Chirotech

Six years of research (2006 – 2012)

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1 - Context and goal of Chirotech

- Research program reconciling conservation of bats and development of wind facilities.

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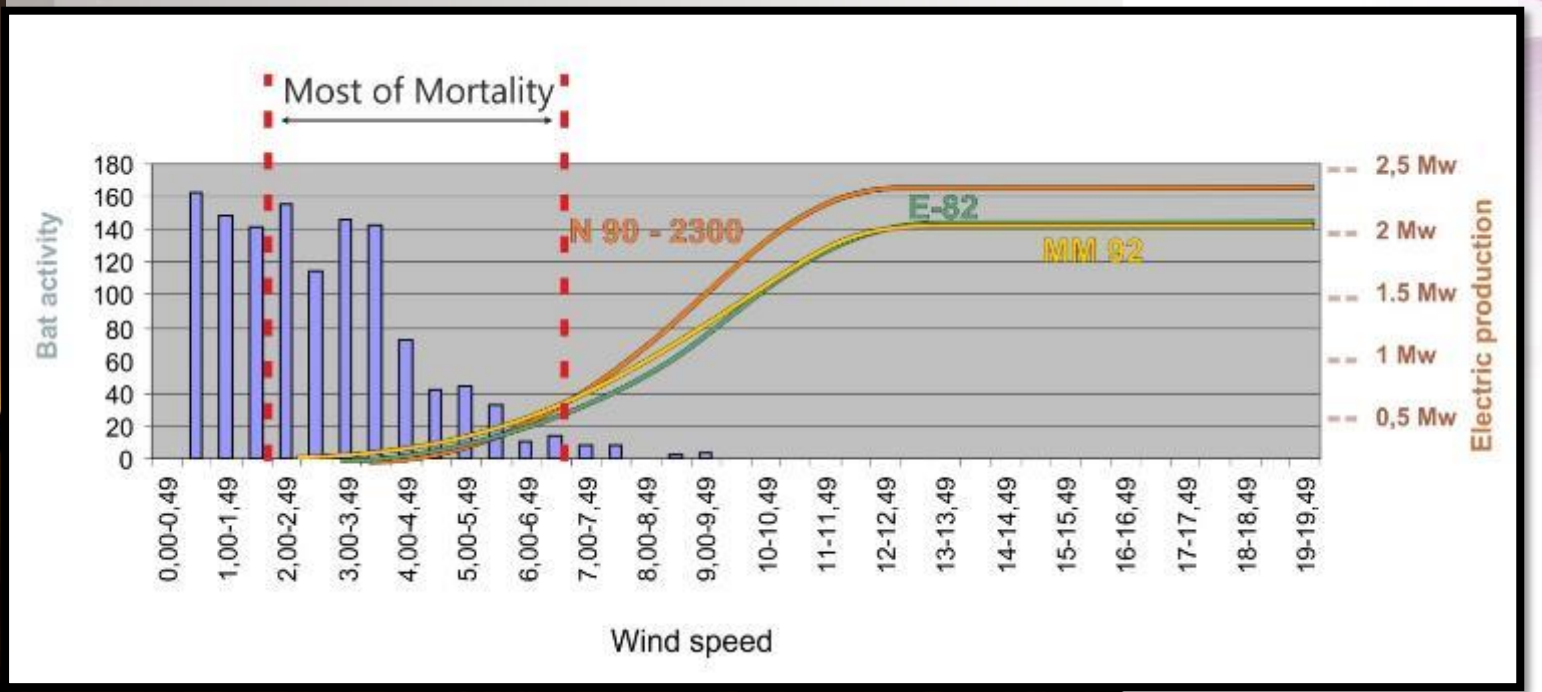

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- **Collecting data** of bat behaviour at turbine's height to **model bats activity** according to time and meteo parameters

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To do this :

- **Collecting data** of bat behaviour at turbine's height to **model bats activity** according to time and meteo parameters

- **Mitigation of wind turbines** according to modeled bat activity

2- Characterizing activity: Material et methods

- **To model the bats behavior based on :**

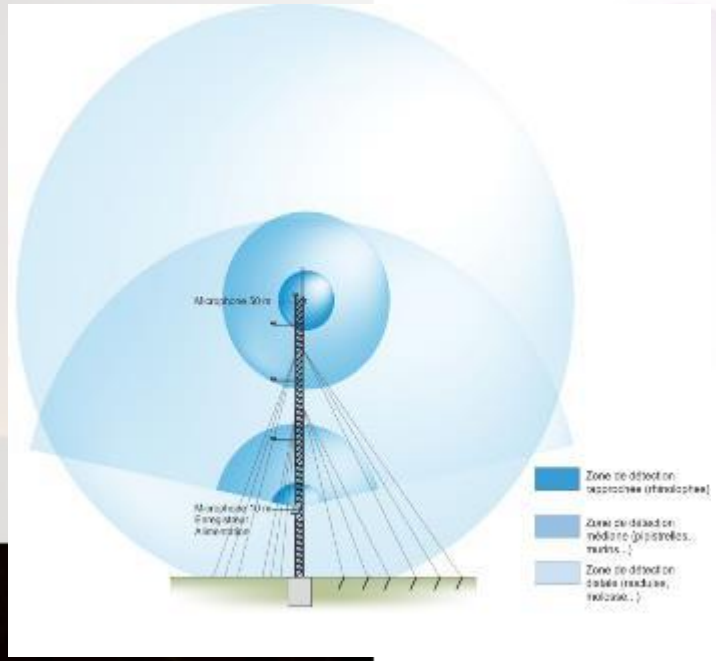
  - Time **- Wind speed**

  - Season **- Temperature** **- Height**

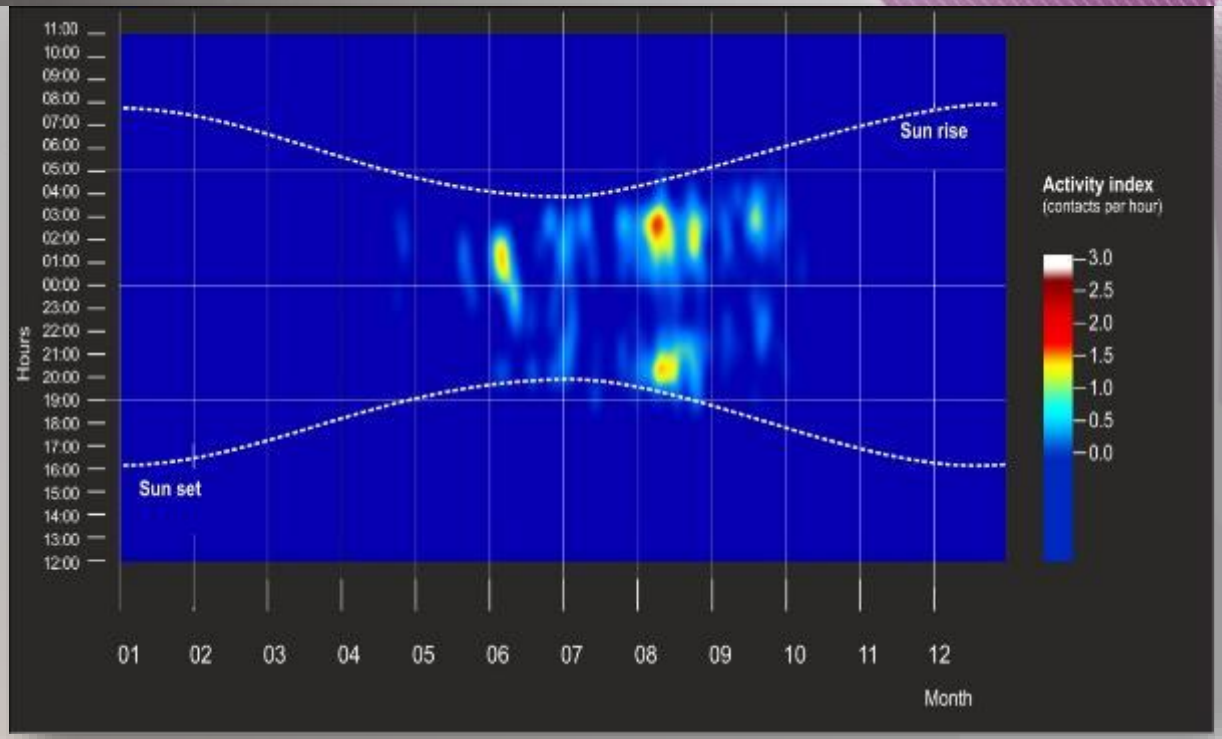
From 2006 to 2011 : **10 initial sites** with **AnaBat**

Since 2011 : **29 sites** equipped with **SM2Bat**

Microphones fixed
for 1 year
at 5m and 50m high



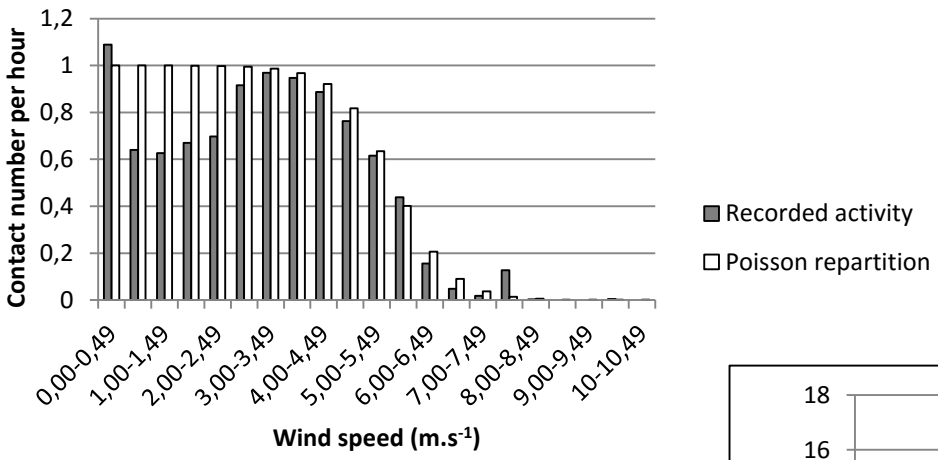
2- Characterizing activity : Results



Peak activity of bats :

- **April to September** (very site-dependent)
- **2-4 hours after sunset**
- Secondary peak **before sunrise** on some sites

2- Characterizing activity : Results

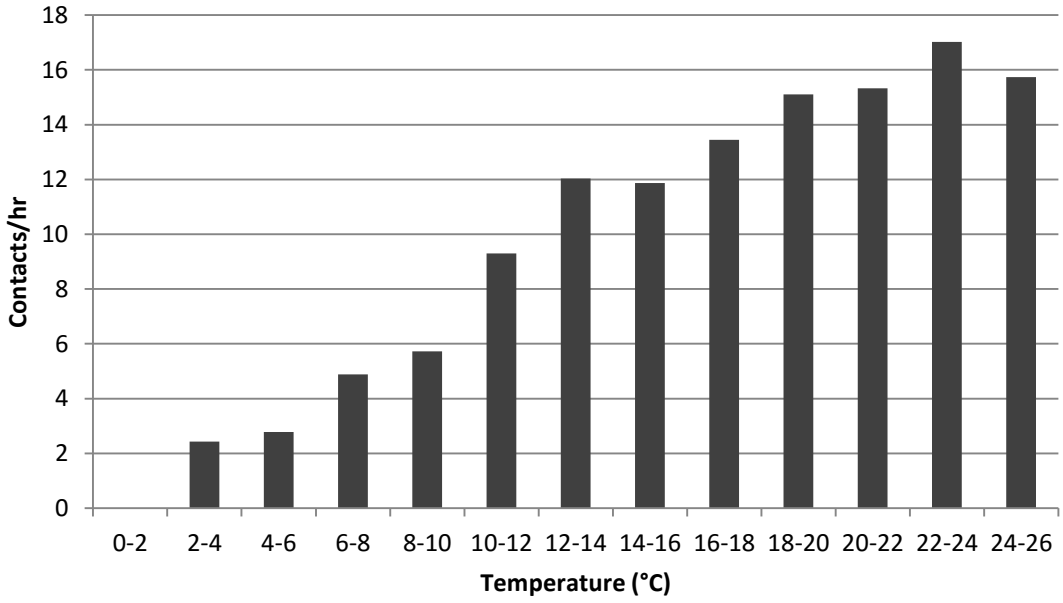


Peak activity of bats :

- Wind speed below **3-7 m.s^{-1}**
- Temperature **above 8-15°C**

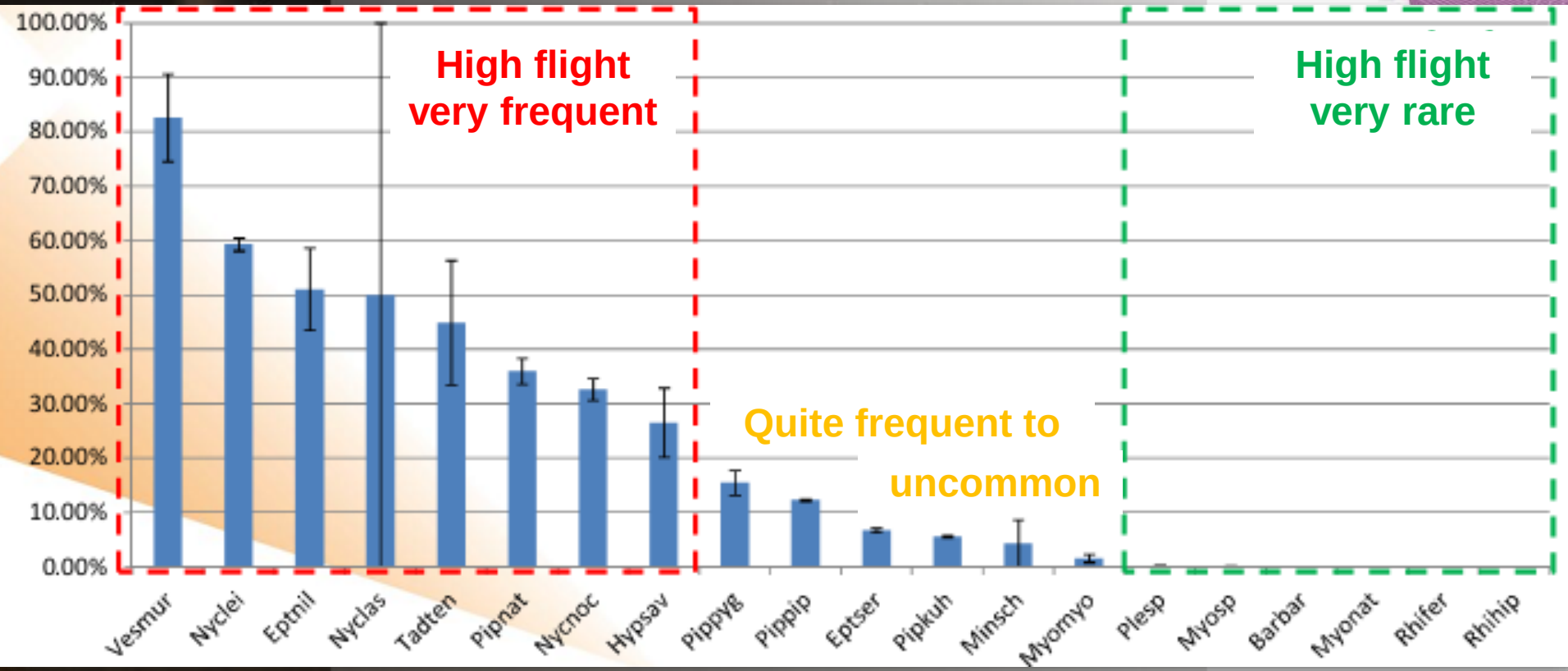
Pattern variations in activity according to wind speed

Pattern variations in activity according to temperature.



2- Characterizing activity : Results

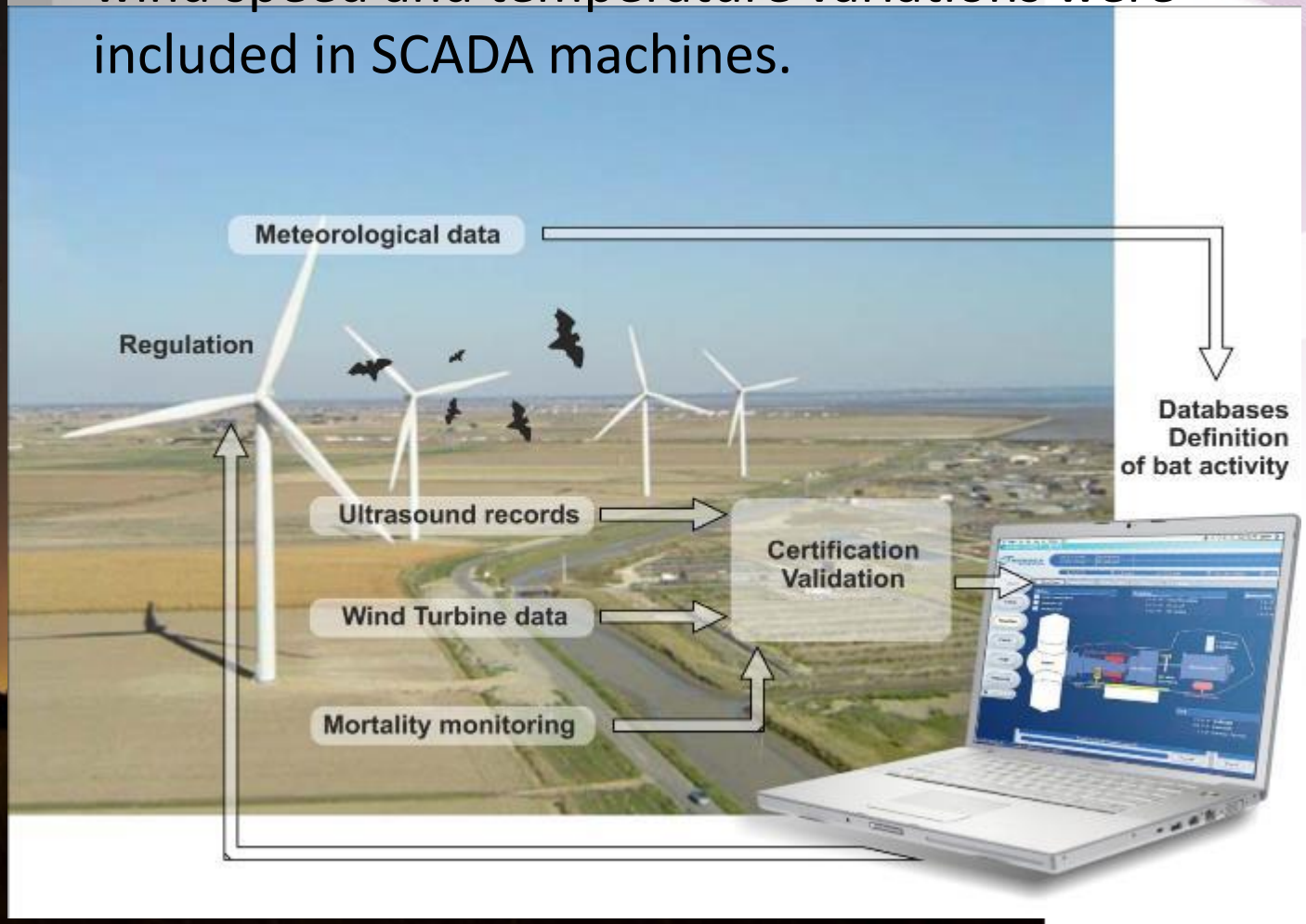
- **Flying time at > 25 m high, by species**



Y. Bas, 2012

3- Regulation of wind turbines

- Combination of temporal variation and response to wind speed and temperature variations were included in SCADA machines.



4- Regulation tests of wind turbines

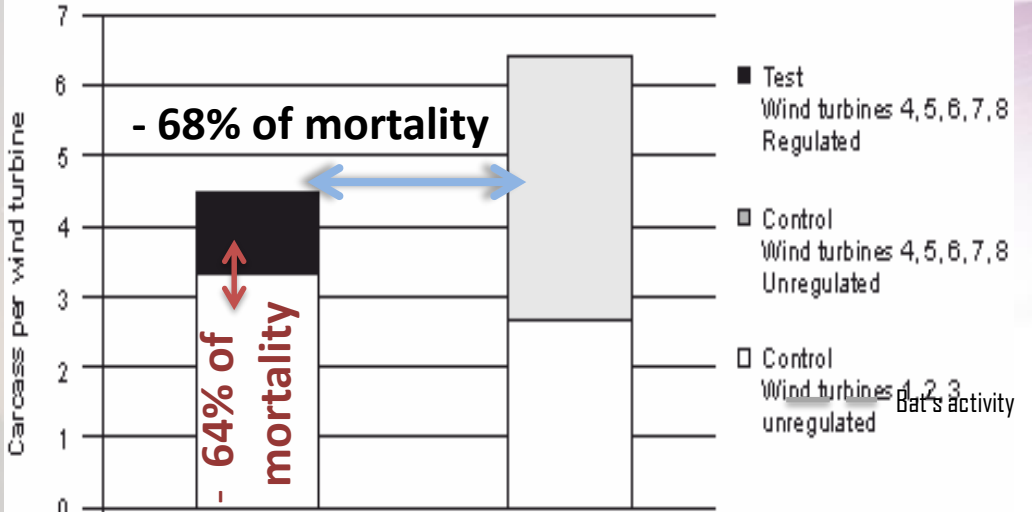
Wind farm in Vendée (Bouin)

2 years of test **(2009 - 2010)**

Each year, monitoring during 12 weeks once a week

Date	Wind Farm	Number of carcasses under the control turbines	Number of carcasses under the regulated turbines	Decrease of mortality	Loss of production
2009 - 2010	Bouin			64%	< 0.1 %

- 5 regulated wind turbines
- 3 control wind turbines



There was strong evidence of regulation effectiveness: the interaction of treatment and period differed significantly ($F_{1,157} = 6.082$, $P = 0.014$, Fig. 4), while the treatment and period taken separately did not ($F_{1,158} = 0.001$, $P = 0.995$; $F_{1,158} = 3.027$, $P = 0.082$).

4- Regulation tests of wind turbines

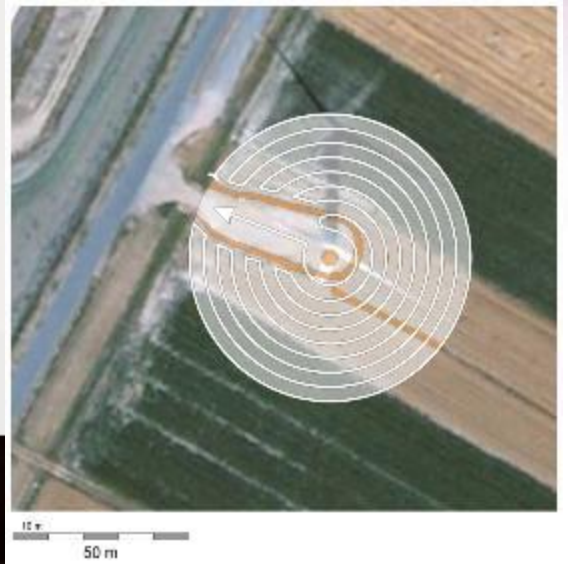
Wind farm in Crau (Mas-de-Leuze)

- 2 years of test
  (2011-2012)

- Each year, mortality monitoring during **14 weeks every 3 days**

- 4 regulated wind turbines
  4 control wind turbines

- 7 weeks of regulation
  7 periods



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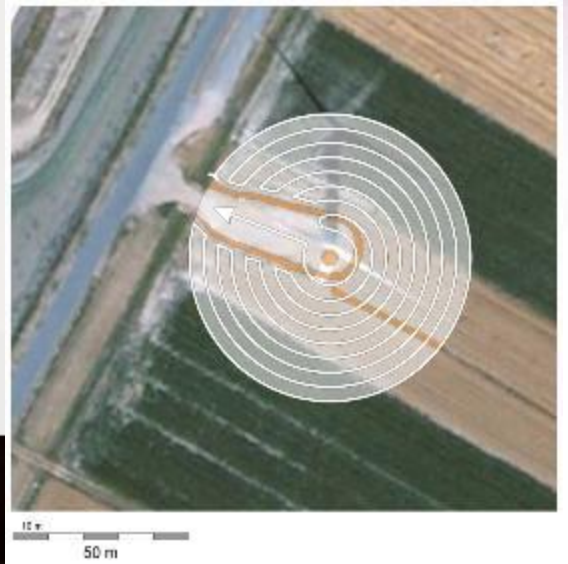

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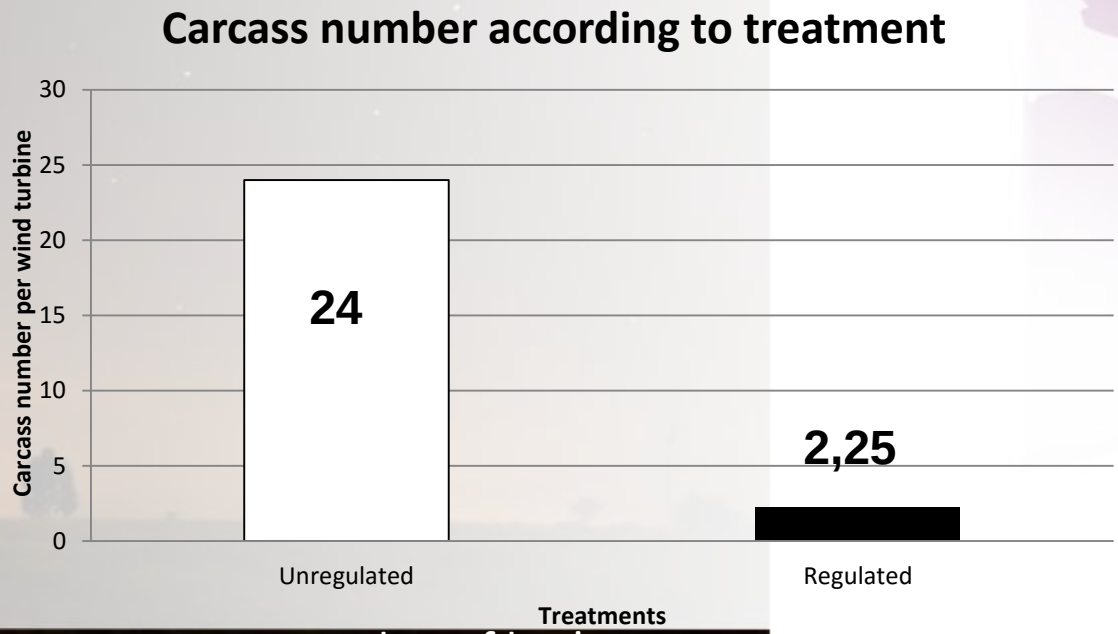
Date	Wind Farm	Number of carcasses under the control turbines	Number of carcasses under the regulated turbines	Decrease of mortality	Loss of production
2009 - 2010	Bouin			64%	< 0.1 %
2011 - 2012	**Mas de Leuze**	**96**	**9**	**90,45%**	**< 0.27 %**

- Mortality 90,45% lower under regulation

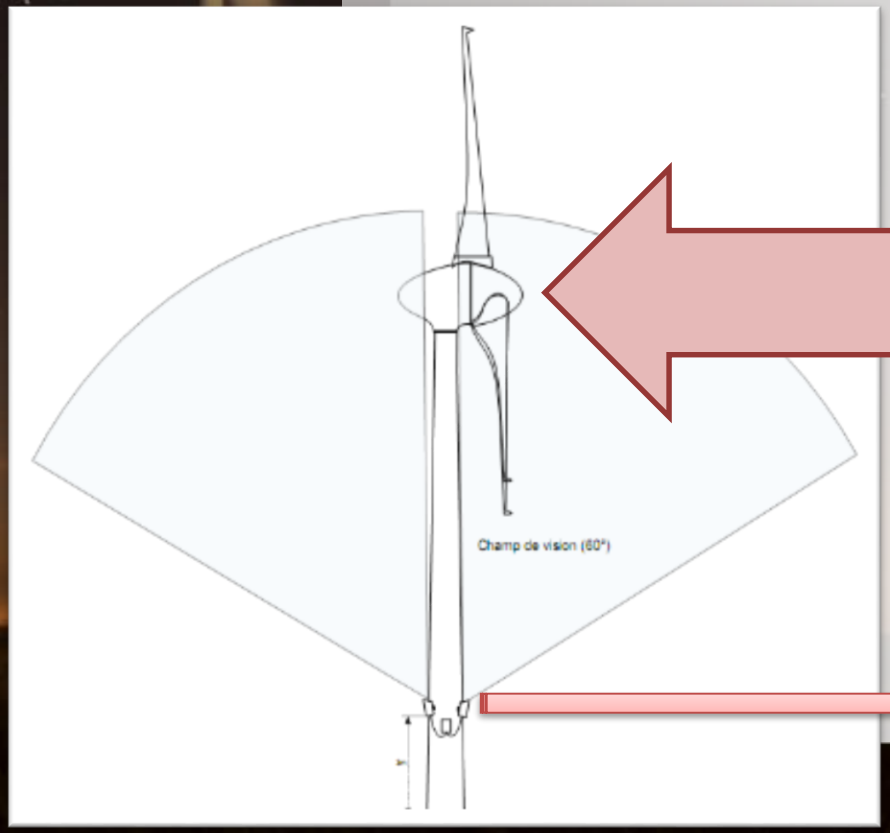
-**Calculated loss of production < 1 %** (Enercon)



Number of bat's carcass (model GAM, P>0,01)

4- Improvement and deployment of industrialization

- **Automated tracking of bat's activity by thermal cameras (Decan®)**

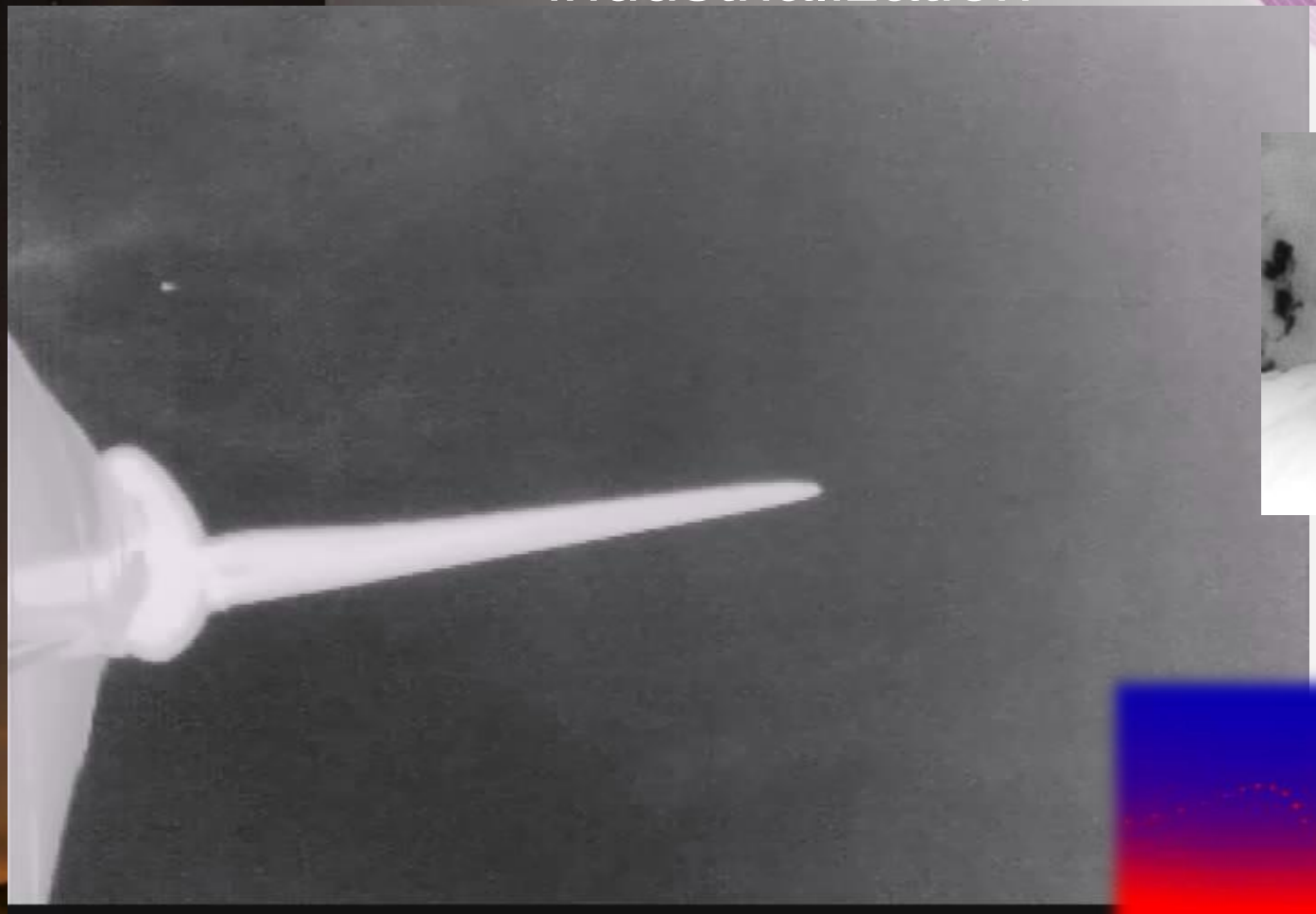


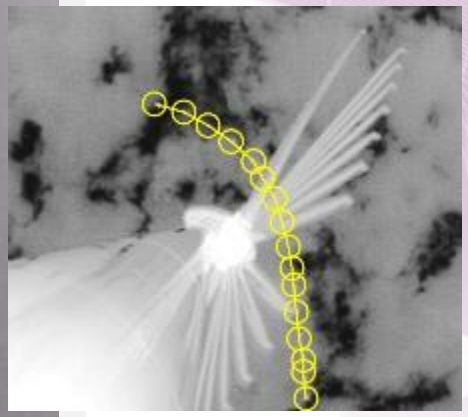
Chirotech®
Predictive algorithm based on **meteorological parameters**

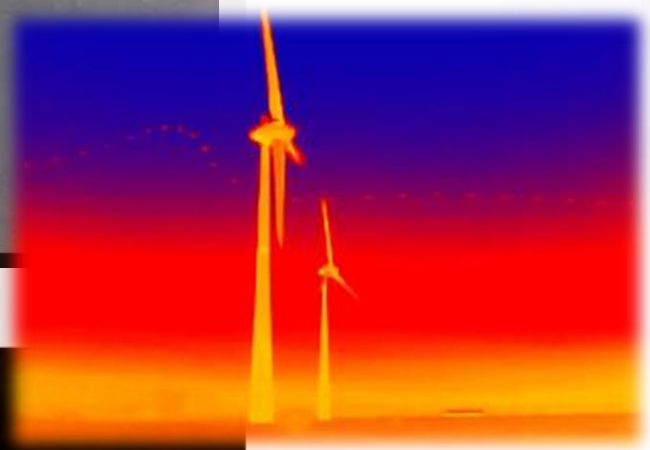
Order
STOP/START

Decan®
Analysis in **real time** with **thermal cameras**

4- Improvement and deployment of industrialization







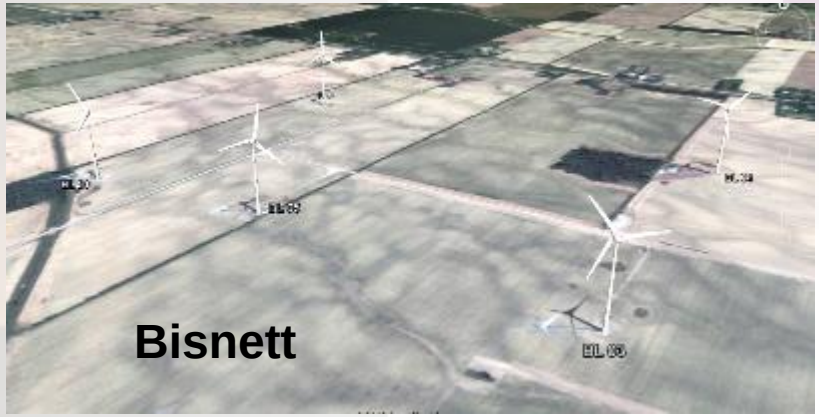
4- Improvement and deployment of industrialization

Two wind farms in Ontario (FrontLine and Bisnett)

- Bat mortality monitoring during **12 weeks twice a week**

- 3 control wind turbines
- 2 regulated wind turbines

- 12 regulated weeks



4- Improvement and deployment of industrialization : Results

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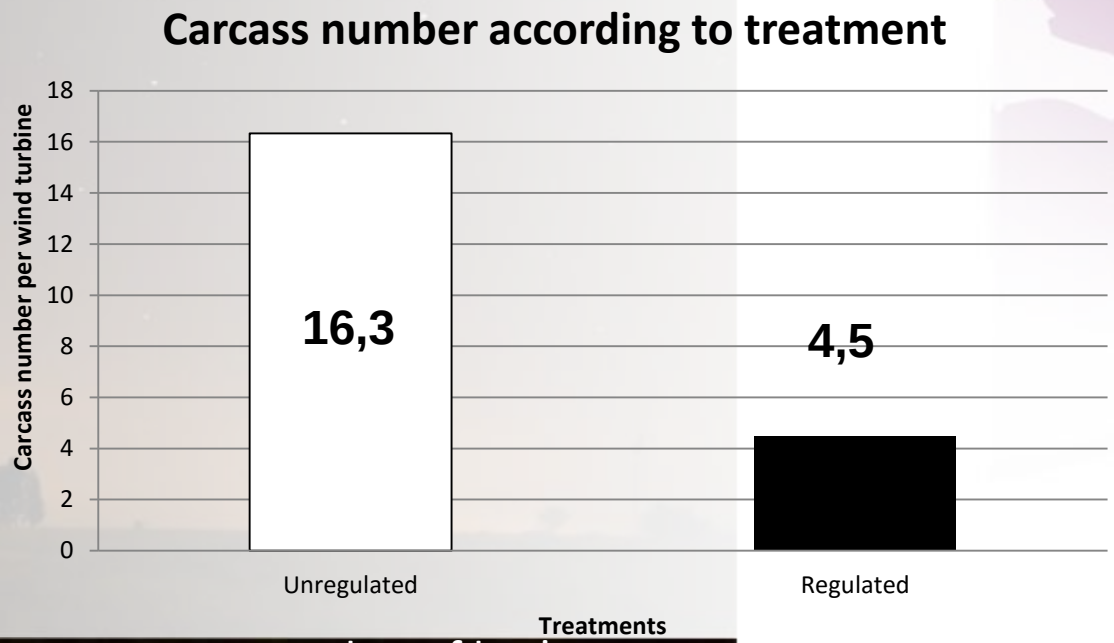
2009 - 2010	Bouin			64%	< 0.1 %
2011 - 2012	Mas de Leuze	96	9	90,45%	< 0.27 %
2012	**Front Line**	**49**	**9**	**78%**	**< 1 %**

- Mortality 78% lower under regulation

-Calculated loss of production < 2 %



Number of bat's carcass (model GLM, P<0,01)

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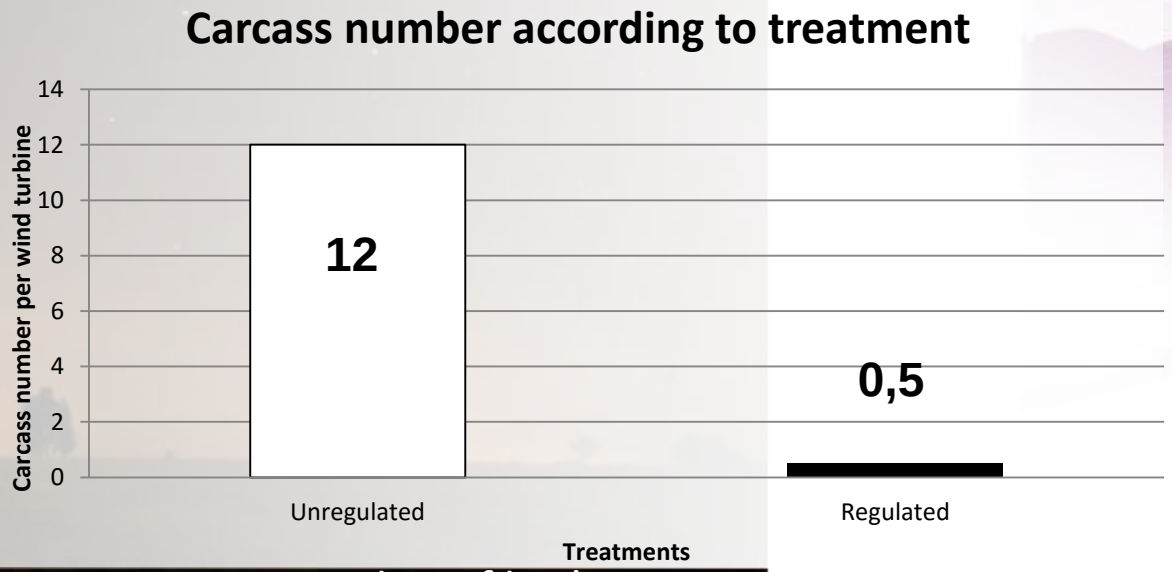
2012	Front Line	49	9	78%	< 1 %
2012	**Bisnett**	**36**	**1**	**96,70%**	**< 0.68 %**

- Mortality 96,7% lower under regulation

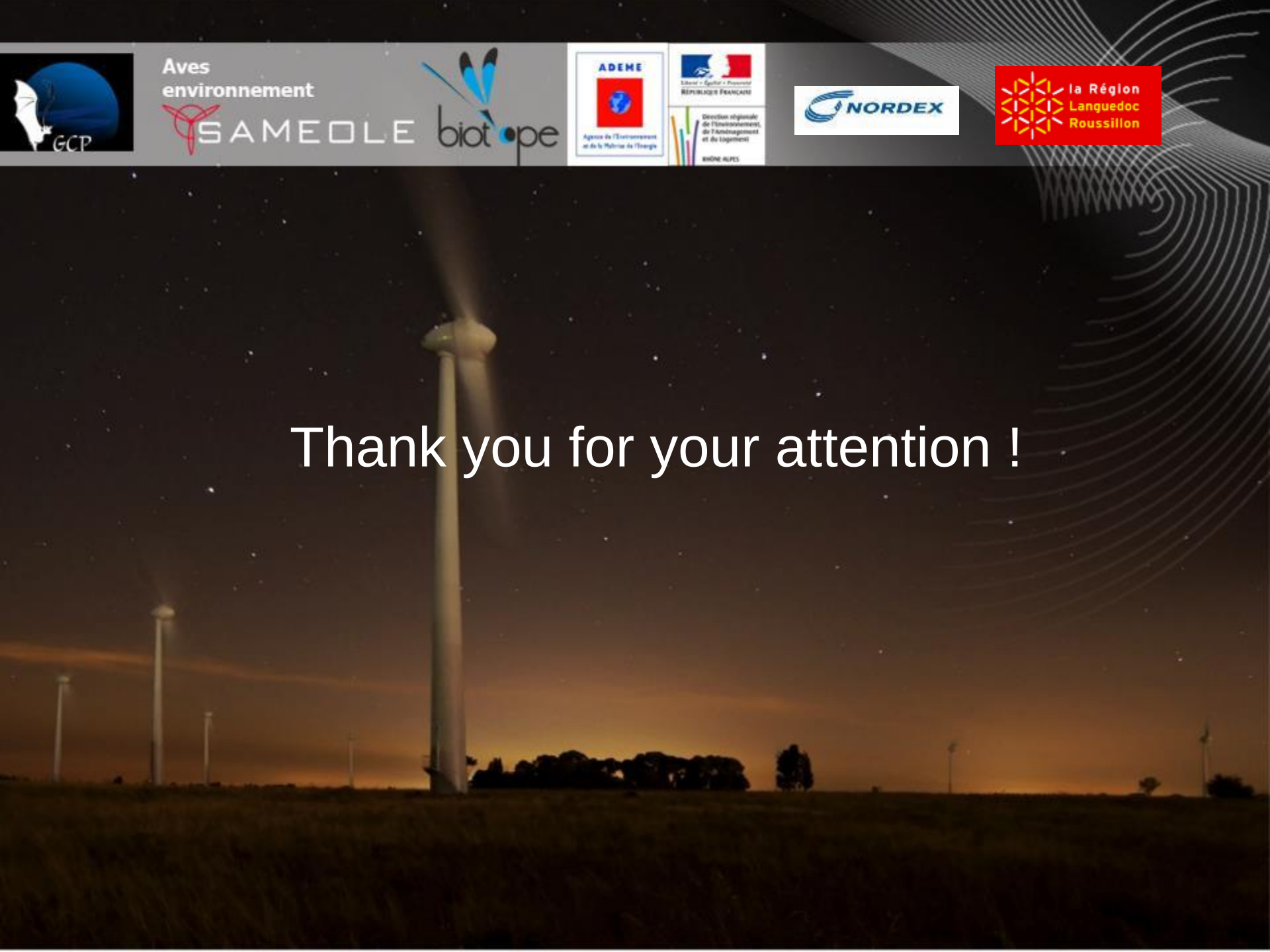
-Calculated loss of production < 2 %



Number of bat's carcass (model GLM, P<0,01)

Conclusion

- Efficient solution: 60-97% decrease in mortality for loss of production less than 0.5 % (less of 5000 $ per year for a wind farm of 10 MW).
- Configurable and adaptable, depending
  - turbine specificity,
  - local behavior of bats,
  - local environmental conditions
- Adapted to migration patterns and annual phenology (for activity monitoring with thermal cameras or SM2Bat)
- Pending industrial certification


Aves
environnement
SAMEOLE
biotope
ADEME
NORDEX
la Région
Languedoc
Roussillon
Thank you for your attention !

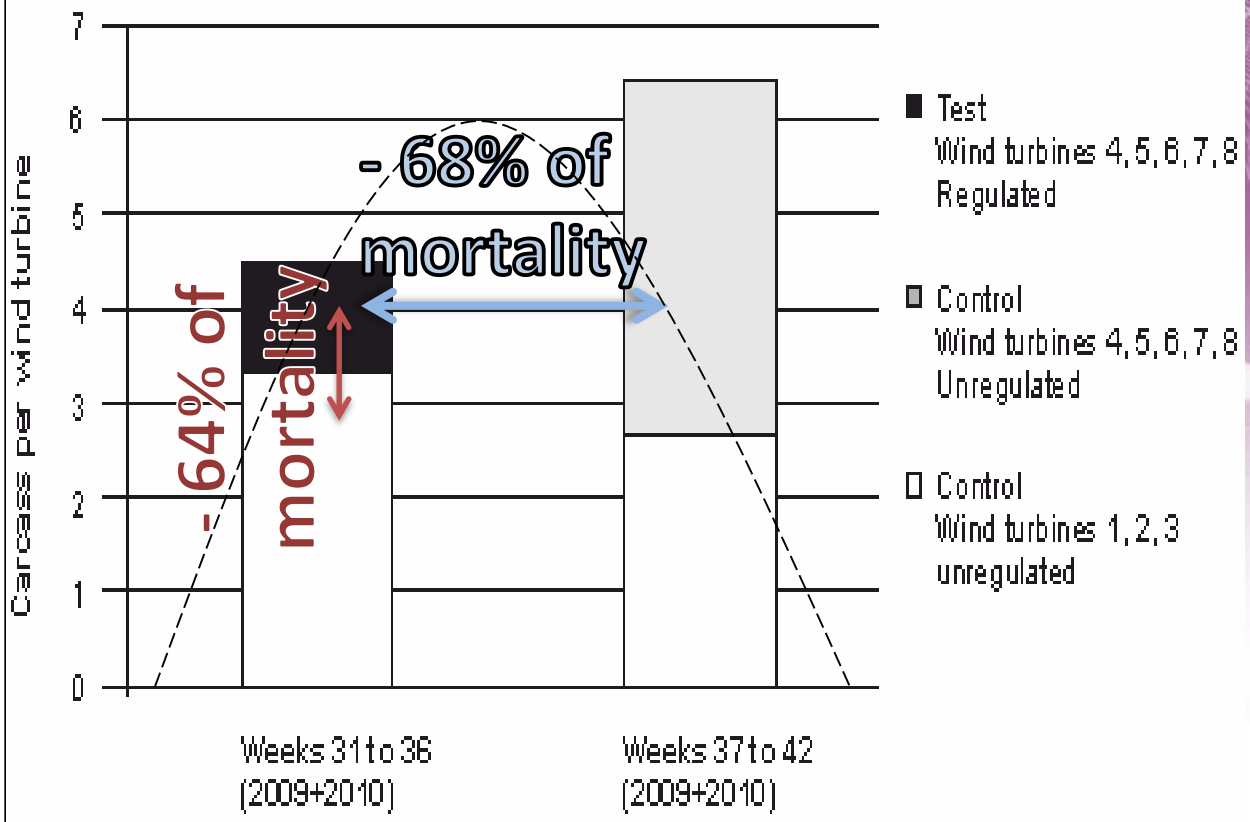
4- Regulation tests of wind turbines

- **Mortality decrease of 64% between** the **control** wind turbines and the regulated wind turbines during regulation test (weeks 31 to 36)

- **Mortality decrease of 68%** for wind turbines 4, 5, 6, 7, 8 (regulated) between the **unregulated periods** and the **regulated periods** (weeks 31 to 42)

- **Calculated loss of production <0.1 %** (Nordex)

Results of Bouin (2009-2010)



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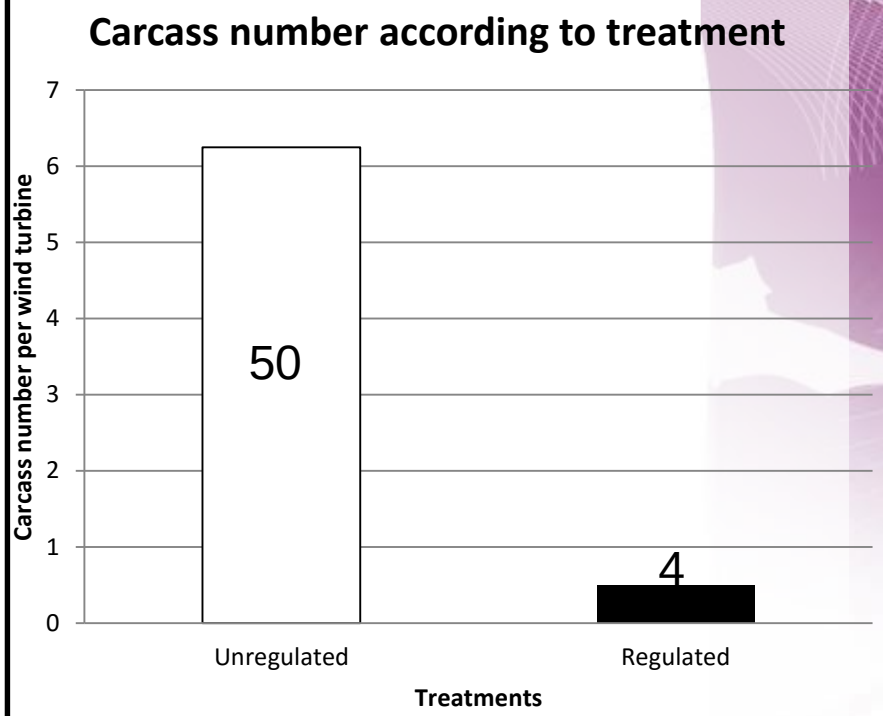
4- Regulation tests of wind turbines

Results (Mas de Leuze - 2011)

- **Mortality decrease of 90,7%** between **control and regulated** wind turbines

-**Calculated loss of production <0,15 %** (Enercon)



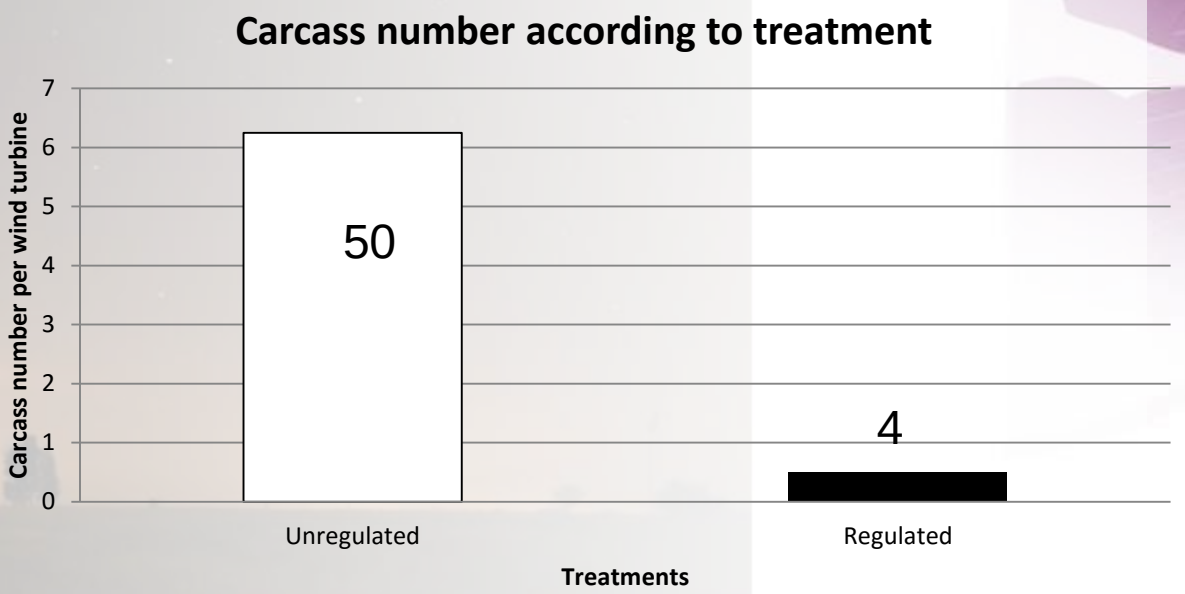
Number of bat's carcass
(model GAM, P>0,01)

4- Regulation tests of wind turbines

Date	Wind Farm	Number of carcass under the control turbines	Number of carcass under the regulated turbines	Decrease of mortality	Loss of production
2009 - 2010	Bouin			64%	< 0,5 %
2011	**Mas de Leuze**	**50**	**4**	**90,70%**	**< 0,3 %**

- Mortality decrease of 90,7% between **control and regulated** wind turbines

-**Calculated loss of production <0,15 %** (Enercon)



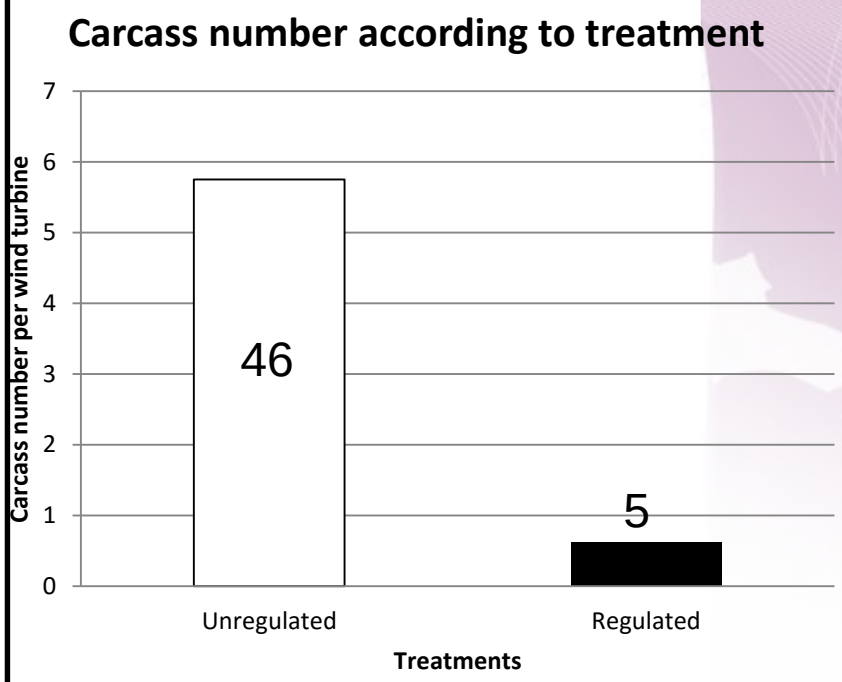
Number of bat's carcass (model GAM, P>0,01)

4- Regulation tests of wind turbines

Results (Mas de Leuze - 2012)

- Mortality decrease of 90,2% between **control and regulated** wind turbines

-Calculated loss of production <0,4% (Enercon)



Number of bat's carcass
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4- Regulation tests of wind turbines

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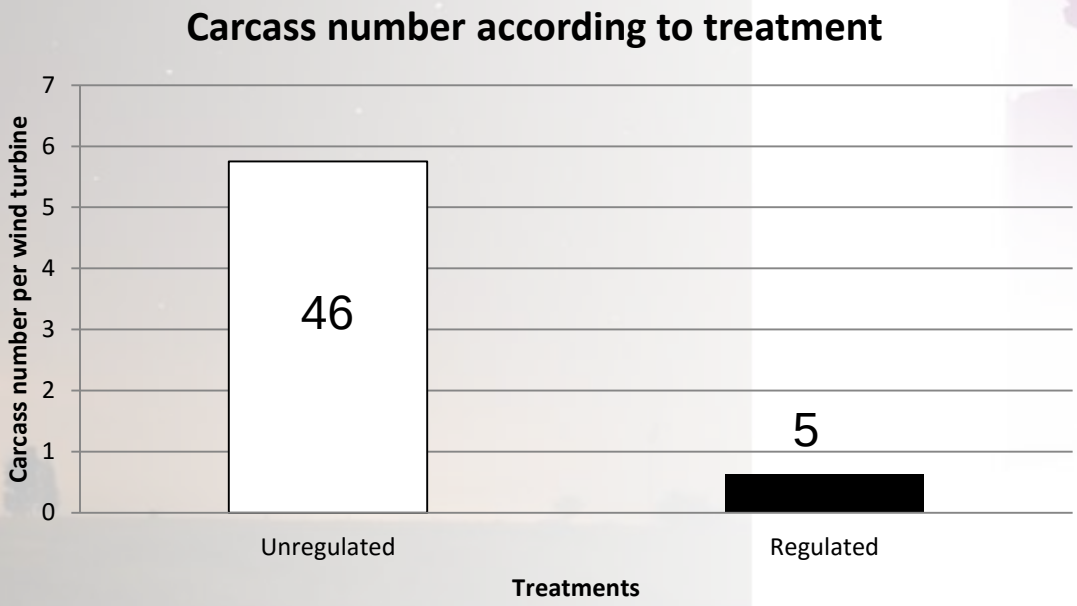
2011	Mas de Leuze	50	4	90,70%	< 0.3 %
2012	**Mas de Leuze**	**46**	**5**	**90,20%**	**< 1 %**

- Mortality decrease of 90,2% between **control and regulated** wind turbines

-**Calculated loss of production <0,4 %** (Enercon)



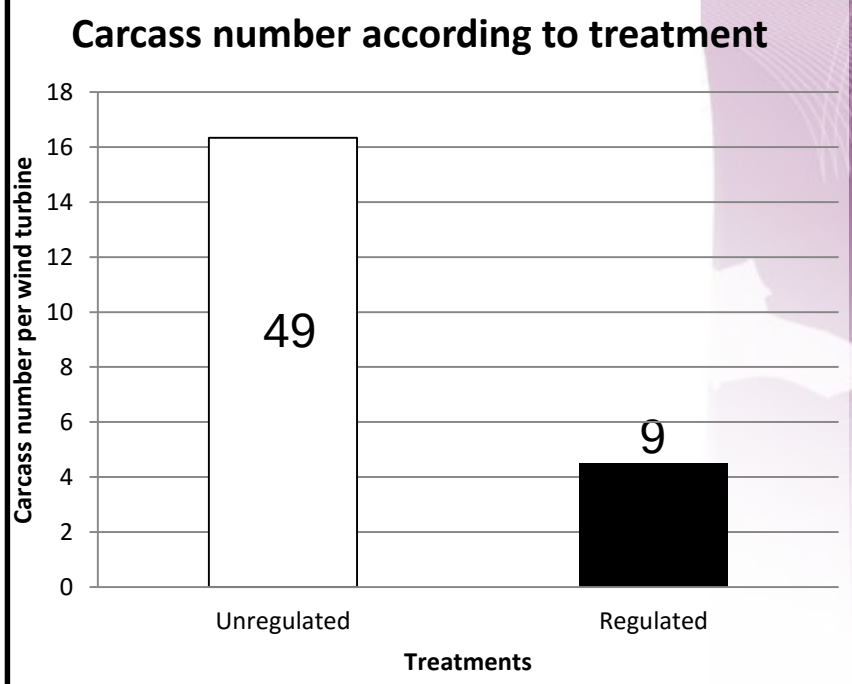
Number of bat's carcass (model GAM, P>0,01)

4- Prospect and Chirotech development

Results (FrontLine - 2012)

- Mortality decrease of 78% between **control and regulated** wind turbines

-**Calculated loss of production <1 %** (Boralex)



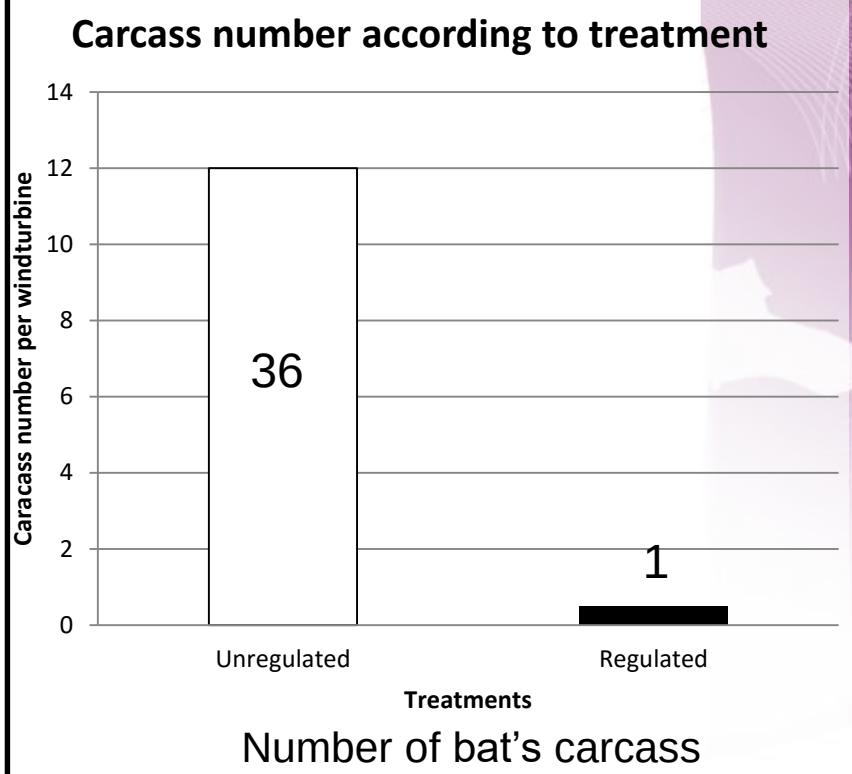
Number of bat's carcass

4- Prospect and Chirotech development

Results (Bisnett - 2012)

- **Mortality decrease of 96,7%** between **control and regulated** wind turbines

- **Calculated loss of production <0,68 %** (Boralex)



Number of bat's carcass