Post-construction Results from The North Hoyle Offshore Wind Farm

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A brief overview of the post construction environmental monitoring at North Hoyle Offshore Wind Farm undertaken by npower renewables; and tentative conclusions of the monitoring results.

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Background

The North Hoyle Offshore Wind Farm is located 6-7 km off the coast of Rhyl in North Wales (Figure 1) and was the first commercial scale offshore wind farm operational in UK waters. It comprises thirty 2MW wind turbines giving a total electrical output of 60MW. The offshore works include 30 foundation mono-piles, transition pieces and Vestas V80 machines with associated inter turbine cabling together with two export cables to shore. All cabling is buried to a nominal depth of 1.5m.

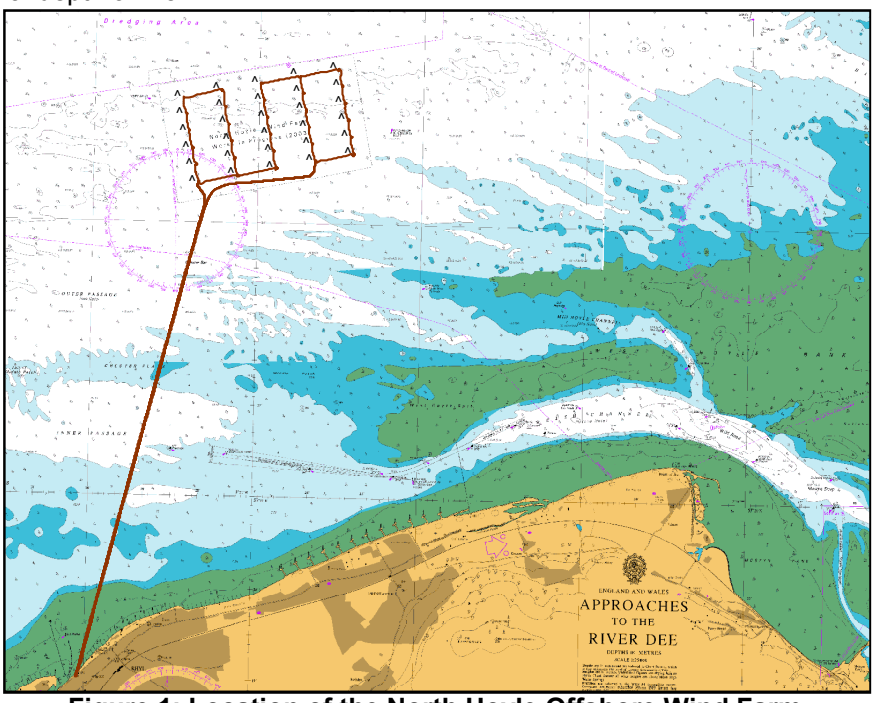

Figure 1: Location of the North Hoyle Offshore Wind Farm.

Inception of the North Hoyle Project began with the development and construction of the meteorological mast in 1999, followed by development of the Environmental Impact Assessment (EIA) in 2001 and its subsequent submission in early 2002.

	Pre-construction	*During-construction*	*Post-construction*
EIA submission	Feb 2002		
Consents granted	August 2002		
Onshore works		Nov 2002 – Oct 2003	
Offshore Foundations		Mar 2003 – Jul 2003	
WTG Installation		Aug 2003 – Oct 2003	
Export Cables		Aug 2003–Sep 2003	
Inter-array cables		Sep- Dec 2003	
Met Mast Installation		Feb 2004	
WTG Commissioning			Nov 2003 – Apr 2004
Full operation			April 2004

Table 1 : Summary Program of Key Milestones

The Environmental Statement for North Hoyle Offshore Wind Farm predicted there would be no deleterious impacts on the physical and biological environment, including the ecologically important Dee Estuary. Monitoring undertaken from 2002 has subsequently compared results against the baseline set out in the Environmental Statement.

npower renewables are now eighteen months into the post-construction monitoring phase and are committed to survey until the end of 2006.

Physical Environment

Post-construction Grab Survey Results (2004)

Overall, the sea bed within and around the wind farm is considered to be composed of fine and medium sands with varying amounts of coarser material. Eastwards from the array

towards the mouth of the Dee estuary sediments are sandier. Coarser areas are found further offshore and to the west of the development. The original site survey carried out in 2001 described the area of the wind farm itself as highly variable over even quite short distances, but consisting largely of sand and sandy gravels with varying amounts of stone and minor clay/silt content, depending upon location (NWPO, 2002).

Since this time, the coarse and medium sands remain fairly evenly distributed over the survey area with no obvious inshore/offshore differences. There has not been a consistent pattern of change in dominant sediment type near and within the turbine array or along the cable route in 2004 with sediments at some sites becoming generally finer, others becoming coarser. As sites within the wind farm array and in control areas have shown both increases and decreases in coarseness there is no trend present that would suggest that wind farm construction, cable burial or adjustment of hydrodynamic forces due to the presence of the piles in the seabed are responsible for the changes in sediment type at each site (Gloyne-Phillips, 2005). The original geophysical survey in 2001 described several areas of rippled and mega-rippled seabed and it is possible that there are different sediment types on the crests and in the troughs of these ripples. It is also plausible that the grab has sampled from different pockets of sea bed type which alter as a result of natural variation over the course of the year.

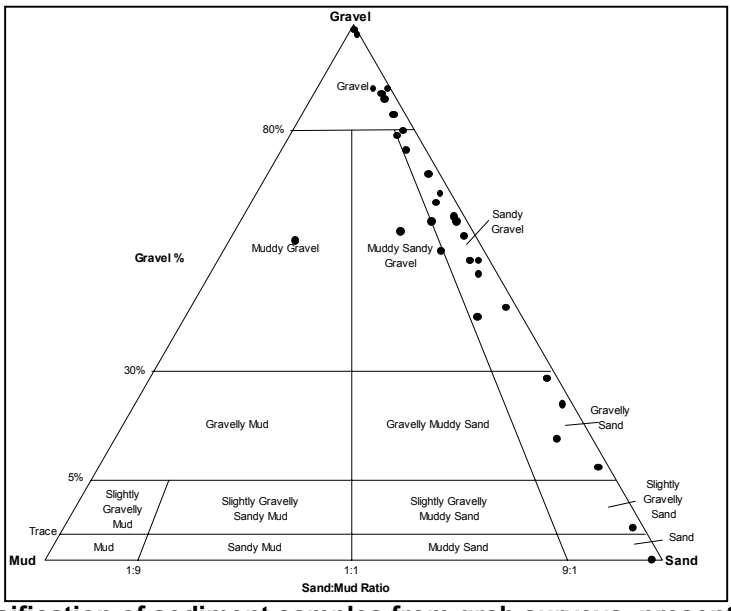

Figure 2: Classification of sediment samples from grab surveys, presented on Folk scale

Development of Scour

A recent study by Cooper (2005) has collated the majority of available data from North Hoyle and for both pre-construction and post-construction periods to develop an informed view on the scouring effects around the wind farm mono-pile foundations.

A detailed description of the local seabed is now available from swath bathymetry, and accompanied by a more detailed resolution of the seabed sediments. A key observation is the highly heterogeneous sediment composition (see Figure 2) over relatively short distances, providing variable contributions of sands and gravels, as well as wide variation in gravel particle size.

Since construction, a key oceanographic event has occurred which provided wave conditions equivalent to the predicted 1 in 1 year peak wave event. A 2004 scour survey has allowed the seabed response to be observed following this key event and compared to the original design estimates of equilibrium scour depth.

Thresholds for sea bed mobility indicate that currents alone only create live bed conditions for the sandy material, with large storms required to exceed thresholds for both sands and gravels. The largest gravels are immobile and are generally regarded as a lag deposit.

Osiris Projects Ltd were commissioned to carry out scour monitoring surveys covering all 30 turbine structures at the North Hoyle development site in Autumn 2004 and subsequently in Spring 2005. These surveys were carried out over 100m square boxes, centred at each mono-pile location, with high-resolution swath bathymetry data (Figure 3). The primary objective of the surveys was to accurately map localised variations in seabed topography, in order to monitor the effects of tidal current scour around the mono-pile structures.

During the surveys carried out during the Autumn 2004 period, rock dumping (armouring) was still in progress and this is reflected by the localised volumetric changes in seabed levels seen at many of the turbine locations during the Spring 2005 survey.

A key observation from the scour surveys is the presence of drill cutting mounds to the south of each pile, and where presently observed, some minor scouring to the north of piles. Further mounds relate to rock armouring around the J-tubes and have variable volume and form.

A review of scour depths has shown that scour estimates for the combined wave and tide case equate well to the presently observed scour depths. This is despite a mixed sediment composition and the presence of the drill cutting mounds and rock armour.

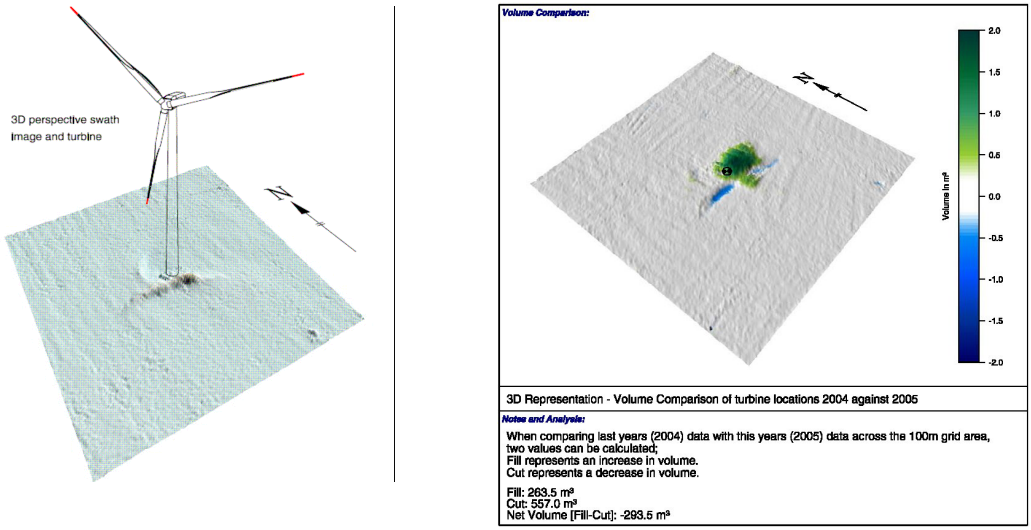

Figure 3: 3D side scan image of WTG 29 (left) with corresponding changes in seabed volume between October 2004 and April 2005 (right).

The second high-resolution post-scour survey undertaken in Spring 2005, has further confirmed the stability, form, volume and content of the rock armour and to confirm that scouring has remained within the design estimate at less than 0.5m.

Biological Environment

Benthic Fauna

Benthic grab surveys for the wind farm location and its surrounding sub-littoral environment have been undertaken annually by the Centre for Marine and Coastal Studies Ltd (CMACS) since a baseline survey in August 2001.

The original baseline survey undertaken in 2001 identified the benthic community distributions according to the MNCR biotope classifications. This classification revealed the benthic community at North Hoyle to fit reasonably well to that of Mackie's shallow Venus community. This community is common throughout the coastal areas of the Irish Sea including that of Liverpool Bay.

The sub-littoral biotopes inferred from samples obtained in 2004 are in broad agreement with the original classifications made in 2001 and, as in 2003, do not provide any reasoning that the biotopes have altered significantly as a result of the North Hoyle Wind Farm construction and operation.

Although changes have been observed in the number of species and individuals, with reductions noted at most sites, there appears to be no uniform pattern for this reduction in taxa and individuals. Rather this has occurred at sites across the entire area, including those within the wind farm and at distant controls. Sites within the wind farm continued to have the highest number of taxa, as in previous years.

The mechanism behind site-specific variability in species composition is postulated to be variability in sediment characteristics (Gloyne-Phillips, 2005), in addition to inter-annual fluctuations at the population level. Major species from previous surveys still dominate or remain common. One example worthy of mention is the Thumbnail crab *Thia scutellata*, which inhabits well sorted medium sands, and is regarded as nationally scarce. It was found in higher numbers and at more sites during the 2004 survey compared to the construction surveys of 2003 and was found at more sites within the wind farm area during 2004 than previous surveys.

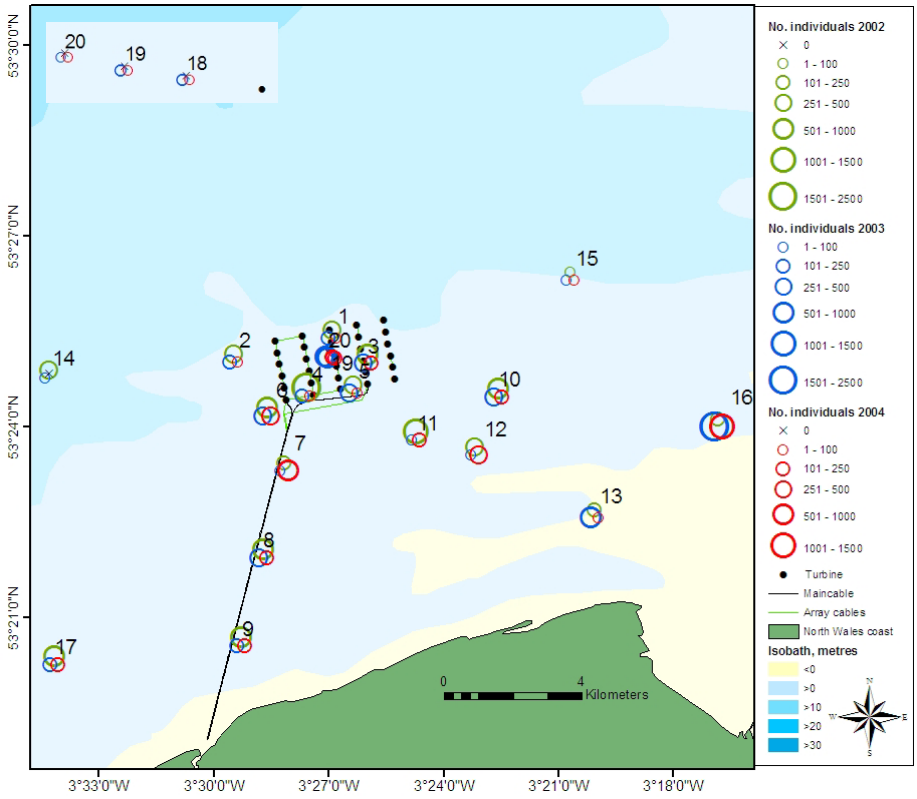

Figure 3: Number of Individuals per Grab Survey site 2002-2004.

This is only the second survey since completion of construction and continuing monitoring will provide reassurance that construction and operation of the wind farm has not had any major deleterious impacts on the benthic infaunal communities.

Epifauna Beam Trawl Surveys

The epifaunal species identified during the 2004 survey indicated that the majority of the trawl sites sampled were within areas of hard sub-stratum. Those sites, which yielded the highest numbers of fish, supported invertebrate species more common with sandy sub-littoral environments. Invertebrate species recorded at the array sites reflected a more intermediate sub-stratum. This is in keeping with findings from previous surveys and does not indicate a change in habitat at this stage. The number of invertebrate species present during all surveys between 2001 and 2004 is directly comparable, although a small increase in total species was observed for 2004. However, all new species were common for Liverpool Bay and the rest of

the Irish Sea. Common species of invertebrates in 2004 were similar to prior years, as was diversity. Any large-scale changes in numbers at most sites in 2004 were primarily attributed to fluctuations of the brittlestar *Ophiura ophiura.*

Although differences in the benthic communities from all three surveys can be observed, the results from the 2004 surveys suggest that characteristics of the Irish Sea assemblages identified after the initial 2001 survey have been retained with the presence throughout the survey area of several key fish and invertebrate species. Gloyne-Phillips (2005) postulates that seasonal changes; inter-annual variation and simple random effects (as well as possible effects of the wind farm development) could all contribute to these differences.

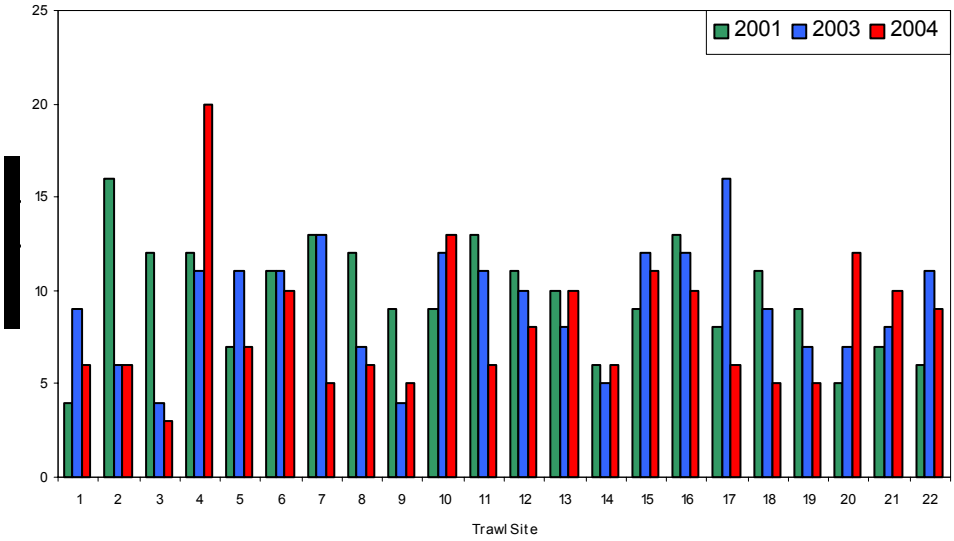

Figure 4: Number of epifauna species found at each site for the three surveys (2001, 2003 and 2004)

The results from the previous surveys identified the benthic communities at the North Hoyle wind farm as having similar qualities to those described by CEFAS for the Irish Sea. The communities identified at the North Hoyle site were similar to communities typical to coarse and stony grounds with species such as hydroids, bryozoans and soft corals such as *Alcyonium digitatum* (Dead Man's Fingers). There is no reason to suggest that any alterations to these assemblages have occurred from the results obtained during the 2004 beam trawl survey. However, future monitoring, including analysis of CEFAS fish data will enable any effects of the North Hoyle Wind Farm on the benthic communities to be identified.

Colonisation of Foundation Structures

An investigation into the marine colonisation of the North Hoyle mono-pile foundations one year after construction was undertaken in the summer of 2004. In all cases the turbines were operating at the time of the visits, although not all were necessarily generating. At the time, wind speeds were generally low.

59 species of animal and 4 plants were identified from the mono-pile structures. A characteristic vertical zonation of communities was found to occur up and down these artificial structures. Up to 9 biota zones were identified, although not all zones were represented at all survey sites.

The species colonising the wind farm structure were all common species found on nearby hard seabed and have most likely been recruited from nearby locations (Bunker, 2004).

Although there was some variation between the turbines, the dominant species included the barnacle *Balanus crenatus*, the amphipod *Jassa falcata* and the mussel *Mytilus edulis*. The common starfish *Asterias rubens* and the sea anemones *Metridium senile, Sagartia elegans* and *Sagartia troglodytes* were also conspicuous.

Based on wet weight sample data obtained, it was calculated that the turbines would each have born around 1000 - 1300kg of attached marine life (Bunker, 2004).

The most dramatic observation made was of large shoals of juvenile whiting *Merlangius merlangus*. These were present around all the underwater structures studied and appeared to be feeding on the amphipod *Jassa falcata*. This observation is noteworthy because the whiting is listed in the UK Biodiversity Grouped Action Plan for commercial marine fish. The importance of the wind farm structures to these populations of fish is, however, still unknown.

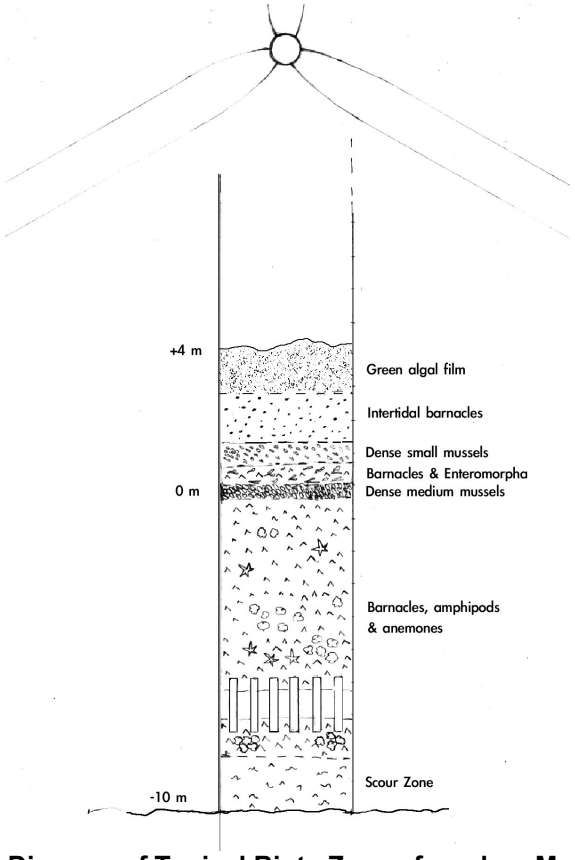

Figure 5: Schematic Diagram of Typical Biota Zones found on Mono-piles after 1 Year

Figure 6.: Dense shoal of juvenile whiting feeding on the tube dwelling amphipod *Jassa falcata*. (Photograph: npower renewables)

Very large numbers of the amphipod *Jassa falcata* were present on the surface of the barnacles. This species builds tubes from collected silt and then feeds on matter suspended in the water column. The turbid waters around North Hoyle and the tide swept wind farm

structures provide an ideal habitat for *J. falcata*. This species is well known as a 'fouling organism' due to its habitat of occurring in large numbers.

It is almost certain that the communities present in August 2004 will change over time. Exactly how the communities might develop is unclear and it is not certain that there will be a succession to a stable 'climax community' (Bunker, 2004). In the case of the North Hoyle turbines, it is anticipated that the piles will be scraped periodically in order to reduce pile loading and hydrodynamic drag.

The importance of the mono-pile structures as artificial reefs and their significance as fish refugia, species nursery or feeding areas cannot currently be verified.

Cetaceans

The Environmental Statement (NWPO, 2002) identified that the only cetacean species seen with any regularity in Liverpool Bay and the local area is the harbour porpoise (*Phocoena phocoena*). Due to the fact that numbers of this species are low in Liverpool Bay, and that it was considered unlikely to be significantly affected by the construction, operation or decommissioning of the North Hoyle Offshore Wind Farm, no specific on-site monitoring for cetaceans was required by the Licensing Authority.

Liverpool Bay and the waters adjacent to the northern Irish Sea are not rich areas for cetaceans compared with other parts of the United Kingdom. The harbour porpoise is the most widely distributed and commonly recorded species of cetacean in the northern Irish Sea, as well as elsewhere in the UK.

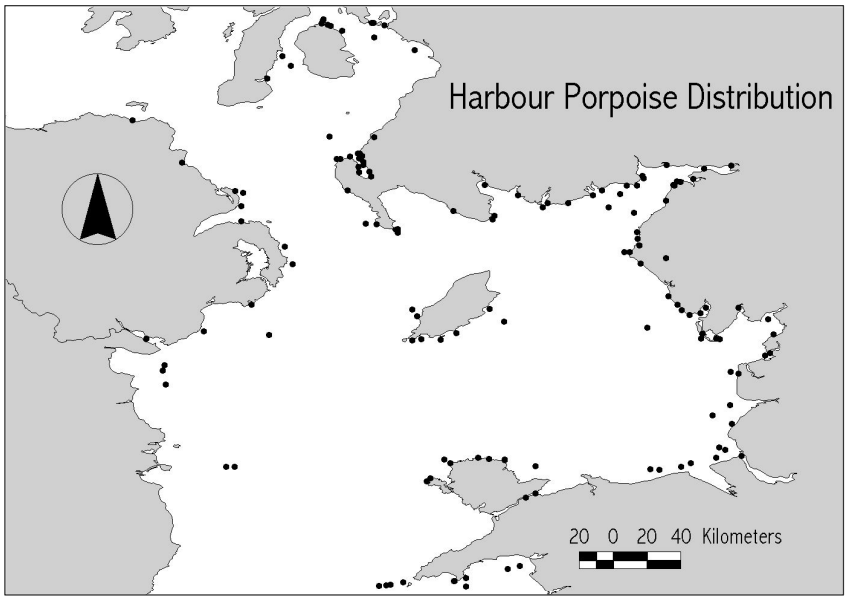

Figure 7:Distribution of Harbour porpoise Sightings 2000-2005.

Although wind farm construction activities can have a detrimental effect on particular near-shore species of cetacean like the harbour porpoise, causing avoidance during pile driving, as has been found elsewhere (NRL, in prep), there is no evidence for long-term distributional changes of any cetacean species from a comparison of sightings data before wind farm construction commenced with those thereafter. However, there has been no systematic effort-related observations collected over the two periods in the vicinity of Liverpool Bay, and the results presented in Gloyne-Phillips (unpubl.) have focussed upon overall distribution patterns from incidental sightings.

Seals

Atlantic Grey Seals (*Halichoerus grypus*) haul out onto West Hoyle bank at Hilbre Island are currently monitored by the Hilbre Island Ranger Service and the Hilbre Island Bird Observatory. Monthly seal count data from Hilbre are published annually in the Hilbre Bird Observatory report.

Maximum monthly counts for Atlantic Grey Seal at the West Hoyle haul out between 1964 and 2002 have been assessed (NRL, in prep). Numbers peak in summer with over 400 individuals regularly present in recent years and a peak of more than 500 in 2001 and 2002. This reflects the importance of this site for Irish Sea Grey Seals which congregate near Hilbre over the summer, swelling the local over-wintering population.

Data are not yet available for 2003 and beyond and it is therefore not possible to comment on the impact of the construction or operation of the wind farm on seal numbers at the West Hoyle haul out.

However, anecdotal records of both grey seal and harbour porpoise within the operational wind farm area and the movements of tagged grey seals through the operational wind farm demonstrate that individual animals are prepared to visit the wind farm site and apparently to forage actively within it (Gloyne-Phillips, unpubl.). Given the concentration of food resources around wind turbine foundations (Bunker, 2004 & NRL (2005)) this is perhaps not surprising but does provide reassurance that the presence of the operating wind turbines does not exclude these marine mammal species from the site.

Birds

The vessel survey route contains seven transects, slightly off-set from west-east, parallel to the turbine rows, covering the wind farm area plus a 2km buffer. The surveys have been undertaken in response to a number of monitoring objectives set by the Countryside Council for Wales relating to changes in bird distribution (Objective 1); barrier effects (2); common scoter distribution (3) and collision risk (5). Objective 4 relates to benthic monitoring and is conditional upon significant environmental effects being recorded.

Post–construction, monthly seabird surveys have been completed continually between March 2004 and present. Between March and October 2004 there were no observations of Red-throated Diver (a known qualifying interest species of the Liverpool Bay proposed Special Protection Area) within the wind farm or the buffer. This does not necessarily infer an effect from the turbines. Divers are known to be wary of some vessels at distances of up to 1km, and on all occasions such vessels were present in the study area. Indeed, Red-throated Diver numbers at the North Hoyle site were recorded as ‘very low’ in the Environmental Statement (NWPO, 2002).

There have been no observations of Black Scoter (also a known qualifying interest species of the Liverpool Bay proposed SPA) within the wind farm and buffer. As with Red-throated Diver, it is unclear whether this is a wind farm or vessel effect. Again, previous survey work suggests that Scoter numbers were relatively low in the North Hoyle area.

Coates (*pers comm*, 2004) has suggested Sandwich Tern, a qualifying species of the Dee Estuary SPA has (from a small number of observations) shown variable responses to the wind farm, with some evident deviation of flight to move around the wind farm, and some flight through the wind farm. No feeding has been observed within the wind farm. However, the low number of observations is unlikely to give these data statistical significance.

Cormorant, a qualifying species of the Puffin Island SPA (breeding), The Dee Estuary SPA (non-breeding), and Little Orme’s Head SSSI (breeding), continue to use the two meteorological masts as convenient perches for drying out, or roosting on at high tide, between fishing trips to the south and towards the Dee (*pers comm* Coates, 2004). Cormorant are increasingly also roosting on the turbine transition piece gantries.

Gannet from either the Ailsa Craig or Grassholm SPA has shown a variable response to the wind farm. Some birds have been recorded in a scalloped flight around the edge of the wind farm, flying into the farm, then flying around the outer edge of each of the outer turbines. Other birds flew directly through the wind farm. Birds entering the wind farm appear to respond to the turbine blades by lowering their flight height (*pers comm* Coates, 2004).

Guillemot and Razorbill, qualifying species of Puffin Island SPA, Great Ormes’s Head SPA and Little Orme’s Head SPA occured within the wind farm, but larger numbers have been

recorded on transect sections outside of the wind farm. According to Coates (*pers comm* 2004), this may indicate some avoidance, although this requires more detailed analysis. In late summer, when adults are with dependent, flightless young, many such groups were recorded within the study area, but none were recorded within the wind farm.

Gull species (including Kittiwake) showed no obvious avoidance of the wind farm or deviation in flight path.

Incidental observations of species other than seabirds have shown that flocks of birds either deviate to avoid the wind farm (*e.g.* Wigeon), or increase in flight height to fly over it (*e.g.* Curlew, Swallow) (NRL, 2005).

Statistical analysis of the last twelve months of monitoring data to March 2005 is still ongoing particularly looking at the changes in distances of birds from the turbines during construction and operation. Some key preliminary findings (to be confirmed) illustrate:

- Scoter showing strong avoidance during construction, moving closer during operation but not as close as pre-construction;
- Red-throated diver showing little difference, but numbers are very low;
- Gannet coming closer during construction and slightly further away during operation, but again low numbers;
- Guillemot showing little difference.

Monitoring Objective 1 seeks to evaluate whether the presence of the wind farm has caused a change in bird distribution (Objective 3 relates specifically to Scoter). Monitoring Objective 2 seeks to evaluate whether the operating turbines cause a barrier to the movement of birds through the wind farm. Data for the operational period of the wind farm is, however, not yet published and no tentative conclusions can so far be drawn.

Overall, the findings of bird surveys recorded few species of conservation concern (*e.g.* Red-throated Diver, Common Scoter and Sandwich Tern) on or crossing the North Hoyle site and of the records which were made of these species from the boat surveys, almost all the birds were recorded at a height of less than 20m. In consideration to Monitoring Objective 5, such flight heights are not likely to result in the risk of these birds colliding with the turbine rotors.

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