



**Strategic Review of Offshore Wind Farm Monitoring Data Associated
with FEPA Licence Conditions**

Fish

Contract ME1117

Project Manager:	Rebecca Walker
Drafted by:	Adrian Judd
Appendices collated by:	Karema Warr, Luca Doria, Sara Pacitto, Shelley Vince, Lara Howe and Rebecca Walker
Checked by:	Stuart Rogers and Jim Ellis
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Cefas
Pakefield Road,
Lowestoft,
Suffolk NR33 0HT

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1. Introduction

The main purpose of FEPA licence conditions relating to fish and fisheries is to offer them protection from impacts associated with construction activities. Those licence conditions requiring surveys to collect data are intended to generate information that will help to validate predictions made in specific Environmental Statements and to determine large-scale change in species distribution, abundance and community structure that may be attributable to the licensed offshore wind farm. The regulators use the outputs from the licence conditions (including pre-and post-construction surveys) to inform the need and scope of revisions to ongoing and future monitoring and mitigation requirements to ensure that any impacts are suitably managed.

A large number of parameters will influence the abundance and distribution of fish stocks both within and between years, including: natural variability; fishing effort; environmental conditions (including oceanographic and climate conditions); seasonal variability in distribution; predator/prey interactions; food availability etc. These are in addition to any effects that marine constructions such as a wind farm may also have. For most offshore wind farm locations there are a lack of robust time-series baseline data for the local abundance and distribution of fish and shellfish. Given this complex backdrop Cefas refer to these investigations on fish within FEPA licences as surveys rather than monitoring.

All FEPA licence conditions for fish and shellfish have their source in the predictions made within the Environmental Statements for these developments. This report considers the FEPA licence conditions relating to fish for offshore wind farms at: North Hoyle; Barrow; Kentish Flats; Scroby Sands; Burbo Bank; Lyn and Inner Dowsing, Rhyl Flats; Gunfleet Sands and Thanet and relates these to the fish surveys undertaken under the FEPA licence. It draws conclusions from the exercise and specifically considers which conditions have been successfully applied and those that might no longer be necessary. It also describes where some conditions could be strengthened, and opportunities for standardising are harmonising data collection to support them.

Summaries of the licence and monitoring outputs for the North Hoyle; Barrow; Kentish Flats; Scroby Sands; and Burbo Bank; Lyn and Inner Dowsing, Rhyl Flats; Gunfleet Sands and Thanet offshore winds farms are included in the Appendices. It should be noted that underwater noise issues are covered in a separate section.

2. Assess which conditions have been successfully applied (or not)

The wording of licence conditions on fish issues has evolved but in essence similar requirements have been applied to all licences. Conditions on the Licence Holder have been applied to FEPA licences to:

- Provide technical specifications of the cables;
- Where electro-sensitive species (e.g. elasmobranchs) are identified in the EIA, fish surveys have been requested to investigate their local distribution and abundance.
- To investigate fish aggregation device (FAD) effects surveys have been requested inside and outside the wind farm to assess distribution and abundance.
- The appointment of a suitably qualified and experienced Fisheries Liaison Officer (FLO) and Fisheries Liaison Representative (FLR)
- Construction activities and surveys need to be agreed with the FLO.
- Notify mariners (including fishermen) of details and scheduling of construction and survey works.

Where fish surveys are necessary to address one or more of these conditions, they are generally amalgamated, providing that the sampling gears and protocols are appropriate. To date most fish surveys have proven useful in building up a picture of post-construction distributions of fish within and outside of the wind farm array. However, the short datasets currently available do not allow for any clear distinction between construction effects and the influence of natural (seasonal / annual) variation on fish distribution and abundance.

Whilst monitoring reports describe the findings of individual fish surveys, a detailed overview of how these relate to construction activities is lacking. As part of the FAD and EMF investigations some sites have looked at stomach contents to see what the fish within and outside the wind farm arrays are feeding on, but such data are limited at present. Further development and standardisation of such techniques may help in better determining cause and effect relationships.

There are safety and logistical problems for undertaking certain types of fish surveys within wind farms – particularly in terms of gathering data from close to the foundations and piles. In future novel approaches may need to be developed to supplement traditional survey techniques, e.g. use of still and video photographic equipment or use of static gears. Given that many wind farms inspect the under-water sections of turbines for examining the colonisation of sessile fauna, or for checking the integrity of the structure, such surveys could usefully collect anecdotal information on fish in closer proximity to turbines and scour protection.

Better integration with national data of trends in fish species may assist in assessing and monitoring impacts by providing better time series datasets

and a clearer context against which change attributable to the wind farm can be measured. Given that fish are highly mobile organisms, it can be difficult to identify site-specific impacts in these FEPA licence surveys. In addition to the inability of the FEPA licence surveys to clearly account for seasonal or annual variation mentioned above, they also do not at present account for the relationship between wind farm induced pressures and other factors that can affect the mortality, health and behaviour of fish populations.

One monitoring requirement where a specific issue has been successfully investigated allowing for a clear hypothesis-driven survey is to better define the timing and distribution of spawning grounds. Of the wind farm reports reviewed only Thanet have this as a licence condition (however, due to logistical problems at Gunfleet Sands a similar approach has been applied there, with surveys undertaken during construction).

3. Recommend which monitoring conditions are no longer necessary (because impacts have been demonstrated to be negligible)

It is not possible to conclude that any impacts on fish have been demonstrated to be negligible and therefore to recommend that conditions can be removed. Conversely, there do not appear to be gross changes in the fish assemblages within wind farm arrays. However, to date, no clear messages on whether impacts are less or greater than predicted are apparent and, from the limited datasets available, all conditions for fish would appear to still be necessary (in some form). There is scope to revise and improve conditions in light of changes in our knowledge and understanding from the FEPA monitoring and other sources (see section 4).

4. Recommend where monitoring conditions may need to be strengthened (because impacts have been underestimated) or amended in light of new information

Whilst all data on fish from the FEPA licence conditions are of interest, they are not providing results sufficient for definitive cause and effect conclusions. What does appear to be emerging from interpretation of the monitoring outputs for fish is a need to develop more novel approaches to fish monitoring, so that assessments can be made in the context of other influences. In addition to this a more targeted approach to monitoring could be considered. For example, monitoring over several sites to give better spatial coverage, greater allowance for temporal variability, utilisation of larger control areas, regional approaches and distribute monitoring requirements of different issues amongst specific sites. Longer time series or spatial extent for surveys may also add value to these surveys (both in terms of baseline and post-construction monitoring). However, for such approaches to work greater co-operation between developers and more definite schedules for construction would be required to allow for monitoring data to be collected at appropriate times. Maybe there is scope for the regulators, The Crown Estate or BWEA to facilitate such co-operation and scheduling.

It is not always apparent from the monitoring reports that the developers have a clear understanding of why they are undertaking fish monitoring. This may account for some of the choice of sampling, analytical, presentational and reporting techniques within the monitoring reports which in some cases goes little beyond describing what was done and what was caught with no detail of why. As previously stated, most of the monitoring conditions are derived from the Environmental Statements for the projects. However, perhaps licence conditions for monitoring can be made more explicit in the future to describe why an issue is important and why it needs to be monitored. In addition to these amendments to the wording of licence conditions further work on investigating options for developing novel techniques to achieve the monitoring objectives.

Issues such as underwater noise and electromagnetic fields have been the subject of various research projects both within the UK and overseas. Whilst these studies have added significantly to our understanding of the potential for such issues to impact marine organisms there are still gaps in our scientific knowledge and understanding on the precise nature and scale of effects and how these may be managed. Regulators need to consider whether current practices for these issues are appropriate and whether any changes are necessary. Licence conditions should also be reviewed to ensure they reflect current understanding and consideration given to needs for future research or mitigation measures.

The requirements on spawning ground surveys should be applied as standard in areas where restrictions on construction activities are included within the FEPA licence conditions. Such surveys are intended to provide a robust dataset on which any reduction or removal of any timing restriction can be assessed. Undertaking these surveys does not in itself guarantee that restrictions may be amended but provides another line of evidence to be considered alongside other information, such as noise propagation models, seabed topography, water depth etc. Once again, any spawning surveys are often best undertaken at an appropriate spatial resolution and greater co-operation between developers to allow standardised data is preferable. Given the high ecological importance of spawning grounds, there is scope for the regulators, The Crown Estate or BWEA to facilitate such studies.

5. Identify comparability of datasets (use of different techniques, analyses, processing etc)

To date similar approaches to herring spawning ground surveys have been applied at Thanet and Gunfleet Sands (and for those recently proposed for Sheringham Shoal) offshore wind farms. This approach provides a strong foundation against which to assess change both for the site specific to the survey but also generating data that is transferable to investigations at other sites.

Surveys at other sites for electro-sensitive species and to investigate FAD effects have utilised a variety of gear types. Cefas advice advocates the use of gear(s) that are not only appropriate for the ground conditions at the site,

but also to allow for the effective sampling the more important fish in the local area. Hence, depending on the site, various types of otter trawl, beam trawl or static gear may be appropriate. The chartering of local fishing boats generally ensures that the gear is appropriate for the grounds and species of the site. What Cefas also advise is that sampling events are as standardised as much as possible, especially in terms of using the same gear. Despite this, it is apparent that in some cases inappropriate gears have been used, e.g. beam trawls are inappropriate for sampling pelagic species, such as herring. This leads to the under-representation of fish assemblages and makes any comparisons between sites difficult. Additionally, some early studies have changed gears between various fish surveys, thus precluding comparisons, due to gear-related differences.

In terms of sampling juvenile fish, Cefas typically advise that a 2 m beam trawl is used, as such sampling can then be undertaken in conjunction with any epibenthic surveys.

Current monitoring practices do not allow for small-scale effects to be assessed, as this would require extensive field surveys, and have primarily been designed to make sure that any gross changes in the fish assemblage can be examined.

Whilst the use of existing datasets (e.g. International Bottom Trawling Surveys) is still advocated to provide a regional and longer-term overview, these often need to be complemented with further site-specific survey data, particularly if the existing data applies to an adjacent location) or to ensure that there are more suitable gears and/or sampling frequencies to better examine the local fish assemblage. This is important because the objectives of the surveys generating the existing data will have determined the gear types, and sampling parameters used and these may not be wholly compatible with the objectives of the FEPA monitoring surveys.

6. Describe what has been done about interactions

Overall very little has been done within the monitoring reports to assess interactions between fish and other environmental parameters. To address this, improvements could be made in all monitoring programmes to better address ecosystem issues by investigating relationships between sediment, benthos, fish, bird and marine mammal monitoring outputs. In terms of fish, the sediment-benthos-fish linkages will be particularly important. Survey reports focus on species of conservation or commercial importance, but the ecological importance of other species (e.g. ecologically important prey species) are often overlooked. Surveys could also be improved if clearer rationales and hypotheses for testing are developed.

7. Review of reporting style and format

To be able to make this review we have reviewed the Environmental Statements to identify what the issues and predictions are, matched these

with the relevant FEPA licence conditions and reviewed the monitoring outputs (see the Appendices). This provides a clear audit trail, i.e. what is being monitored, why it is being monitored and the monitoring results. However, it would have been useful if all the monitoring reports had been structured in this way, to set out a clear and logical sequence.

8. Summary of key conclusions and lessons learned

Issues identified in Environmental Statements and highlighted during their consultation, include:

- Effects of electromagnetic fields on electro-sensitive fish
- Effects of construction and operational noise on fish
- Fish aggregation effects
- Interference/Displacement of fishing activity
- Habitat changes

And the FEPA licence conditions for fish relate to these issues on a site specific basis.

Licensing decisions for all UK offshore wind farms have been made on the premise that impacts on fish will be negligible if certain mitigation measures are applied (e.g. timing restrictions on pile-driving during spawning). In some instances evidence is provided within Environmental Statements to support these conclusions but for some parameters (e.g. behavioural effects of underwater noise from pile-driving or electromagnetic fields from power cables) the knowledge base is insufficient to fully support the conclusions. In such cases, and in the absence of concrete research outputs, licence conditions are used to address specific gaps in our understanding and provide reassurances on the nature and scale of effects.

Whilst the issues have been consistent between sites, different approaches to surveys have been applied largely driven by the data availability for individual sites and the relative importance of the area for conservation or commercial fish species.

- Some developments have used existing data (e.g. Beam trawl surveys from Cefas), whereas others have commissioned new surveys.
- Some have used research boats and scientific gears, whilst others have used commercial gears (some have used both).
- Some have incorporated anecdotal information from fishermen or other surveys whereas others have not.
- Some have undertaken broad scale surveys whereas others have been more targeted.

These differences are largely due to the species of interest at the site under investigation as different sizes and types of gear may be required (epibenthic trawl, pelagic trawls, gillnets, pots, longlines etc) and whether these are of commercial or conservation or ecological importance.

This review has highlighted that comparing data from different seasons, from different sampling techniques and from different gears can lead to erroneous or unsupported conclusions. Better standardisation and planning of surveys to test hypotheses should lead to more focused and robust monitoring in the future.

Appendices – Site Summaries

Appendix 2.1

North Hoyle

The North Hoyle Offshore Wind Farm (NHOWF) is located approximately 6 km off the North Wales coast at Prestatyn. The wind farm, owned by NWP Offshore Ltd (NWPO), features 30 2MW turbines, generating a maximum export capacity of 60MW. Ancillary equipment offshore includes two meteorological masts. Inter-array cabling connects the turbines and two export cables connect the wind farm to the local electricity distribution network at 33kV via an onshore sub-station at Rhyl. Consent for the project was granted in August 2002. Offshore construction commenced during March 2003, and was completed during March 2004 (with partial operation from November 2003). The full 5 year monitoring programme specified within the FEPA licence has now been completed and this is the first wind farm to complete monitoring.

EMF

Licence conditions

Annex 5. Electromagnetic Fields

The Licence Holder must provide the Licensing Authority with information on attenuation of field strengths associated with the cables, shielding and burial described in the Method Statement and relate these to data from the Rodsand windfarm studies in Denmark and any outputs from the COWRIE sponsored studies in the UK. This is to provide reassurance that the cable shielding and burial depth(s), given the sediment type, at the North Hoyle site is sufficient to ensure that the electromagnetic field generated is negligible. Should this study show that the field strengths associated with the cables are sufficient to have a potentially detrimental effect on electrosensitive species, further biological monitoring may be required to further investigate the effect.

Summary of EMF Monitoring and Mitigation

Data on the cable specification was provided by the licence holder.

No sharks and rays were recorded in the surveys from within the OWF since the construction in 2003. Elasmobranch species have been recorded at near-field sites e.g. at Site 4 during 2006 survey. However, this may be due to the use of 2 m beam trawl in these surveys which, if present, will have under-sampled larger and more mobile species, including elasmobranchs. As such the surveys have provided insufficient sampling information to confirm or disprove the conclusion of nil effect within the Environmental Statement.

An outline of COWRIE Phase 2 project plan and studies at Nysted was included within the monitoring report. Licence condition met.

FISH AND FISHERIES

Licence conditions

- 9.1 *Since very little is known about the potential effect of wind farms in terms of enhancing or aggregating fish populations, the Licence Holder must produce proposals for a post-construction survey of fish populations in the area of the wind farm. The Licence Holder shall, in drawing up such proposals, canvas the views of local fishermen. The proposals must be submitted to the Licensing Authority within 3 months of completion of construction of the wind farm.*
- 9.2 *The Fisheries Liaison Officer (see condition 9.11) shall pay due regard during the conduct of any fisheries survey to the need to safeguard the safety of any persons engaged in fishing operations on the site of the wind farm.*

Summary of Fisheries Monitoring and Mitigation

The results from the 2006 beam trawl monitoring survey support the results from the previous surveys (2001-2005) which identified the fish and epifaunal communities within and around the NHOWF as having similar qualities to those sites sampled elsewhere in beam trawl survey in the Irish Sea. When compared to the baseline data of 2001, there was no significant change in the diversity of organisms or the species composition of the benthic and demersal community. The annual beam trawl survey (post-construction) indicated most of the fish species considered were broadly comparable to previous years and within the long-term range, with some species showing recent increases and decreases, but broadly mirroring regional trends.

In summary, the report states that there is strong evidence from the conclusions of the monitoring campaign that the NHOWF represents a benign marine development in environment impact terms. Any construction impacts quickly dissipated. The construction and operation of the wind farm, to date, has shown no measurable indication that any significant environment impact has occurred. The five year monitoring campaign results align closely with contemporary studies at other wind farm sites in Europe and provides a cross check with the predicted conclusions from the EIA.

Monitoring and other site specific issues

- Surveys are looking at differences between fish assemblages within and outside of the OWF array.
- In terms of the use of turbines as Fish Aggregating Devices, future studies could make use of underwater video as a method for examining which fishes are utilising these areas.

- The current site-specific sampling has used 2m beam trawling, which is appropriate for smaller fish but not for the larger species (e.g. elasmobranchs). In the future, the use of additional gears more appropriate for pelagic species and ensuring that underwater inspection of turbines informs on fishes and epifaunal growth would be beneficial.
- The report concludes that there is little impact from the operation of an OWF on the demersal fish assemblage in the general area of an OWF. However, these data do not allow the finer scale temporal or spatial changes/affects to be commented on
- The report is consistent with the advice provided on the monitoring specifications, data from 2m beam trawl surveys in and around the wind farm are presented, and results from a beam trawl survey are used to provide a longer term and more regional context.
- Data collection has been appropriate for demersal species, standard data analyses, using PRIMER, have been undertaken for the fishes collected during the 2m beam trawl survey. These data analyses are appropriate. However, in terms of the 2m beam trawl sampling, raw data from previous reports (e.g. the tables of numbers per species per station) could usefully have been included to facilitate interpretation of the data/conclusions.
- The report suggests no further monitoring after the five-year monitoring programme envisaged by the FEPA licence.

Comments from round up monitoring meeting (May 2009)

- The annual fish monitoring within the site was only undertaken using 2m beam trawl, this only represents a very small proportion of the fish assemblage and will therefore only pick up on any large scale changes/effects caused by the OWF. Although it is useful that this type of monitoring can rule out the more catastrophic effects, it does not provide a definitive answer to the small scale impacts.
- The use of the longer term 4m beam trawl data provided a good backdrop and information on the wider area, but the nearest site to the OWF was 6km distant. Even with a high level of statistical analysis at this site, it will only show the most catastrophic impacts.
- The 2m trawl data only provides one year of baseline to compare effects, this is a common problem with much of the monitoring whereby if you only have one year of baseline data it is very difficult to distinguish what from natural variability in future post-construction monitoring.

- There was also a difference in season between the baseline (2001) and following years survey. The baseline survey was carried out in August, with the continuing monitoring carried out in Autumn.
- Suggestions for better approaches are the use of more targeted surveys to address the most sensitive aspects of the area, so perhaps target a particular season or region that is important for migration/spawning etc. For example the area around North Hoyle is know to be an important area for sole migration, perhaps it would have been of more use to target this particularly sensitive issue. But this doesn't disregard the importance of it being a round 1 windfarm, where there was always a need to undertake basic, broad scale monitoring to try to rule out any unknown large scale, catastrophic effects.

Appendix 2.2

Barrow

Barrow offshore wind farm is situated in the east Irish Sea, 7 km south west of Walney Island, near Barrow-in-Furness. It consists of 30 turbines each capable of producing 3MW of electricity. Construction started in 2005 and was completed in September 2006.

Licence Conditions

9.4 *Since very little is known about the potential effect of wind farms in terms of enhancing or aggregating fish populations, the Licence Holder must produce proposals for adequate pre-construction baseline and post-construction surveys of fish populations in the area of the wind farm. The Licence Holder shall, in drawing up such proposals, canvas the views of local fishermen. The proposals must be submitted to the Licensing Authority at least one month prior to the proposed commencement of the monitoring work. (See also Annex 1 in relation to monitoring of electro-sensitive species).*

Annexes

6. Electromagnetic Fields

The Licence Holder must provide the Licensing Authority with information on attenuation of field strengths associated with the cables, shielding and burial described in the Method Statement and related to data from the Rødsand wind farm studies in Denmark and any outputs from the COWRIE tendered studies in the UK. This is to provide reassurance that the cable shielding and burial depth(s), both between the turbines and along the cable route to shore, given the sediment type(s) at the Barrow site are sufficient to ensure that the electromagnetic field generated is negligible. Should this study show that the field strengths associated with the cables are sufficient to have potential detrimental effect on electrosensitive species, further biological monitoring to that described in Section 7 of this Annex may be required to further investigate the effect.

7. Marine Fish

The Environmental Impact Assessment observed electrosensitive species (e.g. Thornback Ray, Basking Shark) in Morecambe Bay and in the vicinity of the Barrow site. In the absence of any evidence that electromagnetic fields do not pose a risk to such organisms, monitoring work is required to determine the numbers and distribution of such species in the vicinity of the Barrow offshore wind farm (this should include the establishment of a baseline and the use of adequate controls). The results should be presented and discussed in combination with the EMF studies described in the preceding section (6).

Predictions in the Environmental Statement.

The common fish encountered during surveys for the ES are characteristic of the area. In the vicinity of the wind farm are spawning grounds for sprat and a

nursery area for herring and plaice. Results of Cefas Young Fish Surveys show the area to be an important nursery area for flatfish, including plaice and sole. The main fishing activity is gill netting, otter trawling and beam trawling. Amongst those species targeted are sole, plaice, whiting, cod, rays, dogfish and various shellfish species.

The Environmental Statement noted the presence of elasmobranchs in Morecambe Bay and in the vicinity of the Barrow site. In the absence of any evidence that electromagnetic fields do not pose a risk to electro-sensitive species (e.g. thornback ray), monitoring work is required to determine the numbers and distribution of such species in the vicinity of the Barrow offshore wind farm (this should include the establishment of a baseline and the use of adequate controls). Phase 1 of the COWRIE EMF study has been completed (CMACS, 2003) and Phase 2 will be completed in the first half of 2005. CMACS have carried out both phases of the study, and have developed a magnetic field predicting model, and methods for measuring the fields once the cables are laid. BOW will commission CMACS to carry out a model and field validation of the electro-magnetic fields related to the export cable route. Data from the study will be submitted for use in the COWRIE studies.

Monitoring and Mitigation

Fisheries

Pre-construction surveys consisted of three seasonal surveys carried out during 2004 to 2005; autumn flatfish and shellfish, winter roundfish and spring spawning. Beam and otter trawls were used in the surveys. A standard 2m beam trawl was used with a mesh size of 20mm and a cod end of 5mm. There were seven survey stations towed for 15 minutes each. The otter trawl used was standard rock-hopper gear with a cod end mesh size of 80mm. The specification of the otter trawling surveys was modified following the October 2004 survey due to the coarse nature of the seabed (only one trawl was collected in October 2004). Within the wind farm 6 trawls were completed and four reference sites completed outside the wind farm. Tow durations were 30mins. Surveys again showed the fish present were characteristic of the area and that thornback ray and lesser spotted dogfish were the most common elasmobranchs at the site. Different species were caught depending on season, some differences between inside and outside wind farm. However, the summary of findings could have been presented better.

Post Construction monitoring was undertaken in December 2006, March 2007 and October 2007, again using otter and beam trawls. For otter trawls principal species caught in the wind farm site are dab, lesser spotted dogfish, plaice, whiting, thornback ray and whiting. At the control site principal species caught were similar but included red gurnard, poor cod and dragonet. There were no major differences in the sizes of fish within and outside the wind farm area. No significant differences in numbers of thornback rays in or out of wind farm. The main species caught within the wind farm site in beam trawls and

were whelk, brown shrimp, dab, whiting, pink shrimp, sole and sprat and spider crab. No beam trawls seem to have been conducted outside the wind farm at control sites.

Otter trawl pre vs. post construction

In general, the pre and post construction otter trawl results from the wind farm area show similar patterns of abundance, with the most frequently caught fish in both periods being dab, plaice, whiting and lesser spotted dogfish. Results from the reference locations show a similar pattern, and there are no statistically significant differences between the catches of the two most abundant species (dab and plaice) before and after installation of the wind farm, or between the numbers caught in reference locations and within the wind farm area after the wind farm was constructed. Different species spawn at different times of the year, although eggs are mostly spawned between December and April. It appears from the results that there have been no changes to the general time of gonad maturation, or the sizes at which the fish are becoming mature, between the pre and post construction periods. In addition to this, no impact was observed, within the scope of the surveys, on the time of spawning.

Elasmobranch fishes (sharks and rays) are of particular interest to the offshore wind farm industry given their ability to detect very low levels of electromagnetic field. A total of five elasmobranch species were recorded over the entire survey duration. The most abundant of these were lesser spotted dogfish and thornback ray (rocker). In general, the number of elasmobranch species sampled has increased after construction of the wind farm. Concerning thornback ray and lesser spotted dogfish, 2 and 80 individuals were collected in the wind farm area during the survey in October 2007, respectively. For both species the numbers are a little lower compared to the control site, where the catch of thornback ray and lesser spotted dogfish has been 4 and 108 individuals.

Results show that for most of the surveys, and for most of the major species no changes in the ratio of male to female is observed. However, there are some differences in the proportions of male and female whiting between the wind farm and reference sites in March 2007, though this was not apparent in the October 2007 survey. Lesser spotted dogfish showed strong seasonal sexual segregation both spatially and temporally, which is widely reported for this species. There did not appear to be any clear or significant pattern with regard to the comparison of the pre and post construction survey results, although the October 2007 survey coincided with dominance of males within the wind farm and dominance of females at a single reference site (with no clear pattern at other reference sites).

Dab, plaice and whiting showed no significant differences in the proportions of fish above and below their respective MLS between the wind farm and reference locations, or between the pre and post construction periods. Some statistically significant differences were found in dab and plaice data, although this is related only to seasonal differences (with more fish being caught in

December). There was no statistically significant evidence to suggest that construction or operation of the wind farm site had affected abundance. Primer results supported the conclusions of the species-specific tests, with differences related principally to season and not to the presence of the Barrow Offshore Wind Farm.

Beam trawl pre vs. post construction

Much of the diversity of the beam trawls is comprised of infrequently occurring species. The number of species recorded varied most inter-annually in the October and December surveys. The majority of fish species sampled by beam trawl were those also recorded from otter trawling, a number of additional smaller species were recorded: Gobies (black, sand and unidentified juveniles), solenette, five-bearded rockling, and long-spined sea scorpion, bringing the total fish fauna for the survey area to 33. None of these additional species are of commercial value, rare or protected. With the exception of the brown shrimp (*Crangon* sp.), the beam trawl did not record any commercial species in abundance. Overall abundance for beam trawls did not produce significant patterns of seasonal changes, as observed for otter trawl data. While both October surveys show a similar total, December and March surveys appear to be much more variable. The exceptionally high abundance recorded in December 2004 was due to high numbers of the brittle star *Ophiura ophiura* and common starfish *Asterias rubens*. Beam trawling recorded a faunal assemblage expected and previously recorded for the area, with no rare, protected or unusual species present. Echinoderms dominated the fauna although other groups (e.g. crangonid shrimps) were also important. Abundance of species appeared to be highly seasonally variable; with no clearly visible effects on fauna pre or post construction of the Barrow Offshore Wind Farm.

No rare, unusual or protected fish species have been recorded during the conducted otter and beam trawling, and there are no statistically significant differences in abundance being affected by the construction or presence of the wind farm.

Electro-magnetic fields

Post construction EMF measurements have not been undertaken at the Barrow Offshore Wind Farm. However, a research programme has been made by COWRIE investigating EMF and their detection by fish at two wind farms in Liverpool Bay (Burbo Bank and North Hoyle). Field surveys were carried out at Burbo Bank and North Hoyle wind farms in early February 2008. Measurements were made in the shallow water around the tide line, so the survey team had to follow the tide down the beach over a period of 2-3 hours. E (electric) and B (magnetic) field measurements were taken with the hand-held sensor and pod over the cable at the point of highest field strength and also at point up to 50 m from the cable to determine rate of decay and background fields, if present. A GPS was used to log a waypoint at each measurement point. Current flows in each of the cables at the time of survey (i.e. wind farm generating statistics) were provided by the wind farm operators

(power at North Hoyle and SeaScape Energy at Burbo). During the monitoring the current in the cables varied as wind farm production varied with the prevailing conditions. This variation in current will have changed the magnetic field from the cable and, consequently, the B and iE (induced electric field) Field readings taken on site. Data have therefore been normalized to 100A in order to make sensible comparisons and to permit direct comparisons. The typical export cables for Burbo Bank and North Hoyle Wind Farms are 50Hz AC rated up to 36kV with three copper conductors. The cross-sectional area of each cable is 500mm². Each cable is XPLE insulated and steel armoured. The Burbo power export cables are buried to a nominal 3m depth, and the cables at North Hoyle are believed to lie consistently at approximately 2m deep. The cable type and sediment type are comparable to the specifications for Barrow Offshore Wind Farm. CMACS has previously supplied Sea-Scape Energy with a report on electromagnetic fields and marine ecology in which it was predicted that the maximum induced electric field at Burbo would be above 0.5 $\mu\text{V}/\text{m}$ but below 100 $\mu\text{V}/\text{m}$ /6/. This was based on a calculation by ABB, which estimated that the maximum magnetic field would be 0.54 μT . The upper range figure was considered important since fields in excess of 100 $\mu\text{V}/\text{m}$ are potentially repulsive to certain fish species. During the recent COWRIE research the maximum E field measured at Burbo was 40 $\mu\text{V}/\text{m}$ at 60% capacity, axial to the cable alignment. The predicted maximum E field is therefore imposed to 83 $\mu\text{V}/\text{m}$. For Burbo Offshore Wind Farm these findings are useful in that they support previous environmental reporting and do not suggest any need for a revision of the existing monitoring programme that relies on a combination of review of COWRIE supported work and site specific monitoring. Since cable types, current flows and sediment type (well graded sands; mostly medium sand) are comparable for Burbo Bank Wind Farm and Barrow Offshore Wind Farm, the conclusions from the recent EMF studies conducted at Burbo are highly valuable for Barrow Offshore Wind Farm. The maximum EMF at Burbo lies much below 100 $\mu\text{V}/\text{m}$ (values exceeding this are potentially repulsive to certain fish species). The findings support previous environmental reporting and do not suggest any need for a revision of the existing monitoring programme at Barrow Offshore Wind Farm. However, investigation and evaluation of the reasons for the increases in elasmobranchs within the wind farm should be undertaken.

Appendix 2.3 **Lynn and Inner Dowsing**

The Lynn and Inner Dowsing wind farm is currently under construction 5 km off the Lincolnshire coast. The combined wind farm consists of 54 turbines to generate 90MW of electricity. These are two separate projects, and therefore two licences, but monitoring has been undertaken in a single package.

Licence Conditions

9.8 Since very little is known about the potential effect of wind farms in terms of enhancing or aggregating fish populations, the Licence Holder must produce proposals for adequate pre-construction baseline and post-construction surveys of fish populations in the area of the windfarm. The Licence Holder shall, in drawing up such proposals, canvas the views of local fishermen. The proposals must be submitted to the Licensing Authority at least one month prior to the proposed commencement of the monitoring work. (See also Annex 1 in relation to monitoring of electro-sensitive species).

Annexes

6. Electromagnetic Fields

The Licence Holder must provide the Licensing Authority with information on attenuation of field strengths associated with the cables, shielding and burial described in the Method Statement (to be submitted to the Licensing Authority as soon as possible) and related to data from the Rødsand windfarm studies in Denmark and any outputs from the COWRIE tendered studies in the UK (where appropriate). This is to provide reassurance that the cable shielding and burial depth(s), both between the turbines and along the cable route to shore, given the sediment type(s) at the Lynn site are sufficient to ensure that the electromagnetic field generated is negligible. Should this study show that the field strengths associated with the cables are sufficient to have potential significant adverse effects on electro-sensitive species, further biological monitoring to that described in Section 7 of this Annex may be required to further investigate the effect.

7. Marine Fish

The Environmental Impact Assessment observed electro-sensitive species (e.g. Thornback Ray) in this area of the Lynn site (although the frequency and abundance were not quantified). In the absence of any evidence that electromagnetic fields do not pose a risk to such organisms, monitoring work is required to determine the numbers and distribution of such species in the vicinity of the Lynn windfarm (this should include the establishment of a baseline and the use of adequate controls). The results should be presented and discussed in combination with the EMF studies described in the preceding section (6).

Predictions in the Environmental Statement.

Fish survey results showed 25 species recorded of which three (whiting, cod and sole) were target species. The river lamprey was also present, which is an Annex II species under the Habitats Directive and a species subject to a recovery programme and is mentioned by Natural England together with whiting as a BAP species within a grouped species action plan. Beam trawls, otter trawls, dredges, tangle and gill nets, long-line and pots are all used in the area. Species of commercial importance include cockles, brown shrimp, crab, lobster, cod and rays. The area is recognised as a cod nursery area as well as for plaice, whiting, brill, turbot. This is a possible spawning area for spurdog and thornback ray. Herring spawn in the area of the Norfolk coast. The Wash is an important area for crab and lobster spawning and nursery.

Elasmobranchs are able to detect the weak electric fields associated with normal neuromuscular activity or generated by galvanic action. Electric cables have the potential to create electro-magnetic fields. The electrical fields are expected to be zero and hence no impact is anticipated.

The noise generated during construction and operation is expected to be within the range of noises to which fish have been proven tolerant elsewhere. Consistent, repetitive noise, such as pile driving operations, might cause fish to move away. However, the energy of pile driving noise generated is not as great as during seismic surveys and the effect may be significantly more localised. Noise generated during operation may generate raised levels between the sites but the area affected will be small and impacts are likely to be minimal. The levels predicted are below recommended limits.

Summary of the Monitoring Reports

Fisheries

Pre- construction surveys commenced in the summer (early August) of 2004 and proceeded into the summer (early June) of 2005. Original dates for surveys were delayed, sometimes considerably, by continuous poor weather that would have inhibited both efficient sampling and safe working conditions. Stations, within and outside the site, were sampled with otter trawls, shrimp trawls, 2m beam trawls, longlines and pots. Gears and times are as detailed in the table below.

Survey type	Gear	Stations	Timing	Speed
Otter	~12m opening, ~2m lift, 80mm cod-end mesh	10	30 mins	2-3 kts
Shrimp	Twin 6m commercial shrimp beam trawl; 20mm cod-end mesh	12	10 mins	2-3 kts
Epibenthos	2m scientific beam trawl; 8mm cod-end mesh (3 replicates at each)	?	5mins	2-3 kts
Longline	100-hook rig at each station (size 8; squid bait)	11	2 hrs	N/A

Potting	20-50 parlour pots per station (horse mackerel bait)	9	4 days	N/A
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The fauna recorded from the area is consistent with a “hard” bottom of stones, shell, gravel and sand. This allows for the growth of sessile species, most notably the bryozoan *Flustra foliacea* and smaller hydroid species. These in turn provide a spatially heterogeneous environment with micro-habitats in which motile invertebrates can find refuge. Crustaceans dominate this fauna, most notably with pink shrimp, which is by far the most abundant invertebrate species. This, and the numerous other crab species (swimming, spider, shore & hermit crab) and brown shrimp provide important prey to fish species including those of commercial importance. In addition to the commercially fished shrimp species, edible crab and, to a much lesser extent, lobster, are also found. Based on single station data, none of the wind farm stations appear to be more important for commercial species (shrimp, crab & lobster) compared to other (reference) stations, although the cable route stations close inshore appeared to support a greater biomass of the two shrimp species.

Whiting are the dominant demersal fish of commercial interest, and likely to form a key ecological component when they are highly abundant (i.e. all except the summer months), both as voracious predators of invertebrates and fish, and as a prey item to larger predators including fish, birds and marine mammals. While much less common, cod are seasonally important to fisheries and as predators. Bass do occur but appear to be rare. Due to the relatively small distances involved and the highly motile nature of commercial fish species, it is more difficult to identify single-station locations that are of importance to valuable fish. It is clear, however, that distinct seasonal variation in abundance occurs within the area, for example cod being more abundant in winter, and Dover sole more so in summer.

Herring and sprat often occurred and are likely to be the most important pelagic species in the area, although none of the surveys performed were specifically designed for assessing these pelagic species. Flatfish are most commonly represented by dab and, more seasonally, by the commercially important sole. Less frequently occurring are plaice, flounder and brill.

Elasmobranchs are important elements of the community acting as large predators to both invertebrates and fish. While thornback ray appear to be present all year round, summer influxes of dogfish species were recorded. Amongst these was the tope, which is likely to be one of the apex fish predators within the local ecosystem.

Further analysis of the fisheries data will be provided within the final post-scheme monitoring report and will include investigations of population structures of species that are regarded as characteristic of the study area and that of commercial importance. The final interpretation of the fisheries information will be within the context of the prevailing natural conditions at the reference areas.

Mussel surveys were undertaken in August to October 2005 to obtain baseline information regarding distribution and abundance of any edible mussel (*Mytilus edulis*) beds from the vicinity of the proposed wind farm sites. Eighteen stations were surveyed using a 2m mussel dredge. Within The Wash area edible mussel beds fall into two categories- "wild" and those actively managed by fishers. Mussels of a potentially commercially viable quantity were found at only two main locations. However, it is important to note that mussel recruitment and survival within The Wash is inherently unpredictable and highly variable. Mussel stocks within The Wash area can be considered discrete, with little recruitment from external sources.

Further analysis of the data will be provided with the final post-scheme monitoring report and will include assessments of the mussel populations in relation to the constructed wind farm and prevailing natural conditions at the reference areas.

Electro-magnetic fields

Monitoring of EMF is only required during the operational phase and hence no monitoring has been carried out so far.

Appendix 2.4 Kentish Flats

Kentish Flats wind farm is located in the Thames estuary, 8.5 km due north of Herne Bay and Whitstable and was erected in the summer of 2005. It consists of 30 wind turbines with a rated capacity of 90 MW.

Conclusions from the Environmental Statement

Fish species spawning in the area of the wind farm are: herring (*Clupea harengus*) from November to January, lemon sole (*Microstomus kitt*) from April to September, sole (*Solea solea*).

Nursery grounds are present for the following species: mackerel (*Scomber scombrus*), herring, whiting (*Merlangius merlangus*), plaice (*Pleuronectes platessa*), lemon sole, sole, sprat (*Sprattus sprattus*).

Where the wind farm occurs and where the cables are laid there are long term class B cockle beds, class A and long term class B native oyster beds and long term class B mussel beds located at less than 3 km from the development.

Fishing in this area by registered vessels in 2008 was high (above 1,000 tonnes/year) and mainly consisted of sole, horse mackerel, bass and cod from dredging, fixed nets, bottom and midwater trawling.

Licence conditions

“9.6 Since very little is known about the potential effect of wind farms in terms of enhancing or aggregating fish populations, the licence holder must produce proposals for adequate pre-construction baseline and post-construction surveys of fish populations in the area of the wind farm. These surveys should, as a minimum, comprise some seasonal surveys of the fish populations in the region before construction and during the first year of the operational phase and should consider both demersal and pelagic species. The licence holder should, in drawing up such proposals, canvas the views of local fishermen. The proposals must be submitted to the Licensing Authority at least one month prior to the commencement of the monitoring work.”

Annex 1 – Supplementary conditions:

3. Oyster Flesh Contaminants

Oyster populations in the vicinity of the wind farm should be subject to pre and post construction monitoring with analysis of the oyster flesh for a range of contaminants. Samples of oysters should be collected from sites similar to those detailed in point 1, in this Annex, around the main connecting cable route only. This work shall be conducted in association with the local fishing industry and the relevant public health authorities. The results of the pre-construction and post-construction monitoring shall be provided to the public health authorities and CEFAS for assessment.

Fisheries monitoring and mitigation

The following schedule was followed:

A) Baseline surveys carried out between 2001 and 2002:

In the baseline survey a one off beam trawl sampling was undertaken in March 2002. A total of 10 trawls were attempted, towing across the area at approximately 2 knots for 10 minutes with data recorded from all of these trawls (Emu 2002). This exercise should not be considered representative of the fish populations of the area though it can give an idea of what kind of demersal species can be found within the development area and the proposed connecting cable route. This sampling reflected the presence of key common demersal fish species expected in the Thames estuary but no data for pelagic species were gathered.

A total of 11 oyster dredges were completed across the Kentish Flats area. The dredge was towed for 1 km in each case. The sampling indicates the highest concentration of oysters in the area to the south of the main turbine site; higher concentrations of this shellfish were found along the main cable route compared to the turbine site. The data gathered from this sampling exercise corresponded to what are the main Whitstable oyster fishing grounds.

Interactions between fish and benthos were also considered in the baseline survey particularly between flatfish and their preferred preys represented by polychaete worms, crustaceans and bivalves. The benthic fauna sampled by the site specific benthic study revealed a wide range of potential prey items for the commercial species mentioned above both in their adult and juvenile stages. It is thought that the Kentish Flats areas does not play any critical role in this respect since the benthic fauna recorded from the area is widely distributed in the Thames estuary region, therefore the available prey is common.

The assessment of significant impact on fish habitat has concluded that this is going to be low for most fish species spawning in the area and moderate for herring. The impact was also considered to be low for nursery grounds since the loss of habitat is small and the disturbance temporary.

As far as the loss of habitats for shellfisheries, again it is considered that the overall area affected is of little significance. Mitigation measures proposed to limit loss of habitats, spawning and nursery grounds were seabed re-instatement to allow rapid recovery. It is also recommended that cable laying avoids herring spawning period between mid February to early May.

Impact on shellfisheries related to sediment re-suspension was considered to be moderate with the potential to affect the quality status of shellfish beds present in the area due to worsening water quality. Mitigation measures suggested the avoidance of water jetting during cable installation and the monitoring of oysters during pre- and post-construction phases for a range of

contaminants in order to ensure that any lack of impacts from these issues is confirmed.

Noise from construction activities such as piling was considered to be low and limited within a few meters from the operations while further away it is thought that fish will avoid the area. No mitigation or monitoring was suggested on this specific issue.

In terms of commercial fisheries the impact was considered to be moderate during construction particularly for oyster harvesting during cable installation; it was considered low during operation for the relatively limited area affected by the development. Mitigation and monitoring measures proposed were the appointment of fisheries liaison officers who appear to be best placed to identify potential hazards, to communicate arrangements to the local fleet and to make day to day recommendations to minimise impacts as far as possible. Other measures proposed are the employment of guard boats to ensure fishing vessels are informed of dangerous operations and notice to mariners are issued regularly in relation to vessel movements.

B) Pre-construction monitoring carried out between November 2003 and July 2004:

As part of the monitoring programme stipulated within the FEPA licence, EMU Ltd. was commissioned to undertake three trawling exercises for fish and shellfish species. The aim of these sampling exercises was to obtain baseline information regarding seasonal fish populations both demersal and pelagic from the area of the proposed wind farm development. These baseline data will then be used for assessment of potential scheme effects following post-construction trawl sampling surveys.

The gear employed during these surveys reflected the normal equipment used in commercial fishing activities in the Thames estuary. The surveys were carried out in April, June and August. The method involving the use of two side trawls represented a deviation from the agreed methodology and was employed in April and August to mitigate for the potential under sampling of pelagic fish. The June sampling was additional to the original specifications of and was designed to define populations of seasonal bass (*Dicentrarchus labrax*) which move inshore into the outer Thames estuary in early summer.

Trawls were conducted through the proposed wind farm site, within pre-determined target areas and between the lines of the turbine array. Two reference areas were also selected for trawling of fish and shellfish located 1-3 km east and west of the proposed cable route. These reference data are meant to describe the natural variation in fish populations.

Dab, plaice and thornback ray were the most abundant species recorded in the trawls. A full interpretation of the data collected did not appear in the report by EMU given that this was a pre-construction survey.

The number of species retained was higher in April than in August.

C) Post-construction monitoring on March 2009:

The latest monitoring reached conclusions very similar to the previous one dated August 2007 which are as follows:

The Catch per Unit Effort (CPUE) and species showed apparent fluctuation but this was attributable to natural variation in the report. The Kentish Flats monitoring report concludes that no effect arising from the construction of the wind farm was apparent. The monitoring has confirmed the predictions made by the Kentish Flats EIA. Consideration has been given to both the population of fish (by CPUE) and the diversity of the fish community (by number of species) in assessing the pre- and post- construction data. During the summer surveys CPUE increased both inside the wind farm site and in the reference areas. Numbers and CPUE for Dover sole, plaice and flounder were highest in July 2005 otter trawler surveys, whilst dab, thornback ray (rocker) and smooth hound were recorded in highest abundances during the June 2006 bass trawl survey. The variation in the number of individual and the relative CPUE at any specific location is reliant on a range of environmental factors, particularly migration.

In terms of fish interaction with benthic fauna on which they might depend at different stages in their lives the monitoring studies have demonstrated that any changes that have occurred are due to natural variability with no effects attributable to the wind farm construction and operation.

Some of the fish species caught in the area are thornback ray, smooth hound and other elasmobranchs which can potentially be negatively affected by the electromagnetic forces (EMF) generated by the wind farm sub-sea cables. The CPUE for the former has actually shown an increase year on year since 2004. Importantly, as for the impact of the EMF, there appears to be no discernible difference between the data for the wind farm site and the reference areas, including the populations structure changes; it is concluded that the population increase observed is unlikely to be related to the operation of the Kentish Flats wind farm.

Measurements of the levels of a range of contaminants in the flesh of oysters were carried out before and after the installation of the export cables to ensure that concentrations of these chemicals did not increase above the allowed levels. Only natural variations in the contaminant levels were identified by the monitoring with no changes attributable to the construction works. This monitoring has also confirmed the predictions made by the Kentish Flats EIA. The levels of the majority of the contaminants considered during both pre- and post-construction surveys fell within relevant guidelines and standards. The sampling of contaminants in the flesh of oysters harvested in the area has also acted as a safeguard against any adverse public health effects that could have arisen should cable installation have caused a worsening in water quality and quality of the oysters landed from the designated production areas.

Therefore, according to the latest post-construction monitoring report and as predicted by the Kentish Flats EIA only temporary and small scale effects have taken place and no longer term effects have affected the fish populations within the wind farm area.

Monitoring and other site specific issues

- Except for oysters, other shellfisheries present in the area are not considered.
- Since monitoring was not required during construction it is not possible to know the effect that pile driving activities might have had on fish present in the area at the time of the operations.
- Only two reference areas are monitored to compare data.

Appendix 2.5 Scroby Sands

Scroby Sands wind farm is located off the east coast of Norfolk (greater Wash), about 3 km from Great Yarmouth. It generates enough energy to supply over 30,000 homes and a capacity of 60 MW (*source: E.ON website*).

The following fish species spawn in the area where the development occurs: herring from November to January, lemon sole from April to September, sole from March to May.

The following nursery grounds are present off the coast of Great Yarmouth: mackerel, herring, plaice, lemon sole and sole.

There are no commercially important shellfisheries in the area where Scroby Sands wind farm development occurs.

Fishing in the area by registered vessels in 2008 was moderate (approximately 300 tonnes/year) and represented by crabs and lobsters from potting.

Licence conditions

In the Scroby Sands FEPA licence there are no specific conditions requiring the pre-, during or post-construction monitoring of fish, shellfish and fisheries. However, some pre and post construction monitoring was undertaken for fish, as a prey species for birds.

For obvious reasons it is not possible to draw any comparisons with Scroby Sands since no requirement for fish monitoring is set out in the licence conditions.

Appendix 2.6

Burbo Bank

Burbo Bank offshore wind farm is situated on the Great Burbo Flats in Liverpool Bay at the mouth of the river Mersey. It comprises of 25, 3.6 MW turbines which combine to generate 90MW of electricity. It is just over 6 km from the Sefton coast and 7 km from North Wirral.

Baseline surveys to inform the ES were carried out in 2001 – 2002. Pre construction monitoring occurred between September 2005 – April 2006. Construction monitoring covered the period May 2006 – July 2007. Post construction monitoring covers 1 year from August 2007 – July 2008. A gap year was taken between year 1 and year 2 post construction monitoring. Monitoring reports for years 2 and 3 are not yet available.

License Condition 9.6 – OWF as fish aggregating device

Since very little is known about the potential effect of windfarms in terms of enhancing or aggregating fish populations, the Licence Holder must produce proposals for adequate pre-construction baseline and post-construction surveys of fish populations in the area of the windfarm giving strong consideration to non-destructive methods of monitoring. The Licence Holder shall, in drawing up such proposals, canvas the views of local fishermen, North West and North Wales Sea Fisheries Committee. The proposals must be submitted to the Licensing Authority at least three months prior to the proposed commencement of the monitoring work. Written agreement from the Licensing Authority is required at least one month prior to the commencement of the monitoring work. (See also Annex 1 in relation to monitoring of electro-sensitive species).

Summary of Monitoring and Mitigation

The Burbo Bank site is a uniformly sandy substrate supporting a number of soft sediment biotopes that are important for fish feeding and that consist of productive and relatively short-lived organisms. The area supports both adult and juvenile populations of finfish and some shellfish species but it was not consider that the impact of the windfarm would disrupt these populations in the long term.

Techniques used:

Annual 4m beam trawl survey in spring and annual 2m scientific beam trawl survey in autumn.

Review of fisheries data from other (e.g. Cefas) surveys and anecdotal information obtained via the Fisheries Liaison Officer and other sources.

2 * 4m beam trawls with a cod end mesh of 80mm for 30mins at 3.5-4 knots (12 stns)

2m beam trawl with 4mm cod end mesh for five minutes at 2 knots (12 stns)

Also, analysis of lesser-spotted dogfish stomach contents as the most common elasmobranch.

So far, two annual fish surveys, 2m beam trawl carried out in autumn after the benthic grab survey, 4m beam trawl undertaken in spring as part of the post-construction monitoring. Throughout the surveying the importance of using standardised gear has been emphasised. Pre- and during construction surveys have been reported previously; the first post-construction 2m and 4m trawl surveys were completed in September/early October 2007 and May 2008. 2m beam trawl towed at 2 knots for 300m, and 4m commercial trawl at 3 knots for ~2km, both surveys undertaken at 12 established trawl stations.

2m beam trawl: Total number of fish, and species diversity comparable to the baseline (pre-construction) survey and higher than the previous year's during-construction survey. Fish were most abundant in the southern part of the wind farm and at a site close to the export cable (trawl stations 11 and 12 respectively). Small numbers of thornback ray and lesser spotted dogfish were captured, both within the array and adjacent to it. These species have been recorded in similar numbers previously.

4m beam trawl: Fish assemblage sampled has been stable from year to year and certain species have been consistently dominant. Overall numbers of fish in 2008 (adjusted for survey effort) were very similar to the baseline year (2006) but substantially lower than in 2007 (during-construction) when total numbers were at least 80% higher than in the other two years. Thornback ray, lesser spotted dogfish and starry smooth hound have been found consistently throughout the surveys, and future statistical analysis is considered.

A further survey is planned for spring 2010 which, in the absence of major effects from wind farm operation, will be the final survey. Results will be considered together with additional information from a final 2m trawl survey planned for autumn 2009. Monitoring so far has provided a useful account of the fish assemblage in the area, both pre- and post-construction, and there seems to be no obvious changes in the fish assemblage. The work on the feeding habits of the most common elasmobranchs (lesser-spotted dogfish) in the site is welcomed as a novel addition to the sampling, as it indicates that they are feeding within wind farms. However, in hindsight, better studies (e.g. larger sample size, better methodological approach to feeding intensity and condition) would have generated some more robust data. This is something as a 'lesson learnt' that can be applied to other sites in the future.

License Condition 9.7/9.14 – Fisheries Liaison:

The Fisheries Liaison Officer (see condition 9.15) shall pay due regard during the conduct of any fisheries surveys to the need to safeguard the safety of any persons engaged in fishing operations on the site of the windfarm. The Licence Holder must ensure that information is made available and circulated in a timely manner through the liaison officer(s) to minimise interference with fishing operations and other users of the sea.

Summary of Monitoring and Mitigation

This area appears to be most intensively fished in the spring by local and visiting trawlers targeting sole and plaice. No vessels rely on the site exclusively. The ES states that no exclusion zone will be set around the site so the area will be freely accessible to local fishing vessels. However, in reality it is likely that few vessels will want / be able to trawl between the turbines and this effective closure will limit fishing opportunities in the area.

No evidence of fisheries liaison was provided. Local fishermen have assisted with some of the fish surveys, so there may be evidence of commercial fisheries response within the marine fish section of the post-construction report.

License Condition Annex 1.7 – Marine Fish

The Environmental Impact Assessment observed electrosensitive species (e.g. Thornback Ray) in this area of Liverpool Bay and in the vicinity of the Burbo site (although frequency and abundance were not quantified). In the absence of any evidence that electromagnetic fields do not pose a risk to such organisms, monitoring work is required to determine the numbers and distribution of such species in the vicinity of the Burbo offshore windfarm (this should include the establishment of a baseline and the use of adequate controls). The results should be presented and discussed in combination with the EMF studies described in the preceding section (6).

Summary of Monitoring and Mitigation

Monitoring was carried out in collaboration with COWRIE studies; As part of the COWRIE Study a number of visits were made to the shore landfall site on the Wirral in February 2008 to measure actual magnetic and electric fields. The maximum electric field measured at Burbo was 40 μ V/m when the wind farm was generating at approximately 60% capacity. This equates to a maximum electric field in the marine environment of 83 μ V/m when the wind farm generates at full capacity, in line with previous predictions.

These electric fields are of a magnitude that has been demonstrated to influence elasmobranch behaviour and, therefore, with potential to cause an environmental impact.

EMF is an ongoing issue that hasn't been resolved, further monitoring is being undertaken on the marine fish in general which is being considered as evidence of whether EMFs are causing a negative effect.

Monitoring and other site specific issues

- The beam trawl surveys have detected no major impact of wind farm construction and initial period of operation on the distribution of fish locally.
- There is early evidence that the wind farm is acting to attract fish (Fish Aggregating Device (FAD) effect).

- The surveys have provided useful information to suggest that certain elasmobranch species (sharks, skates and rays) do feed inside the operational wind farm and demonstrated clearly that they are not excluded during periods of low power generation.
- Underwater noise from the operation of the windfarm is very low level and highly unlikely to be of any significance to marine fauna such as fish and marine mammals.

Appendix 2.7 Gunfleet Sands

Gunfleet sands windfarm is located approximately 8.5 km south-east of Clacton-on-Sea, Essex. The windfarm has been licensed in two stages, GS1 in round 1 (licensed in 2002) and GS2 in round 2 (licensed in 2007). GS1 consists of 30 turbines each with an output of up to 3.6MW giving a maximum capacity of 108MW. GS2 comprises a further 22 turbines with a maximum total capacity of 64 MW. The two stages are on adjacent sites and are both presently being constructed. This will give a total of 52 turbines at Gunfleet Sands with a total maximum capacity of 172 MW.

Conclusions from the Environmental Statement

Fish surveys to inform the ES were carried out in 2002 (for GS1) and 2007 (for GS2) and pre-construction in 2007. Construction surveys are to be carried out in autumn 2008/09 and post construction surveys in autumn 2010/2011/2012. At present data is only available for the baseline and pre-construction surveys.

Gunfleet Sands (and other inshore sand bars) provide suitable spawning and nursery habitat areas for several commercial fish species. Species known to spawn in the area include thornback rays, sprat, lemon sole, sole, bass and herring. Gunfleet Sands lies 10 km to the west of a recognised herring spawning ground on the Eagle Bank in the Blackwater Estuary. Thames estuary herring belong to a small localised stock, sometimes called Blackwater herring, which sustains a small local commercial fishery. The Thames herring are a spring spawning stock (between late February and April).

Sprat is widely dispersed throughout the shallower areas of the region and especially inshore during autumn and winter. The whole region off Sussex, Essex and Kent is used for spawning by this species, which occurs mainly from February to June and is temperature dependant. Bass are seasonally abundant within inshore waters and estuaries within the area, arriving from further west in the early spring. Bass spawn within the region from April to June. From June onwards, juvenile bass are found in estuaries and shallow bays within the study area.

License condition 9.8 (License 31919/03/0 GS1) – OWF as fish aggregating device

Since very little is known about the potential effect of windfarms in terms of enhancing or aggregating fish populations, the Licence Holder must produce proposals for adequate pre-construction baseline and post-construction surveys of fish populations in the area of the windfarm giving strong considerations to non-destructive methods of monitoring. The Licence Holder shall, in drawing up such proposals, canvas the views of local fishermen. The proposals must be submitted to the Licensing Authority at least one month prior to the commencement of the monitoring work. (See also Annex 1 in relation to monitoring of electro-sensitive species).

License condition 9.37 (License 33723/08/0 GS2) - OWF as fish aggregating device

The Licence Holder must produce proposals for a post-construction survey of fish populations in the area of the wind farm at least four months prior to construction, in order to investigate the potential for the Gunfleet Sands 2 offshore wind farm in enhancing or aggregating fish numbers. The Licence Holder shall, in drawing up such proposals, canvas the views of local fishermen. The Licence Holder must undertake these surveys as detailed in the agreed proposal and submit the results to the Licensing Authority and relevant adviser by the date specified in the schedule required under Condition 9.1

Summary of Monitoring and Mitigation

Due to the changes in fish assemblages at Gunfleet sands throughout the year, fish surveys were undertaken seasonally to acquire accurate representation of the populations. Otter trawls were conducted in summer (June- September), winter (November – February) and spring (March – May). Beam trawl surveys were conducted in the summer months to target smaller species and juveniles that might otherwise be underrepresented by otter trawl alone. Ten otter trawls and ten beam trawls were completed in a total of eight sites on and around Gunfleet Sands and a further two at far-field sites within a reference zone established to the east northeast of Gunfleet Sands. A suite of three seasonal surveys has now been completed prior to construction to provide representative baseline data. It is proposed that post-construction, three seasonal surveys be conducted each year; repeated initially for two consecutive years post construction.

A twin rig otter trawl with 80 mm mesh was used, consistent with techniques employed by the local commercial fisheries. The headline height was 1.2m in the centre and 1m on the wings. Trawls were towed for 30 minutes at 1.8 knots. The average distance of seabed covered by each trawl was approximately 1667 m. The beam trawl surveys were conducted with a 2 m beam fitted with a 20 mm stretched mesh (10 mm “knot” to “knot”) and a cod-end liner of 3 mm “knot” to “knot”. The beam trawl was towed at each site for 10 minutes at an average speed of 3.1 knots, and therefore on average each tow covered approximately 956 m.

License condition Annex 1.6 (License 33723/08/0 GS2) - Fish populations

A number of fish species are common to the general area surrounding the proposed wind farm site. Survey work is therefore required to determine the general status (number and distribution) of fish species in the vicinity of the Gunfleet Sands 2 offshore wind farm.

Summary of Monitoring and Mitigation

This license condition was fulfilled by the above surveys. Pre-construction monitoring reports showed that species common to all three seasonal surveys included thornback ray, cod, whiting, pout, dab, plaice and sole. Species recorded in the August survey only were smooth hound and turbot. Species

recorded in the October survey only were lesser-spotted dogfish, tub gurnard, sea snail, lesser weever and gobies. Species recorded in the April survey only were John dory and bass. The total length of fish was recorded, from the tip of the snout to maximal extent of the caudal fin. The total wingspan for rays was recorded from tip to tip. The sex of elasmobranch species was recorded. Biomass of each species within each trawl was also recorded, with an accuracy of ± 10 grams (wet weight). The reference sites, which lie east northeast of Gunfleet Sands were found to have a similar species composition, species abundance and biomass to other trawl sites on and around the Gunfleet Sands area, and may therefore be considered as suitable reference sites for future monitoring.

License condition 9.9 (GS1 & GS2 licenses) – Fisheries liaison

The Fisheries Liaison Officer (see Supplementary Condition 9.15) shall pay due regard during the conduct of any fisheries surveys to the need to safeguard the safety of any person engaged in fishing operations on the site of the windfarm.

Summary of Monitoring and Mitigation

There is no record within the pre-construction monitoring as to whether this condition has been fulfilled.

Annex 1.6 – (License 31919/08/1 GS1) - Marine Fish

The Environmental Impact Assessment observed electrosensitive species (e.g. Thornback Ray) in this area of Essex and in the vicinity of the Gunfleet Sands windfarm site (although frequency and abundance were not quantified). In the absence of any evidence that electromagnetic fields do not pose a risk to such organisms, monitoring work is required to determine the numbers and distribution of such species in the vicinity of the Gunfleet sands windfarm (this should include the establishment of a baseline and the use of adequate controls). The results should be presented and discussed in combination with the EMF studies described in the preceding section (4).

Summary of Monitoring and Mitigation

Pre-construction monitoring of GS1 and GS2 has produced baseline conditions, against which potential environmental effects on fish distribution in the vicinity of the windfarm sites can be measured. Subsequent surveys during and post construction will allow the determination of any distributional changes in electro-sensitive elasmobranchs and fish species within the Gunfleet Sands area which could be related to electromagnetic fields created by windfarm export cables. With regard to potentially electro-sensitive species, thornback rays were recorded at all the otter trawl locations during the three seasonal fisheries surveys, with the exception of trawl 10 during the August survey. In contrast, lesser spotted dogfish were not recorded within the August 2007 or April 2008 surveys. In August 2007 one smooth hound was recorded within the reference area, but there were no records during the October 2007 or April 2008 surveys. Future monitoring will pay specific

attention to the distribution and abundance of electro-sensitive species across the study area.

Monitoring and other site specific issues

The site of the Gunfleet windfarm is adjacent to a herring spawning ground. A herring spawning ground survey was undertaken in spring 2009 to address the following issues:

- To confirm onset and completion of the main spawning period.
- To identify the main spawning grounds
- To assess the effects of construction activities on spawning behaviour.
- To correlate sea temperatures with spawning behaviour.

Sampling was to begin in February and consist of weekly sampling until the end of the spawning season, with the possibility of twice weekly sampling during the peak of the season. Surveying was to be undertaken with a semi pelagic net with a 32 mm cod end and headline height of no less than 6.5 m. The samples will be analysed for spawning condition using the 9 stage maturity key and be analysed for sex ratios. Once the net had been fully hauled, the sea temperature will be recorded at 1-metre increments from the seabed to the surface using a Conductivity Temperature and Depth (CTD) Meter and calibrated probe. Results of this survey are not yet available.

Appendix 2.8 **Rhyl Flats**

Rhyl Flats Offshore Wind Farm is located approximately 6.5 km off the North Wales coastline within the Liverpool Bay between Towyn and Rhôs-on-Sea. Construction of the 30 2MW wind turbine array is scheduled to begin during late 2007 and continue through to the following year. The development should enter its post-construction phase in 2009.

Licence conditions

9.1 To minimise impacts on fisheries, spawning fish and over-wintering Common Scoter, construction works must not be undertaken between 16 December and March (inclusive). The majority of construction works must take place between April to September (inclusive) the only exceptions to this being works associated with testing and commissioning, the installation of turbines and the meteorological mast in the northern row and the installation of cabling between the turbines and the meteorological mast in the northern and middle rows, which may be undertaken, if necessary, between October and 15 December (inclusive). Should it be critical that works, other than that specified above, are necessary between October and 15 December (inclusive), written approval should be sought, in advance, from the Licensing Authority (following consultation with CEFAS and CCW) which will consider the request on a case by case basis.

9.7 Fish Monitoring: Since very little is known about the potential effect of wind farms in terms of enhancing or aggregating fish populations, the Licence Holder must produce proposals for adequate preconstruction baseline and post-construction surveys of fish populations in the area of the wind farm. The Licence Holder shall, in drawing up such proposals, canvas the views of local fishermen. The proposals must be submitted to the Licensing Authority at least one month prior to the proposed commencement of the monitoring work. (See also Annex 1 in relation to monitoring of electro-sensitive species).

9.8 The Fisheries Liaison Officer (see condition 9.13) shall pay due regard during the conduct of any fisheries survey to the need to safeguard the safety of any persons engaged in fishing operations on the site of the wind farm.

9.15 The Licence Holder must ensure that the liaison officer's environmental remit includes: Monitoring compliance with the commitments made in the Environmental Statement and the Environmental Management Plan. Providing a central point of contact for the monitoring programme described in Annexes 1 and 2. Liaison with fishermen, conservation groups and other users of the sea concerning any amendments to the method statement and site environmental procedures. Inducting site personnel on site / works environmental policy and procedures.

ANNEX 6 Marine Fish: (See also licence condition 9.7 in relation to fish populations).

The Environment Impact Assessment observed electrosensitive species (e.g. Thornback Ray) both within and close to the Rhyl Flats site. In the absence of any evidence that electromagnetic fields do not pose a risk to such organisms, monitoring work is required to determine the numbers and distribution of such species in the vicinity of the Rhyl Flats offshore wind farm (this should include the establishment of a baseline and the use of adequate controls). The survey should make use of non-destructive techniques e.g. live traps and visual methods. The results should be presented and discussed in combination with the EMF studies described in the preceding section (5).

Summary of Monitoring and Mitigation

Pre-construction baseline has been started 2 years in advance and has been split over the two years as apposed to the one year baseline specified in the licence condition. Baseline survey has consisted of the use of Cefas beam trawl data and data collected for North Hoyle wind farm, fisheries liaison officer and beam trawls carried out as part of this monitoring study in 2006 and 2007.

The baseline report found that Constable Bank is characterised by very low levels of fishing activity (4-5 vessels regularly fish with next to none in winter). Charter angling from north Wales coast.

Spawning and nursery areas for rays can be found towards Rhyl-Prestatyn. Plaice and sole nursery area can be found on the landward side of constable bank. Conway and Dee are designated Bass nurseries. No record of herring spawning in the past 50 years.

Elasmobranchs, bass, sole, plaice and other fish species found in Rhyl flats/ Liverpool Bay, although beam trawl surveys carried out by the developer found only 3 individual elasmobranchs consisting of 2 species.

Area is peripheral to commercial fishing areas.

The greatest abundance of fish from the 2005 trawls were recorded to the south of the site and along the cable route. In 2006 the greatest number of taxa and abundance of fish were recorded at locations outside the sites.

Monitoring and other site specific issues

- Construction is currently underway and as of yet there is no report on monitoring during construction.
- There is a licence condition restricting the time that work can be carried out due to spawning times. This was questioned when the applicant changed and the construction schedule altered but remains in place.
- The Baseline Report on Fish and Fisheries further describes the resources but provides no indication of how this information is to be

used to fulfil condition 9.7 or Annex 1, paragraph 6 of the FEPA licence.

EMF

Licence conditions

9.5 Monitoring of Sedimentary and Hydrological Processes, Benthic Ecology, Electromagnetic Fields and Noise & Vibration

The Licence Holder must carry out a programme of sedimentary, hydrological, benthic and other monitoring, as outlined in Annex 1 attached to this Schedule. The full specification for the monitoring programme will be subject to separate written agreement with the Licensing Authority following consultation with CEFAS and the Countryside Council for Wales at least one month prior to the proposed commencement of the monitoring work.

Annex 5 Electromagnetic Fields:

The Licence Holder must provide the Licensing Authority with information on attenuation of field strengths associated with the cables, shielding and burial described in the Method Statement and relate these to data from the Rødsand windfarm studies in Denmark and any outputs from the COWRIE tendered studies in the UK. This is to provide reassurance that the cable shielding and burial depth(s), both between the turbines and along the route to shore, given the sediment type(s) at the Rhyl Flats site are sufficient to ensure that the electromagnetic field generated is negligible. Should this study show that the field strengths associated with the cables are sufficient to have a potentially detrimental effect on electrosensitive species, further biological monitoring to that described in section 5 may be required to further investigate the effect.

Summary of EMF Monitoring and Mitigation

Pre-construction baseline has been started 2 years in advance and has been split over the two years as apposed to the one year baseline specified in the licence condition.

Baseline survey to determine the number and distribution of electrosensitive species and to assess the current status of COWRIE studies was to be carried out and consisted of the use of third party data including data collected for North Hoyle wind farm, and Welsh Skate and Ray group, fisheries liaison officer and beam trawls carried out as part of this monitoring study in 2006 and 2007.

The fisheries report has been carried out which details the baseline distribution of electro-sensitive species. However there is no mention of COWRIE studies or how these findings relate to the potential EMF impact.

Monitoring and other site specific issues

- Construction is currently underway and as of yet there is no report on monitoring during construction.
- There is currently only a baseline fisheries report, but is not related to possible EMF impacts in any way.
- Report was to be submitted in Spring 2008 but has not yet been received.

Appendix 2.9 Thanet

The Thanet Offshore Wind Farm is located 11.3 km offshore from Foreness Point, the eastern most part of the Kent coastline. The wind farm will consist of 100 x 3 MW wind turbines giving a maximum output of up to 300 MW. The license for the windfarm was granted in 2006. Pre-construction monitoring commenced in 2007 with reports submitted in 2008. Much of the monitoring and survey work conducted for the baseline surveys was utilised in the preconstruction reports due to the short time that had elapsed. Construction of the Thanet windfarm is currently in progress.

Conclusions from the Environmental Statement

Baseline surveys to inform the Environmental Statement were conducted in 2005. The Thanet area supports numerous species of fish with lesser-spotted dogfish, dab, sole, smooth hound and thornback ray being commonly caught. Fishing activity at the Thanet site involves coastal vessels operating out of Ramsgate, larger UK vessels from ports further afield, and by EU member state vessels. The fishing area of one drift netting vessel overlaps with the Thanet site and several vessels occasionally set anchor nets within part of the site. Vessels also fish areas along the export cable routes and cross the wind farm site when travelling to and from fishing grounds.

License condition 9.9 – Fish Monitoring

The Licence Holder must within six months of the date of this licence produce proposals for a post-construction survey of fish populations in the area of the wind farm. The Licence Holder shall, in drawing up such proposals, canvas the views of local fishermen. The proposals must be submitted to the Licensing Authority by the date specified in the schedule required under condition 9.2. The Licence Holder must undertake these surveys as detailed in the agreed specification and report by the date specified in the schedule required under condition 9.2.

Summary of Monitoring and Mitigation

Detailed pre-construction survey data is not yet available; however Thanet Offshore Wind Ltd submitted a letter stating the intentions of their post-construction surveys. The surveys will as far as practicably possible repeat the original surveys in the baseline and pre-construction monitoring. Surveys will be conducted in spring and summer of the Thanet site, export cable routes, inshore areas and two control areas. Surveys will be carried out using a demersal otter trawl fitted with a rock hopper and tickler chain. A total of 20 x 30 minute otter trawls will be carried out. It is proposed that the post-construction surveys commence at the first full season following the completion of construction which is currently anticipated to be spring 2010. For each of the adult fish surveys the following analysis will be undertaken:

- Number by species
- Sex ratio, samples of principle commercial species
- Spawning condition by species

- Length distribution by species

Juvenile fish will be sampled concurrently with surveys of epifaunal assemblage. The surveys will use a 2 m beam trawl with a fine mesh cod end, rock hopper, ground line and chain mat. Survey methodology will repeat the original involving slow trawling speeds of 1 and 1.5 knots over a standard time of 5 minutes or standard distance of 200 m. samples will be analysed for:

- Number of individuals of each species retained
- Length distribution by species
- Width of carapace of crustaceans.

Baseline survey monitoring utilised 28 stations including 6 within the windfarm, six tidal excursion sites, three control sites to the north, three control sites to the south, and nine in the vicinity of the export cable route. Positions for repeat sampling will be agreed with Cefas.

License Condition Annex 1.4 – Marine Fish (see license condition 9.9)

A number of elasmobranchs (lesser spotted dogfish, thornback rays, and starry smoothhounds) are common to the general area surrounding the proposed wind farm site. Survey work is therefore required to determine the general status (numbers and distribution) of this and other elasmobranch species in the vicinity of the Thanet offshore wind farm. The results should be presented and discussed in combination with the EMF studies described in the following section (5. Electromagnetic Fields).

Summary of Monitoring and Mitigation

Baseline surveys to inform the ES were carried out in 2005. A spring and summer adult fish survey of the Thanet site, export cable routes, inshore area and two control areas were taken. The survey was carried out using a demersal otter trawl to conduct 19 x 30 minute tows. Juvenile fish surveys were conducted using a 2 m beam trawl at 27 locations within the study area. Catches were analysed for:

- Number by species
- Sex ratio, samples of principle commercial species
- Spawning condition by species
- Length distribution by species

The results of the surveys showed wide ranging differences in species assemblages at different sites. In all 266 species were identified representing a range of taxa. However, the number of species present in any one area is highly variable, ranging between 3 and 44 species. The vast majority of samples showed that species numbers are low, with just a few samples being representative of high numbers. The assemblages across the site have few characteristics in common as a direct result of the variability in the sediment types and species numbers present. This dissimilarity means that there are insufficient characteristics in common to define a biotope. A similar situation was encountered along the export cable route, where the seabed is characterised by outcropping chalk bedrock and occasional areas of loose sand and sand megaripples.

The most prevalent species caught were lesser spotted dogfish and dab. Low numbers of herring were caught in spring and none in summer. Moderate numbers of sole and starry smoothhound were caught, which are species that are targeted by the local fishing community. No species of national or local conservation importance were caught.

Additional fish trawl surveys were not conducted for the pre-construction monitoring report, which instead utilised much of the work of the baseline survey. Supplementary reports for pre-construction were produced for herring spawning surveys in 2007 and 2008 in reference to license condition 9.13 and elasmobranchs to investigate the implications of EMF.

Elasmobranch surveys were conducted in September 2007 using bottom fixed nets. Seven combination fleets of nets were used for the sampling. Three sampling stations were located over the proposed export cable route, 2 over the inter-field cables, and 2 were used as control sites. Each fleet was comprised of four 6" and four 10" mesh nets, each of 91 metres in length, giving overall fleet lengths of 730 metres. The 6" mesh nets were for the targeting of round elasmobranchs such as dogfish, smooth-hounds and tope and the 10" mesh nets for skates and rays. Nets were deployed on the sea bed for soak times of approximately 24 hours.

The overarching objective of the elasmobranchs monitoring study was to investigate the potential behavioural (e.g. attraction or aversion) effects of EMF upon electrosensitive species of elasmobranchs within and around the Thanet Offshore Wind Farm. In this context, the monitoring has two further objectives:

- To investigate if any observed effects are similar for individuals (e.g. of different age or sex) within a species population; and
- To investigate if there is a consistent response between different electrosensitive elasmobranch species.

Four species of Elasmobranch were caught during the course of the survey: thornback ray (*Raja clavata*), lesser spotted dogfish (*Scyliorhinus stellaris*), starry smoothhound (*Mustelus asterias*) and tope (*Galeorhinus galeus*). The predominant species within the samples was starry smoothhound, comprising between 43% - 100% of the individuals caught. Amongst all of the species caught, a significantly higher proportion of the average numbers of individuals caught were females. The report provides a good baseline for future monitoring to assess the impacts of electromagnetic fields.

License condition 9.13 – Timing of Works

The Licence Holder must ensure that seismic surveys and pile driving operations are not conducted between mid February and the end of April so as to avoid the main spawning period for Thames herring. All pile driving operations must use a 'soft start' procedure.

Summary of Monitoring and Mitigation

Herring spawning ground surveys were undertaken by the applicant in response to this license condition to identify the timing of the Thames herring spawning in spring, to estimate the distribution and duration of the spawning, and to provide additional information to assess the need for restrictions on the piling foundations between mid February and 1st May.

Herring surveys were conducted in 2007 and 2008 between February and late April on a fortnightly.

Herring were surveyed using:

- Acoustic instruments to identify the presence, size and distribution of herring shoals in the water column.
- A light demersal otter trawl with a 32mm mesh cod end
- A hand held Conductivity, Temperature and Depth (CTD) to record sea temperature, salinity and depth recorded at 1m increments from the seabed to surface.
- 0.1 m³ Hamon grab for taking small samples of sand and gravel to identify sediment type and spawning potential.

The surveys showed that the main spawning occurred between 2nd March 2007 – 9th May 2007 and 26th March – 3rd April in 2008. The surveys showed that herring spawning has so far been limited to a discrete area of the 'Studhill Ground' and the spawning period has been short (2 to 3 weeks). Thanet Offshore Wind Ltd (TOW) also undertook a modelling study of the potential attenuating effects of the Margate Sands complex in relation to the spawning area. Due to results of these investigations carried out by TOW, Cefas was content for license condition 9.13 to be amended to allow pile driving at Thanet Offshore Wind Farm during the spawning season. However, this recommendation was based on the following points:

- It is based on the construction of up to 100 turbines.
- That construction will be completed during 1st September 2008 and 30th September 2009.
- All pile driving will be completed by 30th May 2009.
- All foundations are to be installed by pile driving.
- Pile driving does not overlap with construction of any other offshore wind farm developments in the outer Thames area during the spawning season.
- Only one pile driving vessel is in operation at any point in time during the spawning season.
- Pile driving is to start on 1st September 2008.
- Piles are inserted at a frequency of approximately 1 every 2-3 days (The duration of piling per foundation to be approximately 5-7 hours).

There was variation to these timings, which were discussed between the licence holder and the Licensing Authority and agreement was made on the revised schedules.

The developer was also to provide the MFA and Cefas with a weekly update on progress during the spawning season (e.g. number of piles installed per row, rough duration of pile driving activity per pile and any problems or requirements to amend installation schedule), and noise measurements

during the pile driving activities. Cefas also suggested monitoring of underwater noise during the spawning season and the potential benefits of spawning surveys during construction and post construction.

License condition 9.10 – Fisheries Liaison

The Fisheries Liaison Officer (see condition 9.20) shall pay due regard during the conduct of any fisheries survey to the need to safeguard the safety of any persons engaged in fishing operations on the site of the wind farm.

Summary of Monitoring and Mitigation

There is no record within the pre-construction monitoring as to whether this condition has been fulfilled.