British Waters. Aquatic Toxicology, 28: 13-28.

Landscape Design Consultants. 2000. Cumulative Effects of Wind Turbines: A Guide to Assessing the Cumulative Effects of Wind Energy Development. ETSU.

Landscape Design Consultants. 2000. Cumulative Effects of Wind Turbines Volume 3: Report on Results of Consultations on Cumulative Effects of Wind Turbines on Birds. ETSU.

Langston RHW & JD Pullan. 2002. Windfarms and Birds: An Analysis of the Effects of Windfarms on Birds, and Guidance on Environmental Assessment Criteria and Site Selection Issues. Bern Convention.

Percival SM. 2001. Assessment of the Effects of Offshore Windfarms on Birds. ETSU.

Posford Duvivier Environment & Hill, M.I. 2001, Guidelines on the impact of aggregate extraction on European Marine Sites. CCW (UK Marine SACs Project).

Posford Haskoning. 2002a. Norfolk Offshore Wind Farm Environmental Impact Assessment. Report to Norfolk Offshore Wind Ltd.

Posford Haskoning. 2002b. Coastal process assessment for Lynn Offshore Wind Farm Environmental Impact Assessment. Report to AMEC.

Posford Haskoning. 2002c. Coastal process assessment for Inner Dowsing Offshore Wind Farm Environmental Impact Assessment. Report to Renewable Energy Systems Ltd.

Richardson JW. 1998. Bird Migration and Wind Turbines: Migration Timing, Flight Behaviour and Collision Risk. Proceedings of the National Avian-Wind Power Planning Meeting III.

Scottish Natural Heritage. 2003. Guidance: Cumulative Effect of Windfarms (accessed via Web Site - http://www.snh.org.uk/pdfs/polstat/cgw.pdf, 17th May 2004).

Sea Watch Foundation 2003. www.seawatchfoundation.org.uk.