

## Impact of wind power plants on black grouse, *Lyrurus tetrix* in Alpine regions

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**A b s t r a c t .** In Styria (Austria) the highest located windpark within Europe was built between 1 800 and 1 900 m a.s.l. at a lek site of black grouse in 2002. After five years monitoring data show a strong decline of the local black grouse population. Collisions of the birds with the towers are recorded, disturbance because of wind park maintenance, infrastructure and tourism are difficult to evaluate. On another mountain ridge in Styria with two windparks and a skilift the same drastic population decline was registered. Within the province of Styria between 30 and 40 locations for windparks were discussed from different points of view (technology, energy, ecology). Locations for windpower plants in alpine regions overlap with lek sites of black grouse to a very high percentage.

**Key words:** black grouse, wind power, lek site, alpine ecosystems, disturbance

### Introduction

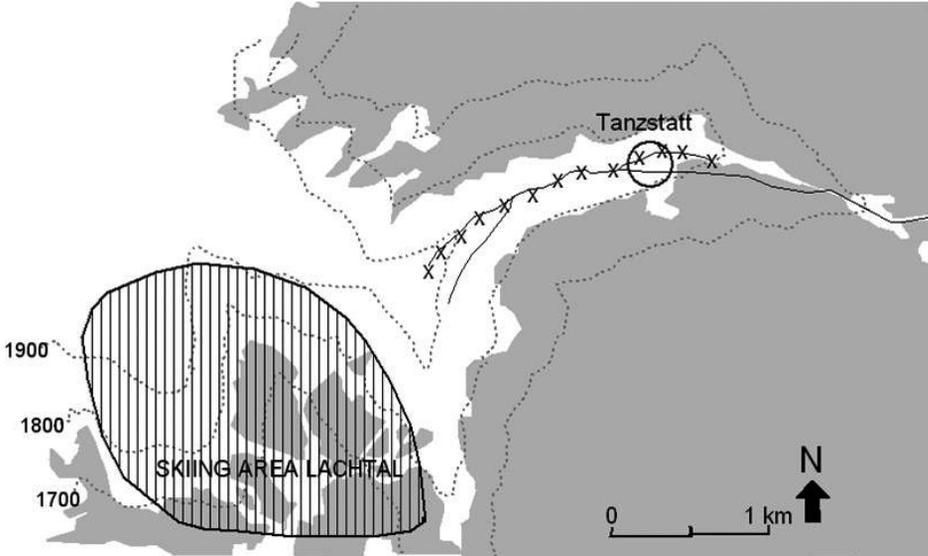
Austria inhabits one of the largest black grouse populations in central Europe. As in a lot of neighbouring countries almost all the populations of lower elevations became extinct. The species now occurs primarily in alpine habitats along the timber line. In the past these alpine habitats were maintained by man in a positive way for grouse especially because of cattle grazing and clearing. Recently other impacts (skiing areas, tourism, intensive agriculture, building projects and infrastructure) have increased. There are a number of studies about the influence of these land use practices on grouse (Watson & Moss 2004, Ingold 2005, e.g. Arlettaz et al. 2007). An entirely new situation is created with the development of renewable energy sources and the building of wind parks in high altitudes. The impact of wind farms on birds is discussed controversially. Many studies emphasis barrier effects, collisions, change of distribution or disturbance, but the effects are often very specific due to species and habitats (Hötker et al. 2005, De Lucas et al. 2007). Studies about the effect of wind farms on black grouse consider so far only experiences from Styria (Austria) (Zeiler & Berger 2003, 2005, Traxler et al. 2005, Deutz & Grünschachner-Berger 2006). Wind is a very important factor for wildlife habitats in mountain areas. Especially in winter wind creates along mountain ridges a mosaic of different snow depths and therefore sites for feeding, hiding or even lekking in early spring. On these ridges the habitat for black grouse often extends like a belt along the timber line. Especially in the eastern parts of the Alps with lower altitudes open ridges with alpine meadows become narrow, as well as the suitable habitat for the species. Therefore there are no alternative habitats available in close surroundings.

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## Study Area

In 2002 the highest located windpark within Europe was built between 1 800 and 1 900 m a.s. in Styria (Austria). The study area embraces about 350 ha around this wind farm named “Tauernwindpark”. Most of the study area is situated above the timber line or in the ecotone between forest and alpine meadows. It is a very smooth mountain ridge with excellent black



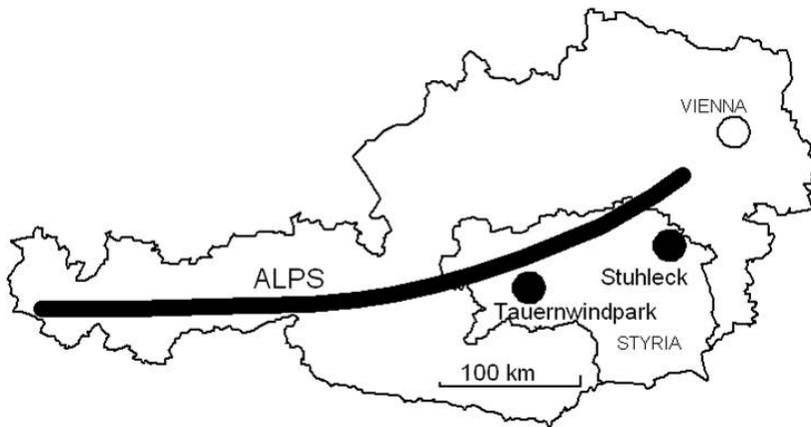
**Fig. 1.** Site of “Tauernwindpark”. The ring marks the site of the former central lek site “Tanzstatt”. (X - site of the wind power plants; Grey - wood; White - alpine meadows; \_\_\_\_ – road).



**Fig. 2.** View over the “Tauernwindpark”. The white ellipse in the background marks the former central lek site “Tanzstatt”.

grouse habitat situated near Oberzeiring within the Lower Tauern, a part of the eastern Alps. The first eleven wind power plants were established in 2002. The park expanded in 2004 with another two towers at the west side (Fig. 1). Since then thirteen turbines are working at a hub height of 60 m. The rotor blade diameters are 66 m, the towers are situated in a line on the mountain ridge from east to west with 171 m distance between (Fig. 2). The central location in the windpark is called “Tanzstatt” which means “dancing place”. It points out the importance of a very well known, historically significant black grouse lek site. The region was dedicated as Important Bird Area by Sackl & Zechner (1995). Formerly it was designated also as Natura 2000 site, but it was exempted from a partly surrounding Natura 2000 area.

A second study area with two wind parks in black grouse habitat is located at the border between Styria and Lower Austria. It is an area of 900 ha in size situated on the mountain ridge Stuhleck/Pretul (1 600 to 1 750 m.a.s.). In 2005 the first wind park, consisting of ten wind power plants, was built there; in 2006 the second park, consisting of five wind power plants, followed (Fig. 3).



**Fig. 3.** The site of the Styrian wind parks in Austria. The “Tauernwindpark exists since 2002, near the Stuhleck, two wind parks were build in 2005 and 2006.

## Material and Methods

Data were collected on the numbers of displaying cocks in spring time. Therefore our results first of all show the local population development on the base of male numbers as well as the annual distribution of displaying males.

The plan to build the wind park was just announced in the year the erection started, so we could not implement long term monitoring anymore. We had to rely upon prior monitoring data of displaying cocks from local hunters (whole-area-monitoring until 2003). Since 2004 the monitoring was implemented together with local hunters and partly by order of the operating company. Depending on the weather conditions black grouse were counted once or twice every year from fixed sites. The numbers of males and females were collected simultaneously every 15 minutes from 04:15 to 06:00 in the morning. Movements of males between lek sites were also recorded. Additionally, we counted the displaying cocks at the central lek “Tanzstatt” several times a year in spring and autumn, starting 2002. Further investigations were made by order of the operating company which are only partly allowed to be published (Traxler et al. 2005).

So we have two main data sets for the “Tauernwindpark”: One for the 350 ha area from 1999 to 2007, the other for the specific lek site ”Tanzstatt“ from 2002 to 2007. A poll among neighbouring hunting grounds in 2006 within a radius of 10 km estimated the population development of black grouse. Found dead birds were analysed by a veterinarian (Research Institute of Wildlife Ecology, University of Veterinary Medicine Vienna).

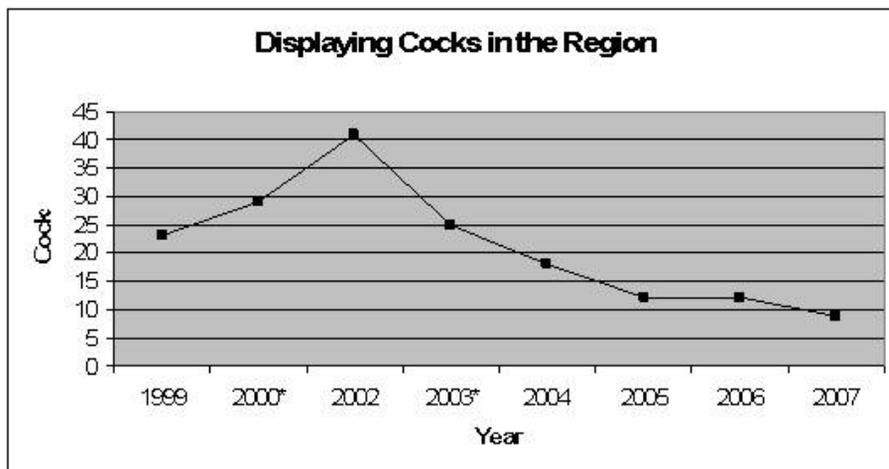
In the second study area, Stuhleck/Pretul, we also have a counting from the local hunters from 2000 in comparison with a concerted counting 2007. Data of potential locations of wind parks (list compiled by Styrian Energy Association) and lek sites of black grouse (data recorded by the Styrian Hunting Association) were compared.

## Results

The analyses of 28 potential sites for wind power plants in mountain areas in Styria pointed out, that 24 are located within black grouse habitat. Especially along the most eastern borderline of the Alps, where smooth mountain slopes are about 1 600 to 1 900 m a.s.l.; 14 sites were overlapping. This is actually the eastern boundary of the alpine black grouse population. Best positions for efficient working power plants are situated usually directly at lek sites.

### Population and distribution development at “Tauernwindpark”

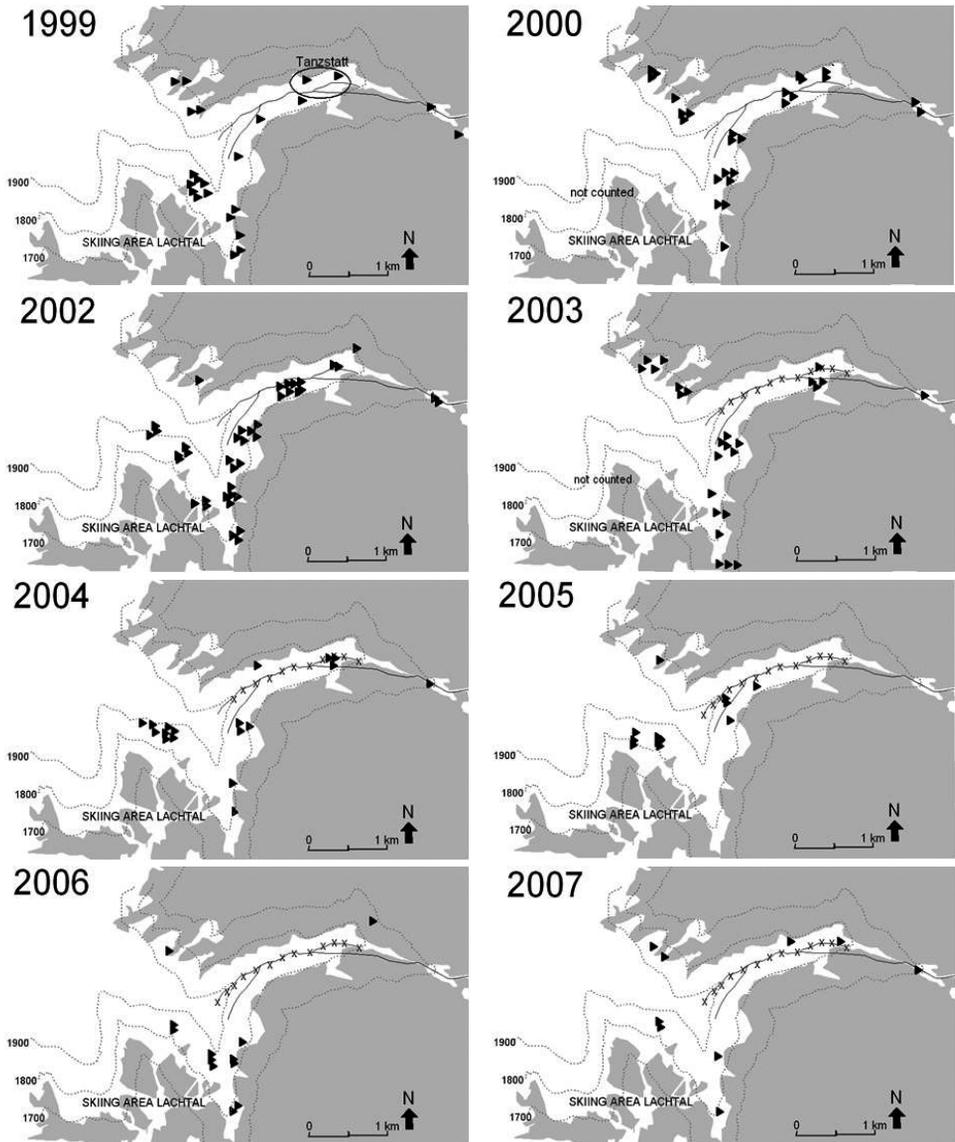
Our monitoring data from the “Tauernwindpark” show typical clumped distribution of black grouse males during lekking period although the number of single displaying cocks as well as the distribution at the study area fluctuates from year to year. The proportion of single displaying cocks increased as the overall number of males decreased. From 1999 to 2002 the local black grouse population increased from 23 displaying cocks to 41. In April 2002 the building project of the wind power plants was started near the central lek site during the reproduction period. Afterwards the overall number declined to 9 males in the whole region until 2007 (Fig. 4). This was the lowest number people could ever remember in the



**Fig. 4.** Recorded is the highest number of seen displaying cocks at a certain time at one morning in spring. In 2000 and 2003 Lachtal (see Fig. 1) was not counted.

region. The number of hen had wild fluctuations at Lachtal (Fig. 5). The distribution pattern of displaying males changed obviously. It shifted to south west. The area around the power plants and smaller eastern leks were more and more avoided (Fig 6).

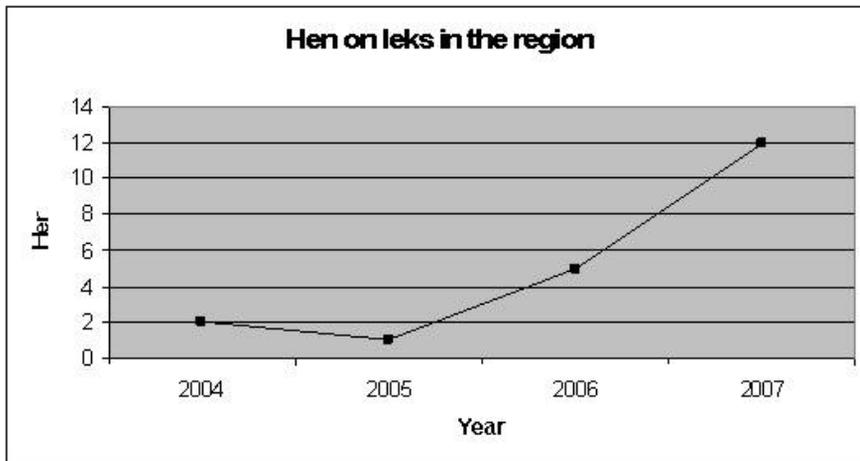
In 2002 a maximum number of 12 males were displaying at the central lek „Tanzstatt“ about 200 m away from building activities with heavy machines and spotlights in the early morning. Although there were people and excavators working, trucks driving etc. the birds assembled regularly at the lek all the same; only when trucks passed by in a distance of about



**Fig. 5.** Alteration of distribution of singing cocks between 1999 and 2007. (X .. Site of the wind power plants; ► - Site of singing cocks; Grey - wood; White - alpine meadows; \_\_\_\_ - road). The disappearance of cocks over the years especially in the area of the wind power plants and eastern parts are striking.



**Fig. 6.** Since 2002 the cocks at the former main lek „Tanzstatt“ are counted with the whole area and separately some more times. Coincidental countings from only one day in this little area are avoided. The graph shows the maximal number of recorded cocks per year at the lek.

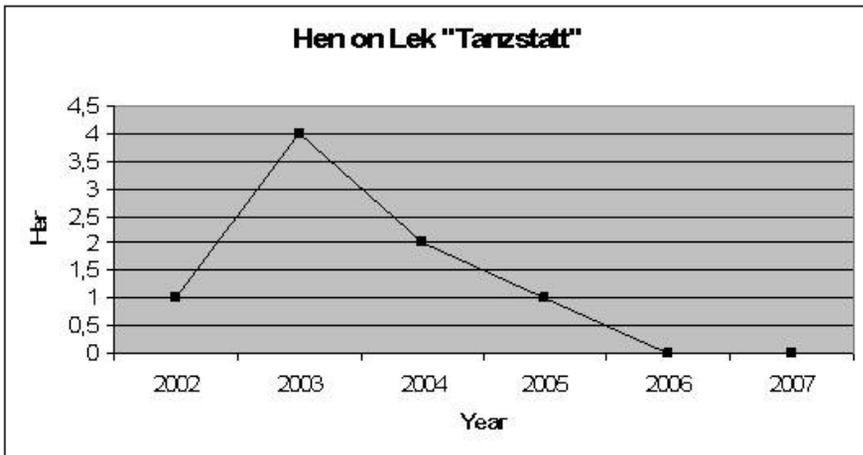


**Fig. 7.** Hen were only included in the countings since we organized them in 2004. The high number of hens 2007 came off only because nine hens were seen at Lachtal (East side, s. Fig. 1). In 2000 and 2003 Lachtal was not counted.

100 m the cocks interrupted their display for a short time but did not leave the site. From 2002 to 2007 the number of males decreased to zero at the central lek between the power plants (Fig. 7). Females were rarely seen (Fig. 8). At this point it has to be mentioned, that until 2006 in spring black grouse males were still shot in the study area<sup>1</sup>. 2007 was the first year in which no cock was shot there any more because there were too few. At the central lek “Tanzstatt” the last cock was shot 2006. No young males (yearlings) could no longer be observed at this central lek site and its surroundings since 2003, one year after erecting the towers.

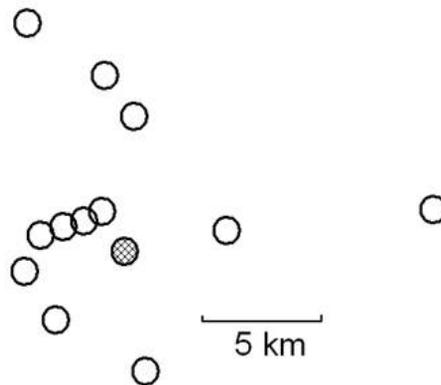
The poll in the surrounding hunting areas within a radius of approximately 10 km around the “Tauernwindpark” resulted in a more or less stable development of black grouse

<sup>1</sup> The Styrian hunting law allows to shoot one of five displaying cocks in a hunting area. These hunting areas have a minimum of 115 ha, 6 hunting areas have parts in the region of the “Tauernwindpark”.



**Fig. 8.** After the erection of the wind power plants not many hen could be observed at the main lek. The table shows the maximal seen hen per year at the lek. 2007 only one hen was observed 150 m under the lek for a short time during mating time in the morning. A hen and her tracks were seen two times in the woods under the lek at a distance of about 200 m during spring.

populations. We asked about observations of decreasing or increasing male black grouse numbers at sixteen neighbouring leks. These leks are situated in continuation to the study area along the timberline on neighbour ridges in distances between three and ten km (Fig. 9). It appeared that no neighbour lek had obviously a strong increasing number of black grouse because of emigrated birds, nor a similar strong decline on other sites could be confirmed.



**Fig. 9.** Sites of leks within a radius of 10 km. At none of these places a striking increase nor a similar decline of cocks was reported. Full circle represents the "Tauernwindpark".

## Collisions

Collisions of black grouse with the power plants are confirmed, but the birds typically fly under the operating distance of the rotor blades, i.e. 27m above ground. Two males were found dead direct under the towers in 2003 and 2004. They were analysed by veterinarians, and were found to have suffered from broken cervical spine, one broken blade-bone and disruptions of lungs and livers. With the utmost probability the birds flew against a hard hindrance. As the birds were found directly at the feet of the towers they presumably flew into

them. Three further black grouse were found within the reach of the towers (Jaklitsch, Kainer, oral comments).

### Rock ptarmigan (*Lagopus mutus*)

Rock ptarmigan was common in the higher western parts of the study area and ongoing mountain tops. In 2004 the two western power plants were erected. In the same year three territories of displaying males were confirmed in spring. 2005 only one displaying cock could be seen there. 2006/07 there was no evidence of displaying rock ptarmigan in this area any more.

### Stuhleck/Pretul Region

In this region only two data sets from monitoring displaying cocks are available. The mountain is well known as a historically good black grouse occurrence and a former important source population. In 2000 sixty displaying males were counted by synchronous counting on the ridge. The number decreased to twenty cocks in 2007.

## Discussion

Fluctuating numbers of black grouse are common in alpine habitats (Klaus et al. 1990). Although in 2002 there seems to be a peak within the population development ("Tauernwindpark": 41 displaying males / 350 ha), the trend after this year no longer show any cyclic fluctuation. Since the "Tauerwindpark" was finished the population trend is strong declining. A former source population developed to a sink one. The first year of the wind park showed almost no impact on black grouse. Within the monitoring period of five years the picture is completely different. This shows first of all, that studies should extend on longer periods to get approved population trends. Counting male black grouse at leks in spring time is an efficient method to get information about population development.

Although we have evidence (photo material) about black grouse beyond wind power plants, the distribution patterns show clearly an increasing avoidance of the „Tauernwindpark“ from year to year. The two wind parks in the Stuhleck/Pretul region show the same development. But as far as now we are not able to explain the causes of the decline.

Because adult male black grouse are holding on their lek sites constantly, negative impacts become more obvious after the elder generation died off. So they are detected too late if no attention is paid to the number of yearlings. This lack of offspring immediately after erection of the park raises the main questions:

- How important are collision victims for the population decline?
- Is the vocal communication interrupted because of the noise of the turbines?
- Are the fast changing shadows of the rotor blades a negative impact on displaying cocks or hen?
- What is the impact by tourism and maintenance?
- Are females visiting leks within the reach of wind mills any more?

## Collisions

Collisions between black grouse and power plants were recorded. It is imaginable, that the birds flew into the white painted towers under bad weather conditions. The foehn wind blows there regularly. This wind is often connected with fog, so the visibility conditions can change

rapidly. There was no systematic searching for dead animals over the years. The influence of raptors on the finding rate of collision victims in alpine areas is also unknown.

### Noise and shadow

Black grouse start to display early in the morning when the noise level is very low. Hjorth (1970) postulates that in Scandinavia singing black grouse can be heard to a distance of 3 km. Depending on the weather conditions and structure of country site we can confirm distances up to 4 km in alpine regions. When wind is blowing strong it is not possible to hear displaying cocks even within a distance of 50 m because of the noise of working turbines. So from our point communication is disturbed. We could see the displaying males, but depending on the wind power the noise of the turbines diminished or eliminated the vocal performance completely.

The influence of the shadows of rotating rotor blades on different species are discussed in many cases (de Lucas et al. 2007). But no description exists of this influence on displaying birds.

### Disturbance by maintenance and tourism

As there are heavy machines necessary to build up wind power plants, well constructed roads are needed to bring material and machines up on mountain ridges. After the building project was finished the roads are used for maintenance which has to take place every day, even in winter. Therefore people appear every day in these regions which formerly were out of reach in winter and during mating time in spring. Additionally the “Tauernwindpark” advertised the park itself as an attraction for tourism. Thereupon more than thousand cars and busses came up to the “Tauernwindpark” during the first years. So there was a high level of disturbance throughout all the year. We cannot determine these impacts, but we assume it cannot be the main reason for the immediate lack of yearlings at the lek sites.

To recapitulate all these questions: We can show a connection between the wind park and the decreasing number of black grouse, but we don't know much about the causes of the disappearance of the species. Most likely is a summation of different impacts. Furthermore work has to be done to find out details. On the other hand we can demonstrate that alpine wind parks are serious threats on local populations of black grouse. So we recommend that future efforts should be directed at identifying such high risk areas of potential locations of wind parks. This information should be used to avoid such areas for wind parks.

### Acknowledgements

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