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

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1 Introduction

This report assesses the conformity of ornithological monitoring at ten UK offshore windfarm developments to FEPA licensing requirements. The conditions set out in the licences have also been assessed for clarity, standardisation, etc. Where appropriate, the specific questions asked in the project outline have been individually addressed in this report.

Only those windfarms where monitoring as a result of FEPA licence conditions has begun have been assessed, ie, those with at least one year of pre-construction monitoring. The following sites have been assessed:

1. Barrow
2. Burbo
3. Kentish Flats
4. North Hoyle
5. Scroby Sands
6. Gunfleet
7. Lynn
8. Inner Dowsing
9. Rhyl Flats
10. Thanet

1.1 Assumptions and out of scope

It is assumed that what data are presented in the reports are a fair representation of what was observed during monitoring and that any analysis and textual summaries are a fair and accurate representation of the data.

Only the conformity to licence conditions has been assessed. The appropriateness of those conditions, in terms of ecological issues, has not been assessed on a site by site basis unless there are very clear omissions or mistakes, but the general value of the conditions has been assessed.

The conformity to a licence monitoring requirement is only accepted if it is explicitly reported. Conformity is not accepted if it can only be inferred, even if data has been collected that would meet the condition if it were analysed appropriately.

Onshore elements of projects such as cabling and grid connections have not been assessed. (Although they are not part of any licence condition required here).

2 Summarise key conclusions of what has been learned

Monitoring is generally of a high standard, both in terms of its ecological value and in terms of meeting, or attempting to meet, the licence requirements given, at least for the main conditions outlined. It is clear that all developers and their appointed consultants have made a good effort to assess the development appropriately. It must be stated however, that all of the developments assessed here have been fully consented and most constructed, so they are all by necessity going to have been assessed and met the various criteria required by the regulatory authorities. In virtually no case was any impact of significance found or any significant mitigation required from the monitoring, but this may be because all issues were dealt with during the consenting process, so that mitigation measures were built into the conditions of consent, or that insufficient sampling took place to detect change. However, with the latter explanation, as discussed in the introduction and conclusion of the main report, the amount of sampling effort required to detect any change needs to be proportionate to the subject under investigation.

The licence conditions are fairly standard across all of the sites considered. A typical licence will require the following:

1. one year of pre- and during-construction monitoring and three years of post construction monitoring
2. An assessment of 'change of use' of the site, a reference site, and the surrounding area by birds
3. An assessment of the distribution of bird specie in the development area, there are sometimes additional species-specific licence requirements
4. An assessment of 'barrier effects'.
5. An assessment of collision risk and/or rate, sometimes conditional
6. A requirement, sometimes conditional, for linking bird and benthic monitoring
7. A requirement to consult with Natural England or Countryside Council for Wales.

Some times licence conditions are given the status of objectives, other times they are merely guidance. Sometimes the details of monitoring methods are stated, at other times not. In one case no objectives or guidance was given at all, but it was stated that the monitoring programme should be agreed with NE. In one case, Scroby Sands, all the monitoring requirements were species (Little Tern) and site specific, with no other general monitoring required.

Conformity with items 1 to 3 above (what we might call 'general bird surveys') was always met in full, or as near as weather, etc, would allow - it was clear that considerable effort was expended to meet these

requirements. Items 4 and 5 (barrier effects and collision) were always addressed, but rarely met convincingly. It is apparent that the appropriate methods do not yet exist, as they do for the other requirements, to address these particular issues and there is little will on the part of the developers to find or trial new methods. This may be for financial reasons, or because they are reluctant to use methods that may find further impacts.

Item 6, the requirement for benthic and bird monitoring linkage was never met, even if it was not conditional upon changes in bird populations being observed. It is difficult to see why this reluctance is present, as benthic monitoring is undertaken any way, but presumably there are reasons of cost.

Other issues that might be of concern, such as the monitoring of sites for nocturnally active species, or the assessment of impacts on species not specifically protected by European legislation (SPA species, etc) are found to be missing from the licence conditions and it may be appropriate to consider widening the reach of these conditions. This may particularly important when considering the cumulative effect of multiple sites when impacts that are not considered important or not considered at all begin to have a combined effect. This would require agreement of a species specific threshold level which would trigger some adaptive management to ensure that significant impacts do not occur. However, when widening the scope of monitoring requirements, regulators should also be mindful of what it is reasonable to expect of developers, given that offshore monitoring is very costly, and some technologies are still in a trial phase.

It is clear that methods need to be developed or, where already existing, standardised, to address these points. Research programmes implemented by the Crown Estate or NERC or by BERR's RAG fund may be the best way to develop them.

3 Describe what has been learned about interactions

No information has been provided on interactions between birds and other animal group, either fish or invertebrates. Only in one case (North Hoyle) was linkage between bird numbers and invertebrate numbers made an objective rather than guidance, and even then it was conditional upon finding a decline in Common Scoter which was not actually observed. No linkage between birds and fish numbers was discussed in any detail at any site. While it is likely that suitable benthic invertebrate data has been collected at many sites, and it is common practice to store samples so that relevant examinations can be made post hoc if required, little enthusiasm was evident in any of the reports for analysing the linkage between bird and invertebrate numbers, even though prey levels might be an important explanatory variable for bird numbers within a development. Should such investigations be undertaken in future, then issues such as the large benthic

sample size required, the mobility of pelagic invertebrate prey and the time lag between collecting bird and invertebrate data must be addressed.

4 Assess which conditions have been successfully applied (or not)

Throughout the wind farms assessed, a high standard of monitoring and an absence of significant ecological issues has been found. For most ornithological issues at an offshore windfarm, a standard set of monitoring techniques exist (eg boat-based and aerial transects), has been updated and which can generally be applied with little adaptation to local circumstances. This has helped to ensure standardised monitoring and the development of a body of knowledge and skills across the industry that can readily be applied to any new development.

Aerial surveys carried out during pre-construction monitoring fly at the standardised 80 metres above the sea surface. Due to the issues highlighted in relation to flying aircraft over the windfarm at these heights some developments are not following these standardised survey heights for post-construction aerial surveys and must fly considerably higher.

For the most part, the licence conditions for the ten windfarm applications assessed here have been written to facilitate the use of these methods. There are however, three key areas which have rarely resulted in a successful monitoring programme, namely the investigation of barrier effects, the investigation and measuring of collision risk and rate, and the linkage of bird and other ecological monitoring. The reluctance to embrace monitoring of the barrier effect and collision is probably due to an absence of easy monitoring methods, while the absence of linkage with benthic monitoring may be because it would require an extensive benthic survey program and the subsequent analyses of the benthic data in relation to information on bird distribution and abundances may be a difficult task, and could produce no clear relationships, unless a considerable effort was directed towards the benthic surveying component. However, as yet it may also be because there is no linkage between the ornithological and benthic specialists and consultancies. An option to explore could be to assess bird distribution in relation to bathymetry and broadscale biotope assemblages and to conduct benthic and bird surveys at the same time of year. However the logistics and costs may be prohibitive. In any case, if population-level impacts are to be investigated, more guidance on quantification needs to be provided.

The barrier effect is the name given to the inability of birds to adopt their preferred course through a turbine array and they are forced to fly around it, which has at the very least energetic consequences and may lead to the abandonment of a local roosting or breeding site. It is best assessed with some kind of measurement of movement rate or flux from a fixed point,

either the shore or a stationary boat. Other data such as migration landing data from SPAs or wildfowlers may be off use, however, these data may not be available in all cases and may not be of sufficient resolution. In the reports reviewed here, it has generally been investigated as part of the standard boat and aerial transect methodology. The spatial distribution of birds seen during the transects is used to detect differences in bird activity before and after construction. The barrier effect however is a matter of movement, or the lack of it and not easily assessed from static density distributions. Some species at risk of the barrier effect are also not easily counted from a boat so counts are even less likely to pick up on this problem. The movement event, whether it be a daily commuting flight or seasonal migration may also be a short lived phenomenon that requires a dedicated effort to monitor fully.

Static counts from a boat are difficult to conduct because of the difficulty of holding the boat stationary for any length of time; the risk of the presence of the boat influencing the birds' behaviour; and the difficulties of observers detecting birds over further away from the viewing point. Shore-based point counts can be useful if the flight can be monitored from the shore, but this is not always the case. One suitable method for assessing the barrier effect is radar, which while it has not been used widely to date, could be used in the future, as it returns detailed and extensive data on movements, and is very effective when combined with standard field observations. It is ideally platform-based, but it can be ship or shore-based. Guidance on the 'bestpractice' application of remote techniques is available from the COWRIE report:
http://www.offshorewindfarms.co.uk/Pages/Publications/Latest_Reports/Birds/REVISED_BEST_PRACTICE_993b22da/

The barrier effect can be a significant issue in certain locations and for certain species it should continue to be a condition of consent, but some thought must be given to the methods used.

Collision risk is the probability of birds being killed by turbine blades as they fly through the windfarm. In certain locations and for certain species, it could have a significant impact on the survival of a bird population in the long term. Whilst collisions themselves are thought to be quite rare events, it may only require a small increase in mortality for an effect to be detrimental to the abundance of a species at a given locality. In general, these licences have required a collision rate assessment post-construction rather than a collision risk assessment pre-construction, but, the latter have generally been provided, if at a somewhat basic level. Population viability assessments, a modelling technique whereby the effect of increased mortality, in this case as a result of collisions, on the future of the population can be calculated have only started to be carried out for more recent offshore windfarm developments, especially with regard to cumulative impacts of several projects. None were undertaken for the projects considered in this report.

A collision risk assessment is almost always required for an onshore windfarm development, but detailed bird activity data is not easy to obtain in that situation. It is a complex calculation requiring estimates of flight durations or numbers of movements within the turbine area which when combined with the geometric parameters of the turbines and a so called 'avoidance rate' (an estimation of the ability of a bird to avoid the blades) returns the predicted number of collisions per year. However, the limitations to collision-risk modeling are acknowledged.

It is more difficult to obtain this kind of information offshore, so collision risk estimates are generally restricted to the calculation of the number of birds at turbine height (height information is collected during boat based surveys, although it is difficult to get reliable estimates of flight height in that environment). If this number is low enough (though this is an arbitrary estimation if a PVA is not undertaken), a collision risk assessment is not performed. There is no reason however why a detailed assessment cannot be done, especially if many of the behavioural parameters of the birds involved can be modelled. In future years, as more generic information is collected, model based collision risk assessments will be possible with bird count data alone.

Collision rate assessment at a constructed wind farm is difficult. Carcass collection is of course virtually impossible, and many of the techniques suggested for automated monitoring - thermal cameras, collision noise detection are not yet sufficiently well developed to produce reliable results. In nearly all cases examined, the collision risk was estimated to be very low, or negligible and collision rate measurement was therefore not undertaken, or it was resisted because of the state of available technology as mentioned above. In several cases, a trial of said technology was suggested or required, but was declined. Radar data has been used at the Lynn and Inner Dowsing sites (using avoidance rates as a proxy for collision risk) with some success. However, the technology will ultimately only develop if there is a push from the regulatory authorities.

The varying levels of detail provided within the licenses at different sites makes the task of comparing, and assessing compliance to license conditions complex. On the other hand, it has been noted that the absence of prescriptive guidance for developers to follow in terms of how they go about providing the necessary detail to satisfy the license conditions has contributed to the difficulties developers faced in the design of proportionate monitoring programs. Where licence requirements are not given the status of objectives, they are not followed with the same level of effort, if at all. For conditional objectives, that is those that are triggered if certain changes in bird populations, (generally those of conservation concern), are noted, more guidance should be provided on what level of change is required to trigger the condition. In no case were any conditional objectives triggered.

At all sites, the standard licence clauses requiring pre-construction,

construction and three years of post-construction monitoring, and the necessity of consulting with Natural England or the Countryside Council of Wales were all met in full.

Responses to the objectives contained within the annexes dealing with ornithological monitoring are outlined in appendix 2.

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

Licence conditions common to many applications include: the requirement to monitor any change of use of the windfarm area and vicinity by birds and the general distribution of birds in the area; to assess any barrier effect; to assess collision risk/rate; and to link ornithological monitoring with benthic monitoring. In some cases, species or location-specific monitoring has been required.

As the licence conditions stipulated tend to be general it is not possible to remove them without actually eliminating the requirement for bird monitoring altogether. The basic conditions covering the use of the windfarm by birds and their distribution in the vicinity should not be removed as they are likely to continue to be a major concern, unless baseline monitoring can suggest otherwise.

Barrier effect monitoring and collision risk/rate monitoring approaches undertaken to date have generally found little significant effect, but this may be because the monitoring techniques are less well developed, as discussed above. These are also widely considered to be potentially serious issues by regulators and conservations bodies alike so should not be removed, and may well continue to pose a problem at other sites.

6 Recommend where monitoring conditions may need to be strengthened (because impacts have been underestimated)

In no cases were significant issues found that required unforseen additional monitoring or significant mitigation to be put in place. In some cases extra monitoring was recommended or carried out where earlier monitoring had failed to eliminate an issue, but in each case there was ultimately not found to be a significant problem.

The monitoring conditions relating to determining change of use or spatial distribution always produce a high quality work programme, probably because of the standardised methods that are available. The conditions relating to barrier effects and collision risk generally resulted in monitoring of

a lesser standard and in no case was a significant effect found, but this could be a circular issue due to the lack of techniques available. Objectives relating to these matters should give more detailed guidance as to the methodology to be followed and continue to request trials of new techniques. Ultimately however, if techniques are not yet available, further work is needed to develop them.

The licence condition requiring the linking benthic and bird monitoring was rarely undertaken, possibly because the fall in bird numbers required to trigger extra benthic monitoring was rarely seen ('linkage' was usually a conditional requirement). In cases where the developer is seeking to explain changes in bird use by a reduction in prey numbers this requirement may be of more value. This requirement may also be of value to improve understanding of why birds are found in particular locations and which impacts may be attributable to wind farms and which may be due to other factors.

A call for generic data to be collected, for example on avoidance behaviour (such as 'Band model' type behaviour) around turbines for use by the whole windfarm developer community and other researchers would be of considerable benefit and need not involve excessive extra cost to each developer. N.B. A 'Band model' is a collision risk calculation method devised by Bill Band of SNH, primarily for onshore windfarms. It uses information on bird numbers and geometric data about the tubines to assess the probability of collision. An 'avoidance factor' is then applied which is an abitrary estimation of the ability of the bird to avoid the turbines, which will be based on its aerodynamic skills, and how focused it is on predators or prey, etc. It is this parameter in particular that needs data to make this kind of model valid (avoidance factors vary between 90% and 99.9%), and for a given species it is genericaly applicable.

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

Basic ornithological monitoring (boat-based and aerial surveying) follows a standard set of methodologies laid out in guidance provided by COWRIE. As a result of this, comparability of data between survey techniques and between different windfarms is good. This is particularly valuable when the monitoring area of different windfarms overlaps. The ecological consultancies involved in this work are also now highly proficient at undertaking these surveys in a standardised manner. A point to note is that while standardisation of survey timings is useful, there is still use in reactive monitoring, such as a survey after particular / adverse weather conditions, as these conditions can cause large scale movements of birds and may have knock on effects (e.g. collision).

In one case the consultants employed to undertake baseline monitoring was different to that used for later work so a different transect route was followed, but since the ultimate output of this kind of work is a density grid, this is not necessarily a problem. Indeed, the processing and analysis of this data is also very standardised, further guaranteeing comparability.

For other monitoring techniques, such as migration monitoring, ferry-based counts, radar surveys and semi-static counts, standardised techniques do not exist and the individual developers have developed their own methodologies and analysis techniqes. In some cases this presented problems and the data was not analysed in depth, or not used at all, such as the radar data at North Hoyle. It would be disappointing if these additional techniques were not promoted as they are often required for meeting some of the licence conditions such as the investigation of barrier effects and collision risk which cannot be addressed with standard techniques. The production of standardised methodologies is the best way to address this problem.

8 Review of reporting style and format

The reports suffer from the problems typical of all environmental impact assessments - there is a great deal of very detailed information to summarise and the format and layout of the report often has to meet legislative requirements and industry expectations. That being said, many reports contain large volumes of almost raw data, anecdotal observations and short textual summaries. A better summary of data would often be of help to any reviewer. The need to constantly repeat the same information, often slightly differently stressed and for different reasons in different places is also a typical drawback of this type of report.

A full summary to date for each year of reporting would aid review, and this was sometimes provided. As would a clear and explicit assessment of how the licence conditions will be addressed and how they have been met. In some cases this was provided.

9 Appendix 5.1 Site Summaries

Site Descriptions

Table 1. Monitoring Periods

	Site	Pre Construction	Construction	Post Construction Year 1	Post Construction Year 2	Post Construction Year 3
OPERATIONAL	Barrow	Dates not available	March 2005 – June 2006 (16 months)	July 2006 – June 2007	July 2007 – June 2008*	July 2008 – June 2009**
	Burbo	September 2005 – April 2006 (8 months)	May 2006 – July 2007 (15 months)	August 2007 – July 2008	August 2008 – July 2009**	NE advised two years sufficient
	Kentish Flats	October 2001 – July 2004 (34 months)	August 2004 – August 2005 (11 months)	August 2005 –July 2006	August 2006 – July 2007	August 2007 – July 2008***
	North Hoyle	April 2002 – March 2003	Feb 2003 – Feb 2004	March 2004 – March 2005	March 2005 – March 2006	March 2006 – March 2007
	Scroby	2002 & 2003	2004	2005	2006	
UNDER CONSTRUCTION	Gunfleet Sands 1 & 2	October 2007 – March 2008				
	Lynn & Inner Dowsing	November 2002 – March 2005	Phase 1 Apr–Dec 2007 Phase 2 2008 **			
	Rhyl Flats	May 2005 – November 2006				
	Thanet	2 years up to 2007**	Scheduled for 2009			

*Boat survey data (year1)
**Data not available for review
***Report covers up to November 2007

1. Barrow Windfarm (30 turbines) is located in the eastern Irish Sea, c7km off the coast of Barrow in Furness. The nearby Morecambe Bay is designated as both a RAMSAR site and a Special Protection Area in accordance with Article 4 of the EC Directive on the Conservation of Wild Birds 79/409/EEC (the Birds Directive) as a result of internationally important populations of wintering waterfowl.

Baseline surveys to inform the ES were carried out in 2001 / 2002. Pre construction surveys required as part of the FEPA licence took place in 2004 – 2005. Construction monitoring covered the period March 2005 – July 2006 . Post construction monitoring covers two years to date, from July 2006 – September 2008.

2. **Burbo** Windfarm (25 turbines) is located c7km from the coast of North Wirral and Crosby, in an area in the south-east corner of Liverpool Bay known as Great Burbo Flats. Liverpool Bay is under consideration for designation as a SPA as a result of internationally important populations of Common Scoter and Red Throated Diver. The two nearby estuaries, the Mersey and the Dee, are both designated SPAs for internationally important numbers of wintering waterfowl and for breeding tern populations (Dee only). The Mersey Narrows and North Wirral Foreshore Site of Special Scientific Interest (SSSI) is a candidate SPA, also for wetland bird species.

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. Effort was directed towards four key species – Red Throated Diver, Common Scoter, Common Tern and Cormorant.

3. **Kentish Flats** Windfarm (30 turbines) is located in the Thames Estuary, c 8.5km north of Herne Bay and Whitstable on the North Kent coast. There are a number of coastal SPA sites, including Thames Estauary and Marshes; Medway Estuary and Marshes; Swale and Thanet Coast, and Sandwich Bay, each designated for supporting internationally important breeding and wintering populations of waterfowl.

Baseline surveys to inform the ES were carried out in 2001 – 2002. Pre construction monitoring occurred between November 2002 – July 2004. Construction monitoring covered the period August 2004 – August 2005. Post construction monitoring covers 2 years 3 months, from August 2005 – November 2007.

4. **Noth Hoyle** Windfarm is located approximately 7.5km from the North Wales Coast, off Prestatyn and Rhyl, and lies within a sector of the Irish Sea known as Liverpool Bay. Liverpool Bay has been proposed for designation as a SPA as a result of internationally important populations of Common Scoter and Red Throated Diver. The two nearby estuaries, the Mersey and the Dee, are both designated SPAs for internationally important numbers of wintering waterfowl and for breeding tern populations (Dee only). The Mersey Narrows and North Wirral Foreshore Site of Special Scientific Interest (SSSI) is a proposed extension to the Dee SPA, also for wetland bird species.

Baseline surveys to inform the ES were carried out in 2001 – 2002. Pre-construction monitoring occurred between 2002 – 2003. Construction monitoring covered the period February 2003 – February 2004. Post construction monitoring covers 3 years, from March 2004 – March 2007.

5. **Scroby Sands** Windfarm (30 turbines) is located on a sand bar system approximately 3km offshore of Great Yarmouth. The site is located directly

offshore from the Great Yarmouth North Denes SPA, designated for the largest breeding colony of Little Tern in the UK.

Little Tern did not breed in numbers at North Denes between 2002 – 2004. In 2002 the colony was destroyed by vandalism (7 pairs did fledge chicks). In 2003 helicopter search and rescue activities displaced birds (10 pairs did fledge 2 chicks). In 2004, there were 40 nests but no chicks fledged. In 2005, 221 active nests were recorded, and 400 chicks hatched but virtually all were predated (by single pair of kestrels!), with only 11 fledging. In 2006, 369 pairs fledged an estimated 673 chicks (supplementary feeding of kestrel pair took place). In all years, Little Terns established at Winterton, some 12km to North. In 2002, 124 pairs fledged 43 chicks. In 2003, 233 pairs fledged 447 chicks. In 2004, 150 pairs were recorded but all failed. In 2005, 83 pairs were recorded, but again all failed.

Baseline surveys to inform the ES and an Appropriate Assessment were carried out in 1995 and 1999 respectively. Pre construction monitoring occurred in 2002 & 2003. Construction monitoring covered 2004. Post construction monitoring covered 3 years, 2005, 2006 and 2007.

6. Gunfleet Sands Windfarm 1 (30 turbines) and 2 (turbines) is located approximately 7km south-east of Clacton-on-Sea in the Thames Estaury. There are a number of coastal SPA sites, including Hamford Water; Colne Estuary; Blackwater Estuary and Dengie, each designated for supporting internationally important breeding and wintering populations of waterfowl.

As well as the dedicated pre construction surveys carried out between October 2007 – March 2008, additional aerial and boat-based surveys have also been carried out over the Gunfleet Sands study area as part of the on-going data collection associated with both the GS1 and GS2 projects.

The GS1 ES (Hydrosearch, 2002) presented data on birds obtained from boat surveys undertaken monthly between October 2001 and July 2002. Boat surveys of the GS1 survey area have continued since the submission of the GS1 ES (in July 2002). An interim report of the results collected during the period July 2002 – December 2004 was produced in February 2005 (RPS, 2005).

Results from subsequent boat-based surveys undertaken in the period January 2005 – February 2007 were presented in the ES for GS2 (DONG Energy, June 2007). This ES also presented the findings of aerial surveys that were carried out in sectors TH1, TH2 and TH4 in the period March 2005 to June 2006.

7. Lynn (27 turbines) and **Inner Dowsing** (27 turbines) Windfarms are located approximately 5 – 7km offshore from the Lincolnshire coast by Skegness. There are a number of coastal SPA sites in the vicinity of the wind

farm area, although all are at least 4km from the nearest point of the Lynn and Inner Dowsing wind farm areas.

Pre consent surveys covered the period October 2001 – October 2002. Following submission of the ES chapters, monitoring continued from November 2002 – April 2003. Pre construction monitoring to meet FEPA requirements covered the period Aug 2003 – March 2005. The first phase of construction monitoring (installation of the foundations and transmission pieces) took place between July and December 2007. The second phase (installation of towers, turbines and blades) took place in 2008. Radar data has been used at the Lynn and Inner Dowsing sites (using avoidance rates as a proxy for collision risk) with some success.

8. Rhyl Flats Windfarm (30 turbines) is located approximately 8km north of Abergele and 10km north-west of Rhyl, on the north Wales coast. Rhyl Flats lies within a sector of the Irish Sea known as Liverpool Bay. Liverpool Bay has been proposed for designation as a SPA as a result of internationally important populations of Common Scoter and Red Throated Diver. The two nearby estuaries, the Mersey and the Dee, are both designated SPAs for internationally important numbers of wintering waterfowl and for breeding tern populations (Dee only). The Mersey Narrows and North Wirral Foreshore Site of Special Scientific Interest (SSSI) is a proposed extension to the Dee SPA, also for wetland bird species.

At the start of the monitoring studies, a list of the key bird species was agreed with CCW.These are the species of highest conservation concern around the Rhyl Flats wind farm for which an ecologically significant reduction would be of concern. The list contained eleven species (red-throated diver, fulmar, cormorant, shag, common scoter, kittiwake, common tern, Sandwich tern, little tern, guillemot, razorbill), which are the qualifying interest for the SPAs and SSSIs within the vicinity of the windfarm. Baseline surveys to inform the ES were carried out in 2001 / 2. Pre construction monitoring took place between May 2005 – November 2006.

9. Thanet Windfarm (100 turbines) is located in the outer Thames Estuary, 11.3km off Foreness Point, the most easterly part of Kent. Pre construction monitoring took place for two years up to 2007, although no reports are available for review.

Key Monitoring Issues

No defined objectives exist for Burbo, although issues 1, 3 and 7 (see Table 2 below were addressed and analysis focussed on the lesser black backed gull, terns and the red throated diver. All issues at Scroby Sands are directed toward Little Tern. No specific objectives have been identified for Gunfleet Sands 1 and 2, the requirement being to provide generic information on bird / windfarm interactions.

10 Generic and Site Specific Issues

Table 2. Generic and site specific issues

	Issue / Site	1. Change in bird use	2. Barrier effect	3. Distribution in wider environment	4. Assess rate of bird collision	5. Little Tern	7. Benthos surveys
Operational	Barrow	Y	Y	Y	Y[1]		
	Burbo						
	Kentish Flats	Y	Y	Y	Y		
	North Hoyle	Y	Y	Y	Y[1]		Y[2]
	Scroby Sands					Y	
UNDER CONSTRUCTION	Gunfleet Sands 1	Y	Y	Y	Y		
	Gunfleet Sands 2	Y	Y	Y	Y		
	Lynn & Inner Dowsing	Y	Y		Y		Y
	Rhyl Flats	Y	Y	Y	Y[1]		Y[2]
	Thanet	Y	Y	Y	Y[1]		

1. If Issues 1 and 2 reveal significant use of the wind farm site by populations of conservation concern, at heights that could incur a risk of collision, a programme of collision risk monitoring will be implemented.
2. If Issue 3 shows a change in Common Scoter population in the vicinity of the wind farm site, monitor the benthos to determine whether there the change is a result of change in Common Scoter food supply.

1. Changes in bird use.

This objective applied to monitoring species abundance and behaviour in order to determine if there were any changes between the wind farm site and reference site pre, during and post construction. This was a generic issue, applied to all sites where information was available (although in the case of Scroby Sands, the issue is directed only at Little tern).

2. Barrier effect.

This objective applied to monitoring the movement of species through the wind farm and reference site pre, during and post construction. This was a generic issue, applied to all sites where information was available. (although in the case of Scroby Sands, the issue was directed only at Little tern).

3. Distribution of bird species in the wider environment.

This issue applied to the wider distribution of divers and wildfowl at five sites. At Barrow, it applied to the area of the east Irish Sea, and includes monitoring

movements of birds, specifically Common Scoter, to and from Walney Island. At Kentish Flats and Thanet, monitoring was required to cover the Greater Thames Estuary, including movements of wildfowl to and from the coastal SPA sites surrounding the Thames Estuary. At North Hoyle and Rhyl Flats, this issue was concerned with the distribution of Common Scoter and divers in Liverpool Bay.

4. Assess the rate of bird collisions

There were four sites where this was a clearly defined issue, and four where it was only to be implemented if the results of monitoring for other issues revealed a significant use of the windfarm site by populations of conservation concern, at heights that could incur a risk of collision (although in the case of Scroby Sands, the issue was directed only at little tern).

5. Monitoring of Little Tern

Scroby Sands had no other issues except those associated with Little Tern. An Approporiate Assessment concluded that the impact of the wind farm was likely to be of moderate significance at most. Monitoring was required to validate the conclusions of the Appropriate Assessment, and was focussed on four key areas; feeding ecology; breeding ecology; prey studies and post construction collision monitoring.

6. Benthos surveys

In addition to separate requirements for monitoring benthic communities, there were two sites where additional monitoring as part of the ornithological monitoring conditions was required.

At Lynn and Inner Dowsing, it was required to inform reasons for possible changes in bird distribution and density on site. However, the developers ornithological consultancy argued that the majority of bird species present were pelagic feeders and so did not carry out benthic surveys. At Rhyl Flats and North Hoyle, it was only to be implemented if the result of other monitoring work revealed a change in the Common Scoter population, in order to determine if the change was a result of food supply.

11 Monitoring methods

Table 3. Monitoring methods

	Site	Boat surveys	Aerial surveys	Radar surveys	Migration surveys	Site Specific ornithological surveys	Pseudo static surveys
OPERATIONAL	Barrow	Y	Y		Y		
	Burbo	Y					
	Kentish Flats	Y	Y				
	North Hoyle	Y	Y	Y			
	Scroby					Y	
UNDER CONSTRUCTION	Gunfleet Sands 1 & 2	Y	Y				
	Lynn & Inner Dowsing	Y	Y			Y	Y
	Rhyl Flats	Y	Y				
	Thanet						

1. Boat Surveys

The boat-based methodology is based on that recommended by Camphuysen (COWRIE, 2004). The boat-based survey consists of a line-transect route to survey birds on the water during which regular snapshots are taken to survey flying birds. Additional information regarding, age, sex, plumage and behaviour is recorded wherever possible. Line transect surveys are carried out with a strip width of 300m (All birds are recorded within each of 0-50m, 50-100m, 100-200m, 200-300m, 300+m bands from the boat, perpendicular to the ship). Snapsots to record flying birds are carried out at regular timed intervals. Flying birds (with birds on the surface recorded as 0) are divided into three flight height bands: 1= <20m (below potential strike height), 2 = 20-120 m (within potential strike height) and 3 = >120m (above potential strike height). Birds are initially detected by eye with identification aided by the use of high quality binoculars. Sea state and other variables that can affect observer efficiency are also recorded.

Barrow

Boat monitoring covered the windfarm site plus a 2km buffer, and a reference site of equal size. Survey transects were 1km apart, the advantage being that the majority of birds were counted, although there was a risk of birds displaced by the passage of the boat (especially divers and scoters that are better counted by aerial survey) being doubled counted. The boat used allowed for two observers to scan either side of the boat at an observation height of 6m asl.

Pre construction surveys (Dates not available)

Construction survey period March 2005 – June 2006 (6 surveys / May 05 – Oct 05)
Post Construction 1 - 2008 (3 surveys, July, August and October, May not done)

Burbo
Boat monitoring covered the windfarm site plus a 2km buffer, and a reference site. Survey transects were 1nm apart (2km ?). Two observers scanned either side of the boat at an observation height of 5m asl.

Pre construction surveys September 2005 – April 2006 (6 surveys)
Construction May 2006 – July 2007 (13 surveys)
Post Construction 1 - August 2007 – July 2008 (7 surveys, Aug – Sep 07 no boat, March June 08 bad weather)

Kentish Flats
The FEPA licence stipulated that a minimum of one boat-based survey / month would be required from August to October and February to April to monitor divers, sea duck and other species. Boat-based surveys would also be required at least monthly between May and July to monitor the effects of the windfarm on terns and other resident species.

Boat monitoring covered the windfarm site (9.9 km^2) plus a buffer extending approximately 1.8km, and a reference site of 8.7 km^2. Transects were spaced 1km apart, and within the reference site were surveyed every 2 – 3 months, approximately 35% of all visits (in line with EN guidelines of coverage every two months). This increased to 44% in 'year 5' 12/05 – 12/06, which relates to halfway through year 2 of post construction.

Various modifications to the standard survey techniques were made, such as taking 90^0 scans to one side of the boat at recording intervals of two minutes, as opposed to the 10 minutes interval (localises bird positions more accurately). Snapshots, counting all flying birds, extending 500m ahead of the boat and within 300m to the side were taken every 2 minutes.

Surveys up to December 2006 reported so far (21 surveys)(halfway through year 2). Unfortunately, a 2008 updated survey report was omitted from this review, but should be included in the future follow on project.

Pre Construction – includes ES survey period (10/01 – 07/04)(50 surveys)
Construction – (August 2004 – August 2005)(18 surveys)
Post Construction 1 – August 2005 – July 2006, 2 - August 2006 – July 2007

North Hoyle
Boat monitoring covered the windfarm site plus and a reference site.

Pre and during construction, boat survey methods for species other than terns followed those described in Komdeur et al 1992 and largely followed the methods recommended after the COWRIE research project and as described in Camphuysen et al (2004). For observations of terns the boat was moored at four points and the direction of flight of birds through the wind farm was recorded on four occasions.

Post construction, transects were spaced 1km apart (i.e. different layout to pre and during construction). Various modifications to the standard survey techniques were made, such as taking 90^0 scans to one side of the boat at recording intervals of two minutes, as opposed to the 10 minutes interval (localises bird positions more accurately). Snapshots, counts of flying birds, extending 500m ahead of the boat and within 300m to the side were taken every 2 minutes.

Pre-construction January 2002 – Mar 2003 (8 surveys / Nov 02 – Mar 03)
Construction February 2003 – February 2004 (11 surveys / Feb 03 – Feb 04)
Post-Construction 1 – March 2004 – March 2005 (11 surveys / March 04 – March 05)
2 - April 2005 – March 2006 (13 surveys / April 05 – March 06)
3 - April 2006 – March 2007 (12 surveys / April 06 – March 07)

Gunfleet Sands 1 & 2
The FEPA licence stipulated that 2 surveys per month during the period November to beginning of March be carried out, covering the winter period.

Transect survey method was used consistent with that recommended in Camphuysen et al. (2004). Surveys undertaken over a total area of 142.2 km2. Flying birds were recorded using snapshot counts.

Pre construction October 2007 – Mar 2008 (9 surveys / Oct 07 – Mar 08)

Lynn and Inner Dowsing
The FEPA licence required that 19 surveys per year were carried out, two per month in August, October, February and April; 4 per month in September and March; and one per month in November, December and January. The four surveys in March and September are permitted to be 2 sets of concurrent days.

Additional requirements for construction period required 14 per year, one survey to be carried out over January/ February, and November/December, one survey per month for the rest of the year apart from September and October when 3 per month, should be conducted.

Two modifications to standard methodology; Forward scanning using high quality binoculars (as opposed to by eye) was undertaken to improve detection of divers and sea-duck that are known to flush from the sea surface at considerable distance from the vessel. Two 90° line transects were

operated simultaneously wherever possible, to improve the probability of detection of rare species and those occurring at low density.

Pre construction surveys (14 surveys / November 2002 – March 2005)
Construction 1 – April 2007 – November 2007 (8 surveys / April – December 2007) 2 – 2007/8 (report not available at time of writing)

Rhyl Flats
The boat surveys between August 2005 and February 2006 (inclusive) largely followed the methods recommended after the COWRIE research project and as described in Camphuysen et al (2004).

The surveys up to February 2006 were undertaken by a team comprising two bird surveyors with only one surveyor observing (from one side of the boat) at any one time, and another working as a designated scribe. The survey methods applied at Rhyl Flats from March 2006 were very similar, with the exception that one bird surveyor observed each side of the boat.

Pre-construction August 2005 – November 2006 (17 surveys)

2. Aerial Surveys

Large scale aerial surveys of strategic wind farm areas have been undertaken in three distinct phases Liverpool Bay and have been ongoing since the winter of 2000/2001 as follows:

Between 2000/2001 and 2003/2004 by the Wildfowl and Wetlands Trust (WWT) as part of the All Wales Common Scoter Survey commissioned by the Countryside Council for Wales (CCW), covering Liverpool Bay and Morecambe Bay; By the National Environmental Research Institute (NERI) for East Irish Sea Developers Group in July and August 2004; and by WWT over the winter of 2004/2005 to date. Large-scale surveys of strategic wind farm areas have been organised by WWT with financial contributions from offshore wind farm developers, and with financial assistance from the Department of Trade and Industry (DTI), Defra and statutory conservation agencies. This programme has been designed to provide large-scale survey data covering the nearshore waters in Northwest England (from Anglesey to the Solway Firth), in the Greater Wash and in the Thames (from Flamborough Head, Yorkshire, to Sandwich Bay, Kent). These data are being used to inform the environmental impact assessments of Round II offshore wind farms, fulfil some of the FEPA license monitoring requirements for Round I projects such as Kentish Flats, and to aid marine SPA identification.

The aircraft flies at a speed of 185 kmh at approximately 75 – 80m altitude, and transects are flown at 2km intervals. Information on species, numbers, distance bands and location through the aircraft GPS is recorded during these surveys from both sides of the plane by two observers. Birds were located on one of four distance bands (44 - 163m, 163 – 282m, 282 – 426m and 426 – 1000m) from the plane. Based on distance sampling protocols. All post

construction aerial surveys did not cover windfarm footprint as plane had to fly at too high an altitude in order to avoid turbines.

Barrow
Pre construction surveys May – August 2004 (3 surveys)
Construction March 2005 – June 2006 (2 surveys / October 2005 + February 2006)
Post Construction 1 – July 2006 – June 2007 (2 surveys / January + February 2007)

Kentish Flats
No methodology was available for the Jan 02 JNCC survey. Up to August 2002, distance bands were set at 49 – 174m / 175 – 459m / 460m>. From January 2003 onwards, distance bands were standardised to 44 – 163m / 163 – 282m / 282 – 426m / 426 – 1000m.

Surveys up to December 2006 reported so far (4 surveys / Nov 05 – Feb 06)(halfway through year 2).

Pre Construction – (October 01 – July 04 - includes ES survey period)(7 surveys)
Construction – (August 2004 – August 2005)(6 surveys /Oct 04 – July 05)
Post Construction 1 – August 2005 – July 2006
2 - August 2006 – July 2007
3 - August 2007 – July 2008

North Hoyle
The methods used during these aerial surveys have been based on those described in Komdeur et al (1992), updated with recommendations following a review by Fox et al (2001), and more recently following the guidance set out in Camphuysen et al (2004). The aerial survey transects were 2km apart and flown at a height of 76m (250 feet) and a speed of approximately 200km/h.

Birds were assigned to one of four following bands using a clinometer: 44 – 163 / 163 – 282 / 282 – 426 / 426 – 1000m (except the Aug 02 survey – see Kentish Flats).

Pre-construction January 2002 – Feb 2003 (5 surveys / Aug 02 – Feb 03)
Construction March 2003 – March 2004 (4 surveys / May 03 – March 04)
Post-Construction 1 – March 2004 – March 2005 (9 surveys / May 04 – March 05)
2 - March 2005 – March 2006 (15 surveys / May 05 – March 06)
3 - April 2006 – March 2007 (3 surveys / June 06 – Feb 07)

Gunfleet Sands 1 & 2
The FEPA licence stipulated that 4 surveys should be carried out during the winter months, of which 2 must be undertaken in the mid-winter period (at a

comparable time to those undertaken in the EIA), to enable comparison with the baseline flights shown in 2002 and 2003.

The Gunfleet Sands wind farms are located within aerial survey sector TH 1 and data from four flights flown during winter 2007/08 are available for this area.

Pre construction November 2007 – Mar 2008 (4 surveys / Nov 07 – Mar 08)

Lynn and Inner Dowsing
The FEPA licence stipulated that 4 surveys per year be carried out, two in September, one in February and one in March. The Licence Holder should make all reasonable efforts to undertake the 4 surveys at these times. However, if circumstances dictate that the Licence Holder cannot reasonably undertake the surveys at these times, the surveys should be distributed over the rest of the winter months (October - January).

Aerial surveys were conducted during the pre construction phase only.
Pre construction surveys (4 surveys / November 2002 – March 2005)

Rhyl Flats
No methodology was available for the Jan 02 JNCC survey. Up to August 2002, distance bands were set at 49 – 174m / 175 – 459m / 460m>. From January 2003 onwards, distance bands were standardised to 44 – 163m / 163 – 282m / 282 – 426m / 426 – 1000m.

Pre construction May 2005 – March 2006 (8 surveys)

Radar Surveys

North Hoyle
National Wind Power Offshore Ltd commissioned a pilot study, formally outside of the FEPA monitoring requirements, to test the utility of land-based and boat-based marine surveillance radar (MSR). The aim was, through overlapping radii of detection by observers with standard optics, land-based MSR and boat-based MSR, to find a best method of monitoring movement of key species, the effectiveness was measured by the ability of each survey method to record over distance and identify species and flock sizes.

The study site was off Llanddulas in Colwyn Bay. Field work was undertaken over three continuous 24 hour periods in March 2003. Radars were set up on land (6kW and 12kW Furuno S-band) at Llanddulas, south of the main common scoter concentration, and using the existing radars of the Prince Madog (Furuno 35 kW S-band and12kW X-band) 1km to 2km north of the main common scoter concentration. On the boat, visual observations were made during daylight hours.

Lynn and Inner Dowsing
Radar data has been used at the Lynn and Inner Dowsing sites (using avoidance rates as a proxy for collision risk) with some success.

3. Migration Surveys

Barrow
Pre construction surveys (4/10/2004 – 31/04/2005)(Dawn – noon each day)

An independent late autumn study was undertaken by Walney Observatory in collaboration with the other developers in the area (East Irish Sea Developers Group (EISDG)) looking at the Wildfowl and seabird migration along the Eastern Irish Sea Flyway. The aim of the survey was to quantify numbers and to accurately identify the flight heights and migration routes undertaken by seabirds, gulls and wildfowl using the eastern Irish Sea flyway off the western coastline of Walney Island during the late autumn passage period.

A study of spring migration passage within Morecambe Bay was also undertaken in an effort to provide a composite picture of the migration patterns in the area.

Construction surveys None
Post Const year 1 September 2007 – October 2007 (21 days; 24/9 – 7/10; 18/10 – 24/10)

A land based survey was set up to gain some information on the passage of Pink-footed Goose and Whooper Swan off Walney Island during the autumn 2007. The survey performed by the Walney Bird Observatory used Hilpsford Point as observation site. This location holds a purpose built hide for wildfowl and seabird observations. Its geographical position at the southernmost point on Walney Island, allows for uninterrupted view to Barrow Offshore Wind Farm.

The timing of the survey initiation was triggered by anecdotal evidence from daily recording activities at Walney Bird Observatory indicating when the migration of the main target species had commenced.

Continuous monitoring took place between dawn and dusk each day (c0700-1900hrs)

For each record the following data were registered; species, number of birds, approximate flight direction, approximate distance to the shoreand approximate flight height. The distance observation bands are based on the positions of existing buoys in the area close to Barrow Offshore Wind Farm.

Species specific surveys

Scroby Sands
Boat surveys
10 minute survey periods at 17 sampling points, recording all activity within 300m.
Pre construction 2002 – 17 surveys
Pre construction 2003 – 17 surveys
Construction 2004 – 13 surveys
Post construction 2005 – 11 surveys
Post construction 2006 – 9 surveys

Land surveys
Observations were made of birds foraging, recording parameters such as height, distance from shore, tide etc at key breeding sites (North Denes / Winterton)
Pre construction 2002 – Four North Denes, five Winterton
Pre construction 2003 – Six North Denes, five Winterton
Construction 2004 – Six North Denes, seven Winterton
Post construction 2005 – Eight North Denes, five Winterton
Post construction 2006 – Eight North Denes, five Winterton

Radio tracking
Telemetry carried out from boat mainly due to difficulties in keeping in range along shore. Data collected included %time spent in diff activities, number and duration of foraging bouts, distance travelled between fixes, distance of fixes from shore.
Pre construction 2002 – No radio tracking??
Pre construction 2003 – 5 sessions tracking 9 birds
Construction 2004 – 10 sessions tracking 14 birds (lots of probs with eqpt failure – boats and tracking eqpt).
Post construction 2005 – 11 sessions tracking 15 birds
Post construction 2006 – 13 birds tracked

Prey Studies
Net sampled upper 30cm of water column (limit fished by Little Terns) to determine available prey resources. Two tows carried out at each sampling station ()for 500m, producing a 1km sample at each station (sampled 920m). All fish and inverts retained, preserved for post analysis in order to determine biomass.
Pre construction 2002 – Riley net used, 17 surveys
Pre construction 2003 – New net design, calibrated against 2002 net on five sample dates, 19 surveys
Construction 2004 – 13 surveys
Post construction 2005 – 11 surveys
Post construction 2006 – 10 surveys

Breeding studies

Colony development
Carried out by RSPB / EN staff – nest counts, fledgling counts
Data available from studies by Skeate et al, 2004 in a project covering East Norfolk Population.

Feeding behaviour
Observations were made of chick feeding at breeding sites, recording parameters such as when adults left / returned; identity of prey and size; and fate of prey item
Pre construction 2002 – 9 visits
Pre construction 2003 – 25 visits
Construction 2004 – poor breeding year meant no observations
Post construction 2005 – four visits North Denes only
Post construction 2006 – six visits North Denes only

Collision monitoring
Assessed after 2006 season using Band model

Pseudo-static surveys

Lynn and Inner Dowsing
The Fepa licence required 3 sea based 'pseudo-static' stations coupled with 1 terrestrial station. This had the aim of providing information on the passage of SPA birds between the coast to the development sites and their zone of influence. The sea based stations should be arranged such that one is sited between the development site and shore (3-3.5km from the coast) another in the development site and another east of the development site. The observations at each station should be of 30 minutes duration. It is important that all four counts should be as close in time as possible to aid comparability. Static observations at each station should be undertaken on each boat survey in August, September, October, February, March and April. The terrestrial observations should occur at the same time as the boat surveys. This was carried out during the pre construction period only

12 Appendix 5.2 Conformity to objectives across all sites

Barrow:

Objective 1. *Determine whether there is a change in bird use and passage, measured by species, abundance and behaviour and the reference site.*

This objective was completed in full. The recommended methods were followed with sufficient effort and rigour. As yet, no significant impacts have been found.

Objective 2. *Determine whether there is a barrier effect to movement of birds through the site*.

Barrier effects were considered but only assessed using general bird surveying techniques of boat and aerial surveying

Objective 3. *Determine the distribution of wildfowl and divers in the Irish Sea, covering the Barrow site and the vicinity. This will include movements of wildfowl to and from Walney Island and common scoter*.

This objective was met in full

Objective 4. *If objectives 1 or 2 reveal significant use of the Barrow site by populations of conservation concern, at heights that could incur a risk of collision, a programme of collision risk monitoring will be implemented*.

A collision risk assessment was performed, but no risk montoring was undertaken

Burbo:

No specific objectives were given except a requirement that the monitoring programme be developed in consultation with English Nature. The results of this consultation were not included, however a reasonably full monitoring programme was undertaken.

Kentish Flats:

Objective 1: *Determine whether there is change in bird use and passage through the windfarm site, measured by species, abundance and behaviour*

This objective was met in full

Objective 2: *Determine whether there is disruption to bird flight lines*

Barrier effects were considered but only assessed using the general bird

surveying techniques of aerial surveying.

Objective 3: *Determine the distribution of wildfowl and divers in the Thames Estuary, covering the Kentish Flats site and the vicinity. This will include movements of wildfowl to and from the coastal SPA sites surrounding the Thames Estuary*

This objective was met in full

Objective 4: *Determine the rate of bird collision at the Kentish Flats site*

This objective was not considered achievable with available technology

Objective 5: *Determine the efectiveness of mitigation mearures implemented during windfarm construction*

This objective was met in full

North Hoyle

Objective 1: *Determine whether there is change in bird use, measured by numbers and behaviour, of the wind farm site and a buffer to be specified.*

This objective was met in full

Objective 2: *Determine whether there is a barrier effect to movement of birds through the site.*

Barrier effects were considered but only assessed using general bird surveying techniques of boat and aerial surveying. Detailed requirements of the objective stated that monitoring from stationary boats, platforms or radar should have been undertaken and none of these alternatives were used.

Objective 3: *Determine the distribution of common scoter in Liverpool Bay, through continued contribution to aerial survey co-ordinated by CCW, covering North Hoyle and the vicinity*

This objective was met in full

Objective 4: *If Objective 3 shows change in common scoter population in the vicinity of North Hoyle, monitor the benthos to determine whether the change is a result of change in common scoter food supply*

This objective was not triggered, though there was some debate about the levels of change required to trigger it.

Objective 5: *If Objectives 1 or 2 reveal significant use of North Hoyle by populations of conservation concern, at heights that could incur a risk of*

collision, a programme of collision risk monitoring will be implemented

This objective was not triggered.

Scroby Sands

No specific objectives were given, rather a detailed Common Tern monitoring programme was outlined which was met in full.

Gunfleet

Objective 1: *To confirm that the predictions made in the Environmental Impact Assessment are correct*.
This objective was not feasible at the time of the latest available report

Objective 2: *Assess collision risk prior to construction of the windfarm and any actual collisions during and post construction*.

Collision risk for Divers only was assessed prior to construction. Post construction monitoring was not yet possible

Objective 3: *Provide generic information on bird/windfarm interactions*.

This objective was partially met at the time of the latest available report.

Lynn and Inner Dowsing

Objective 1: *Assess changes in usage of area by feeding birds and birds on passage*.

This objective was met as far as possible. Certain detailed requirements were found difficult to meet – the use of pseudo static montoring for example.

Objective 2: *Assess collision risk prior to construction of the wind farm and any actual collisions during and post construction*.

Collision risk was assessed prior to construction but collision monitoring post construction was not used, except for a radar study of migrating geese which addressed this issue to some extent.

Objective 3: *Survey benthos to inform reasons for possible changes in bird distribution and density on site*.

This objective was not met. It was stated that most species found were pelagic feeders.

Rhyl Flats

Objective 1: *Determine whether there is change in bird use, measured by numbers and behaviour, of the wind farm site and a buffer to be specified*.

This objective was met in full, as far as is possible at the stage of construction.

Objective 2: *Determine whether there is a barrier effect to movement of birds through the site*.

Barrier effects were considered but only assessed using general bird surveying techniques of boat and aerial surveying

Objective 3: *Determine the distribution of common scoter and divers in Liverpool Bay, covering Rhyl Flats and the vicinity*.

This objective was met in full, as far as is possible at the stage of construction.

Objective 4: *If Objective 3 shows change in common scoter population in the vicinity of Rhyl Flats, monitor the benthos to determine whether the change is a result of change in common scoter food supply*.

Baseline benthic monitoring was undertaken, in preparation for this condition being triggered.

Objective 5: *If Objectives 1 or 2 reveal significant use of Rhyl Flats by populations of conservation concern, at heights that could incur a risk of collision, a programme of collision risk monitoring will be implemented*.

This objective was not considered, but not yet triggered.

Thanet

Objective 1: *Determine whether there is a change in bird use and passage, measured by species (with particular reference to Red-Throated Diver), abundance and behaviour, of the wind farm site, 1km and 2 – 4km buffer zones and the reference site*

This objective has been met so far

Objective 2: *Determine whether there is a barrier effect to movements of birds through the wind farm site and the 1km and 2 – 4km buffer zones*

Barrier effects were considered but only assessed using general bird surveying techniques of boat and aerial surveying

Objective 3: *Continue to determine the distribution of wildfowl and divers in the Greater Thames estuary, covering the Thanet wind farm site, 1km and 2 –*

4km buffer zones and the reference site

This objective has been met so far

Objective 4: *If objectives 1 or 2 reveal significant change of use of the wind farm site and 1km and 2 – 4km buffer zones by populations of conservation concern, at heights that could incur collision, a programme of collision monitoring will be implemented*.

This objective has not yet been triggered