

Windfarm collisions : even increasing populations can suffer strong demographic impacts

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Introduction

Wind farms can affect bird species in two ways: directly via collisions with wind turbines, or indirectly via habitat loss for species that avoid windfarms. However very few studies estimated precisely the demographic impacts on populations of species concerned, even though such quantification is critical to make the stake seriously considered by politicians, stakeholders and general public.

The lesser kestrel *Falco naumanni* is an endangered migratory short-lived raptor, susceptible to collision with wind turbines. The largest population in France breeds in villages of Hérault department, within a 20-km radius around the Aumelas plateau, an important feeding area for falcons (Fig.1). The settlement of a windfarm on this plateau in 2006 could negatively affect their population viability in the long term. We aimed at evaluated the impacts of windfarm turbine collisions on demography of the largest lesser kestrel population in France.

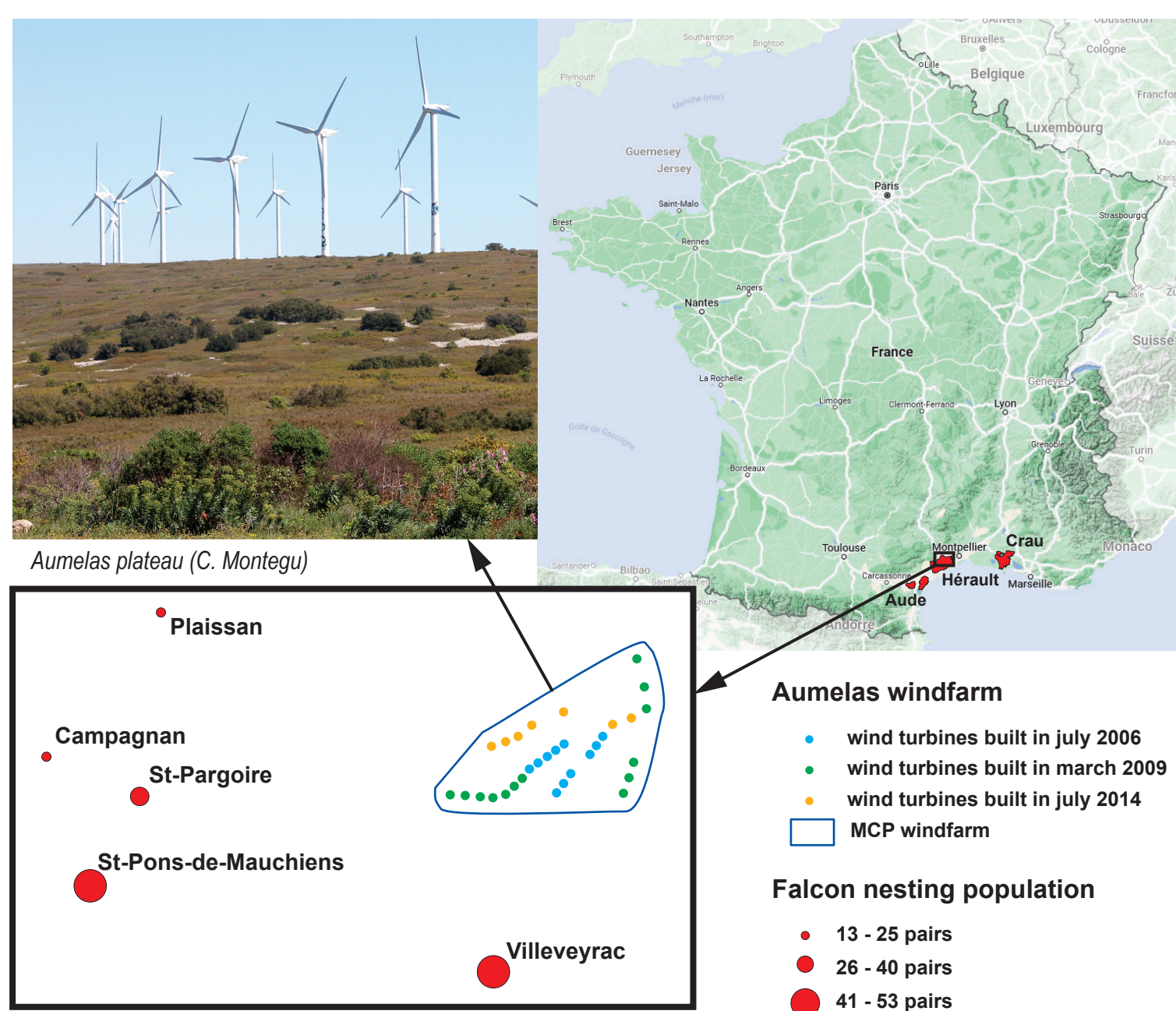


Figure 1. Breeding populations of lesser kestrels in France with a zoom around Aumelas windfarm.

Methods

To resume, in a first step we estimated vital parameters (fecundity, survival rates), as well as immigration numbers, thanks to a detailed monitoring of reproduction of the studied population and monitoring of marked individuals from a nearby population (Crau).

In a second step, we estimated mortality rates induced by wind turbines, by using the results of carcasses searches in the windfarm of Aumelas.

In a third step we ran population dynamics simulations, based on matrix population models, using vital parameters previously estimated, to predict population trajectories over 30 years, accounting for immigration or not.

Results

Table 1. Parameter values estimated to the matrix population model.

Parameter	Population ¹	Age	Year	Mean estimates ± SE
Productivity²	Hérault	subadult	2006-2020	0.838 ± 0.078
		adult		1.409 ± 0.131
Breeding frequency	Crau	subadult	2006-2020	0.349 ± 0.040
		adult		0.824 ± 0.025
Survival	Crau	juvenile	2006-2020	0.474 ± 0.0305
		subadult & adult		0.674 ± 0.026
Annual immigration	Hérault	subadult		26
Mortality rate³	Hérault		2007-2008	0.011
	11 turbines		2009-2014	0.023
	24 turbines		2015-2020	0.030
	31 turbines			

¹ Population indicates the origin of the dataset used to estimate each value.

² Productivity was approximated by the number of juvenile female fledged per breeding female.

³ Mortality rate referred only to collisions with wind turbines.

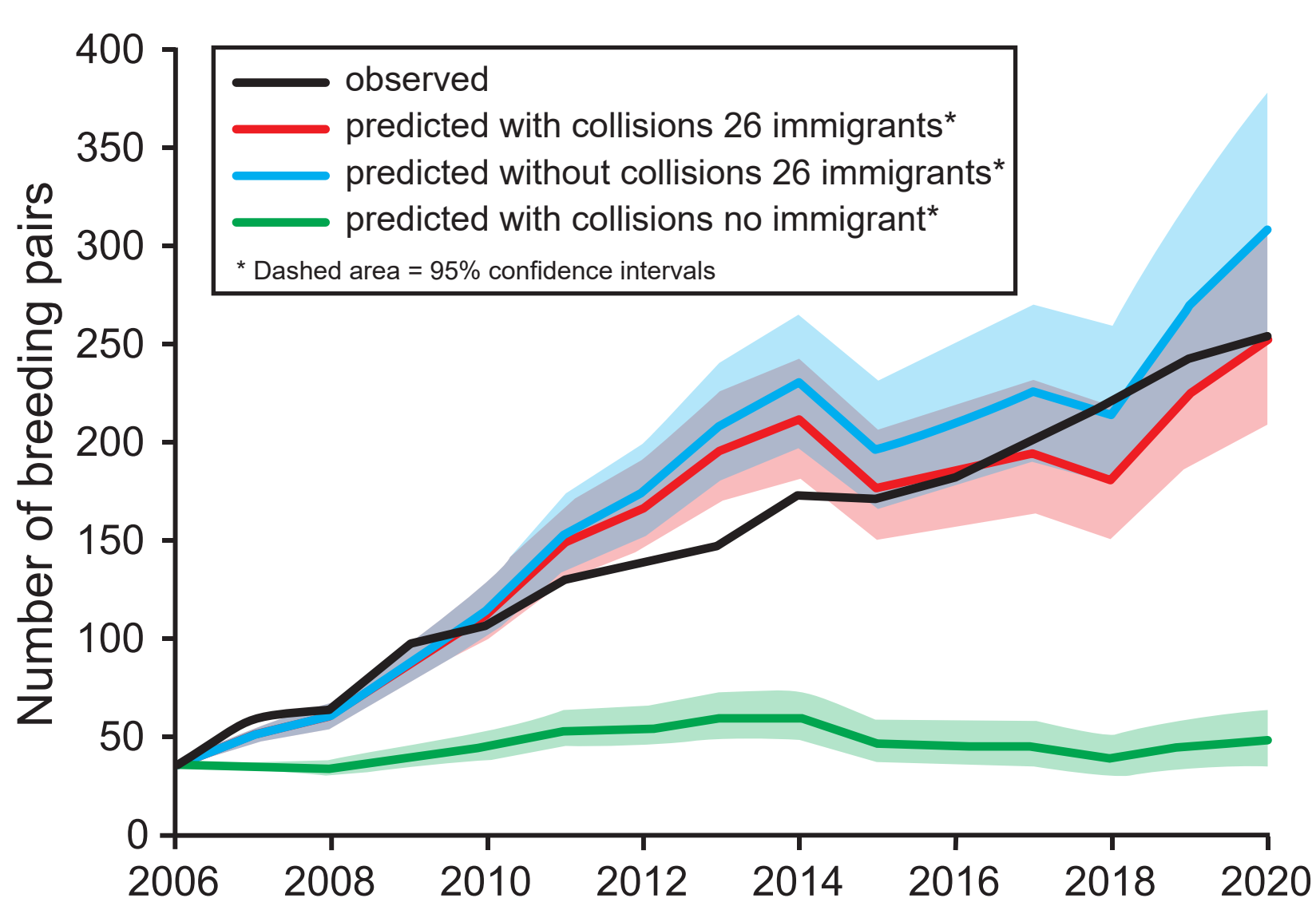


Figure 2. Number of breeding pairs (2006-2020) in the Hérault population observed and predicted by the matrix population model.

Estimation of mortality by collision with wind turbines

On the overall windfarm of Aumelas plateau, 43 dead bodies of lesser kestrels were found between 2013 and 2020 with the standard monitoring protocol. After correcting biases due to cadaver persistence, prospector efficiency and surface really prospected, we estimated that 154 falcons have been killed by wind turbines for this period, i.e. 3.6 times more than the cadavers really found.

Retrospective PVA¹

From the observed population size in Hérault, the inter-annual population growth rate was 1.166 between 2006 and 2020.

The additional mortality rate due to collision was estimated at 3% of females every year. When modelling the population trajectory without windfarm mortality, the population size should have reached a peak of 308 breeding pairs in 2020, i.e. 22% higher than the 252 pairs predicted by the model with windfarm mortality.

¹ Population Viability Analysis

Prospective PVA

If the current situation prevail in the next 30 years, with 26 immigrants per year, the population would continue to grow up to 869 breeding pairs in 2050 [95% Confidence intervals: 331 – 2657] (fig. 3A). Without additional mortality due to collisions, the population would reach 1742 breeding pairs [95% Confidence intervals: 590 – 5722] in 2050 (fig. 3A). The relative impact of collisions was progressively increasing over the years, reaching 21% difference (with the projected population without collision) after 10 years and 50% after 30 years (fig. 3B).

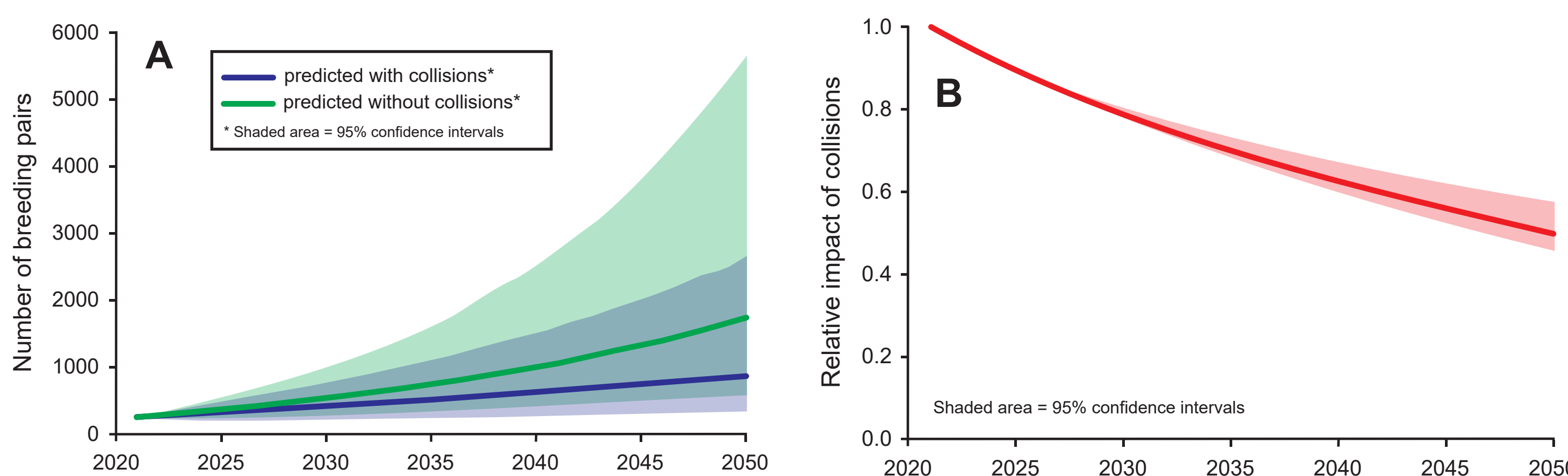


Figure 3. Projection of population sizes in Hérault, as simulated by the matrix population model until 2050 (A). Relative impact of collisions, estimated by the difference in population size between projections with and without collisions (B).

The population growth rate λ would decline with increasing mortality rates (fig. 4). With current number of immigrants, the population would decline ($\lambda < 1$) if mortality rate would exceed 11%. Without immigration, λ would decrease linearly with the mortality rate induced by collisions (fig. 4). Hence each percent of increase of mortality would result in a 1% decrease of λ , and the population in absence of immigration would decline if mortality rate would exceed 5%, i.e. 1.6 times the current mortality rate (3%).

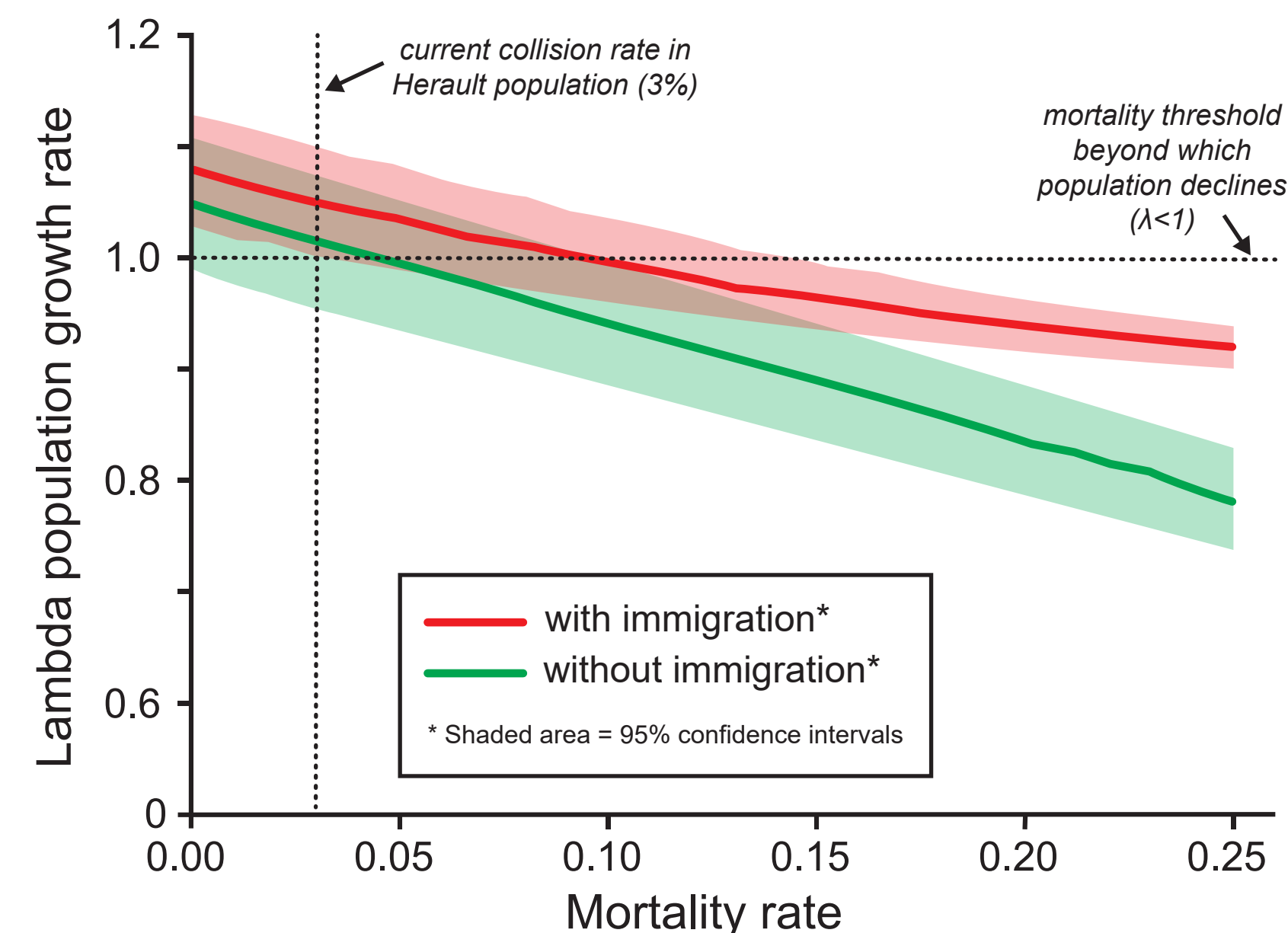


Figure 4. Variation of projected interannual population growth rate λ of the population of lesser kestrels, according to mortality rate induced from collision with wind turbines.

Conclusions



lesser kestrel (Y. Pimont)

Despite lesser kestrels being shorter-lived birds with higher fecundity, we found that additional mortalities induced by collisions with turbines may also have a strong impact on their population dynamics. We found that the current population growth rate was correlated to mortality rate induced by collisions.

The matrix model showed that the population growth observed was only possible if there was a constant recruitment of 26 immigrant individuals each year in the population. Without overmortality by windfarm, we predict that this population would have 22% more breeding pairs than that observed in 2020. Simulations over 30 years showed that, under current immigration rate, the population should decline if overmortality exceeds 11%. If immigration ceases, the population would decline above 5% overmortality per year.

It is urgent to monitor and reduce overmortality by collision on windfarms that threatens this lesser kestrel population. Especially that, since 2010 in southern France, at least six other carcasses of lesser kestrels have been found in other windfarms, within areas used by falcons as post-nuptial stopovers or along migratory routes.

More generally we advocate the use of PVA demographic models into impact assessment studies to avoid placing new windfarms close to rare species that could not sustain additional mortality by collisions.

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