



# The effect of wind farms on vultures in Northern Spain: fatalities, behaviour and correction measures

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# Mortality rates, species affected

AREA	A	B	C
Windfarms	125	64	62
Turbines	3305	1879	908
Turbines sampled	57.45%	49.39%	69.49%

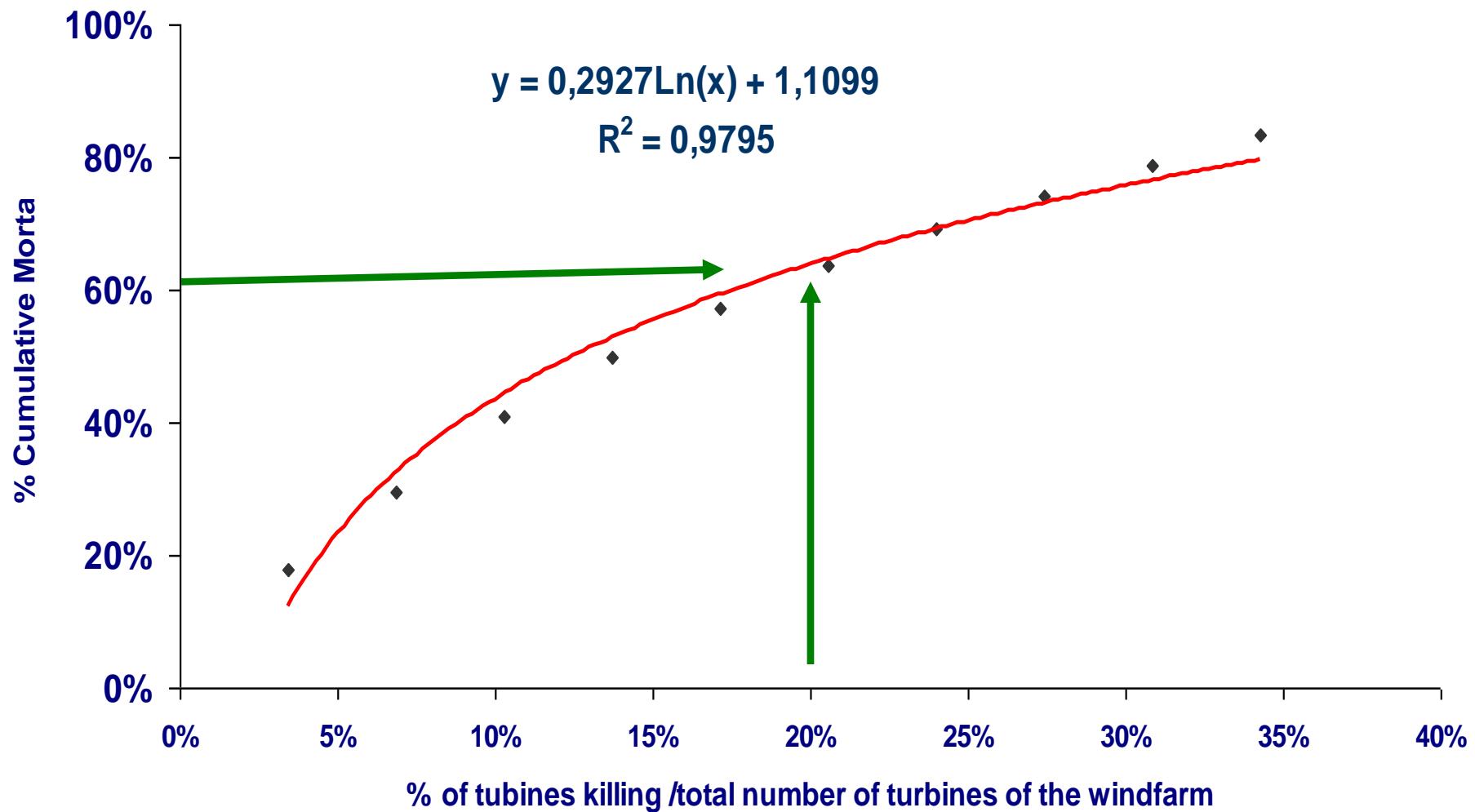
## Mortality rates

Vultures/turbine/year	0.184	0.002	0.420
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## COLLISIONS

<i>Gyps fulvus</i>	2035	4	527
<i>Neophron percnopterus</i>	3	-	5
<i>Aegypius monachus</i>	3	-	-
<i>Gypaetus barbatus</i>	-	-	-
<i>Gyps rueppellii</i>	-	-	1
<i>Gyps africanus</i>	-	-	1

# How many turbines are really dangerous ?

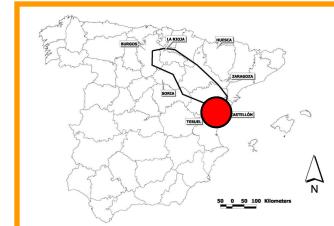




# Case study

# Northern Valencia (1)

- 10 windfarms :267 turbines.
- Environmental Impact Assessment (EIA) and EIS since 2004.
- Operating since September 2006.
- Measures against BSE resulted in changes both in food availability and space distribution (EIS uneffective).
- GV collisions increase: 393 birds killed from 2006 to December 2010.



# Northern Valencia (2)

- 33 turbines were shut down from May 2008-Sep. 2010 : Economic loss.
- Both Wind developer and Environmental authorities accussed at court by affecting Birds Directive 2009/147/CE (79/409/CE).

# Raptor species in the area

Species	Crossings	Nº Individuals
<i>Circus cyaneus</i>	4	7
<i>Milvus migrans</i>	32	41
<i>Circaetus gallicus</i>	67	75
<i>Buteo buteo</i>	36	38

**89,30% of crossings and 91.7% individuals  
belong to griffon vultures**

<i>Aquila chrysaetos</i>	24	29
<i>Gyps fulvus</i>	3088	5485
<i>Hieraetus pennatus</i>	30	31
<i>Accipiter gentilis</i>	5	6
<i>Accipiter nisus</i>	21	21
<i>Falco peregrinus</i>	6	6
<i>Falco tinunculus</i>	100	118
<i>Falco subbuteo</i>	1	1

Ejulve

Peñarroya

Cinctorres

Vertedero RSU



0 10 20 Km





# Consequences

# Correction measures

- **Avoiding griffons feeding at rubbish dump**

Goal: reduce mortality.

Measure: Closure of rubbish dump.

- **Provide vultures with food**

Goal: “Remove” vultures from rubbish dump

Measure: Build 2 vulture restaurants

Both applied simultaneously

Ejulve

Peñarroya

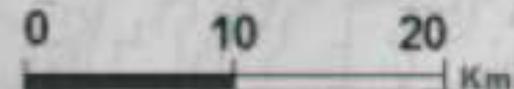
## STATISTICAL PROCEDURES

General Linear Models - GLM

General Additive Models -GAM

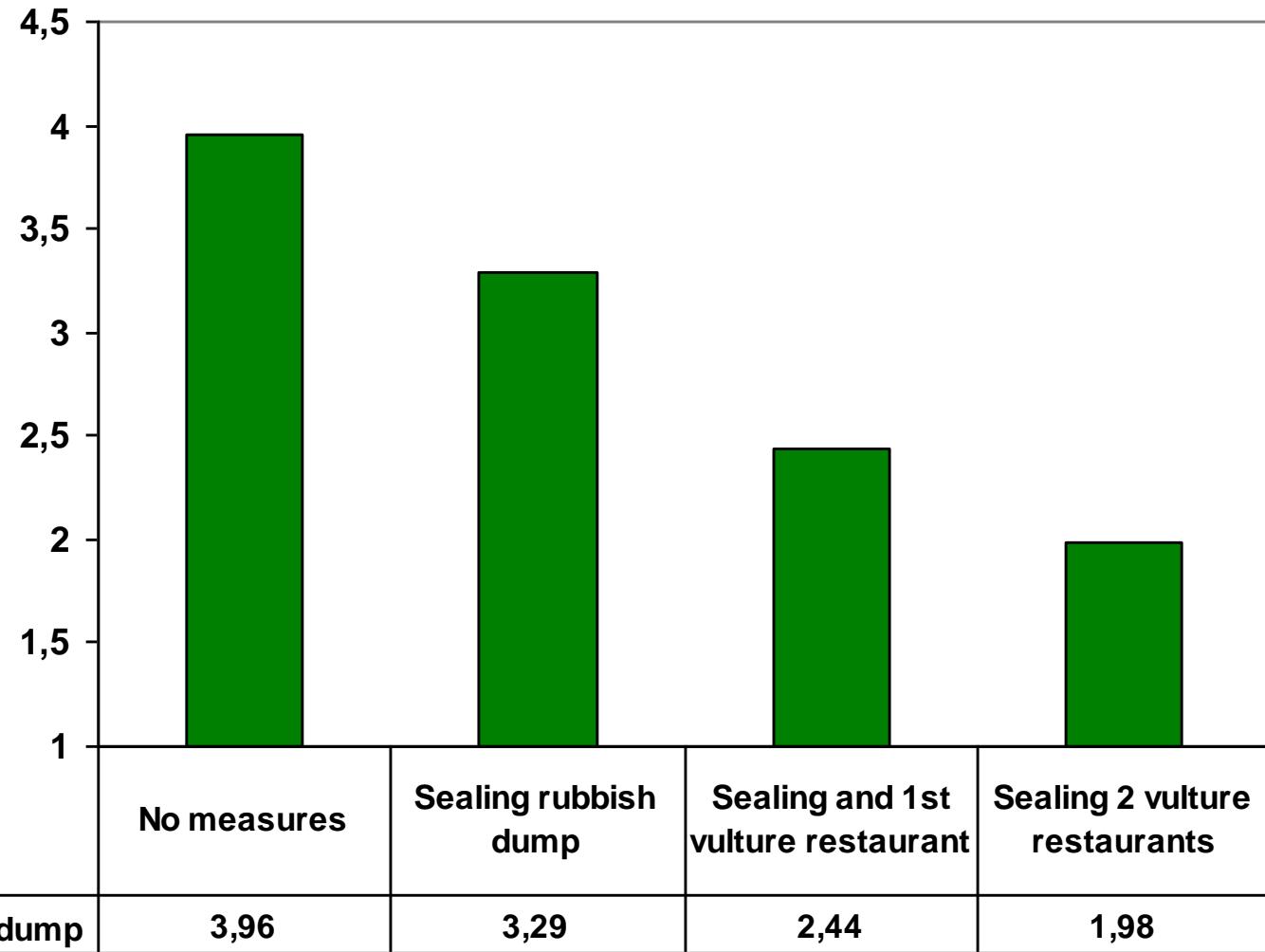
**Dependent:** Number of vultures at rubbish dump

**Independent:** 1) Measures taken at the rubbsih dump  
2)Food provided/not at V. restaurants  
3) Date

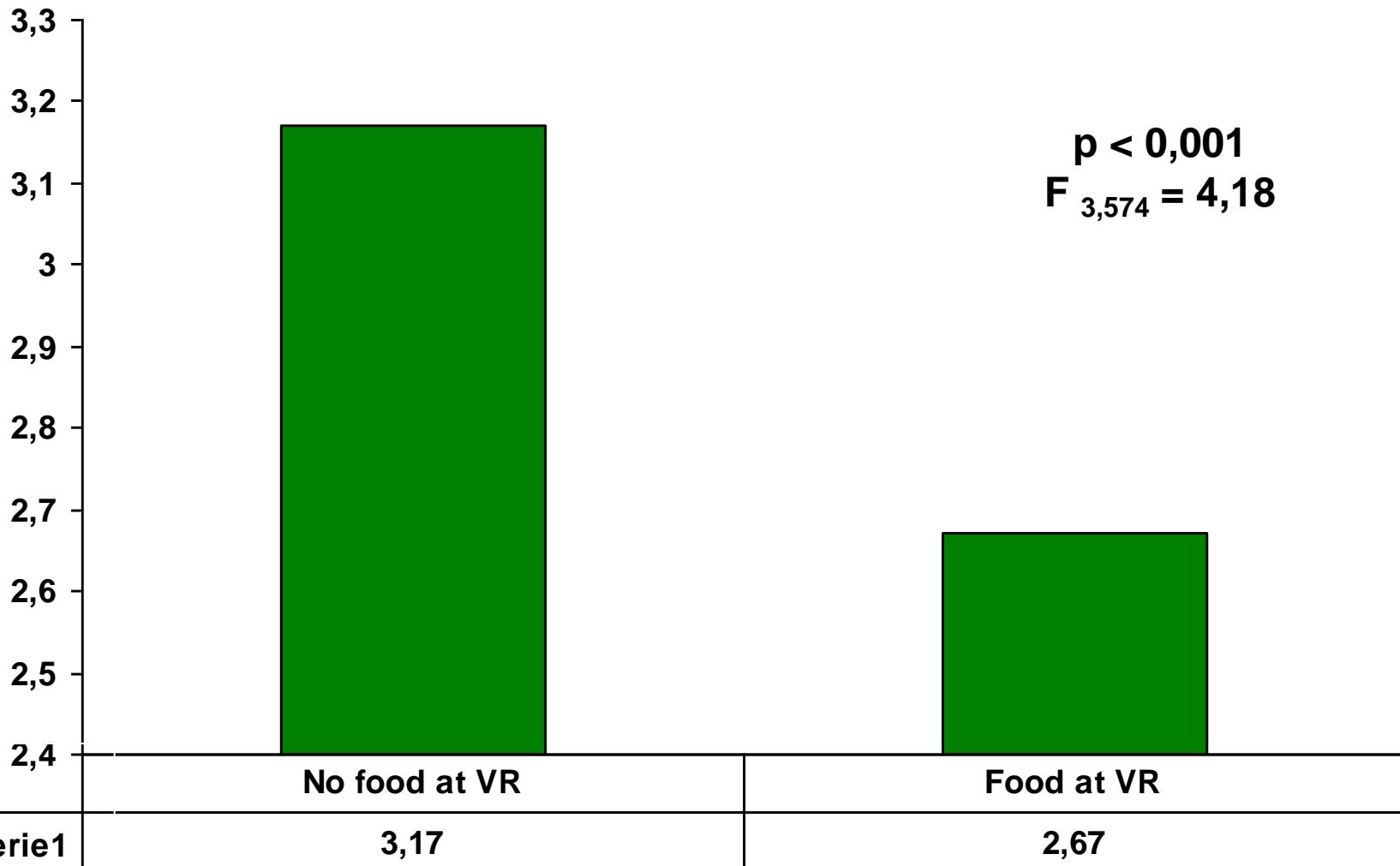


# Rubbish dump use vs. closure

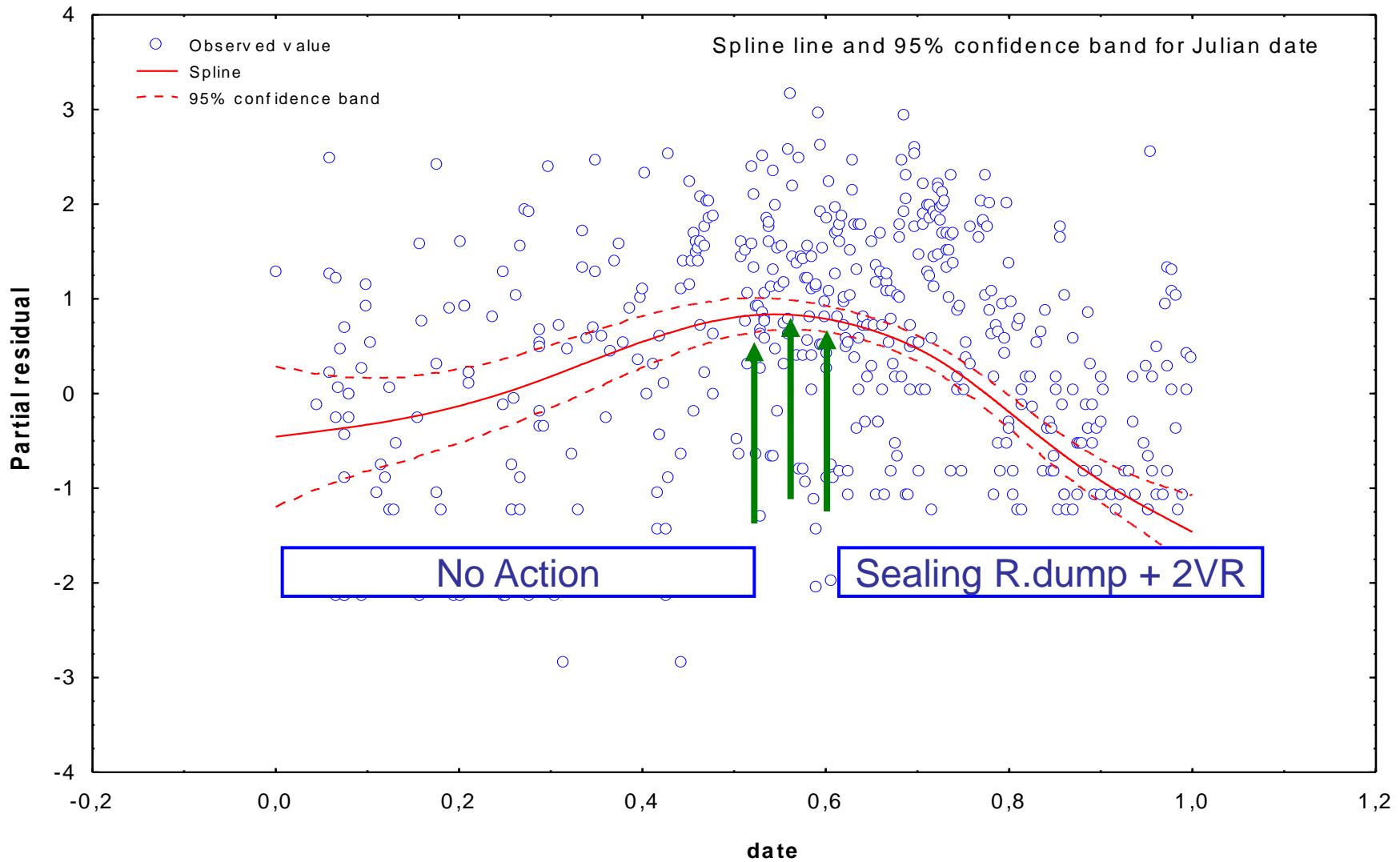
**GLM**  
 $p < 0,004$   
 $R^2 \times 100 = 40,74\%$   
 $F_{3,574} = 3,17$



# Rubbish dump use vs. Food at vulture restaurants



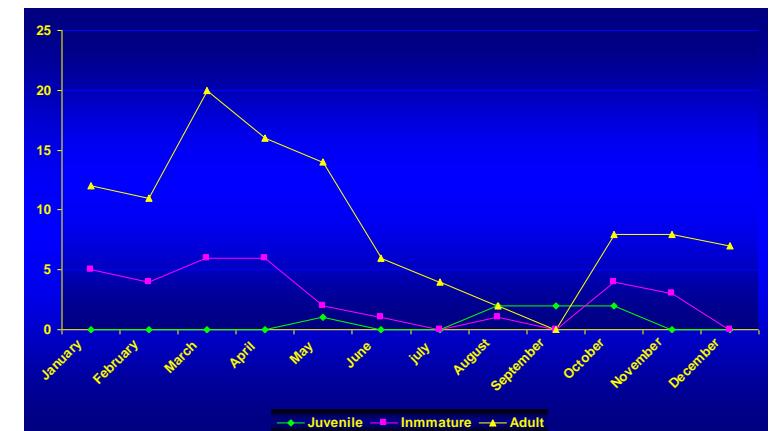
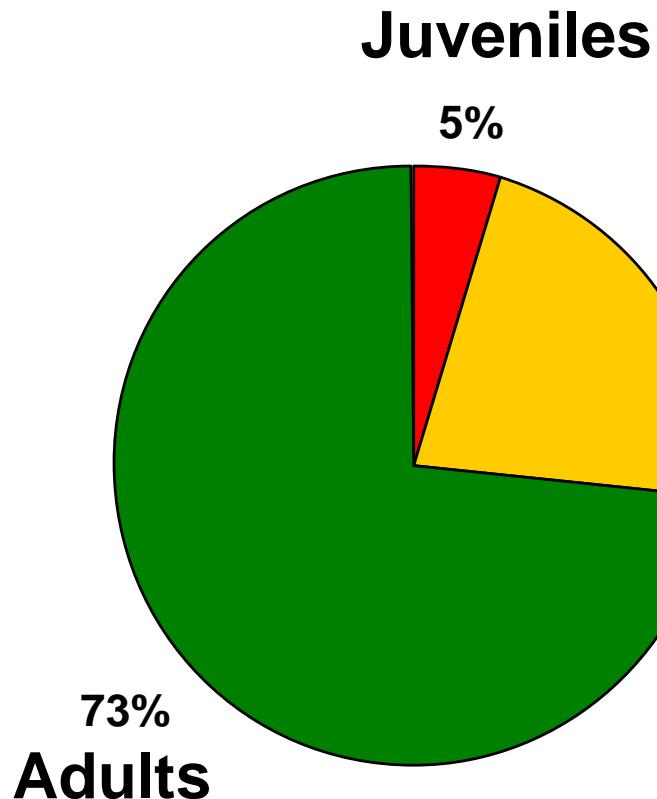
# GAM-model



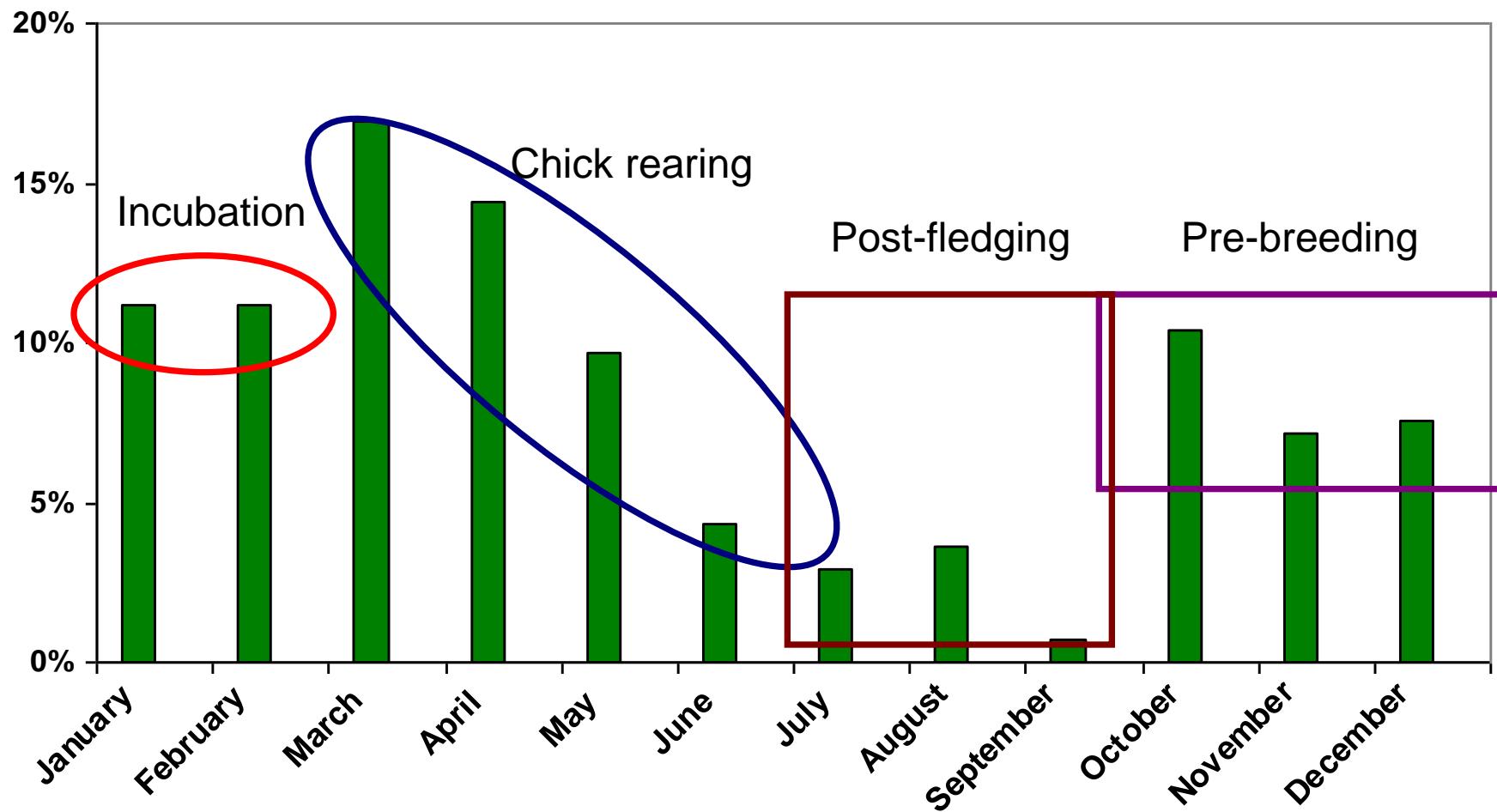


# Mortality trend

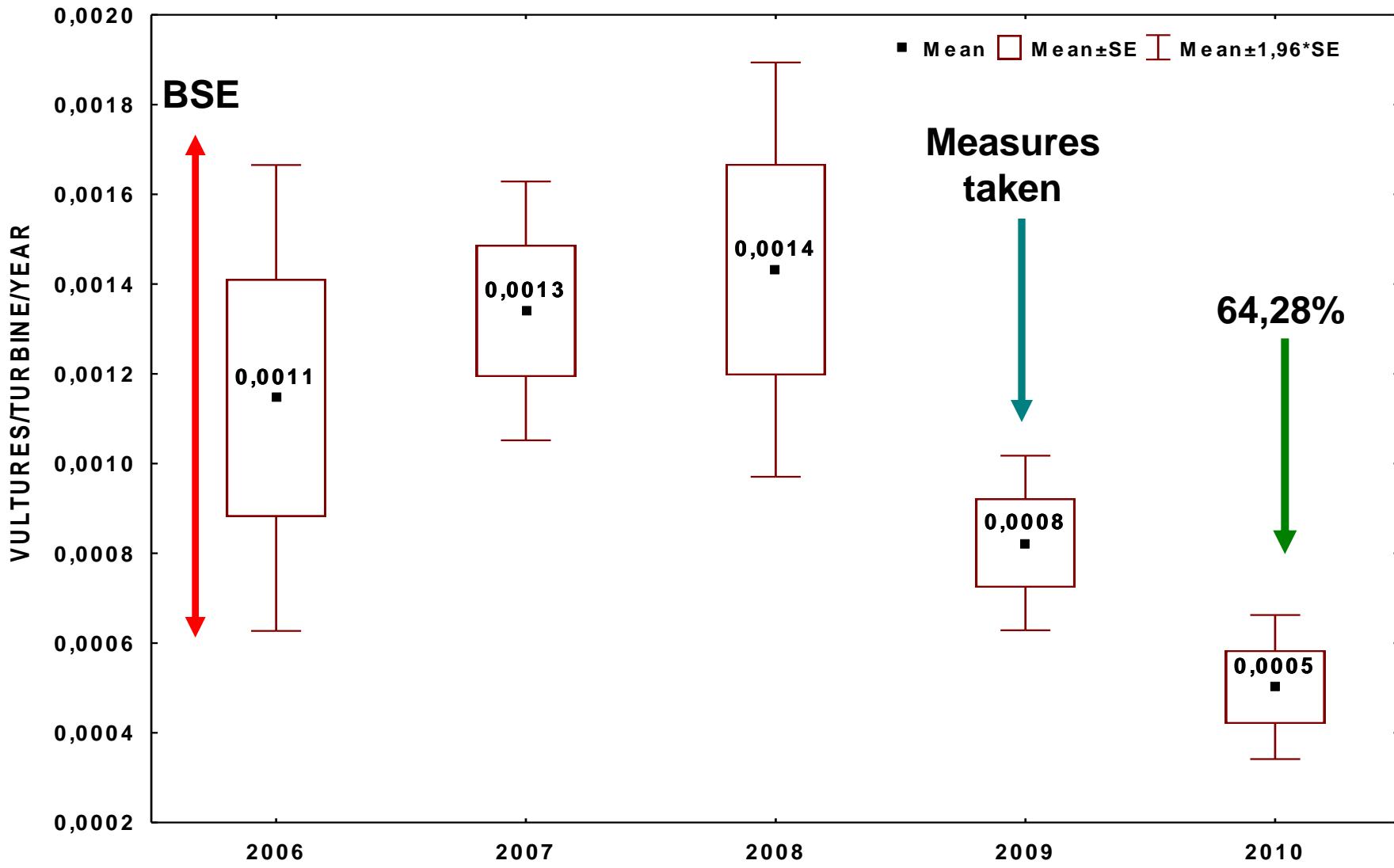
# Age of vultures collided



# Percentage of mortality through the year



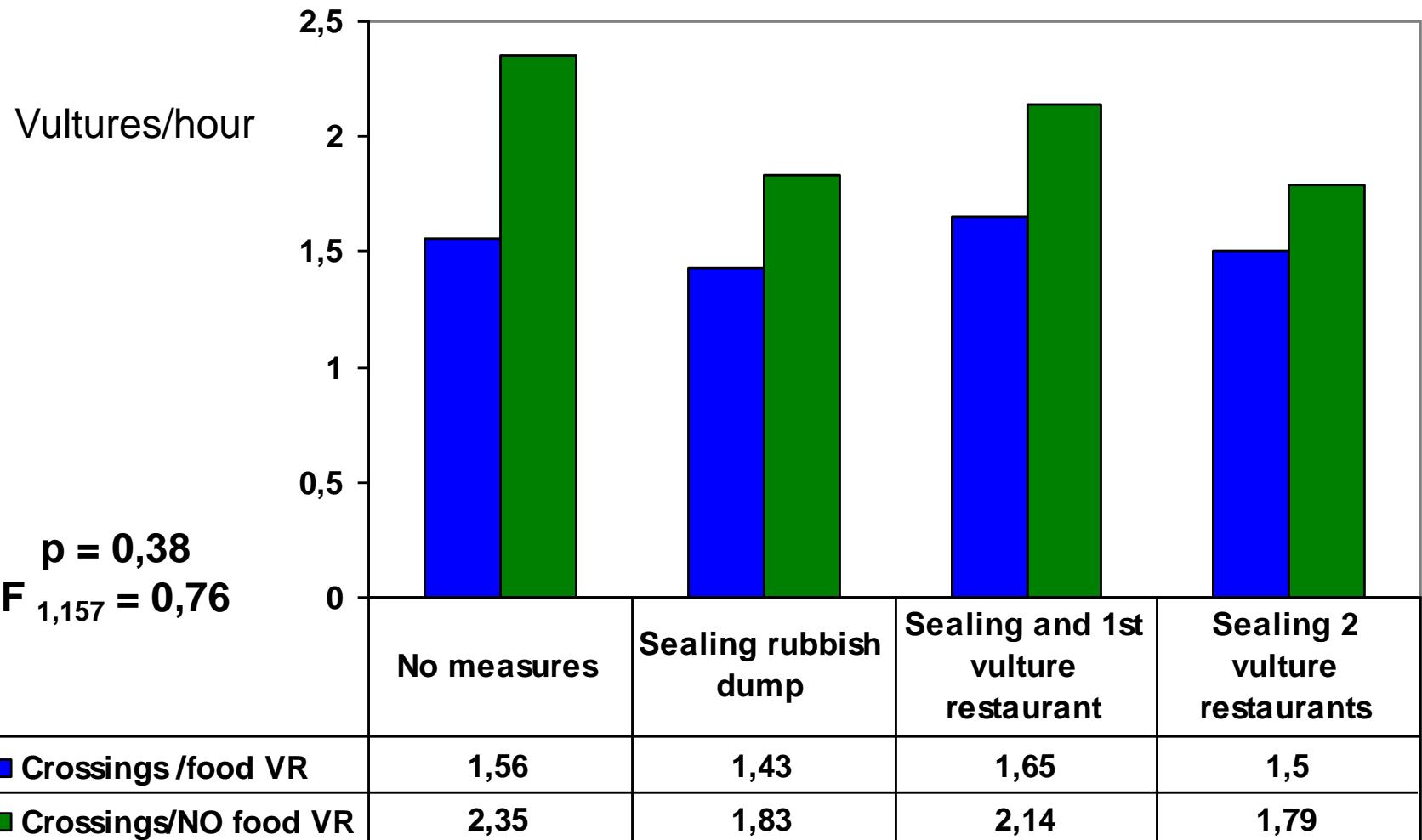
# Mortality of Griffon vultures (vultures/turbine/day)



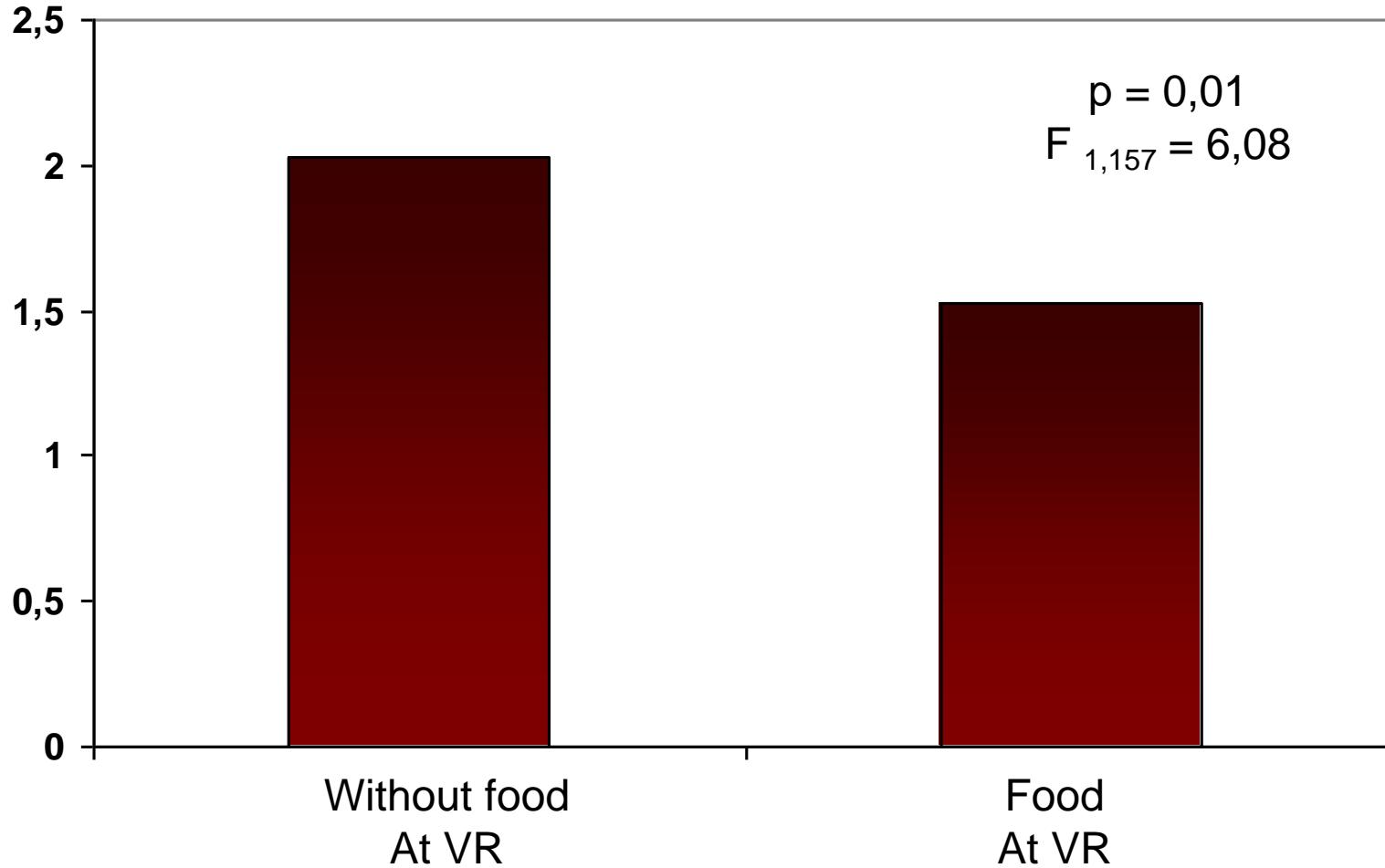


# Other variables affected by measures adopted

# Crossings through turbine strings vs. The two correction measures



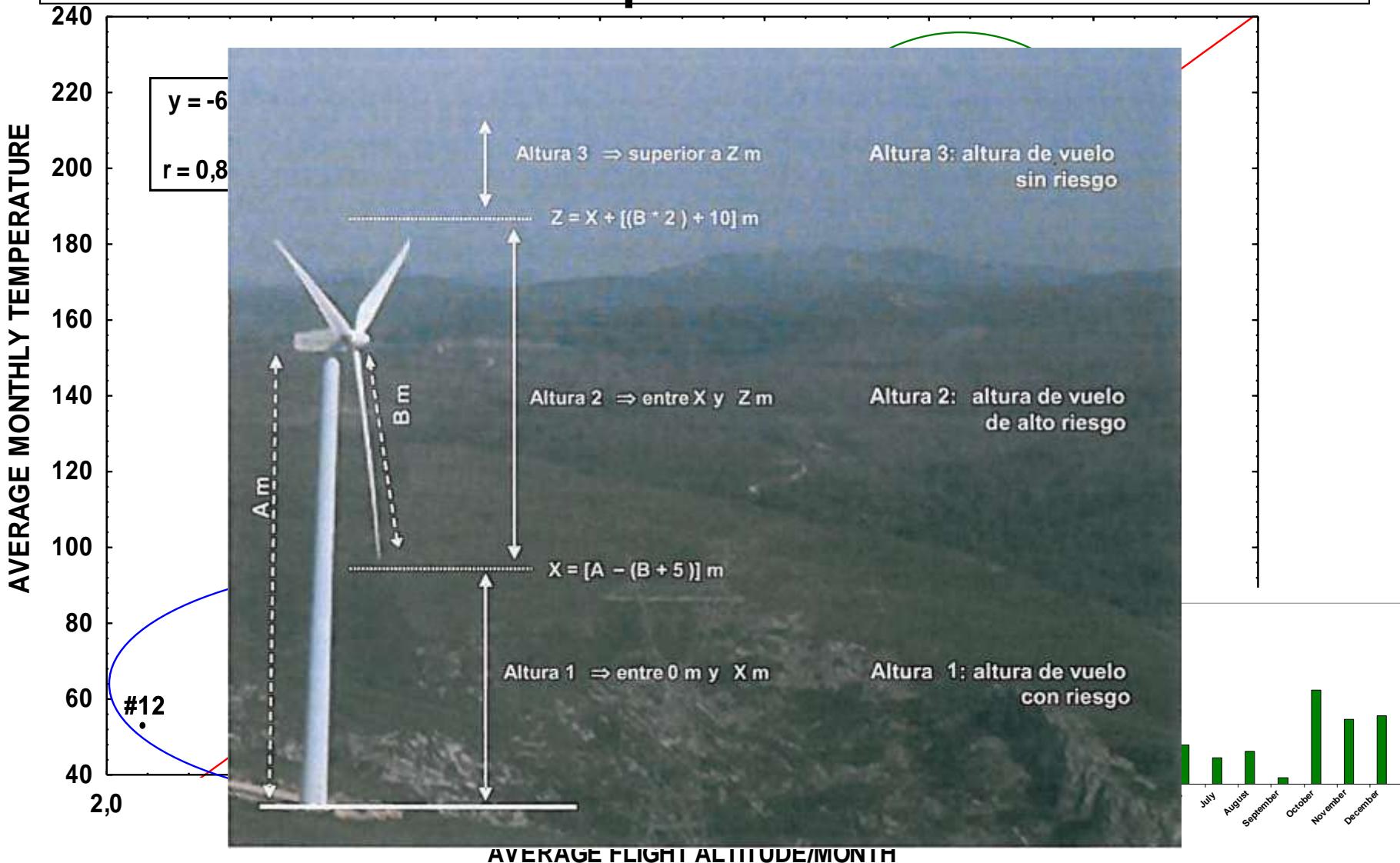
# Crossings through turbine strings vs. Food provided at v. restaurants





# Understanding flight behaviour of griffons

# Flight altitude vs. Daily mean temperature



# Flight vs. Wind conditions

- **GLM / variables nested on turbine string**

Slope

Tail / cross wind flying vulture components

Temperature

Tail / cross wind wind vectors

Turbine string: A1, A2, A3, F1

Date

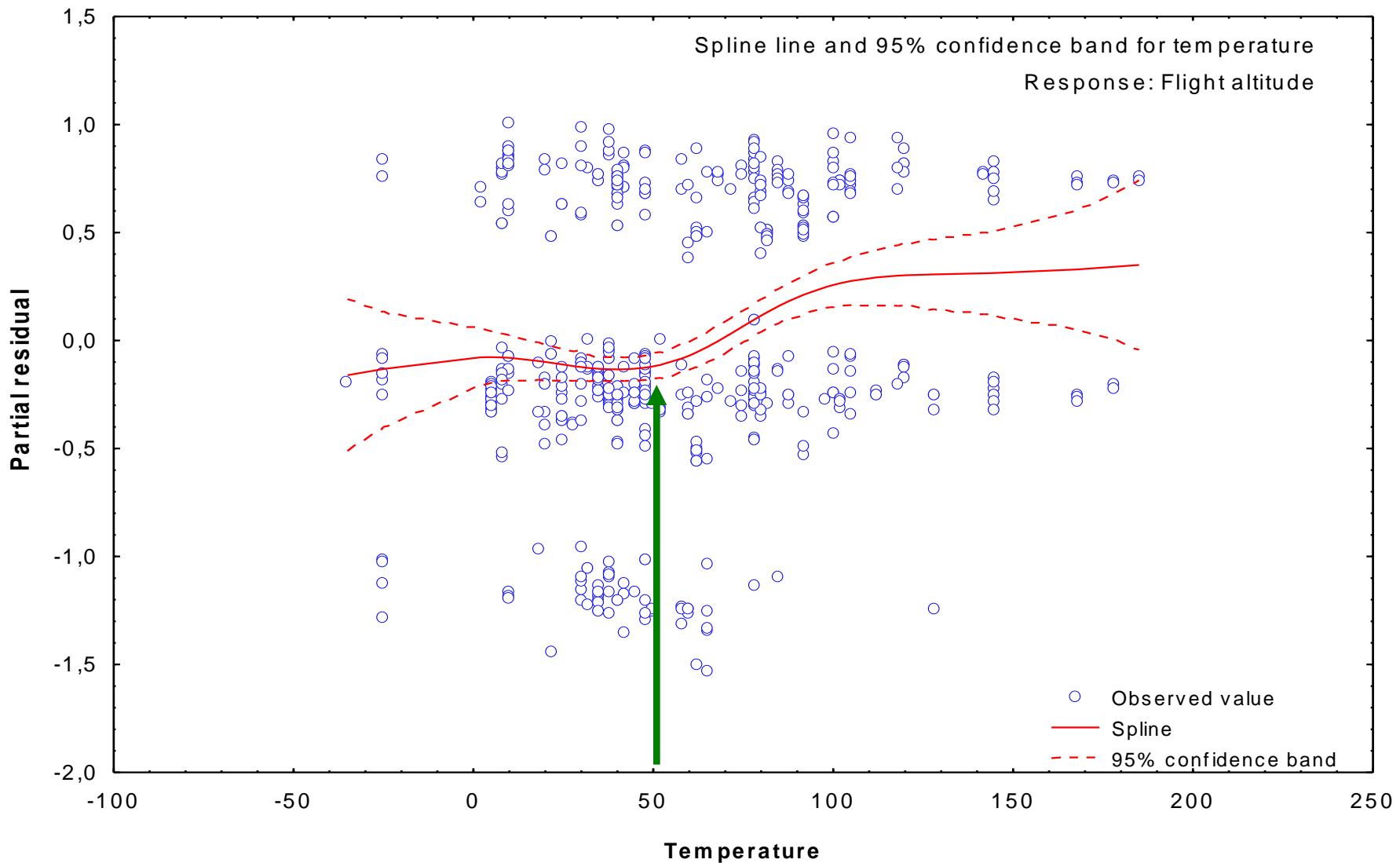
Flight altitude: 1, 2 & 3.

# Flight altitude- GLM model

Hierarchically nested factor design

	SS	D.f.	MS	F	p
<i>Turbine string * Slope</i>	4,6297	3	1,5432	3,99	0,0080
<i>Turbine string * Temperature</i>	8,5487	3	2,8496	7,36	< 0,001
<b>date</b>	3,2062	1	3,2062	8,29	0,0042
<b>date^2</b>	2,3639	1	2,3639	6,11	0,0138

# Flight altitude GAM-model



# Complementary measures

- Monitoring of GV movements by means of Satellite Tracking Using GPS- PTT's
- Population viability analysis (PVA) to measure the effect of mortality.



# Conclusions

- Opening of V. restaurants reduced mortality.
- Use of rubbish dump by GV was related with food lacking.
- The court let the turbines be operating full-time since 1st September 2010.
- Crossings over windfarms were reduced/not eliminated by opening V. restaurants.
- Flight height was mainly affected by temperature and slope near turbines.

# Acknowledgements

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