Effect of wind turbine mortality on noctule bats in Sweden: predictions from a simple population model

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… the projected number of annual fatalities… for the mid Atlantic highlands … in the year 2020 … range from 33,000 to 111,000 bats … figures are very troubling (Kunz et al. 2007)

Kunz et al. 2007
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Fatality frequencies of bat species at wind farms in northern Europe

Common noctule	**471**
Nathusius´ pipistrelle	**353**
Common pipistrelle	**279**
Leisler´s noctule	**66**
Parti-coloured bat	**56**
Serotine	**39**
Pygmy pipistrelle	**29**
Northern bat	**13**
All other species	**20**

Source: EUROBATS 2011

The noctule in Sweden

Population estimate:
65-115 000 individuals (Sohlman 2008)

Noctules are common along the coast and in agricultural areas, but more irregular in forest regions inland. All individuals probably migrate long distances

We assume population size = 90,000 in year 2000 (t = 0), all reproductive, and equal sex ratio - **hence 45,000 reproducing females**

Projected growth of wind farming in Sweden

- **2000-2010:** 110 new turbines per year, **100 within noctule range**
- **2011-2020**: 1,000 new turbines per year, of which half outside noctule range and the rest in forest areas, where noctules are sparse **- 250 per year that potentially may affect noctules**

Source: Energiverket 2010

The model…

$$N_{t+1} = s_{ad}\, N_t + s_{juv}\,(b_0 - \beta N_t)\, N_t - hN_w$$

N_t = population size year t

s_{ad} = annual survival of adults — **0.56** (Heise 1989)

s_{juv} = annual survival of young — **0.54** (Heise 1989)

b_0 = fecundity (no. young per female) — **1.65** (Heise 1989)

β = density dependence of fecundity — 1.13×10^{-7}

N_w = annual fatalities per turbine — **0.9** (Seiche 2008)

h = no. turbines within noctule range

Can we use estimates of fatality rate from Germany (N_w = 0.9)?

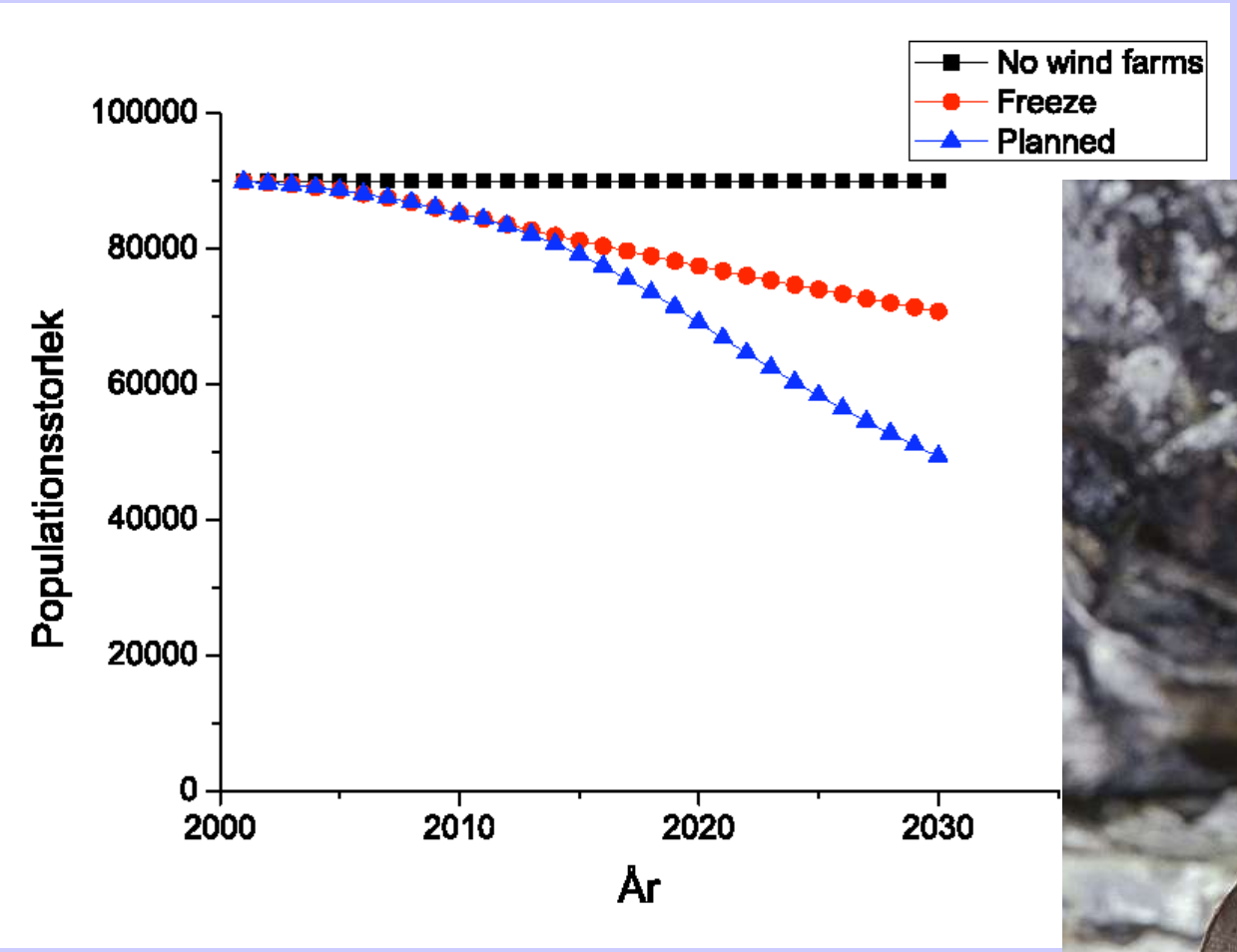
One-visit-per-turbine studies:

- **Sweden - 0.11 dead bats per turbine (160 turbines)**
  1 of 17 was a noctule (Ahlén 2002)

- **Germany - 0.07 dead bats per turbine (94 turbines)**
  1 of 7 was a noctule (Kusenbach 2004)

Not significantly different by chi-square tests

Prediction


No wind farms
Freeze
Planned
100000
80000
60000
40000
20000
0
Populationsstorlek
2000
2010
2020
2030
År

Conclusions

1. **Wind farming in Sweden will probably have a negative effect on the noctule bat at the population level.**

or

2. **The assumptions do not hold and the result may be far off. In particular**
   a) species specific fatality rate at wind turbines (N_w = 0.9 in Germany) may be too high
   b) population size ($N_{t=0}$ = 90,000) may be too high or too low
   c) adult survival (s_{ad} = 0.56 in Germany) is probably too low

But in any case…

… we can not exclude the risk that wind farming will affect the noctule in Sweden at the population level

…but to make useful predictions we really need better population data

Thank you!