The European Perspective: Some Lessons from Case Studies

by

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Roots of the Problem

Attitudes toward the possible interactions between birds and wind turbines in the early days of large scale commercial development of wind energy in Europe, and in particular the U.K., were based upon rather little information of direct relevance. The results of studies in California at large Wind Resource Areas such as Altamont Pass, together with limited although detailed European work (e.g., Pedersen and Poulsen 1991; Winkelman 1992; Meek et al. 1993), all became well known and often cited by developers and conservationists alike.

On the basis of such information, the response of both the statutory and nonstatutory conservation agencies to new proposals was guarded. In the UK, for example, the agencies broadly supported the idea of renewable energy. However, in the absence of evidence to the contrary, there was fear that impacts similar to those identified elsewhere could significantly affect the U.K.'s internationally important populations of wintering waterfowl, or bird species dependent upon its fragile upland ecosystems.

A stalemate situation rapidly developed. Evidence derived from disparate sources was put forward by one side or another, and refuted by the other side on the grounds that data relating to particular species, habitats, wind farm designs, and turbine types could not be extrapolated to proposed future developments.

In the U.K., the response came when the Department of Trade and Industry, through its agency Energy Technology Support Unit (ETSU), commissioned a review of the current state of knowledge on this issue. This review was to result in a report for wide distribution to interested parties (Lowther and Tyler 1996). Since the report was completed, further work has been undertaken that is of direct relevance to the industry in Europe today.

Limitations of time and length prevent a complete synopsis of all of these studies, which have, in any case, been of varying quality. I therefore limit my discussion here to four case studies that serve to illustrate several principles:

- Careful siting and consideration of nature conservation issues early in the planning of wind farm developments is key to avoiding serious bird fatality problems.
- Studies into the effects of wind farms on birds need to be scientifically robust, and planned so as to take into account other environmental factors that may affect local bird populations.

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- Studies at novel turbine locations demand novel approaches, without losing their scientific credibility.
- Ornithological studies must keep abreast of developments in the wind energy industry, and should seek to provide adequate information before policies are determined, rather than afterwards.

Case Study 1: Tarifa, Spain

Based upon Martí Montes, R. & L. Barrios Jaque (1995) *[Effects of Wind Turbine Power Plants on the Avifauna in the Campo de Gibraltar Region]*. Spanish Ornithological Society.

The problems encountered following the development of wind energy in the Municipal District of Tarifa have been widely reported and were discussed at the First National – Avian Power Planning Meeting in Colorado (Martí 1995; see also Janss, this volume). Briefly, several wind farms were constructed within the National Park of Alcornocales, which had been declared a Special Protection Area for Birds under the European Birds Directive of 1979. The developments lay along the migration path of internationally significant numbers of raptors and within the breeding ranges of a number of other protected species.

Despite the international significance of the region for birds, no objective consideration of the possible impacts of the developments was undertaken prior to construction. The possibility that significant avian mortality may have occurred led to a great deal of conflict between the Regional Government, developers and conservation agencies. Several administrative and penal charges were filed, along with a complaint to the Environmental Agencies of the European Commission. Matters reached a critical level when potentially significant levels of actual mortality began to be reported in the media.

In response to the problem, the Spanish Ornithological Society (SEO) was commissioned by the Regional Government of Andalusia to investigate the effect of the turbines on bird populations and to formulate measures that would enable a more rational regulation of the future industry.

Due to financial constraints, field work necessarily focused only on detecting mortality of medium and large soaring birds, as well as their behavior in relation to the turbine structures. Methods used by the SEO were similar to those previously employed at Altamont Pass. At two operating wind farms (named PESUR and E3), accounting for a total of 256 turbines, sample sites were selected at random and searched for injured or dead birds. A total of 87 turbines were selected, together with the meteorological towers adjacent to the turbines and sections of associated power lines. Weekly checks were made of the power lines, and the wind turbines were checked twice weekly.

As controls, checks were also made during different seasons, to assess the effect of carcass removal by scavengers, and to examine the ability of the observers to detect dead birds.

During the one-year study, an estimated 106 birds were killed through collisions with turbines and power lines. Of these, 89 were large to medium sized birds. The most affected species were kestrels (49 birds) and Griffon Vultures, *Gyps fulvus* (30 birds). It was concluded that, had additional resources been available and had smaller species also been studied, mortality figures would have been higher. The total number of medium-large birds killed per turbine per year was estimated to be 0.34 for the two wind farms studied. A detailed account of the findings is given by the SEO in their report (see above).

The number of raptor fatalities at Tarifa was considered unacceptably high, and far higher than indicated in any other European studies. On the basis of their findings, the SEO made a series of important recommendations to influence policies toward future wind farm development in Europe and, in particular, in Spain:

- Protected natural sites should be excluded from planned wind energy developments except in certain cases where zoning could be established on the basis of detailed pre-construction surveys and detailed mitigation prescriptions, to an extent where minimum impacts on avian populations could be expected.
- In sites which are currently unprotected, but which are nevertheless considered to be important from a nature conservation perspective, wind farms should only be permitted where detailed ornithological surveys indicate that impacts would be minimal.
- Wind farm developments should be subject to Environmental Impact Assessment in accordance with European Law.

The SEO also made recommendations in relation to the coverage of predevelopment ornithological studies at future developments in areas considered to be important for birds:

- It is necessary to study not only numbers and distribution of birds in a proposed wind farm, but also their behavior, as this can significantly affect the risk of impacts to individual birds.
- Studies should be done to document migration routes and the meteorological conditions under which these are used.
- Once the behavioral patterns of birds have been established, the layout of wind farms should take into account these findings, leaving corridors or open areas in places where turbines would pose a clear danger for such birds. Similarly, the wind speeds at which the turbines start and stop should be regulated according to the results of bird behavior studies.
- Monitoring of the effects of wind farms is essential to identify any necessary new mitigation measures.

The Tarifa study is important in a wider European context. It highlights the need to fully assess the ornithological importance of a site at the earliest stages of the wind farm planning. Ideally, this should be at the site-selection stage, in order to avoid unnecessary costs both to developers and to conservation agencies.

Significantly, however, the Tarifa case also illustrates the potential to avoid impacts through careful design of wind farms, in the light of pre-construction studies. Far from suggesting a policy of total prohibition in important bird areas, the study illustrates the potential for developing wind farms that are compatible with avian issues.

Case Study 2: Bryn Titli, Wales, U.K.

Based upon: Green, M. (1995) *Effects of Windfarm Operation on the Winter Bird Community of the Bryn Titli Uplands*. Unpublished report.

The Bryn Titli wind farm comprises 22 wind turbines in an upland part of Wales (U.K.), in open habitats supporting traditional sheep grazing and heather moorland. Ornithological studies were carried out by the Royal Society for the Protection of Birds. The studies focused upon the use of the uplands during the winter by four species of raptors: Red Kite *Milvus milvus*, Buzzard *Buteo buteo*, Kestrel *Falco tinnunculus* and Peregrine *Falco peregrinus*, as well as Raven *Corvus corax*. The first winter study was carried out during construction of the wind farm and the second was during the first year of operation. The aim of the study was to compare, between years, the time spent by these species within the wind farm with that spent in an adjacent control area of similar habitat. To this end, observations were made from strategic locations within the study area, during which all occurrences of raptors and other notable species were recorded and their positions and heights were recorded.

Following analysis of the results, it was concluded that Red Kite preferred the (future) wind farm site before construction, but thereafter showed greater proportional use of the control area. The data also indicated a shift in Raven activity away from the wind farm site, toward the neighboring area. For the other species, it was suggested that only slight evidence for a negative impact was detected.

A number of methodological problems, highlighted by the author, weaken the scientific validity of the findings:

- No pre-construction baseline studies had been undertaken on the site and, as a result, it was not possible to factor out of the results any normal variation in usage of the area by the species in question;
- Data were collected during July of the first year but not during July in the second year. As a result, it was necessary to remove all July data from the final analysis before statistical tests could be performed;
- Logistical problems were encountered during the second year when access to two observation points could not be obtained for a period of over one month in autumn. It was therefore also necessary to remove this period from the previous year's data set before analyzing the results;
- At least one of the species concerned, the Peregrine, occurred at a very low density within the study area. Only one or two pairs were recorded. It is questionable whether sufficient data could be gathered to properly assess the effect of the wind farm on this species;
- As part of a tourism project, a Red Kite feeding station was established within 9 km of the wind farm during the second year. The researcher acknowledged that this could have had an effect upon the frequency of occurrence of this species in the study area, but this effect was not quantified. Large numbers of Ravens were also known to have visited the feeding station, with similar probable effects upon the results for this species;
- Three of the five target species are carrion feeders. Relative numbers of livestock in the wind farm area and control site varied significantly between years. It was not possible to quantify this change during the study, so any effect that it may have had upon the results is unknown;
- Grouse shooting occurs in the Bryn Tilti uplands in the late summer and early autumn and it is certain that this activity would affect the outcome of observations made at this time. The rela-

tive frequencies of shoots in the wind farm area and the control area were not recorded, however. Neither were the numbers and distribution of people and vehicles.

The findings at Bryn Titli, and the problems with the study, highlight the need for more careful planning and execution of studies. Although the approach of an experimental area and a control area was entirely appropriate, inadequate account was taken of other environmental variables that may have caused the perceived differences between years. This difficulty was compounded by data collection problems during the second year, which prevented robust statistical testing of results. Also, given the lack of pre-construction baseline data, natural variation could not be taken into account.

Case Study 3: Blyth Harbour, North-east England.

Based upon Still, D., B. Little and S. Lawrence (1995) *The Effect of Wind Turbines on the Bird Population at Blyth.* ETSU Report W/13/00394

Nine 300 kW wind turbines were erected on the harbor breakwater at Blyth, Northumberland, in 1992. The harbor and adjacent rocky and sandy shorelines were known to comprise important areas for shorebirds and wildfowl. Internationally significant populations of Purple Sandpipers *Calidris maritima* and Sanderlings *C. canutus* occur in the area, as well as a nationally important population of Eider ducks *Somateria mollissima* [= Common Eider]. In addition, the area also supported large populations of gulls, Cormorants *Phalacrocorax carbo,* and non-marine species. In comparison to other coastal sites around the U.K., overall avian activity in the area was therefore considered to be high.

A program to monitor the effects of the wind turbines on the local bird populations was instigated prior to construction and was continuing in mid-1998. The methodologies used are scientifically rigorous and were based on a detailed understanding of the issues highlighted by researchers elsewhere. Furthermore, they demonstrate an imaginative response to the particular problems faced at such a site.

The research program was based upon clear objectives, which were established at the earliest stage of its planning. For each objective, a particular methodology was either adapted from precedents, or developed specifically for the site in question.

The methodologies approached a series of questions and were based upon the Before-After Control-Impact (BACI) principle:

Effects on Purple Sandpipers.—High water counts were made at a roost located on the Harbour Breakwater on which the wind turbines were sited. Monthly counts were made at the nearest alternative roost and the feeding areas of the Purple Sandpipers were identified within the wider general area. The observer examined the use of the Breakwater at varying stages of the tide, and identified which alternative roosts were used when exceptional high tides forced the birds away. The flight behavior and flight lines of these Purple Sandpipers were recorded on arrival and departure from the Breakwater roost.

Other Species.—Counts of the other species in the Blyth Harbour area were made on a regular basis throughout the study. The flight behavior of gulls, Cormorants, and Eider ducks were recorded on

arrival and departure from the harbor basin. Bird activity in the area was calculated using the techniques of Orloff and Flannery (1992), although the method was adapted to reflect the reduced study area. The level of activity of birds was recorded in ten-minute intervals within a one-mile radius of two observation points.

Mortality Study.—The exposed position of the wind turbines, surrounded on two sides by the sea, presented particular difficulties in estimating the reliability of mortality counts. To overcome this, a series of novel methods were developed.

In order to establish background mortality, regular beach searches were carried out on a weekly basis throughout the study. In addition, tests were carried out to establish the efficiency of corpse recovery by the observer. Twenty bird corpses were distributed along a 1-km stretch of beach. The effect of wave action on the removal of corpses from adjacent beaches was examined by ringing previously found bird corpses and leaving them on the beach for one week. During a series of intensive searches, the beach was revisited on a daily basis and the movements of the corpses were monitored.

A further complication arose from the fact that birds striking turbines were likely to fall into the sea and possibly sink. To investigate the maximum buoyancy period, a sample of four fresh corpses were tethered in the estuary and their condition was monitored on a weekly basis. To detect where corpses falling into the sea were likely to make landfall, a release experiment was conducted where wooden blocks were deposited into the water on either side of each turbine during different wind and tide conditions.

It is likely that some of the measures taken to assess efficiency of corpse recovery were unsuccessful. However, it was clear that the timing of corpse searches on a weekly basis was adequate.

Full details of the findings of the study to 1995 are given in Still et al. (1995, *op. cit.*). In summary, it was found that, despite the large populations of birds in the harbor, there had been relatively few collisions (34) during the operation of the wind farm. Cormorants did not appear to be at risk, and were observed to avoid flying critically close to the turbines. Eiders, however, appeared to be more prone to collision in the early years of the study – at least 12 individuals were believed to have collided during the first 2.5 years of operation. Data gathered more recently, however, suggest that the wintering Eider population may be adapting to the turbines. Collision rates have fallen in recent years and were zero in 1996/97, despite increases in the size of the local Eider population.

No adverse effects of the local Purple Sandpiper population have been detected during the study, and the species demonstrated an apparently high level of tolerance to disturbance even during construction of the wind farm. Gull populations were not shown to have been affected by the development, although some collisions did occur. Recent studies at the site have suggested that collision risk to gulls may be greatest when the resident population engages in food piracy on non-resident individuals.

The Blyth Harbour study serves to illustrate that good practice in avian/wind farm studies involves consideration of all factors that may affect the outcome of the study. In the absence of precedent, novel methods were used to assess carcass recovery rates. Anticipation of such factors, even if they are

eventually discarded as insignificant, is preferable to identifying flaws in a dataset once the study is completed and funding has ceased.

Case Study 4: Tunø Knob Offshore Wind Farm, Denmark

Based upon Guillemette, M., J.K. Larsen and I. Clausager (1998) *Impact assessment of an off-shore wind park on sea ducks*. NERI Tech. Rep. 227. National Environmental Research Institute, Denmark.

Several European countries are on the verge of developing the significant wind energy potential of offshore sites. U.K. predictions estimate an offshore capacity at least equal to that onshore by 2010.

Many of the offshore waters off Europe are of high significance to internationally important populations of seabirds. Conflicts may arise where such areas coincide with the shallow seas favored as wind energy sites.

It is essential, therefore, that avian issues are identified and their significance assessed at an early stage. By doing so, wind energy developments can be guided to suitable regions where impacts are minimized, and maritime equivalents to the problems of Tarifa can be avoided. This need was recognized by the Danish Ministry of Environment and Energy at an early stage. In response, it commissioned a detailed three-year study at a wind farm at Tunø Knob. The wind farm consists of ten 500 kW turbines located in 3-5 meters of water. Operation commenced in autumn 1995 and the results of the ornithological survey were published in early 1998.

Studies by Guillemette et al. (*op. cit.*) were carried out during the winter, and concentrated upon populations of Eider ducks and the Common [= Black] Scoter *Melanitta nigra*, which represented the most common components of the local bird population.

The study had two aims. The first was to compare bird abundance and distribution in the potential impact area using the BACI (before-after control-impact) technique. The second aim was to establish whether birds in the immediate vicinity of the turbines were affected, in order to assess the causes of any effects detected in the BACI study.

During the BACI study, bird counts and location were recorded from February to April. In addition, aerial surveys were carried out in the wider area to monitor trends at a regional level. The benthic community was also sampled annually in order to assess variation in food supply.

The findings of the BACI studies were apparently dramatic, at least for Eiders. Between the two winters, Eider numbers in the wind farm area declined by 75%. This contrasted with the control area and with population trends in the larger region, which showed no significant trends during the study period. For the Common Scoter, numbers in the wind farm area declined by 90%, but a similar trend was evident in other areas in the region.

The extent to which the wind farm caused the population changes was questionable. During the same period, the abundance and age composition of blue mussels *Mytilus edulus*, which formed an important part in the diet of both bird species, changed significantly in the area. This change was sufficient to account for a high proportion of the overall variation bird populations between years.

Furthermore, the mapping exercise showed a high degree of variation in the spatial distribution of Eiders over the study area, suggesting that the observed changes were due to natural variation.

The results of the second part of the study were as follows:

- 80% fewer Eiders landed within 100 m of the turbines than at 300 to 500 m.
- Eiders showed no different response to the turbines when they were switched off to when they were operational.
- 90% of the variation in Eider numbers in four quadrats positioned at varying distances from the turbines could be explained by food supply.

It was concluded that the change in eider numbers between years could not be explained by the presence of the wind turbines. However, a note of caution was urged, on the grounds that the second part of the study was conducted in a year when there were fewer Eiders in the area. Sensitivity to disturbance in a large flock may significantly differ from that in a small group of birds. The results for Common Scoter were even less conclusive, owing to the relatively low numbers of individuals present in the region in the second year. It was recommended that further studies be initiated to examine the Tuno Knob wind farm further.

The Tunø Knob study represents a milestone in the investigation of the effects of offshore wind farms on birds – an issue that is likely to become more important in Europe in the forthcoming years. The apparent absence of significant effects at Tunø Knob should not engender complacency with respect to planned offshore developments. The authors highlight a number of issues that require further attention. These included effects on other species and different stages of the molt cycle, effects on larger flocks, a need for collision studies and studies of disturbance by construction and maintenance vessels, and studies of effects of very much larger offshore wind farms. Such investigations will need to be carried out at a European level if they are to be meaningful.

Conclusions

It is not possible in a presentation such as this to provide a comprehensive overview of all of the studies that have been carried out in the U.K., much less the rest of Europe. I have attempted instead, to relate the findings of four important studies that, as indicated earlier, illustrate a number of principles.

Clearly, much could be done to increase our understanding of the interactions between birds and wind farms. In the U.K., for example, a detailed and rigorous study of the effects of wind turbines on upland birds is still awaited. We are relatively certain that collision risk can be minimized through site selection and turbine layout. However, the long term effects of disturbance on the breeding success of site faithful species, for example, remain uncertain.

In the wider European context, it is essential that international nature conservation laws and agreements be taken into account in the planning and development of wind energy. This will be particularly relevant to member states that are on the verge of developing large-scale wind plants, and to those neighboring states that seek to join the EU.

The predicted development of offshore facilities will reduce the pressure on ornithologically important terrestrial sites. However, it is essential that potential problems unique to offshore developments are

investigated rigorously. In this way, the recommendations of the Spanish Ornithological Society with respect to future land-based sites may also be effectively applied to sites at sea.

It has been clear, at least from the U.K. experience, that inadequate planning and resources are occasionally given to avian - wind energy studies. The inadequate resources are hardly surprising, since the bill is most usually footed by the developer and there is often an understandable reluctance to commit to long term, detailed studies. The inadequate planning may reflect the fact that Local Planning Authorities, which in the U.K. determine whether a development may proceed, have frequently required that a wide range of issues be tackled at each development. This often has the effect of spreading resources too thinly at any given site, and results become insubstantial and untestable.

Many of our European partners have decided to deal with the avian – wind energy issue in a strategic and co-ordinated manner. The primary objective of those working in the U.K. must now be to ensure that a strategic approach is applied there as well.

Literature Cited

Note.—The citations for the four principal reports used as the basis for the four case studies are listed at the start of each case study and not repeated below.

Lowther, S.M. and S. Tyler. 1996. A review of the impacts of wind farms on birds in the U.K. ETSU Report No. W/13/00426/REP3.

Martí, R. 1995. Bird/wind turbine investigations in southern Spain. p. 48-52 *In:* Proceedings of National Avian – Wind Power Planning Meeting, Denver, CO, July 1994. DE95-004090. RESOLVE Inc., Washington, DC, and LGL Ltd., King City, Ont. 145 p. www.nationalwind.org/pubs/avian94/default.htm

Meek, E.R., J.B. Ribbands, W.G. Christer, P.R. Davy and I. Higginson. 1993. The effects of aero-generators on moorland bird populations in the Orkney Islands, Scotland. *Bird Study* 40(2):140-143.

Orloff, S. and A. Flannery. 1992. Wind turbine effects on avian activity, habitat use, and mortality in Altamont Pass and Solano County Wind Resource Areas 1989-1991. P700-92-001. Rep. from BioSystems Analysis Inc., Tiburon, CA, for Planning Dep., Alameda, Contra Costa and Solano Counties, CA, and Calif. Energy Comm. [Sacramento, CA]. Var. pag.

Pedersen, M.B. and E. Poulsen. 1991. [Impact of a 90m/2MW wind turbine on birds/Avian responses to the implementation of the Tjaereborg wind turbine at the Danish Wadden Sea]. *Danske Vildtunders.* 47. 44 p. (Danish, Engl. summ.)

Winkelman, J.E. 1992a-d. [Effects of the Sep wind farm at Oosterbierum (Fr.) on birds, 1-4: collision victims, nocturnal collision risks, flight behaviour during daylight, and disturbance.] RIN-Rep. 92/2-5. Instituut voor Bos- en Natuuronderzoek (IBN-DLO), Arnhem, The Netherlands. (Dutch, Engl. summ. & captions[†]).

General Discussion

[†] The English summaries of these reports were reprinted in "Proceedings of National Avian – Wind Power Planning Meeting, Denver, CO, July 1994", available from Nat. Wind Coord. Commit., c/o RESOLVE Inc., 1255 23rd St. N.W. (#275), Washington, DC 20037. The abridged version of these Proceedings available on the World Wide Web does not contain these summaries.

One participant had a question regarding the Danish study, and the issue of Eider and mussel numbers. Stewart Lowther replied that this had not been studied in detail. He added that changes in the mussel populations might have been related to disturbance of sediments caused by turbine construction.