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Final Report

Analysis of black stork flight behaviour under different weather and land-use conditions with special consideration of existing wind turbines in the Vogelsberg SPA

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Drone photo of the Hallo wind farm taken from a westerly direction

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Summary

The overall objective of this research project was to improve the state of knowledge on flight behaviour in black storks under different weather and land-use conditions. In addition, the aim was to analyse flight behaviour in spatial proximity to wind turbines (WTs), as there are as yet no published studies on this issue in Germany.

The project area chosen for this study is the Vogelsberg natural landscape unit at Freiensteinau. Within this natural landscape unit, the black stork has a centre of distribution as well as a nesting site that has been in use for several years and has given rise to successful hatches (Atzenstein nesting site). The project area is also particularly suited to addressing the questions motivating this study because two wind farms are located in spatial proximity to the regularly used Atzenstein nesting site. Other successful nesting sites of black stork pairs are situated approximately 6.6 km and 11 km away from these wind farms.

Flight behaviour was categorised by direct observation of observable flight movements with respect to flight altitude (vertical observation) and species-specific behaviours. The impact of weather and land use was assessed by statistical analysis.

For the purposes of analysing flight behaviour in the vicinity of WTs, a radius of 250 m around the turbines was defined as a danger zone. When the birds entered this zone, their flight movements were described in detail (vertical and horizontal observation), taking into account weather data and the turbine blades' tip speed.

In accordance with the questions motivating this research project, the analyses took into account the impact of topography and land-use types on flight behaviour. A further assessment approach involved the identification of potential and utilised feeding habitats offering a good food supply in a 6 km radius around the Atzenstein nesting site.

The study commenced in late March 2016 and was undertaken jointly by the Büro für ökologische Fachplanungen (BöFa) and gutschker-dongus partner consultancies. The first meeting of the project-accompanying advisory council took place on 12 April 2016 in Ulrichstein. The closing meeting was held on 22 November 2017 in Wiesbaden.

The project remit involved the assessment of not only the own research data from the Freiensteinau project area and the data provided by the NABU Hessen conservation NGO but also the findings of previous black stork studies. The latter had also been conducted in spatial proximity to existing wind farms and were thus able to contribute technical data to the issues addressed by the present black stork study. Specifically, these are the studies on the Alpenrod wind farm in the Westerwald, the Rabenau wind farm in the Gießen administrative district, and the Wohnste wind farm in the northern German lowlands. With respect to the Rabenau study, it should be noted that its context is similar to that found in the Freiensteinau project area. Black storks were already breeding in the vicinity of the site later chosen for the wind farm development.

The study on the Moskau-Kreuzstein wind farm was included with a view to a more detailed consideration of the impact of topography and land use on flight movements. At the time the study was undertaken, wind farms had not yet been developed in proximity to the study area.

A spatial behaviour analysis had already been conducted in 2015 in the vicinity of the neighbouring planned Hintersteinau wind farm. The subject of the study had been the same black stork nesting site at the Atzenstein hill; therefore the study was taken into consideration as a comparison to the 2016 assessment.

In order to compare spatial behaviour as determined by direct observation with actual spatial behaviour as determined by telemetry, the present study also evaluated the telemetry study of a black stork fitted with a transmitter in France. Similar to the research at the Alpenrod wind farm, this study also covers the Westerwald natural landscape unit.

However, at the time of publication of the present black stork report, the data of the telemetry study had not yet been released. Therefore, the information regarding this study will be re-added to this report following the release of the data and an updated version of the report will then be published.

Quality assurance for the present black stork study with regard to its methodology and implementation was provided by the ARSU GmbH and Planungsgruppe Grün GmbH consultancies.

Observation points, flight movements, flight altitude categories

Flight movements in the Freiensteinau project area were recorded in the period from 1 April to 11 August 2016 on 40 recording days, with observers working in pairs at observation points and a total recording effort of 640 hours.

At the outset of the study, a total of 12 observation points for recording were available for selection. These were largely reduced to 3 observation points (No. 5b, No. 7 and No. 9) based on visibility analyses, field visits with the quality-assuring consultancies, and photo visualisation. These three observation points were best suited to the various requirements of a black stork spatial behaviour analysis, such as visibility into the nesting site location in the forest and the wind farm respectively, and good surveyability of flight movements in both near- and long-distance ranges.

The survey in the undulating study area was undertaken by recorders who had been calibrated by means of flying drones. A total of 121 flight movements were recorded which could be subdivided into 303 flight events. Five different flight altitude categories were distinguished in this context (0–25 m; 25–50 m, 50–80 m, 80–190 m, > 190 m).

A total of 29% of the recorded flights were in the 80–190 m category (rotor height, altitude category 3) which is a critical height for collisions with modern WTs. This percentage constituted the largest proportion of flight movements in the five altitude categories.

It should be noted in this context that altitude category 3 comprises a 90 m span in altitude while the lower altitude categories cover smaller spans. As a result, it was to be expected that a greater number of flight movements would be recorded in altitude category 3.

Moreover, given the topography and the presence of trees and shrubs it was not always possible to observe the black storks' flights close to the ground. It is therefore possible that flights in the low altitude categories are underrepresented. However, a relatively high number of flight movements took place in the danger zone of modern WT. The other evaluated studies on wind parks, i.e. the Alpenrod, Moskau-Kreuzstein and Wohnste studies, have also shown that during the breeding period black storks regularly fly at altitudes that are critical with respect to wind turbines. The proportion of flight movements visually recorded at critical altitudes as part of the above studies varies from 8% to 32%.

Flight behaviour in the vicinity of wind turbines

In the course of the present study conducted in 2016, on ten out of 121 flights (8.3%) black storks approached WTs to a degree that brought them into the danger zone (250 m radius around the WT; horizontal view). Flythroughs through wind farms were not observed during the present study. At the times the flights in the danger zone of the WTs occurred, weather conditions were always favourable (no precipitation, no high wind speeds, optimum visibility). Overall, the black storks observed were seen to fly horizontally and at times very closely around either the entire wind farm or individual turbines. The WTs were in operation at the times the flights were recorded, with rotors aligned parallel, but also sometimes perpendicular, to the direction of flight.

NABU Hessen recorded a flythrough through the wind farm by two black storks at a critical altitude. However, the birds had chosen a sufficiently wide corridor between turbines and weather conditions were also favourable at that time.

The study on the Alpenrod wind farm (spatial behaviour analysis and monitoring) recorded flights in the danger zone at a similar proportion to that observed in the project area. Out of a total of 105 recorded flights, eight (7.6%) took place in the turbines' danger zone.

The Rabenau wind farm study painted a picture that is more or less similar: Out of a total of 50 flights, 3 (6%) took place in the danger zone. As part of that study, in May 2016 a black stork was observed to clearly engage in a horizontal manoeuvre to avoid entering the wind farm.

Looking at the combined results of the reviewed studies on black storks breeding near wind farms at Freiensteinau, Alpenrod, Hintersteinau, Rabenau and Wohnste respectively, a total of 27 (6.7%) out of 406 flights were observed in the turbines' danger zone (horizontal view). Out of these, only 12 flights can be described as conflict-laden given that they took place at the turbines' critical altitude in the rotor area (vertical view). These 12 flights constitute 45% of the risky flights (or 3% of total flights). Given this low proportion of conflict-laden flights, it would appear that the species takes a "precautionary approach" to WTs. The birds flew around the wind farms or traversed them if there was a sufficiently wide corridor.

Overall, it can be seen that despite the in part only short distances between nesting sites and the nearest wind turbine (550 m to 1300 m) only a very small proportion of total flights must be regarded as conflict-laden. In all those instances the storks managed to fly around the wind farms or fly through them if there was a sufficiently wide corridor; no collisions were observed. Moreover, none of the adult birds went missing in the course of the surveys, which means that there were no collisions during the study period.

Impact of weather conditions on black stork flight altitude

The present study could not infer a statistically supported model that would explain the probability of the occurrence of flights in the altitude category covering the rotor blades. Following a correlation assessment of the available weather parameters, the following parameters were used for further statistical analysis: wind speed, nacelle alignment (wind direction), visibility, temperature, sunshine duration, precipitation and air pressure.

Further parameters were discarded due to their correlation with other parameters. However, in the course of statistical analysis it became apparent that sunshine duration was often statistically significant. Despite the unfavourable R-squared values of the respective underlying binomial Generalised Linear Models (GLM) this may point towards sunshine duration having a certain impact on black stork flight altitudes. Further more comprehensive studies, especially studies using telemetry data, could provide further insights in this respect.

In conclusion it can be said that thermals are highly likely to influence black stork flight altitudes. However, this is a conclusion that could not be drawn with certainty as part of the present study. Thermals probably play a role in particular for long-distance flights.

Land use, feeding habitats and topography

With respect to flight movements, no particular preference could be detected for land-use types. Compared to arable land or grassland, the different forest types were used significantly more frequently relative to the proportion of land area under forest cover around the nesting site, although open countryside constitutes a significantly higher proportion of land use.

For the birds studied it was shown that independent of the land cover present in a black stork pair's home range, flight movements traversed all landscape elements contained therein. Therefore the determining factors were the land-use type in which the nesting site and the feeding habitats sought out by the birds were located and the land-use types they had to fly over on their way between the nesting site and feeding habitats. It is therefore reasonable to conclude that land use in itself had no discernible impact on the spatial distribution of the black storks' flight activity.

In the other reviewed black stork studies, the birds showed a slight bias towards watercourses, and floodplains in particular, which are essential feeding habitats or lead towards such habitats; flight activity was slightly higher in such areas and the birds used them as flight corridors. It is likely therefore that black storks use distinctive valleys for orientation and that more frequently valleys also serve as flight corridors – as long as they lead towards the birds' essential feeding habitats.

In addition, it could be shown that black storks generally fly over peaks in German low mountain ranges.

The present study found a changeover, in terms of flights towards feeding habitats, from those located north of the nesting site (predominantly ponds) in the springtime to feeding habitats located to the south (predominantly semi-natural watercourses and alluvial floodplains) in the summertime. The greater abundance of amphibians in feeding habitats located in the northern to north-western section of the study area may explain the preferential use of these areas in the springtime (cf. Section 4.6).

This behaviour is evidence of a certain flexibility of the species when it comes to utilising hunting habitats in the vicinity of the nesting site, as long as the area contains an appropriate range of suitable hunting areas.

With reference to flight behaviour we can conclude that while valleys can serve as guides, flights traverse all landscape elements. In addition, it is important for black storks to have available a complex network of feeding habitats free of disturbances which can be utilised flexibly in the course of the year.

Flight activity, phenology, spatial behaviour and distances

In the Freiensteinau project area a total of approximately 0.19 flights per hour of observation or 1.52 flights per recording unit (8 hours) were recorded (121 plausible flights, two observers).

Taking into account the other reviewed studies on black storks, it was found that for studies undertaken in the vicinity of breeding territories at a distance of up to 3 km to the nesting site, generally using two recorders working synchronously and 18 days of observations at eight hours each per recorder, a number of approximately 0.17 flights of black storks is realistic. This equates to an average of approximately 1.4 flights per recording unit (cf. Table 51).

The studies reviewed show that approximately 79–98% of visually recorded flights from the nesting site covered a radius of up to 3000 m. Between 2% and 21% of flights covered distances of up to 6000 m from the nesting site (cf. Table 54). It should be noted, however, that the studies reviewed focused on a potential area of conflict and did not constitute full-coverage spatial behaviour analyses of entire territories.

Conclusions

The overall review of the black stork study conducted and the existing studies evaluated here shows that there have been several successful breeding attempts by black storks within a radius of 3000 m of existing wind turbines (WTs).

In Freiensteinau it was found that on 10 flights out of a total of 121 the birds entered the danger zone around the turbines. Of these, five flights were at a critical altitude. These risky flights all took place under conditions of good visibility and low to moderate winds.

Moreover, it could be shown that the black storks studied flew to within a few metres of active wind turbines, actively flew around, over or under the turbine area and, in individual cases, traversed wind farms if the situation was "manageable". Where weather conditions were favourable, the birds passed around the edge of the installations or flew between turbines if there was a sufficiently wide corridor. It would appear that the adult birds studied only approached the wind farm if the risk was calculable.

Weather conditions do not significantly influence flight altitude in the danger zone. However, thermals probably play a role in flight altitude, especially when it comes to long-distance flights.

Land use does not impact on the spatial distribution of flight activity. However, the black storks observed were seen to evade active WTs, at times flying only very closely around them.

Overall it can be said that despite the in part only short distances between nesting sites and the nearest wind turbine (between 550 m and 1300 m) only a very small proportion of total flights must be regarded as conflict-laden. In all these instances the storks flew around the wind farms or through them if there was a sufficiently wide corridor; no collisions were observed. Moreover, none of the adult birds went missing in the course of the surveys, which means that there were no collisions during the study period.

In general it can be said that these conclusions were drawn based on observations of a small number of black storks and should therefore not be generalised. For this reason, it would be important to conduct further investigations (telemetry of birds breeding in the vicinity of WTs) and especially studies using new GPS transponders which record altitude data at the same time. This would allow for more profound statements on altitudes and spatial behaviour as well as on the utilisation of feeding habitats and primary home ranges.

Moreover, telemetry studies should be conducted over a period of at least 3 to 5 years focusing on several black stork specimens in different breeding areas so as to allow for assessments of a broader range of comparative data as well as of long-term data.