The offshore wind farms have only a small impact on migrating waterfowl - a Swedish study

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The above statement is part of the results presented in a report on the four-year study in southern Kalmar Sound where field observations and radar tracking were the study methods used and in which a total of 1.5 million migrating waterfowl were studied. Bird flocks that approach the groups of offshore wind turbines head-on (seven at Utgrunden and five at Yttre Stengrund) in Kalmar Sound in general fly around them on either side. The spring migration corridors of waterfowl, predominantly Eider *Somateria mollissima*, have been displaced slightly closer to Öland after construction of the wind turbines in the Sound. This has caused a small increase in flight time for about 30 % of all birds migrating through the Sound, in the region of a 0.2-0.4 % increase in the total migration time. Military radar data were made available for the study and revealed that even in conditions of fog, mist and darkness, flocks make a detour around the turbines. Exactly how they detect the presence of the turbines in such poor visibility conditions is not known, but all the available evidence points to the fact that they manage to somehow. The study documented that there are collisions between waterfowl and the offshore turbines – one collision was actually observed. A total risk estimate for the 1.5 million waterfowl that migrate annually in this area predicts a loss of up to 14 birds per year caused by these 12 offshore wind turbines in southern Kalmar Sound. This number should be compared with the total number of birds migrating through the area. The risk is less than one bird lost per 100 000. The impact of these turbines on waterfowl populations in general is therefore extremely small, as is their impact on the predominant species in Kalmar Sound, the Eider.

The study

During four spring and four autumn seasons from 1999–2003 a bird study has been carried out which has included one and a half million migrating waterfowl in southern Kalmar Sound in the Baltic situated in southeast Sweden. The study has been carried out in connection with the two groups of wind farms that have been constructed offshore at Utgrunden and Yttre Stengrund with seven and five wind turbines respectively.

The migrating patterns of the waterfowl through the Sound and the flocks' reactions on encountering the wind turbines have been studied and documented during periods of good visibility through direct observations and by following the flocks with optical measuring instruments. During periods of less good visibility (such as fog or mist or during the night), and similarly during the day with good visibility, radar analysis of saved radar films from military reconnaissance radar has been made in order to follow the flocks and to document their reactions and behaviour when they encounter the wind turbines on their migratory path.

Wind farms

In southern Kalmar Sound – which is 20 km wide at this point – there have been seven wind turbines at Utgrunden since autumn 2000, which have been erected approximately in the middle of the Sound. The five wind turbines at Yttre Stengrund, situated about 3 km from the shore line, were erected in the summer of 2001 and are about 20–30 km south of Utgrunden.

Spring and autumn flights

The study includes a total of 859000 spring migratory waterfowl and the corresponding figure for the autumn study is 674000 birds. Up to 95% of the spring flight of waterfowl is dominated by Eider. Up to 56% of the autumn flights of waterfowl in southern Kalmar Sound is dominated by Eider, and the other species consist mostly of Duck, Goose and Cormorant. This autumn waterfowl flight occurs mainly along the west side of the Sound and thus nearer the Yttre Stengrund wind farm section.

Choice of flight path

After the construction of the wind farms the spring flight of waterfowl takes place to a greater extent than formerly along the Öland side of the Sound. Most of the spring flight's migratory paths have thus been shifted up to 2 km eastwards. During both the spring and the autumn flights most of the waterfowl flocks avoid flying nearer than one kilometre from the wind turbines. In good visibility the flocks seem to make a choice from at least 1–2 kilometres distance from the wind farm as to whether to pass on the right or on the left of the turbines. In the spring they fly mainly to the right of the Utgrunden wind farm as the flight often takes place in westerly and southerly winds. It is probably easier to pass the turbines with the wind behind them than to turn into the wind. Naturally some of the flocks (about 3%) fly nearer to the turbines (0–500 metres), but the part of all the flocks that makes some kind of correction of choice of path is about 30% in good visibility at Utgrunden in the spring and about 15% at Yttre Stengrund in the autumn. These flocks then have to fly in a curve round the wind turbines which lengthens the flight path by up to 1.2–2.4 km, or for a few flocks up to 2.9 km, This lengthening of the flight path makes up 0.2–0.4 total flight path of the waterfowl from the breeding area to the wintering area and vice versa, which can be rendered as a certain increase in energy expenditure for the birds' migration.

Night and mist

Radar monitoring of flocks shows that in all it is quite a limited waterfowl flight that takes place in fog and mist. About 5–6 per cent of the total flight in spring and autumn respectively migrate in such conditions, and this corresponds very closely to the amount of time (5–9 per cent of the time studied) in which there is fog and mist. These flocks avoid the wind turbines in the same way as those who migrate in good visibility. The nocturnal waterfowl flight in Kalmar Sound is extensive and makes up 22–27 per cent of the total waterfowl flight. The nocturnal migratory flocks fly at a greater distance from land than those who migrate by day. Also during the night flight the waterfowl flocks seem to react to the wind turbines from a long distance, ca 500–1000 metres before they reach these. The flocks that come nearer to the turbines at night (in both the autumn and spring flights) fly in a curve round the wind turbines in the same way as those that migrate in the daytime.

Rare species

Only a few of the rare, red-listed species observed, or birds of prey in the area, seem to fly into the immediate area of the wind farms during migration. About 4 per cent of the somewhat rarer species observed fly in the spring into the immediate area of the wind turbines at Utgrunden and 5 per cent in the autumn at Yttre Stengrund. This is comparable to the number of Eider (2–6 per cent) that during spring and autumn fly into the immediate vicinity of the wind farms. These somewhat more unusual bird species behave very much in the same way as the ordinary waterfowl species on encountering the offshore wind turbines. Altogether these species make up ca 0.3 per cent of the waterfowl observed.

Collision risk

In the autumn of 2003 one bird collision was observed at Yttre Stengrund. This was the only collision that was observed during the whole period of the research. A flock of about 310 Eider flew as near as ca 100 m from the northernmost wind turbine at Yttre Stengrund and the outer flank of the birds was struck by the rotor. Four Eider fell into the water and three of these were observed flying quickly away from the area, while one bird was estimated killed. In addition five near-accidents were observed where the flocks flung themselves to one side or turned sharply at the turbines in order to avoid a collision. A calculation of the risk of collision showed that one bird per year and wind turbine collides with the existing turbines in Kalmar Sound. One premise in the calculation of the risk of collision is that only flocks that fly within 100 metres from the wind turbines run the risk of colliding. Moreover this premise is based on the fact that these flocks continue to fly straight ahead and do not turn off when they reach the turbines. The number of waterfowl which, according to this calculation of the risk of collision, risk colliding with the turbines must be seen as a scenario of the worst that can happen. As the flights in the main occur in different places in the Sound during the spring and autumn flights respectively, the spring flight is affected by the wind turbines at Utgrunden in the first place and the autumn flight by the turbines at

Yttre Stengrund. A risk number has been calculated for the total flight round the clock and for the whole of the spring and autumn flights respectively, from detailed studies of the actual number of flights within 100 metres from the turbines at Utgrunden wind farm in the spring (ca 0.2 per cent of the flocks) and at Yttre Stengrund in the autumn (ca 0.3 per cent of the flocks). According to these risk calculations for southern Kalmar Sound a maximum of 1–4 flocks in the spring and a maximum of 10 flocks in the autumn might run the risk of colliding with any of the wind turbines. If the only observed collision is to illustrate an "average collision" the total maximum sum of 11–14 birds per year might be killed and about three times as many might be injured more or less seriously in collisions with the existing 12 wind turbines in the Sound. Consequently only about one bird per wind turbine and year would be killed in a collision with a wind turbine. This should be seen against the background of the estimated total number of waterfowl that pass through the area during the research period day and night: ca 500000 waterfowl each spring and 800000 each autumn.

Resting birds

The area round Utgrunden provides for 1000 to 2000 resting waterfowl during spring and autumn alike and fewer during winter. Long-tailed Duck dominates amongst the resting birds, but in the spring and summer some Eider and Common Scoter can be seen. The area round Yttre Stengrund provides for fewer resting waterfowl and amongst these there are no Long-tailed Duck. There are fewer Long-tailed Duck in spring after the construction of the wind turbines at Utgrunden. This cannot be definitely attributed to their construction as the number of birds in the reference area was also reduced during the same period. This is probably due to a relatively large variation in general from year to year in the area. Possibly the reference area is too near (ca 3 km) the wind turbines to mirror such variations or possible effects of the wind turbines. Research into the positions of the resting places of the different flocks of waterfowl and their daily rhythm has been carried out at the wind farm area at Utgrunden. These studies show differences in the different species' choice of resting place and a certain daily rhythm. The visits of the wind farm service boat is disturbing during the daytime so that the Long-tailed Duck as well as the Common Scoter fly away from their food-seeking areas in the immediate vicinity of the wind turbines. During the mornings and evenings they are to be found again in the immediate vicinity of the wind turbines. Eider have occurred as a rester in the area both before and after the erection of the wind turbines, but they keep mainly to the area north of the wind farm and are not much disturbed by the service boat. It is quite obvious that, in spite of the wind turbines and frequent visiting boats, there are still many waterfowl that use the Utgrunden area as a resting and foraging place. The differences in the shaping of the sea bottom and the composition and thus the differences in e.g. the occurrence of mussels is probably the main reason for the differences in the resting places for the different species of birds.

Summary and Conclusions

- Roughly ca 30% of the waterfowl that migrate through Kalmar Sound are affected to some extent by the wind farms Utgrunden and Yttre Stengrund.
- The Utgrunden wind farm has displaced the migration corridor for spring migrating Eider eastwards in towards the coast of Öland.
- There has been no significant change in the migration corridor during the autumn flight.
- The majority of all the Eider and other migrant waterfowl avoid the near vicinity of the wind farms.
- The birds generally begin the evasive manoeuvre 1–2 km before the encounter with the wind farms.
- The birds' behaviour is similar independent of the time of day or night and visibility – the majority of all the waterfowl react to and avoid the wind farms also at night and in poor visibility.
- For these waterfowl that make this evasive manoeuvre the total migration flight, or migration time, is prolonged by 0.2–0.5%.This entails only a marginal increase of energy expenditure for the whole migration.
- Very few waterfowl flocks fly so near the wind turbines (≤ 100m) that they risk a collision.
- A calculation of collision risk based on data collected during the Kalmar Sound studies shows that 1–4 flocks (one bird per flock) during the spring flight and ca 10 flocks during the autumn

flight risk colliding with the existing wind turbines. Consequently, this entails one waterfowl killed/wind turbine annually.

- A collision of an Eider flock with the rotor blade of one of the turbines has been recorded and showed that four of the 310 Eider in the flock were involved or hit.
- The construction of the Utgrunden wind farm has a possible impact on the attractiveness of the area for resting and wintering, indirectly through the activity of the service boat.
- Utgrunden is still used by Long-tailed Duck, Eider and other resting waterfowl.
- Obviously the service boats that go to and from the turbines are a greater source of disturbance than the wind turbines themselves.

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