

# Mortality of radio collared Willow Ptarmigan in Smøla wind-power plant.



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# Why Willow Ptarmigan studies at Smøla?

- Terrestrial "bad flyer" model species large enough for radiotelemetry
- Smøla willow ptarmigan (*Lagopus l. variegatus*), only endemic subspecies
- Important small game circumpolar
- Turned out to be # 1 on "dead birds list"
- In total 82 dead willow ptarmigan found inside or close to the SWPP area (2006-2010).



# Field Methods



Spring and autumn Surveys



VHF-telemetry



Cause



Winter capture

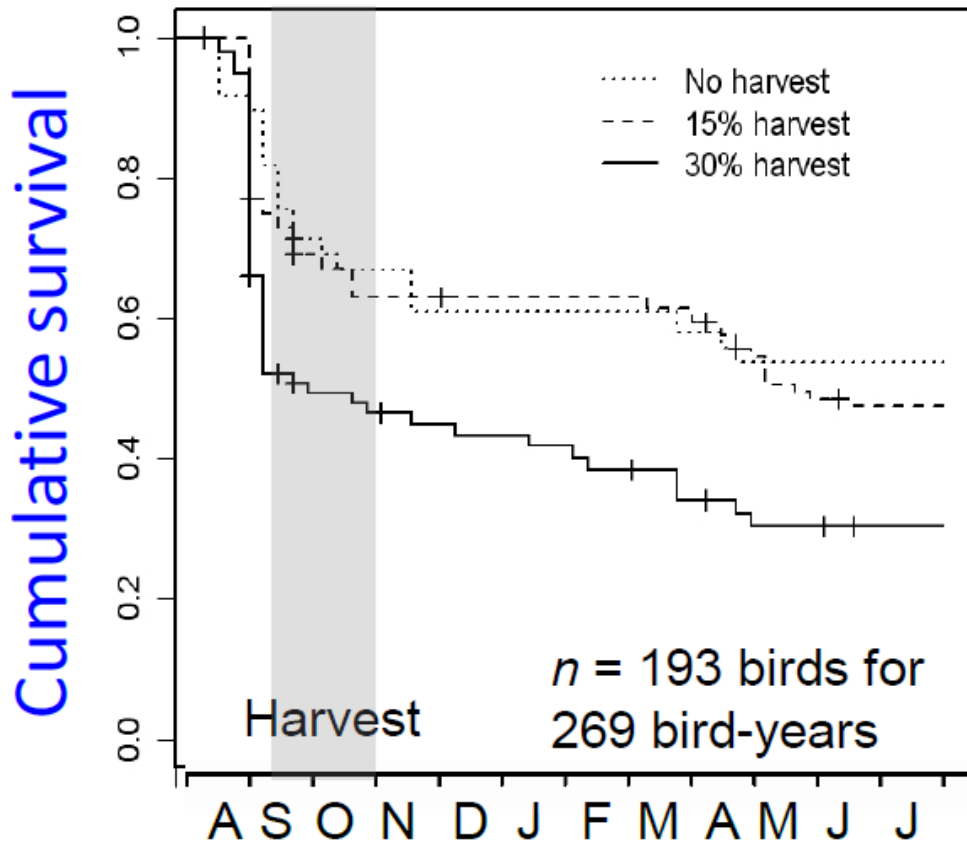


# Survival Analysis

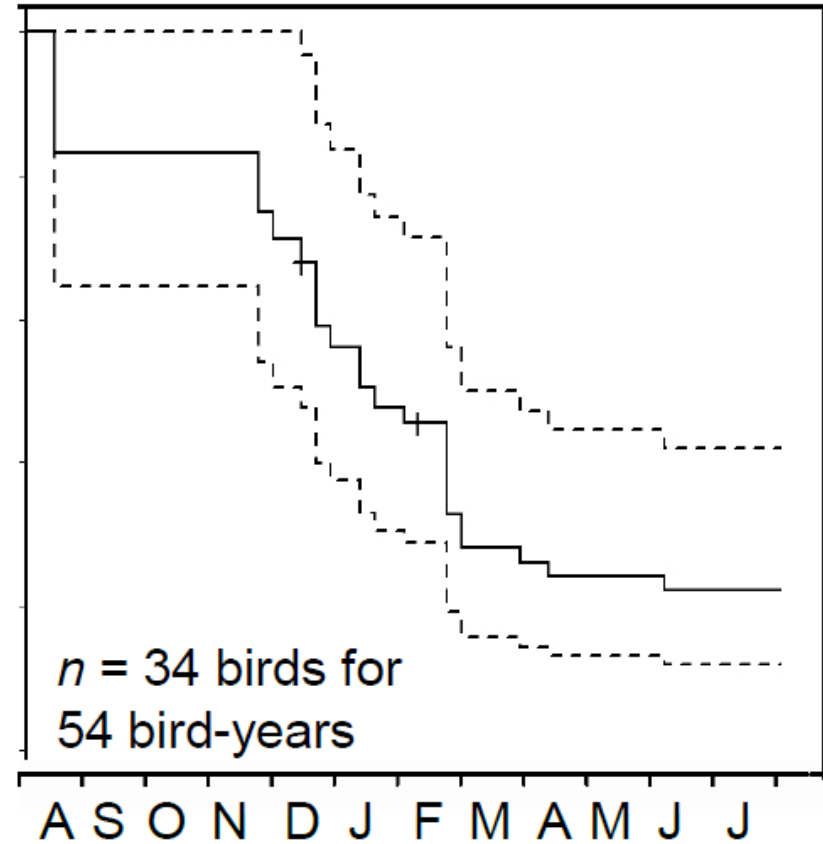
- **Known fate models:** staggered-entry telemetry data
  - **Estimating risks:** Nonparametric cumulative incidence function estimator for mortality (Heisey & Patterson 2006)
  - **Software:** implemented in Program R
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- **Sample:** radio-marked willow ptarmigan,  $n = 34$  individuals monitored for 54 bird-years, individual as random effect
  - **Causes of mortality:** raptor (56%), turbine (and predation) (33%) or other (11%,  $n = 27$ )

# Kaplan-Meier Cumulative Survival Rates

## Meråker (Inland)

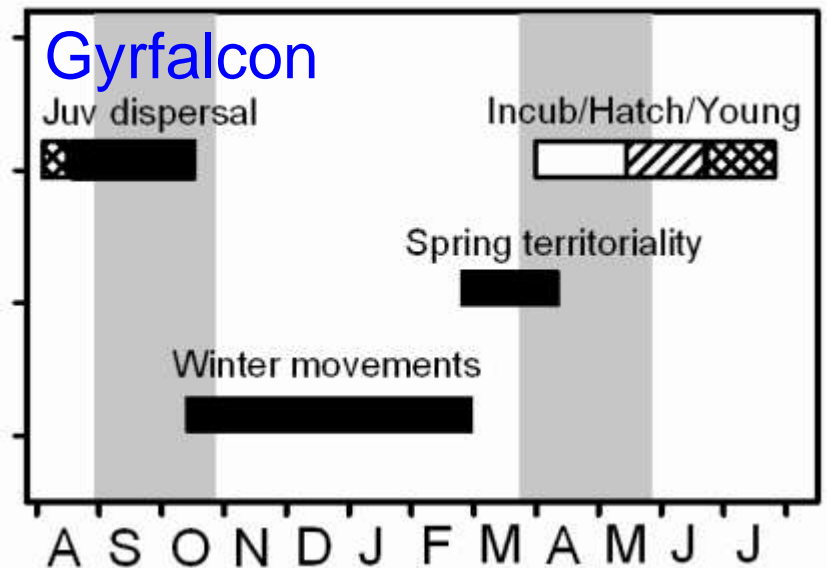
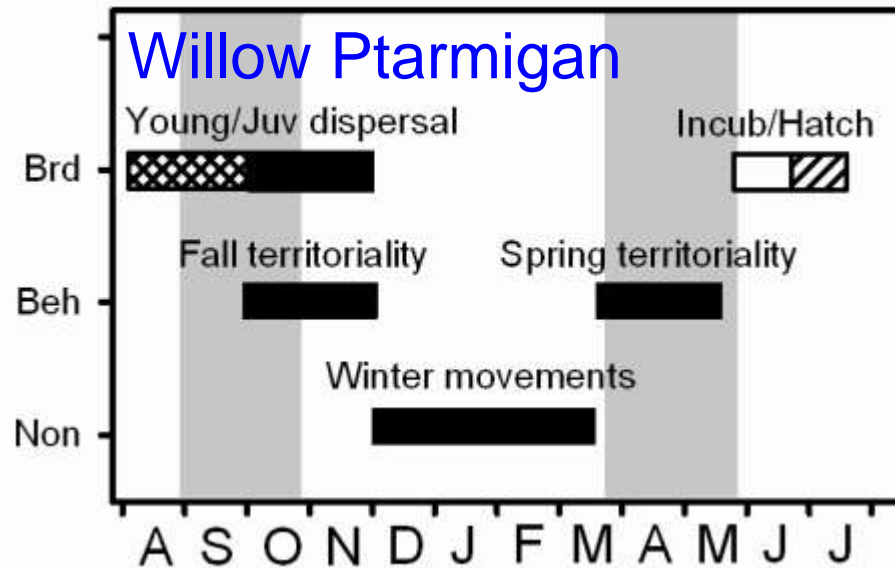
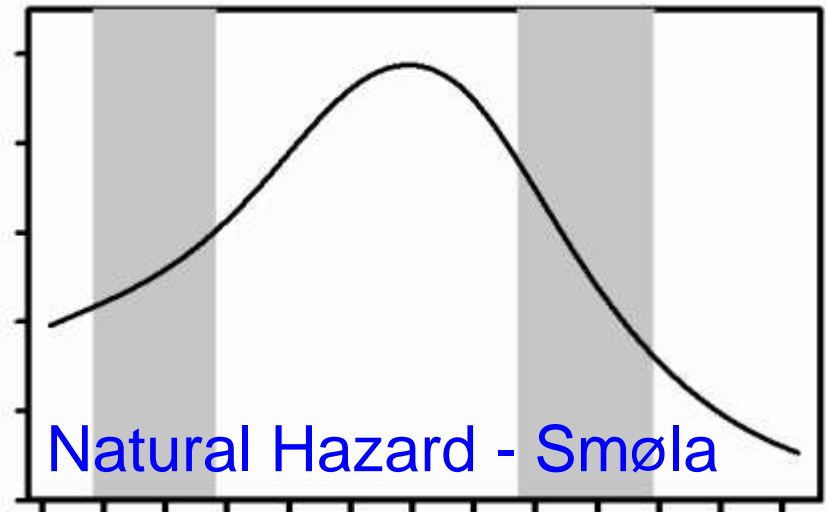
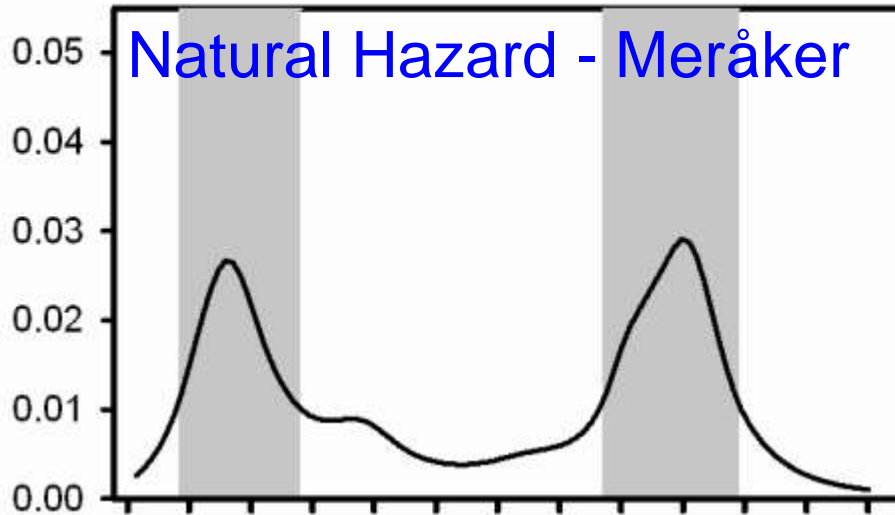


## Smøla (Coastal)



Month of year

# Ecological Correlates of Natural Mortality



Month of year

# Are Willow Ptarmigan killed by turbines or raptors?



- To what extent do raptors feed on wind-turbine killed willow ptarmigan?
- Scavenger removal tests carried out in the SWPP area during two weeks of November 2010 and March 2011.
- Willow ptarmigan carcasses were laid out on every 3rd wind-turbine, in total 23 carcasses, approx 700-1000 m between each carcass (gives 1.3 carcasses/km<sup>2</sup>).
- Each carcass was equipped with radio-transmitter and camera.

# Are Willow Ptarmigan killed by turbines or raptors?

- During the two weeks in November 2010, in total 5 carcasses were removed from the original position; three by avian scavengers and two by American mink, whereas one additional carcass was eaten by a raven at the original position.
- During March none of the carcasses were removed (heavy snowfall?).
- So far we believe that raptors still kill willow ptarmigan also at Smøla (in addition to wind-turbines).
- Observations of gyrfalcon at the coast of Norway coincides with heavy mortality of radio-tagged willow ptarmigan at Smøla.





# What is the risk of Willow Ptarmigan colliding with turbines?



How often do willow ptarmigan fly in rotor height?

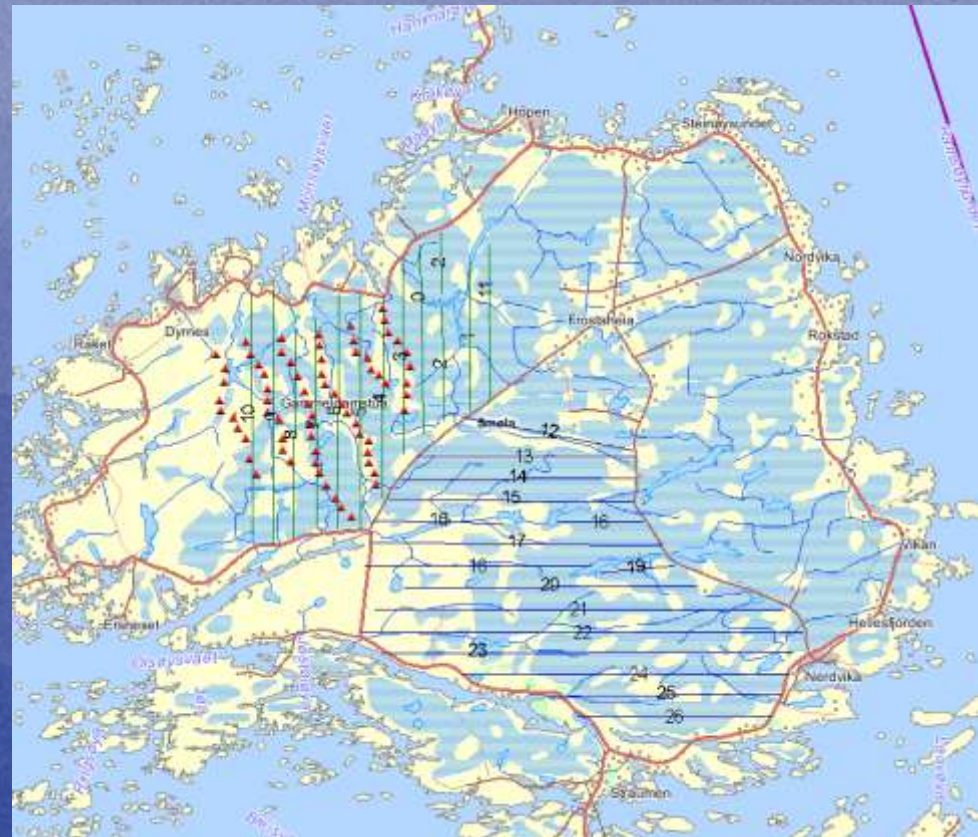
2% of 212 observations above 15 meter but none in rotor height (30m).

Willow ptarmigan collide with turbine tower.

Register flight height when willow ptarmigan is flushed; above or below 15 meter

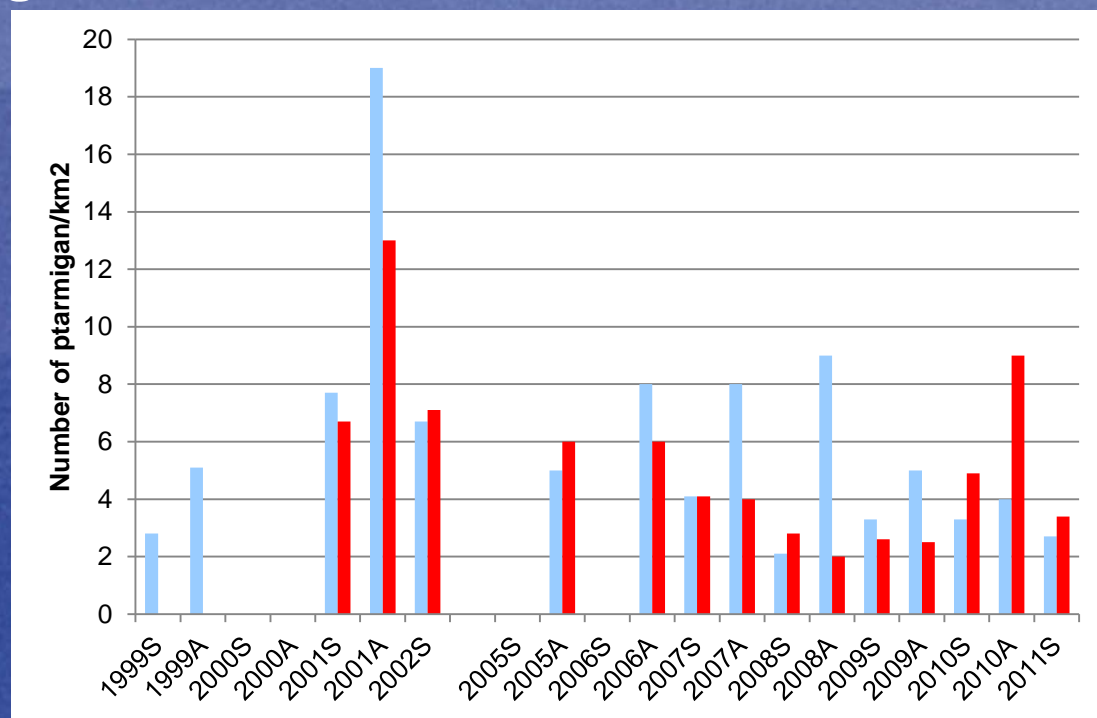
# What about effects on the Willow Ptarmigan population size at Smøla?

- Density estimates of breeding population (April-May) and August population in SWPP and control area (CA).
- SWPP: 12 census lines (total 55 km)
- CA: 9 census lines (total 45 km)



# What about effects on the Willow Ptarmigan population size at Smøla?

- No indication of reduced population size in SWPP compared to CA.
- Differences in autumn seem to be evened out during winter giving almost identical spring densities in both areas.

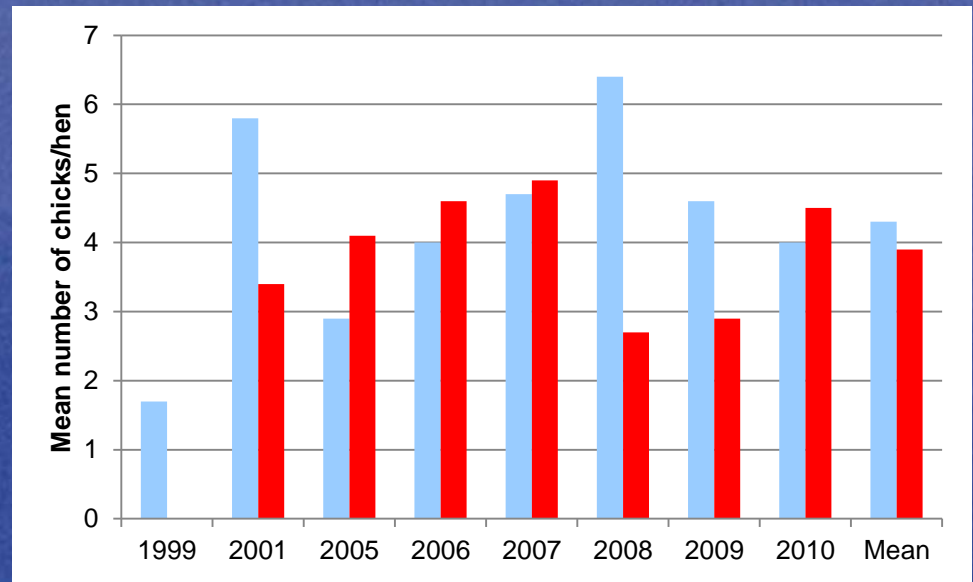


# What about effects on the Willow Ptarmigan population size at Smøla?

- Finite rate of population growth  $\lambda = (F/2)S_j + S_a$ , where  $F/2$  is the number of female young per pair under a 1:1 sex ratio,  $S_j$  is juvenile survival, and  $S_a$  is adult survival. If 1-month old juveniles have similar overwinter survival rates as adults ( $S_j = S_a^{11/12}$ ), then the average brood size necessary to maintain a stationary population ( $\lambda = 1$ ) can be estimated as  $F = 2(1 - S) / S^{11/12}$  (Sandercock et al. 2011).
- The chick production necessary to balance an annual survival rate of e.g. 0.54 (unhunted inland population), would be 1.6 young per pair.
- To balance an annual survival rate of 0,30 would need 4.2 young per pair.
- What do we find at Smøla?

# What about effects on the Willow Ptarmigan population size at Smøla?

- According to our survival analyses we find an annual survival rate of 26.2% [95% c.i.: 15.8 – 43.6%].
- The chick production necessary to balance this survival rate is 5.04 young per pair [2.4 – 9.1].
- Given the annual survival rate found in the Smøla willow ptarmigan population, chick production only occasionally balance mortality.



## Conclusions:

- Annual survival of radio-tagged willow ptarmigan is much lower at Smøla than in inland willow ptarmigan populations (<30% vs. >50%).
- The mortality pattern is different from the pattern found in inland populations ; high winter mortality at Smøla.
- Heavy winter mortality of radio-tagged birds seems to be caused by a combination of natural mortality and turbine-induced mortality.
- Natural mortality is caused by migrating raptors.
- Compared to other willow ptarmigan populations, chick production is reasonably good, and no difference is found between the SWPP area and the control area.
- However, chick production only occasionally balance mortality.

## Some important questions to sort out:

- The population effect of natural mortality compared to turbine-induced mortality.
- The importance of scavenging of dead willow ptarmigan, to better separate natural mortality from turbine-induced mortality.
- To sort out possible mitigating measures to reduce the collision hazard for willow ptarmigan.
- Understand sink/source dynamics of Smøla willow ptarmigan population – is annual survival higher outside SWPP?

Thank you for your attention!

