CONTENTS

11 MARINE MAMMALS

11.1 Introduction

This section describes the existing environment with regard to marine mammals, namely seals and cetaceans[1], and details the potential impacts of the construction, operation and decommissioning phases of the Thanet Offshore Wind Farm (Thanet) project. The study area for marine mammals is relatively wide covering a large section of the southern North Sea and eastern English Channel due to the migratory behaviour of cetaceans.

11.2 Assessment Methodology

11.2.1 Data collection

Information on cetacean status and distribution is sourced primarily from the National Sightings Database (1973 to present) maintained by the Sea Watch Foundation (SWF) and the Strandings Scheme organised by the Natural History Museum in London (1913 to present). For details of the Sea Watch National Observer Scheme, see Evans (1980, 1992, 1998), Evans *et al* (2003), and Reid *et al* (2003).

Systematic land based watches have been carried out at Dungeness in Kent, and less regularly at Sandwich Bay in Kent, Aldeburgh/Orford Ness and Southwold/Walberswick in Suffolk, and in the last few years, by members of the Essex Wildlife Trust at various sites along the Essex coast.

Sea based coverage is generally poor in the southernmost North Sea and eastern English Channel, although some evidence is available. Watches have been made from ferries operating to continental Europe out of Dover in Kent and Harwich in Essex. MAFF (now Defra) Fisheries Research vessels and the Channel Fisheries Protection vessel both report mammal sightings, and a dedicated cetacean survey off the coast of East Anglia has been conducted by Sea Watch and EarthKind in summer 1999 (Rosen *et al*, 2000).

A major international collaborative programme, the Small Cetacean Abundance in the North Sea (SCANS) project, was conducted throughout the North Sea in July 1994, in order to provide a baseline assessment of abundance of the major species (Hammond *et al*, 2002). However, no cetaceans were observed in the eastern English Channel during the survey.

Unless a dedicated survey is undertaken, sightings data tends to be collected opportunistically. Sightings effort, therefore, tends to be highest between the months of April and September, when sea conditions are usually more suitable for observation. Because of this, it is likely that winter sightings may be under-representative of true populations in the National Sightings Database.

As part of seabird surveys in the North Sea and English Channel, offshore cetacean sightings data have also been collected by the Joint Nature Conservation Committee's (JNCC) Seabirds at Sea Team (Northridge *et al*, 1995; Reid *et al,* 2003). **Section 11.3**

[1] Whales, dolphins and porpoises.

draws upon the data described above to develop a baseline description of the cetacean population in the study area. This information is supplemented by data collected during the aerial and boat based bird surveys carried out as part of the baseline studies for this Environmental Impact Assessment (EIA) between November 2004 and October 2005 (see **Section 8, Ornithology**). Incidental sightings of marine mammals during these surveys were recorded within the immediate area of the Thanet site.

Baseline data on seals was obtained by way of a recent survey of seal haul out sites by the Kent Mammal Group (Bramley Associates, 2004) and through a literature search on UK populations of grey and harbour seals.

11.2.2 Impact assessment

In order to carry out the impact assessment, a literature review was carried out of existing research into seal and cetacean behaviour in response to sources of human induced disturbance, including research carried out at existing wind farm sites across Europe. In particular, information has been obtained from monitoring studies of the movement and behaviour of seals and cetaceans around the Horns Rev offshore wind farm in Denmark.

In studying the effects of noise, research into cetacean hearing and communication was also used to compare against the noise generated during construction, operation and decommissioning.

11.3 Existing Environment

11.3.1 Protection under international and national conservation legislation and agreements

Most marine mammals present in the North Sea are protected by International Conventions and Agreements and/or national legislation. For example, all dolphins and porpoises are protected under the BONN Convention (1983) on the Conservation of Migratory Species of Wild Animals (Appendix II - Migratory species conserved through Agreements) and BERN Convention (1979), on the Conservation of European Wildlife and Natural Habitats (Appendix II - Strictly Protected Fauna Species). They are also protected under Annex II and IV of the EC Habitats Directive (92/43/EEC), the Agreement on the Conservation of Small Cetaceans in the Baltic and North Seas (ASCOBANS) (1992) and the UK Wildlife and Countryside Act 1981. Harbour and grey seals are protected in the UK by the Conservation of Seals Act (1970).

11.3.2 Introduction to the study area

The waters of the southern North Sea and eastern English Channel are relatively unimportant for cetaceans compared with other parts of the United Kingdom. Fifteen species of cetaceans have been recorded since 1980 in nearshore waters i.e. within 60km of the coast, although four of these are known only from strandings (Evans, 1998, Sea Watch Foundation, unpublished data). Only two species out of a UK total of 28 species are either present throughout the year or recorded annually as seasonal visitors to the region and another two species occur on a more casual basis. No species is abundant, the most frequently observed in nearshore waters being the harbour porpoise *Phocoena phocoena* and bottlenose dolphin *Tursiops truncatus*, both of which are nevertheless uncommon. Offshore, in the eastern English Channel, the long-finned pilot

whale *Globicephala melas* is recorded annually, and in the southernmost North Sea, the white-beaked dolphin *Lagenorhynchus albirostris* occurs at least occasionally (Evans, 1998, Sea Watch Foundation, unpublished data).

Other cetacean species recorded less than five times in the region since 1980 include Atlantic white-sided dolphin *Lagenorhynchus acutus*, short-beaked common dolphin *Delphinus delphis*, striped dolphin *Stenella coeruleoalba* (stranding only), Risso's dolphin *Grampus griseus*, killer whale *Orcinus orca*, Sowerby's beaked whale *Mesoplodon bidens* (stranding only), sperm whale, *Physeter macrocephalus* (stranding only), humpback whale *Megaptera novaeangliae*, fin whale *Balaenoptera physalus* (stranding only), sei whale *Balaenoptera borealis*, and minke whale *Balaenoptera acutorostrata*. Sightings plots for the four most common species recorded live, that is long-finned pilot whale, white-beaked dolphin, bottlenose dolphin and harbour porpoise, are provided in **Figures 11.1** to **11.4** (Evans, 2005 unpublished). Sightings of unidentified dolphins are plotted in **Figure 11.5** and rare species in **Figures 11.6** and **11.7** (Evans, 2005 unpublished).

The status, seasonal occurrence, and ecology of the four species of cetaceans recorded regularly in recent years off the coast of Kent and in adjacent sea areas are given below.

11.3.3 Long-finned pilot whale

The long-finned pilot whale is only a casual visitor in the coastal waters of Kent (see **Figure 11.1**), but is recorded regularly further west in the English Channel and west of the Isle of Wight. Although recorded in the UK in most months of the year, peaks in sightings and numbers of individuals in the western English Channel occur in November. Although there is no distinct breeding season, births in UK waters show a slight peak in late winter to early spring i.e. January to March (Evans, 1980; Martin *et al*, 1987).

A highly social species, long-finned pilot whales are usually found in groups of six to 40 animals, although pods in offshore deep waters can range to more than 1,000 individuals (Hammond *et al*, 2002). Seasonal inshore movements of pilot whales in different areas have been correlated with the abundance of prey. Evans (1980) reported seasonal movements and by-catches associated with mackerel fisheries in southwest England.

11.3.4 White-beaked dolphin

This species is common in British and Irish waters, and is found most abundantly in the central and northern North Sea, across to northwest Scotland. It also occurs less commonly in the southern North Sea, and occasionally in the English Channel. No white-beaked dolphins were recorded in the North Sea south of 54° N, i.e. between Flamborough Head and Hornsea from line transect surveys undertaken in July 1994 (Hammond *et al*, 2002) for the North Sea and English Channel.

White-beaked dolphins are occasionally seen in the southernmost North Sea (see **Figure 11.2**), in August and September, and these are peak months for sightings rates and individual rates when corrected for effort (Northridge *et al*, 1995; Evans *et al*, 2003). They are rarely reported between November and April. It should be noted that some of the records of unidentified dolphins are likely to be of this species (Evans, 2005 unpublished).

White-beaked dolphins feed upon mackerel, herring, cod, poor-cod, sandeels, bib, whiting, haddock, and hake, as well as squid, octopus, and benthic crustaceans. White beaked dolphins are known to utilise the North Sea and English Channel for both feeding and breeding. They breed mainly between May and August, although some breeding may also occur in September and October.

11.3.5 Bottlenose dolphin

Essentially an inshore species, the bottlenose dolphin is most frequently sighted in British and Irish waters within 10km of land, although as noted above, it does also occur in offshore waters. In coastal waters, bottlenose dolphins often favour river estuaries, headlands or sandbanks where there is uneven bottom relief and/or strong tidal currents (Lewis and Evans, 1993; Liret *et al*, 1994; Wilson *et al*, 1997). The species is scarcely reported in the central and southern North Sea, although it occurs seasonally along the south coast of England at particular localities, but because of the paucity of vessel surveys dedicated for cetaceans, it may be under-recorded in the region. Nevertheless, it is the species most likely to be encountered in the vicinity of the Thanet site (see **Figure 11.3**), mainly in spring, May, and early autumn August to September, with most reports coming from the vicinity of Dungeness, which is probably due to much higher observer coverage there.

Groups usually vary between two and ten individuals including young, and elsewhere in the UK where the species is more common, group sizes tend to increase in late summer when they may number tens of individuals. Sightings of unidentified dolphins (see **Figure 11.5**) may also be of this species, although some, particularly those in the North Sea, are likely to have been white-beaked dolphins.

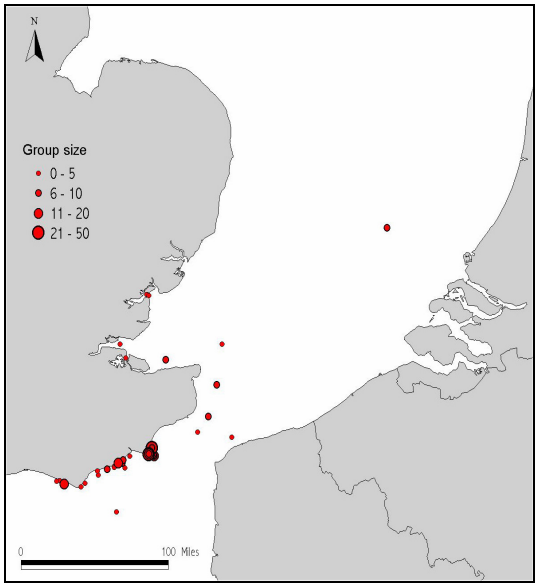
The species has an extended breeding season, with births peaking between May and October (Evans 1980 and 1998; Evans *et al*, 2003; Wilson, 1995; Grellier, 2000). Bottlenose dolphins feed upon a variety of benthos such as eels, flounder, dab, sole, turbot, haddock, hake, and cod, and mid-water fish such as salmon, trout, bass, mullet, herring, blue whiting, as well as marine invertebrates such as cephalopods and shellfish.

11.3.6 Harbour porpoise

Although the harbour porpoise is the most common cetacean species recorded in the UK, it is rare in the English Channel, particularly in the eastern section. However, the species has been observed regularly in recent years in the southernmost North Sea, particularly off the Dutch and Belgian coasts, but also in Suffolk, Essex and Kent (see **Figure 11.4**). There is some indication of seasonal movements by harbour porpoises into the area, with most sightings occurring between March and May and particularly in April, although the species has also been recorded between June and October, and casually during winter months (Evans *et al*, 2003).

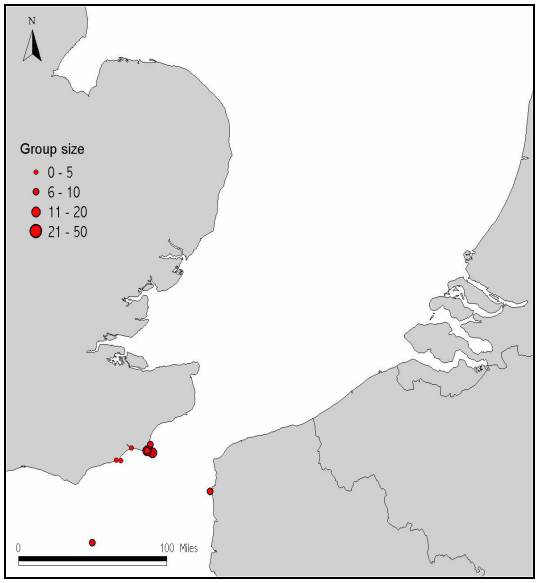
The main diet of porpoise is small fish, usually less than 40cm in length, such as young herring, sprat, sand-eel, whiting, saithe, and pollack, although prey such as dab, flounder, sole, and cod are taken particularly in winter months. Breeding occurs mainly between May and August, with a peak in June, though some can be as early as March.

Figure 11.1 Long-finned pilot whale sightings in South East England



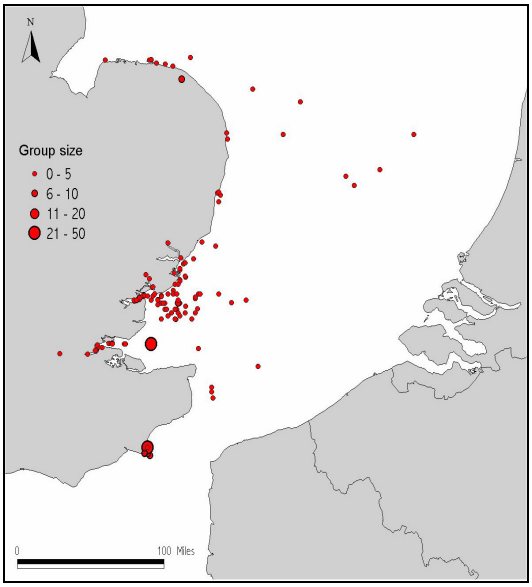
Source: Evans, 2005, unpublished.

Figure 11.2. White-beaked dolphin sightings in South East England



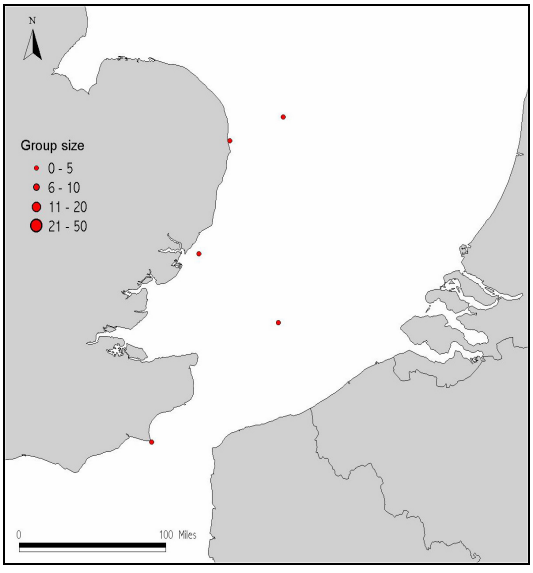
Source: Evans, 2005, unpublished.

Figure 11.3 Bottlenose dolphin sightings in South East England



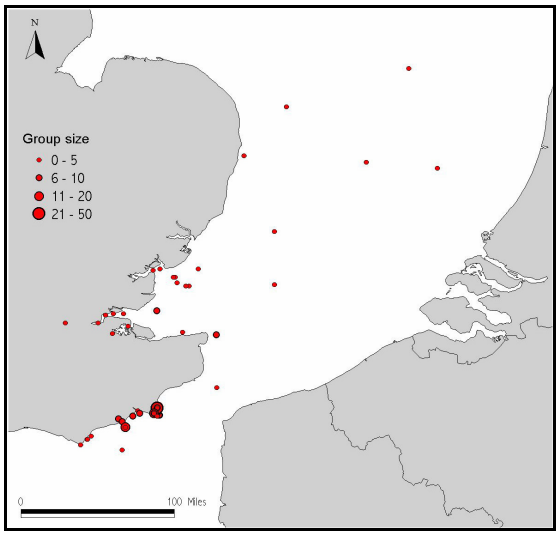
Source: Evans, 2005, unpublished.

Figure 11.4. Harbour porpoise sightings in South East England



Source: Evans, 2005, unpublished.

Figure 11.5 Unidentified dolphin sightings in South East England

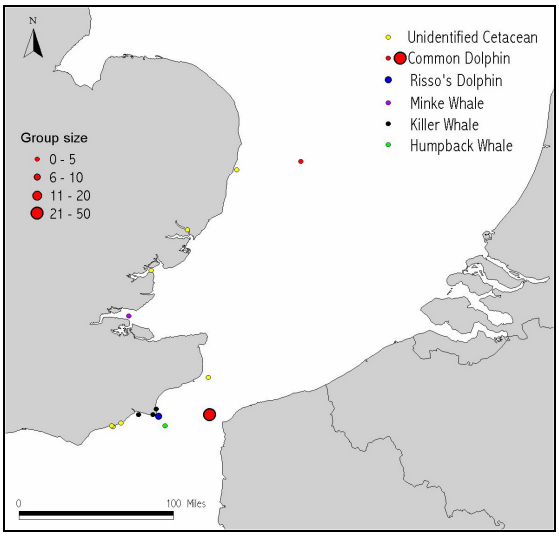


Source: Evans, 2005, unpublished.

Figure 11.6 Sei whale sightings in South East England

Source: Evans, 2005, unpublished.

Figure 11.7 Other species sightings in South East England



Source: Evans, 2005, unpublished.

11.3.7 Seals

Two species of seal breed in British waters, namely the grey seal, *Halichoerus grypus*, and the common or harbour seal, *Phoca vitulina*. The UK population of grey seals is estimated to be in the order of 120,000, about 45% of the global population, and the UK population of harbour seals is estimated at around 32,000, about 5% of the global population (English Nature, 2004a).

Harbour seals haul out onto tidally exposed sandbanks, rocks or mud, and some beaches, to rest, moult and suckle their young. They also breed near to their haul out sites, but may feed a long distance from these locations (Brasseur and Fedak, 2003). Harbour seals are more likely to be found out of the water between June and September, during times of pupping and moulting, which occurs from August to September (Hammond *et al,* 2003). Grey seals haul out on land between foraging trips and for breeding, where they form large aggregations. Pupping occurs around January in the southern North Sea, while moulting occurs in February and March (Hammond *et al,* 2002).

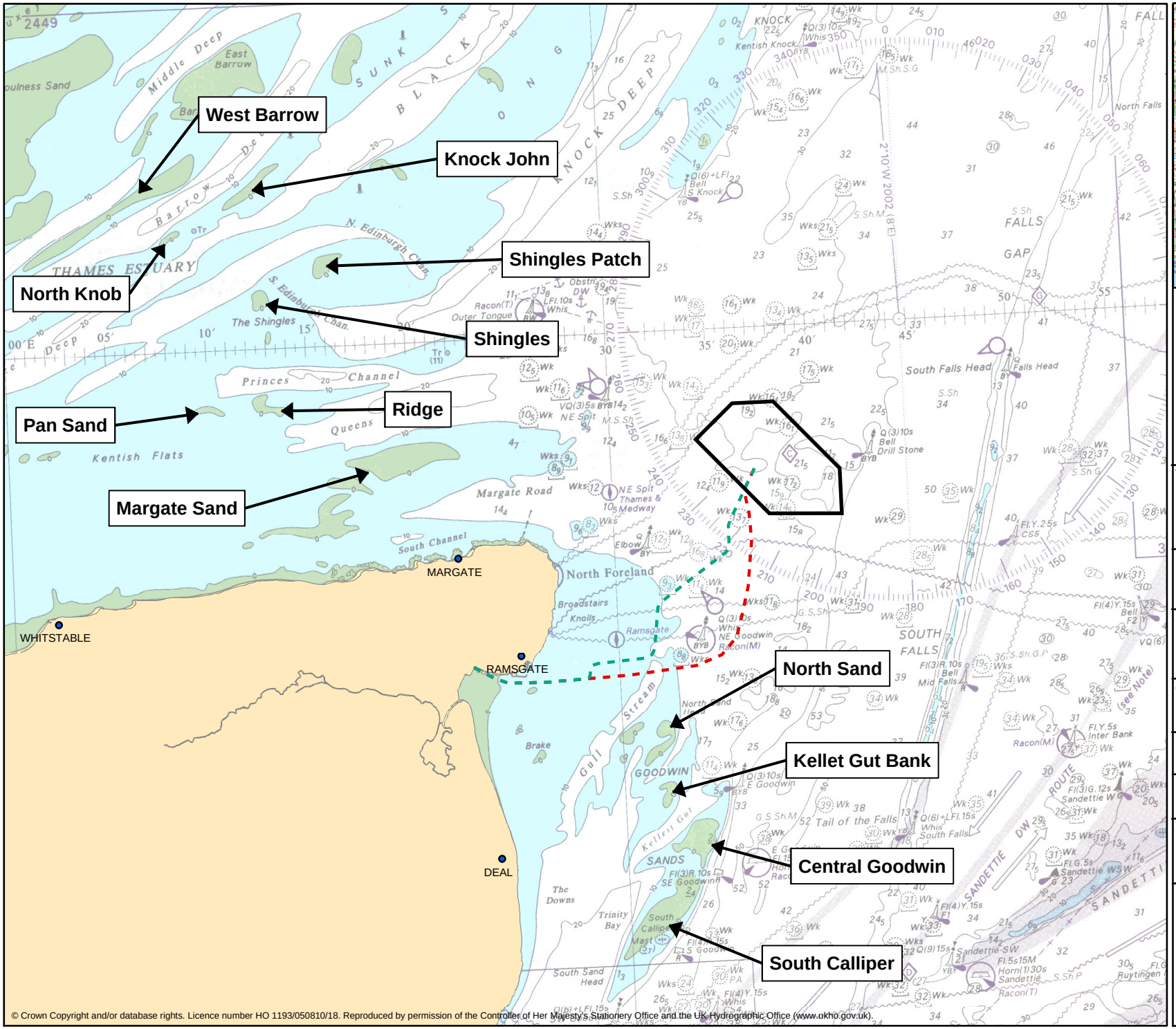
Even though no significant haul out sites were identified south of Suffolk in two recent English Nature marine planning documents (English Nature, 2004a and 2004b), a recent survey by the Kent Mammal Group has identified sites in the region of the Thanet site (see **Figure 11.8**). **Table 11.1** displays data from the survey of haul out sites around the North Kent coast. The North Sand to South Calliper sites are all within the Goodwin Sands complex, offshore of Deal and Sandwich in Kent. The Goodwin Sands and Margate Sands complex are the most important haul out sites in the vicinity of the Thanet site. A large group of seals numbering 150 was recorded on one occasion at Margate Sands, and there have been reports of 60 to 80 animals on the Goodwin Sands complex in one day, with the majority tending to be harbour seals (Jonathan Bramley, pers. comm., 2005). East Barrow, just northeast of West Barrow (shown in **Table 11.1**) is also considered a primary haul out site in the region.

Table 11.1 A pilot survey of haul out sites for harbour seal and grey seal on sandbanks off of the north Kent coast.

Sandbank	Harbour seal	Grey seal
West Barrow	21	3
North Knob and Knock John	0	0
Shingles and Shingles patch	n/a	n/a
Pan Sand and Ridge	12	4
Margate Sand Complex	19	0
North Sand	25	20
Kellet Gut Bank	1	1
Central Goodwin	34	0
South Calliper	n/a	n/a
TOTAL	**112**	**28**

Source: Bramley Associates, 2004.

NB. 'n/a' in the results refers to a sandbank(s) not showing at time of survey.



Legend:

- Wind Farm Site Location
- Proposed Cable Route 1
- Proposed Cable Route 2

Title:

HARBOUR SEAL AND GREY SEAL HAUL-OUT SITES

Project:

THANET OFFSHORE WIND FARM

Source: Main Chart - Not to be used for navigation.
© Haskoning UK Ltd.
Inset Map -
Derived from MiniScale by Ordnance Survey.
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Client:

THANET OFFSHORE WIND LTD

Drawn by:	Checked:	Drawing No:
SMG	SDG	9P5164/06/501
Date: 21/09/2005		Figure: 11.8
Scale: 0 1 2 3 4 5 Kilometres		Revision No: 002

ROYAL HASKONING

11.3.8 Aerial and boat based surveys 2004-2005

Boat based and aerial bird surveys were carried out between November 2004 and October 2005 (see **Section 8**). Any sightings of seals and cetaceans were also recorded during these surveys. However, there were no qualified marine mammal observers on board, so records may not have involved the species identification. The results are summarised in **Table 11.2**.

Table 11.2 Seal and cetacean sightings during boat based bird surveys

Survey date	Species observed	No. of individuals	
		Control Block	Survey Block
15/11/2004	Harbour porpoise	3	6
10/12/2004	Harbour porpoise White-beaked dolphin	2 0	6 1
17/02/2005	Harbour porpoise	6	7
09/03/2005	Harbour porpoise	0	3
23/03/2005	Harbour porpoise Grey seal Common seal	2 1 0	4 0 1
30/04/2005	Harbour porpoise	5	3

11.3.9 Cetacean sound production and hearing

Animals such as cetaceans that live entirely within an aquatic environment rely heavily on sound, both to acquire information about their environment and for communication (Evans, 1987; Richardson *et al*, 1995). Additional sounds may, therefore, cause disruptions to the lives of cetaceans, distracting, or frightening them, as well as providing the potential for causing behavioural and physiological upset.

The sounds produced by toothed whales and dolphins may conveniently be divided into:

- Pure tone whistles generally in the frequency range 500Hz to 20kHz, used mainly for communication; and
- Pulsed sounds or clicks varying from 500Hz to 150kHz, used mainly for echolocation.

Source levels for both types of sound are estimated usually to be between 150 and 200 decibels (dB), although pulsed sounds for non-echolocatory purposes may be produced at source levels of 115dB, mainly in the frequency range below 20kHz (Richardson *et al*, 1995). Most of these measurements were made in captivity and it should be noted that animals could modify their sound production, particularly its intensity, in confined situations.

As an example, the bottlenose dolphin makes a wide range of vocalisations. Echolocation clicks, used for orientation and foraging, are composed of intense short duration broadband clicks (40 to 130kHz) (Au, 1993). Clicks are broadcast in episodic trains that can continue for the duration of a dive and culminate in buzzes and whines as targets are approached. Burst pulse vocalisations such as barks, yelps and donkey-like brays (200Hz to 16kHz) may have a variety of social functions. Whistles are pure tone frequency modulated calls ranging from 2 to 20kHz. Clicks and whistle vocalisations can be made simultaneously.

Most toothed whales, dolphins and porpoises can hear sounds over a wide range of frequencies from 75Hz to 150kHz, with greatest sensitivity around 20kHz, although low frequency hearing has not been fully investigated. The auditory sensitivities of porpoises, dolphins and the smaller toothed whales are greatest at very high frequencies, between 10 and 150kHz, with a hearing threshold of about 40dB at those frequencies, increasing to around 100dB at 1kHz and 120dB at 100Hz (Richardson *et al*, 1995).

11.4 Impacts during Construction

11.4.1 Impacts on cetaceans due to construction noise

Sounds generated within the hearing range of cetacean species tend to elicit specific responses:

- The animal or animals move away from the sound source;
- They increase their dive times, remaining underwater for longer periods, possibly as a result of a rapid flee response; and
- Social groups may bunch together (Richardson *et al*, 1995; Evans, 1996).

Sometimes, a cetacean species can shift the sound frequency at which it is communicating, and thus avoid or at least reduce interference with anthropogenically induced sounds. Long term effects upon survival and reproduction of cetaceans have scarcely been demonstrated, however, because of the extreme difficulty of distinguishing from other anthropogenic factors and natural environmental changes, it is almost impossible to say whether these occur.

Cetaceans are highly mobile mammals, however, potential impacts may occur due to disturbance to feeding activity or migration. Sources of disturbance would include noise and vibration from vessel movements and piling operations.

Subsea acoustic noise and vibration levels were measured in a recent UK study of wind turbine construction and operation (Nedwell *et al*, 2003; Nedwell and Howell, 2004). The authors concluded that a strong avoidance reaction would be likely during construction for a range of marine mammal and fish species at ranges of up to several kilometres, and that injury was likely within one hundred metres. Cable trenching at North Hoyle offshore wind farm, on the other hand, could be detected at ranges of up to 7km although source levels and transmission loss could not be measured in those instances.

Most attention on the potential impact of wind farm construction upon cetaceans has been focused on the harbour porpoise, as the main species occurring in coastal north European waters. The most detailed study to date has been that of Tougaard *et al* (2003a) at Horns Rev in Denmark. Using acoustic click detectors called T-PODs, the authors deployed these before, during, and after wind farm construction and found a significant reduction in porpoise sonar activity as follows:

- Duration of encounters declined from five to three minutes during pile driving activities;
- Waiting time between encounters increased from 6 to 71 hours;
- Daily mean click intensity declined from 46 to 21 clicks per minute; and
- Daily frequency of minutes with more than five clicks declined from 1% to 0.1%.

They also found that porpoises were displaced over distances exceeding 12km, although rapid re-colonisation occurred following resumption of normal activities, usually within four to six hours. There is likely to be a strong avoidance reaction by cetaceans to construction of the Thanet project. Although the importance of this area is low for all cetacean species, including harbour porpoises and bottlenose dolphins, it is proposed that soft start procedures are implemented in accordance with the JNCC guidelines (2004) developed for the oil and gas offshore industry. The procedure involves the following steps:

- Beginning at least 30 minutes before commencement of piling activities, visual checks from a suitable high observation platform to note any marine mammals within 500m;
- If marine mammals are seen within 500m of the centre of the planned piling activities, the start of the activities should be delayed until they have moved away; and
- Power and frequency of hammering should be built up slowly from a low energy start-up over at least 20 minutes to give adequate time for marine mammals to leave the vicinity.

Given the implementation of the above mitigation measures, it is anticipated that the noise and human disturbance during construction is likely to have a **minor adverse** impact on cetacean populations.

11.4.2 Impacts on seals due to construction noise

As for cetaceans, seals may be prone to disturbance from construction activities. Of particular significance would be impact to haul out sites, where disturbance is known to lead to abandonment of young. However, it is also possible that construction activities may disrupt their foraging behaviour.

Brasseur and Fedak (2003) investigated seal reactions at haul out sites to anthropogenic disturbance, including motorboats. They found that seals would leave their site with powerboats passing over a kilometre away. However, evidence appears to suggest that seals are able to habituate to anthropogenic noise. Although they are more sensitive to low frequency noise than small cetaceans, such as porpoises and

dolphins, they have been seen to haul out near to military firing ranges (Thompson *et al*, 2001).

Seals in the water most often react to disturbances by moving away or by diving (Hoffman *et al*, 2000). Such disruption may be significant if the construction activities are located within an extensively used foraging area. No information is available on the use of the Thanet site by harbour seals for foraging, however, data from the boat based bird surveys indicate that seals rarely use this area.

A study of seal movements was undertaken around the Horns Rev wind farm in the Danish Wadden Sea (Tougaard *et al,* 2003b) before and during construction. Although the resolution of the information collected was not sufficient to draw clear conclusions on the effects of the construction phase on seals, it showed that seals foraged for food within the wind farm site during construction, thus suggesting that they are not particularly distressed by such development and disturbance. Also, monitoring during the construction and operation of the Nasrevet wind farm in Sweden suggests that seals quickly habituate to construction activity and noise (Westerberg, 1999).

Although local population estimates are lacking, seal populations in the area of the Thanet site are not considered significant. The wind farm site would be over 10km from the nearest haul out site at Margate Sands, therefore, it is considered that impacts on this haul out site are of **negligible** significance. The impact of construction activities on foraging seals is uncertain, however given the initial evidence from studies in Denmark and the low numbers of seals present in the area, it is anticipated that any effects would be of **minor to negligible** significance.

11.4.3 Impacts due to increased vessel traffic and collision risk

There is no information on ship collisions with cetaceans and seals in the North Sea (Hammond *et al*, 2003). Although a distinct possibility, the small and infrequent size of seal and cetacean populations in the area, as well as the small size of species most often found, suggests the incidence of ship collision with construction vessels to be unlikely. The overall significance of this impact is considered to be **negligible**.

11.5 Impacts during Operation

11.5.1 Impacts on cetaceans due to operational noise

A series of acoustic measurements were undertaken by Westerberg (1994) from a 220kW operational wind turbine. These suggested that the turbine generated low frequency tones peaking around 16Hz at a sound level of circa 20dB above background noise, assumed to be circa 80dB re: 1µPa in a fairly calm sea, at a distance of 100m from the turbine (Westerberg, 1994 and 1999). This seemed to be the case irrespective of wind speed, as noise from the turbine and ambient noise levels increased at the same rate with increasing wind speed, such that the relative intensity of the turbine noise remained constant. From this measurement, the wind turbine's source level at a distance of 1m was estimated at circa 115-120dB re: 1µPa. No precise information exists as yet for the cumulative sound source levels of a number of turbines arranged in formation, as in a wind farm.

The two cetacean species most common to the region of the Thanet site are bottlenose dolphin and the harbour porpoise. Species also likely to visit the area are the white-beaked and common dolphin, but then only seasonally and in small numbers. The hearing sensitivity and range of vocalisations of all these species is generally above 1kHz, echolocatory clicks occurring up to 130kHz, although whistles range from 200Hz for a bottlenose dolphin, 500Hz for a long-finned pilot whale, 4kHz for a common dolphin to 8kHz for a white-beaked dolphin and long-finned pilot whale, 16kHz for a bottlenose dolphin. These appear to be well above the peak frequencies recorded for wind turbines (Westerberg, 1994 and 1999; Nedwell *et al*, 2003; Nedwell and Howell, 2004). No baleen whale species that vocalise at frequencies below 100Hz have been observed in the immediate vicinity of the Thanet site. The cetacean species occurring in the region are all odontocetes i.e. toothed whales, whose hearing sensitivity and range of vocalisations is generally between 75Hz and 150kHz.

Although studies of the effects of offshore wind farms on marine mammals are in their infancy, available information indicates that the noise and vibration generated by wind farms would be in the same frequency range as those emitted from existing sources such as shipping, submarine pipelines, wind and waves (Metoc, 2000). Therefore, an operational wind farm is likely to contribute to background noise levels only.

Lastly, a survey of harbour porpoise populations in relation to the Horns Rev wind farm, through Before After Control Impact (BACI) analysis, showed no significant changes in porpoise abundance inside the wind farm area relative to control areas from baseline to post-construction (Tougaard *et al*, 2003a). Monitoring data for Horn Rev for harbour porpoise in 2003 and 2004 appear to confirm these findings (Tougaard *et al*, 2004 and 2005).

Based upon evidence collected to date, it is predicted that the impact of operational noise upon cetaceans within the study area would be of **negligible** significance.

11.5.2 Impacts on seals due to operational noise

Common and grey seals have a similar hearing range of between 1kHz and 40-50kHz. Hearing is most sensitive at frequencies of between 10 and 30kHz (Thompson *et al*, 2001). The hearing threshold of seals is, therefore, above the sound level generated by an operational wind farm. As the wind farm would be constructed over 10km from the nearest haul out site at Margate Sands, generated noise would have attenuated to such an extent that any potential impact would be **negligible**.

Seal studies carried out for the Swedish Bockstigen project, before and during construction and for two years after the start of operation, showed that the wind turbines did not affect seals in any respect (Sundberg and Söderman, 1999). Seals have also been observed at Horn Rev during operations (Tougaard *et al*, 2003b). Considering these research findings, and the wide ranging feeding behaviour of seals, it is anticipated that there would be **no impact** on seal populations during the operational phase.

11.5.3 Impacts on cetaceans and seals due to vibration

There are no complete studies that consider the impacts of vibrations caused by the operation of wind turbines upon either seals or cetaceans. However, it is possible to

infer, from the evidence collected at Horns Rev (Tougaard *et al*, 2003b, 2004 and 2005) where harbour porpoises and seals have been observed within the operational wind farms, that any impact is likely to be of **negligible** significance.

11.5.4 Impact on cetaceans due to electromagnetic fields

The results of the model simulations showed that a cable with perfect shielding i.e. a grounded cable, does not generate an electric field (E-field) directly. However, a magnetic field (B-field) is generated in the local environment by the alternating current in the cable. This in turn, generates an induced E-field close to the cable within the range detectable by electrosensitive fish species (CMACS, 2003).

The magnetic B-field generated by a subsea power cable may be of sufficient intensity to affect species that use the Earth's geomagnetic fields to orientate themselves in their environment. Cetaceans appear to be sensitive to variations in the Earth's magnetic field (Klinowska, 1990). For example, cetaceans are thought to be sensitive to changes in the geomagnetic field of 30-60nT, and probably employ much finer levels of discrimination (CMACS, 2003). Consideration might, therefore, be given to whether cetacean migrations might be affected by electromagnetic fields generated from the interconnecting cables and export cables.

CMACS (2003) demonstrated that the magnitude of the B-field associated with the cable modelled in their study[2] falls to background levels within 20m of the cable. Burial was shown to be ineffective in 'dampening' a B-field, however cable burial to a depth of at least 1m is likely to provide some mitigation for the possible impacts of the strongest magnetic and induced electrical fields that exist within millimetres of the cable. Burial to greater depths has a negligible effect on the B-field emitted. Earlier studies have shown that existing cables, buried 1m below the seabed, create a magnetic field on the seabed above the cable that is smaller than the Earth's geomagnetic field (Soerensen and Hansen, 2001). There are clearly major differences depending on cable design, current and voltage, but it must be remembered that the alternating field generated by the cable is different from the background geomagnetic field and may, therefore, be perceived differently. There is currently no evidence of responses by cetaceans to electromagnetic fields associated with alternating current cables (CMACS, 2003).

Kirschvink *et al* (1986) suggested that harbour porpoises do not depend on geomagnetic signals for navigation, where alternative parameters such as temperature, salinity and bathymetry are perhaps more efficiently used for navigation in the relatively shallow waters where they occur. Although knowledge of the potential impacts is currently limited, the relatively shallow environment and the limited use of the area by large migrating whales, combined with the minimal distance over which the B-field is recorded over background levels, suggest that any such impact would be **negligible**.

With respect to seals, there is currently no evidence that seals are influenced by, or use electromagnetic fields. Therefore, it is likely that there would be **no impact** on seals due to electromagnetic fields during operation.

[2] A 132kV XLPE three-phase submarine cable designed by Pirelli with an AC current of 350 amps buried at a depth of 1m.

11.6 Impacts during Decommissioning

Assuming that explosives would not be used, the impacts associated with the decommissioning of the wind farm on cetaceans and seals would be similar to those during construction. The overall significance of any potential impact is, therefore, considered to be **negligible**.

11.7 Cumulative Effects

It is known that a number of wind farms are proposed for the Thames Estuary area including the London Array, Gunfleet Sands and Great Gabbard with the Kentish Flats wind farm already constructed. Cumulative effects may arise for marine mammals should more than one of these wind farms be constructed within the same period as the Thanet project. The most significant cumulative impact for marine mammals is likely to be associated with the construction noise. It is, therefore, recommended that the noisiest activities of the different wind farms construction be co-ordinated, as far as practicable. In addition, it is proposed that suitable mitigation measures for each project be identified in liaison with English Nature and JNCC e.g. soft start procedures. Given the implementation of such mitigation measures and the relatively low importance of the area for marine mammals, it is predicted that the cumulative effect would cause a short term, **minor adverse** impact.

11.8 Monitoring Proposals

No monitoring is proposed for marine mammal populations.

11.9 Summary

Only four cetacean species have been recorded on a regular basis in the vicinity of the Thanet project in the southern North Sea and eastern English Channel, namely the harbour porpoise, bottlenose dolphin, white-beaked dolphin, and long-finned pilot whale. Of these, the most likely interactions would be with harbour porpoise or bottlenose dolphin, and then primarily during the construction phase when pile driving activities are taking place. The seasonal presence of the two species in the region differs slightly, with porpoises present in highest numbers between March and May, and particularly in April, whereas bottlenose dolphins are most frequently observed during May and October. Overall, the region is not considered of significant importance to seals and cetaceans.

Marine mammals are likely to be affected by construction noise and increases in vessel traffic and collision risk during construction. There is limited knowledge on the effects of construction noise on marine mammals, however, recent studies undertaken by Tougaard *et al* (2003a) during the construction of the Horns Rev offshore wind farm in Denmark indicate that harbour porpoises were affected during piling operations over a 12km distance, although rapid re-colonisation occurred following resumption of normal activities, typically within four to six hours. Evidence from observations during the construction of the Horns Rev (Tougaard *et al*, 2003b) and Nasrevet (Westerberg, 1999) offshore wind farms suggests that the construction activities do not have any large scale influence on the seals. Overall, it is therefore considered that construction noise is likely to have a **negligible** to **minor adverse** impact on marine mammals.

Although ship collisions with cetaceans and seals are a distinct possibility, the low frequency of seal and cetacean activity in the Thanet area, and their relatively small size and high manoeuvrability, suggests that the incidence of such events is very unlikely. The overall significance of this impact is, therefore, considered to be **negligible**.

Marine mammals could be affected by the operational noise and the electromagnetic fields generated by the subsea cables during operation. Although studies of the effects of offshore wind farms on marine mammals are in their infancy, available information indicates that the noise and vibration generated by wind farms would be in the same frequency range as those emitted from existing sources such as shipping, submarine pipelines, wind and waves (Metoc, 2000). Therefore, an operational wind farm is likely to contribute to background noise levels only.

Theoretically, the electromagnetic field generated by subsea power cables may be of sufficient intensity to affect species that use the Earth's geomagnetic fields to orientate themselves in their environment. However, no clear knowledge of the potential impacts is available. Overall, given the relatively shallow water and the limited use of the area by large migrating whales, combined with the minimal distance over which the electromagnetic field is recorded over background levels, it is estimated that any such impact would be of **negligible** significance.