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Fact Sheet

Red Kite *vs.* Wind Turbine ?

A analysis of Red Kite (*Milvus milvus*) collision risk as a function of Wind Turbine rotation speed

Based on detections made by *SafeWind* systems on 251 operating wind turbines from January 14, 2019 to January 14, 2023

Lauréat du PASS FRENCH TECH

DOES SHUTTING DOWN A WIND TURBINE REDUCE THE RISK OF BIRD COLLISION ?

The scientific littérature suggests that the risk of bird collision on wind turbines depends on several factors[1,2] :

- The bird's own speed, their abilility to anticipate movement and their ability to maneuver in flight.
- The frequency, abundance and phenology of species at the site.
- Weather conditions.
- The diameter and height of the rotors.
- **The rotor speed → this factor is the only one that can be controlled during the operation of the wind turbines.**

S*afeWind* is a video-detection system on wind turbines that allows to study or reduce the risk of bird collision by scaring and/or regulating turbine, depending on operators requests. From 2019 to 2023, theses systems have produced hundreds of thousands of Red Kite detections and 30 collisions, lethal or not, have been recorded.

For each detection achieved, *SafeWind* records the rotation speed of the wind turbine. It thus becomes possible to study the influence of this speed on collision risk of and, ultimately, to assess the usefulness of stopping a wind turbine in the event of close vicinity of a bird in flight. This is the objective of this FactSheet, taking the Red Kite (*Milvus milvus*) as an example.

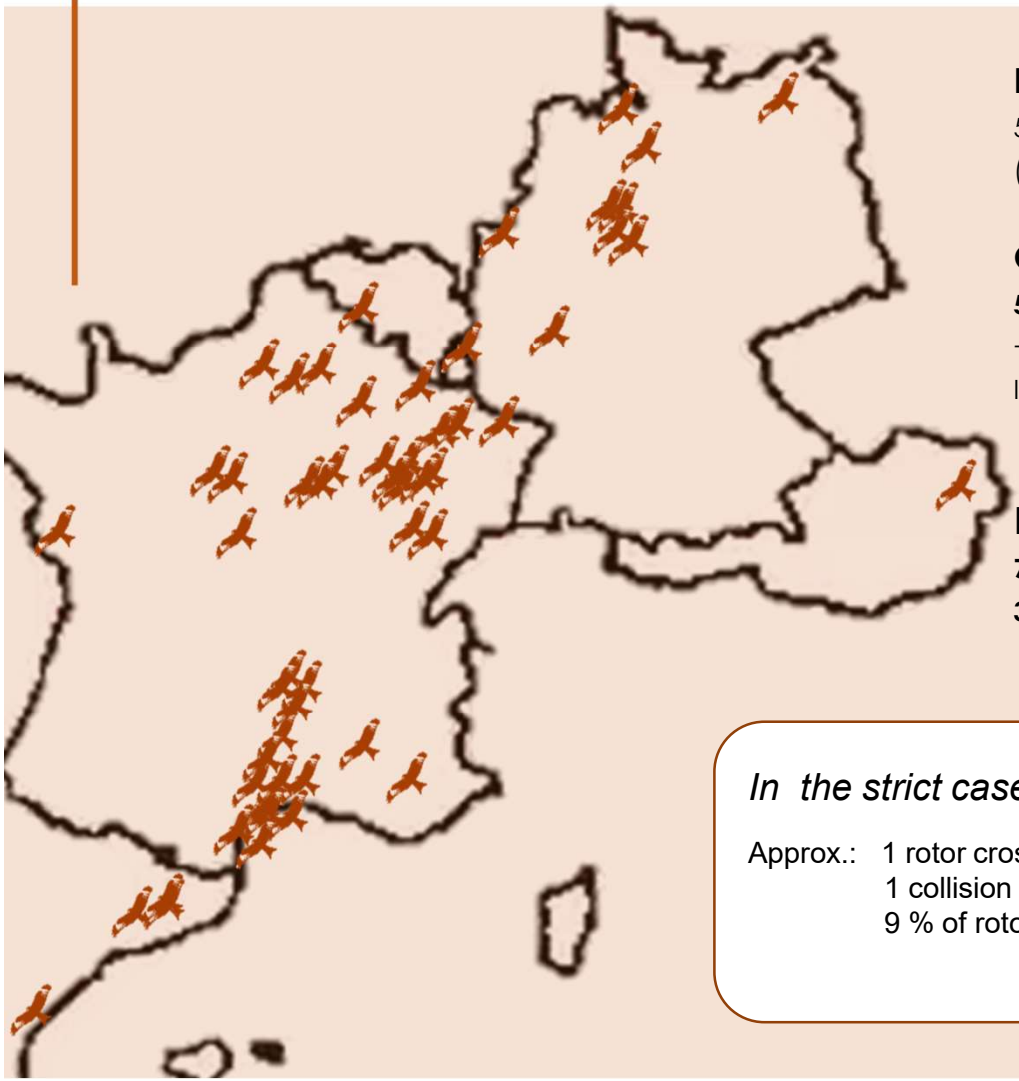
The Red Kite can reach a flight speed of 21 $m.s^{-1}$ or 76 km/h (*nb : 22 $m.s^{-1}$ or 79 km/h for the Black Kite*)[3].
This species should therefore be able to avoid other flying birds or moving objects within its natural speed range.

As a consequence, Red Kite collisions should be more frequent when the linear speeds at the blade tip (BTS) are greater than 76 km/h.

This is the hypothesis we will test in this study.

[1] *Chamberlain, D. E. et al. (2006). The effect of avoidance rates on bird mortality predictions made by wind turbine collision risk models. Ibis, 148, 198-202.*
[2] *Barrios, L., & Rodriguez, A. (2004). Behavioural and environmental correlates of soaring-bird mortality at on-shore wind turbines. Journal of applied ecology, 41(1), 72-81*
[3] *Bruderer, B., & Boldt, A. (2001). Flight characteristics of birds: I. Radar measurements of speeds. Ibis, 143(2), 178-204*

STUDY SITES



Description of equipped wind farms

56 operating windfarms from January 14, 2109 and January 14, 2023
(= 251 wind turbines with presence of Red Kite)

General data

596'517 detection videos : with 306'202 Red Kite videos
+ 290'315 *Milvus sp*. videos.
Including 404'745 videos with recorded rotor speed

Results

734 rotor crossings with 237 Red Kite and 497 *Milvus sp*.
30 collisions including 22 Red Kites and 8 *Milvus sp*.

In the strict case of Red Kite :

Approx.: 1 rotor crossing for 1'000 detection videos
1 collision for 15'000 detection videos
9 % of rotor crossings result in a collision (22 / 237)*

*4 % with Red Kite + *Milvus sp*.

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COLLISIONS IN DESCENDING ORDER OF ROTATION SPEED (1/2)

Date	Time	Sepcies	Country	Blade Tip speed (SCADA logging, km/h)	Lethality
29/02/2020	*15:40:39*	*Milvus milvus*	Germany	294	Yes
21/03/2021	*11:56:14*	*Milvus milvus*	France	274	Yes
01/06/2021	*10:18:52*	*Milvus milvus*	France	274	No, blown
05/06/2020	*12:06:33*	*Milvus sp.*	France	268	Yes
28/10/2020	*14:34:44*	*Milvus milvus*	France	251	Yes
28/05/2022	16:25:25	*Milvus sp.*	France	241	Yes
05/09/2019	*13:24:48*	*Milvus milvus*	France	224	Yes
25/11/2020	*08:34:10*	*Milvus milvus*	France	214	Yes
26/11/2020	*14:24:19*	*Milvus milvus*	France	208	No, blown
11/11/2022	*15:47:16*	*Milvus milvus*	Spain	183	Yes
23/01/2022	*15:24:31*	*Milvus milvus*	Spain	182	Yes
02/02/2021	*17:04:53*	*Milvus milvus*	Spain	182	Yes
25/04/2022	*10:57:37*	*Milvus sp.*	France	178*	Yes
22/07/2022	*09:49:24*	*Milvus milvus*	France	174*	Yes
23/07/2022	*15:14:23*	*Milvus sp.*	France	174	Yes

* = Estimated speed (Estimated from videos when SCADA was unavailable)

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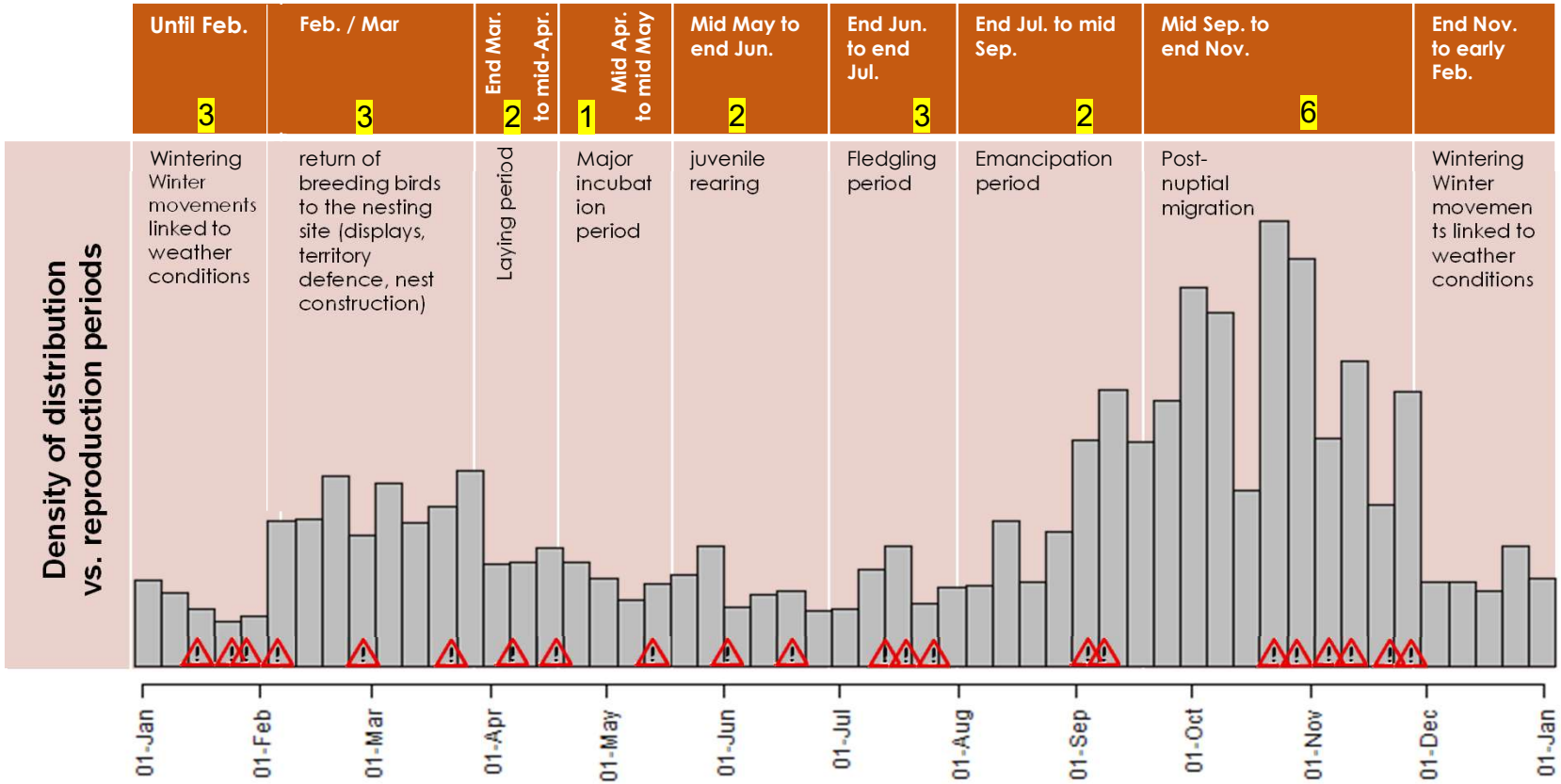
COLLISIONS IN DESCENDING ORDER OF ROTATION SPEED (2/2)

Date	Time	Species	Country	Blade Tip Speed (SCADA logging, km/h)	Lethality
04/07/2021	*16:47:02*	*Milvus sp.*	France	170*	No, blown
06/11/2019	14:21:04	*Milvus milvus*	France	166	Yes
02/06/2022	*16:54:11*	*Milvus sp.*	France	166	Yes
04/04/2019	*12:42:50*	*Milvus milvus*	France	164	Yes
16/07/2019	*08:38:07*	*Milvus milvus*	France	163	Yes
24/10/2022	*11:43:16*	*Milvus milvus*	Spain	140	Yes
18/04/2020	*12:23:00*	*Milvus milvus*	France	131	Yes
12/08/2019	*13:51:27*	*Milvus sp.*	France	130	Yes
07/05/2022	*09:09:15*	*Milvus sp.*	France	129	Yes
26/01/2022	*11:53:48*	*Milvus milvus*	Spain	119	Yes
12/05/2021	*12:52:37*	*Milvus milvus*	France	117	Wounded
08/09/2022	*11:24:53*	*Milvus milvus*	France	112	Yes
16/07/2022	*09:28:01*	*Milvus milvus*	France	90	Yes
13/06/2022	*11:35:04*	*Milvus milvus*	France	32	Yes
12/01/2023	*13:59:00*	*Milvus milvus*	France	32	No

* = Estimated speed (Estimated from videos when SCADA was unavailable)

SEASONAL DISTRIBUTION OF RECORDED COLLISIONS

Seasonal distribution of detections and collisions for *Milvus milvus*, and biological cycle in France[4]
(n= 306'202 detections and 22 collisions for *Milvus milvus* ⚠)

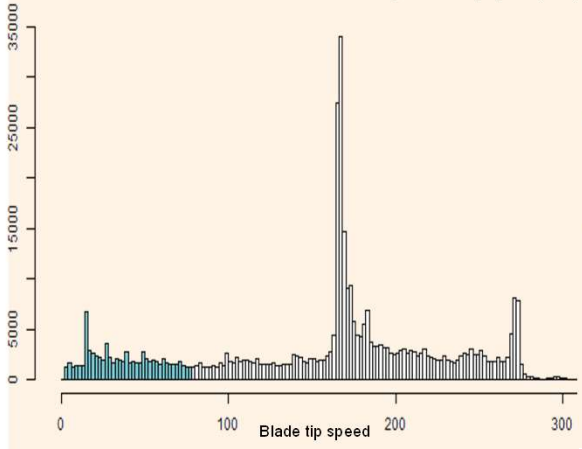


[4]PNA-Milan-Royal-2018-2027 - *French Ministry for Ecology, Sustainable Development and Energy.*

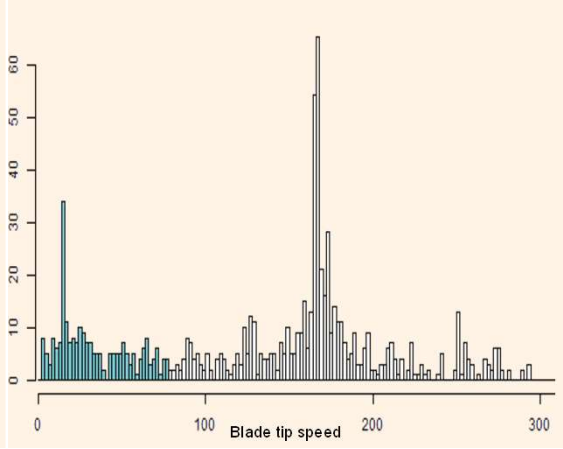
BLADE TIP SPEED DISTRIBUTION *MILVUS MILVUS + MILVUS SP.*

Videos detection	Rotor crossings	Collision events
404'745 video	**851 video (734 events)**	**30 events (incl. 4 nonlethal)**
18 % below 76 km/h	**27 % below 76 km/h**	**< 7 % below 76 km/h**

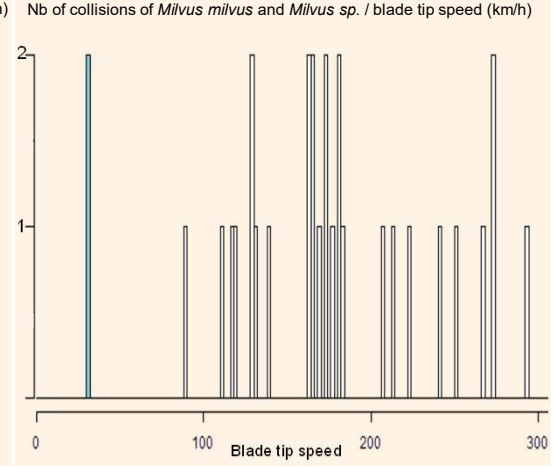
Nb of video detections of *Milvus milvus* and *Milvus sp.* / blade tip speed (km/h)



Nb of rotor crossings by *Milvus milvus* and *Milvus sp.* / blade tip speed (km/h)



Nb of collisions of *Milvus milvus* and *Milvus sp.* / blade tip speed (km/h)



→ **96% of lethal collisions are observed when blade tip speed (BTS) > 76 km/h**
And 92% of lethal collisions when BTS > 110 km/h

→ **The proportion of rotor crossings is statistically higher when BTS < 76 km/h**
nb of video are compared, McNemar's Chi-squared test - p-value <2.2e-16
0.31% vs. 0.19 % → Tendency to avoid rotor more when BTS > 76 km/h

→ **The proportion of lethal collisions is statistically higher when BTS > 76 km/h**
nb of events are compared, McNemar's Chi-squared test - p-value <2.2e-16
1/213 vs. 25/521 → Ten fold more risk of lethal collision if crossing with BTS > 76 km/h
2/273 vs. 24/461 → Seven fold more risk of lethal collision if crossing with BTS > 110 km/h

CONCLUSION

1. Red Kite mortalities on wind turbines are revealeld throughout its biological cycle.
2. Lethal collisions occur at high rotational speeds but also at very low speed (32 km/h BTS), when the wind turbines are said to be « feathered », therefore already in functionnal shutdown, and do not produce electricity.
3. Non-lethal collisions are also observed at high rotation speeds (> 270 km/h BTS)

4 %
of rotor crossings (all speeds combined) lead to a collision

7 x
more risk of mortality when BTS > 110 km/h

92 %
of lethal collisions occur when BTS > 110 km/h

→ **The collision risk for Red Kite appears to be related to the rotation speed of the wind turbines.**

While this species appears to be cautious in avoiding crossing rotors more when the blade speed is greater than its own maximum flight speed, it is less successuf in avoiding collisions when the blade speed is greater than this maximum flight speed.

The individual factors (less cautious or less watchfull birds) or environmental factors explaining the rotor crossings at high rotation speed as well as the reduction in avoidance capacity must still be explain.

DISCUSSION

About bird protection

→ The data obtained by the *SafeWind*® systems allow for the first time to confirm the influence of the rotation speed of the wind turbines on the risk of collision for the Red Kite.

→ The principle of real-time detections of this species by automated systems in order to initiate a slowing down of the wind turbines therefore appears to be effective in significantly reducing the risk of collision.

→ However, this risk cannot be completely canceled by this method since collisions are also observed when the wind turbines are « feathered », therefore already in functionnal shutdown, and do not produce electricity[5].

→ Reducing the risk of collision in the latter cases requires implementing means other than wind turbine regulation.

About safier rotation speed thresholds

→ The significant reduction in the risk of collision does not require a complete shutdown of the wind turbines (ie BTS = 0 km/h).

→ More than 90% of lethal collisions could be avoided by slowing the rotors down to a speed threshold of 110 km/h BTS, which is significantly higher than the maximum speed of the Red Kite in the wild.

→ However, this threshold must be refined by continuing to detect and record collision events. The detection systems should therefore provide means of verification including at least continuous video recording and ex-post checks.

To go further

→ Several models of contemporary wind turbines have a minimum production speed below the threshold of 110 km/h BTS. Considering for these turbines a minimum production of 6 rounds per minute, the BTS is thus 92 km/h for a 80 m rotor diameter and 80 km/h for a 70 rotor diameter.

→ Rather than completely shutting down theses turbines in case of a bird being detected, simply reducing their rotation speed down to the production threshold would theorically make possible to address two major challenges for windpower production : the significant reduction of collision risk for birds and the reduction of intermittent power production.

→ Additionaly, avoiding repeated stops and restarts of turbines and induced grid disconnections should also help to preseve their lifespan while facilitating the balance of grid at a larger scale.

[5]. For information, we observed feathered turbines with BTS up to almost 70 km/h.

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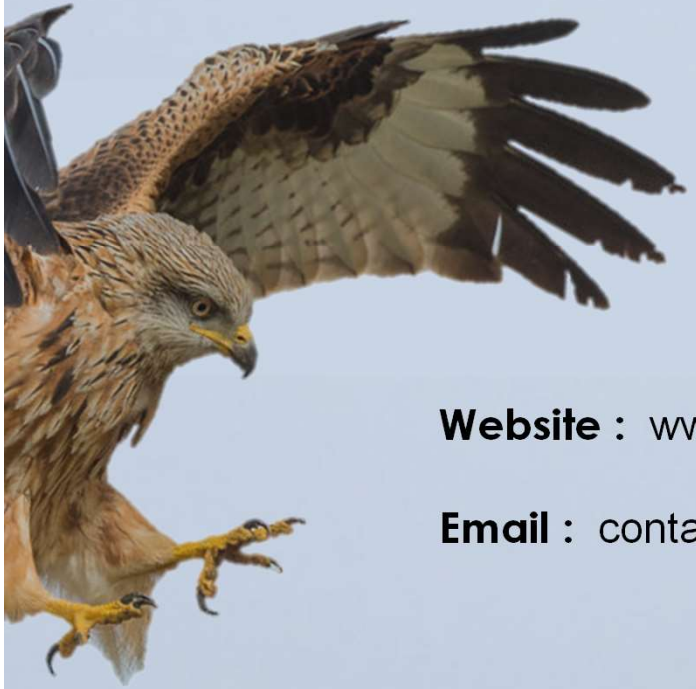

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