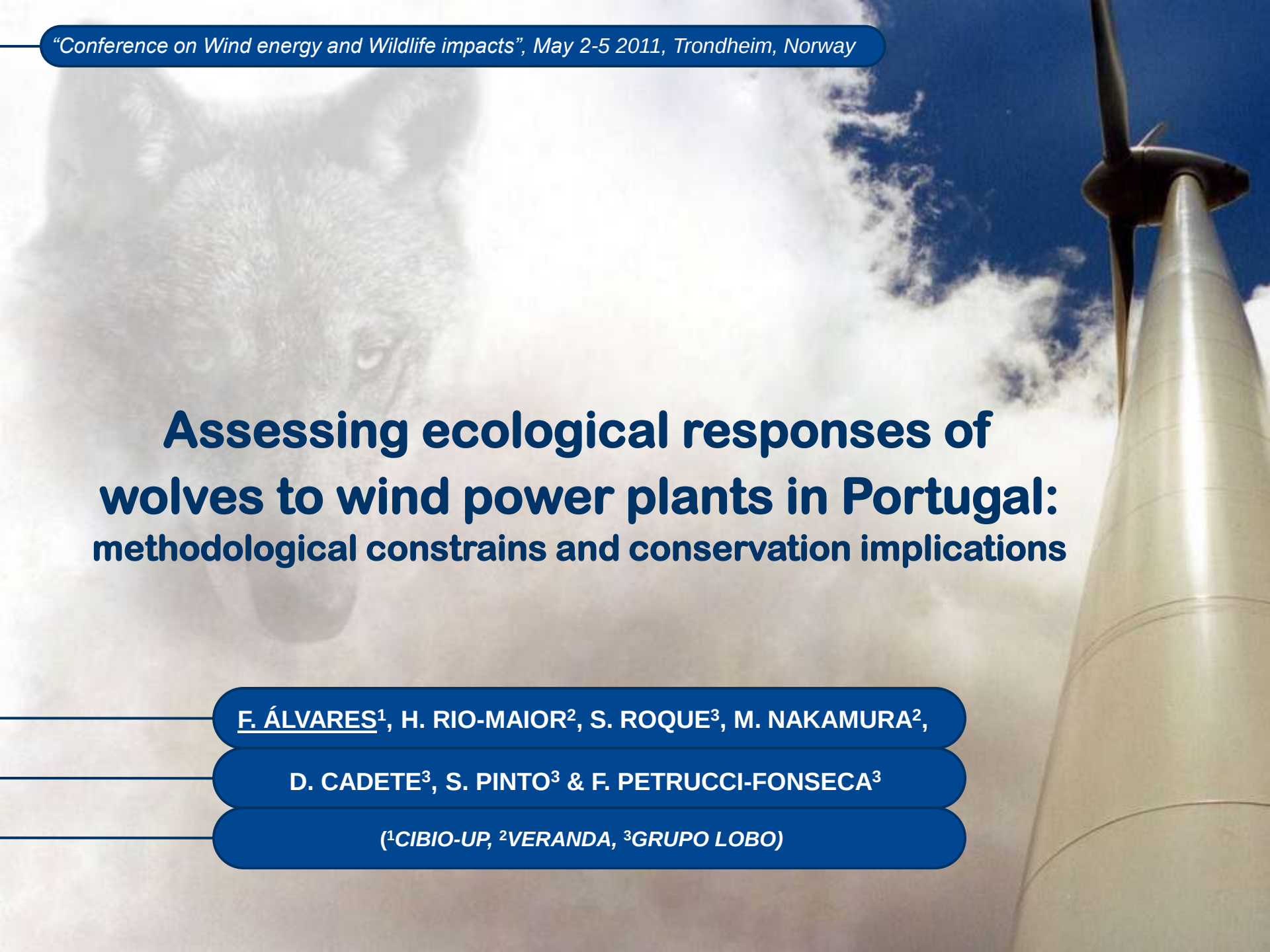
"Conference on Wind energy and Wildlife impacts", May 2-5 2011, Trondheim, Norway



Assessing ecological responses of wolves to wind power plants in Portugal:
methodological constrains and conservation implications

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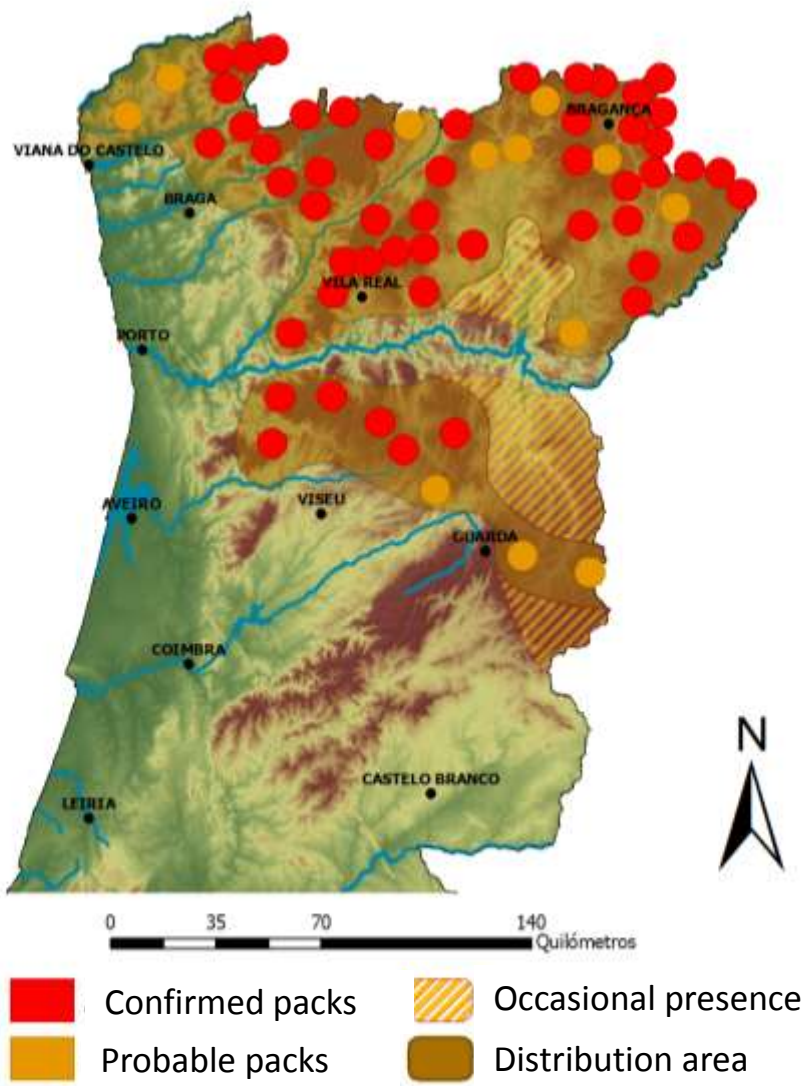
([1]CIBIO-UP, [2]VERANDA, [3]GRUPO LOBO)

Wolf in Portugal: population status



Source:
Pimenta *et al*. (2005). Wolf National Census 2002/2003

- Protected and Endangered
- 63 packs; ± 300 individuals
- Ecological features:

Livestock comprises >80% diet

High human-caused mortality

Wolf in Portugal: habitat features

- Protected and Endangered

- 63 packs; ± 300 individuals

- Ecological features:

Livestock comprises >80% diet

High human-caused mortality

- Habitat features:

Mountainous areas with intensive human use

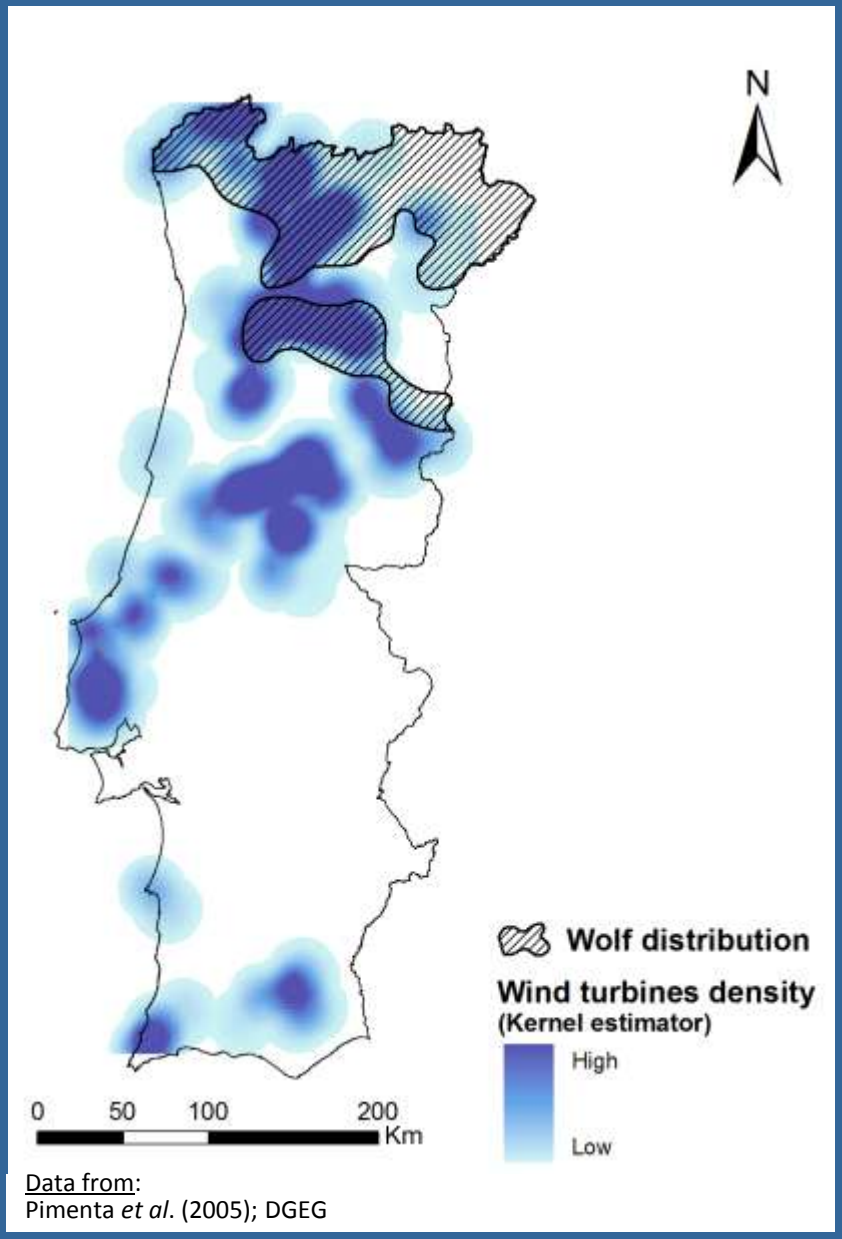
High human density (~ 40 inhab./km2)

High road density (~ 0.7 km/ km2)

Low forest cover (~ 20 %)

Mostly shrub land (> 60%)

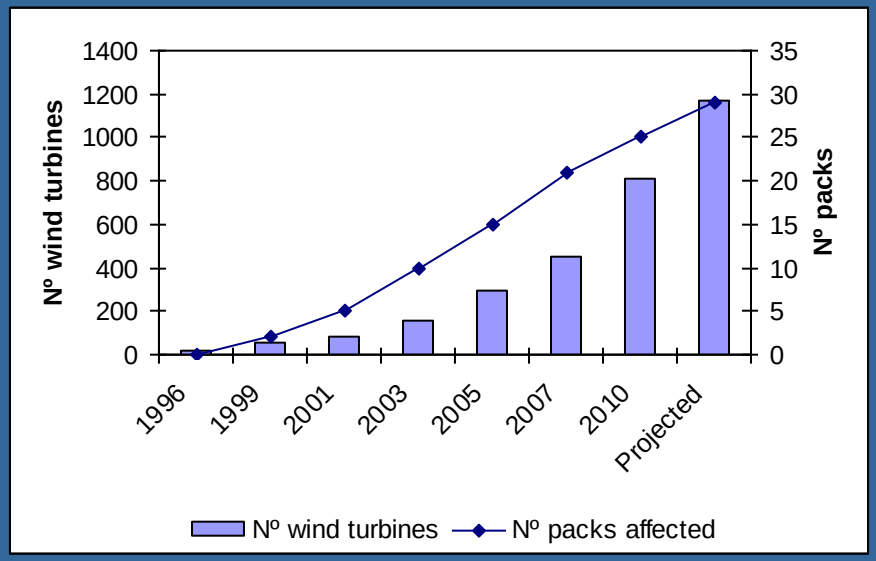
Wolves and Wind-power development



Data from:
Pimenta *et al*. (2005); DGEG

Annual evolution of wind-power in wolf distribution area:

- cumulative number of wind turbines
- number of packs affected by installations



In a near future:

- Almost 1200 wind turbines across wolf distribution area (6 turbines/100km^2)
- 46% of all packs in Portugal

Wolves and Wind-power development

Potential impacts on wolves:

- Human disturbance (↑ mortality risk)
- Acoustic/visual disturbance
- Habitat changes

Human disturbance:

Road network built for wind-power development leads to a considerable increase in traffic

<u>Pre-construction period:</u>

0.06 - 0.2 vehicles/hour

<u>Construction period:</u>

3.8 vehicles/hour (20-60 fold increase)

<u>Post-construction period:</u>

0.8 vehicles/hour (4-13 fold increase)

Assessing wolf ecological responses to wind power plants

Wolf as a focal species in EIA of wind power plants

Current studies are based on wolf population monitoring rather than a real impact assessment design

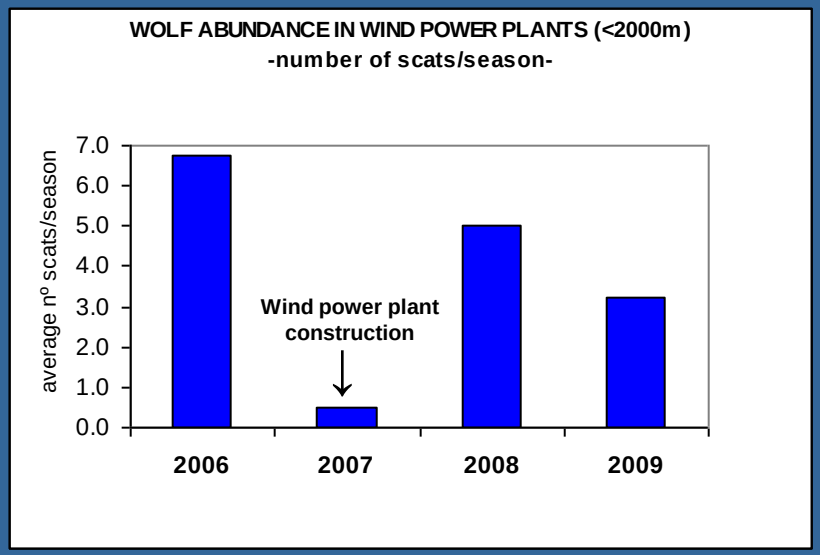
Field Methods:

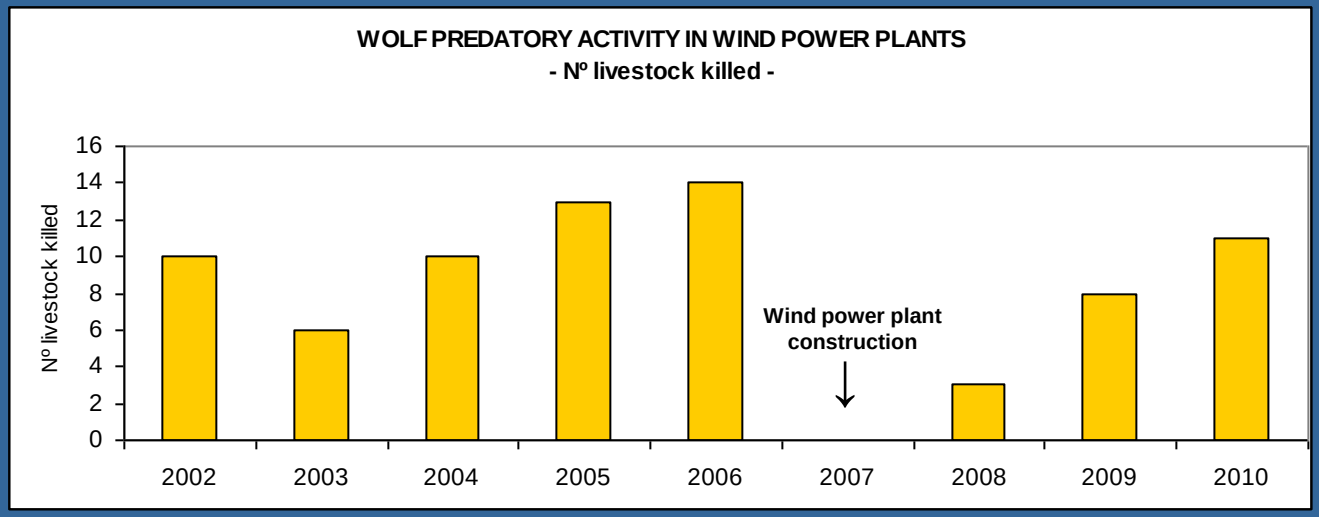
- Scat surveys (2x2km grid) and quantification through abundance indexes (confirmation of wolf scats by genetic analysis)
- Howling surveys
- GPS telemetry

Impact assessment based on:

- Temporal evolution of wolf presence indicators inside “Impact area” (proximity to wind turbines)
- Differential use between “Impact area” (e.g. with wind turbines) and “Control area” (e.g. remaining pack territory without wind turbines)

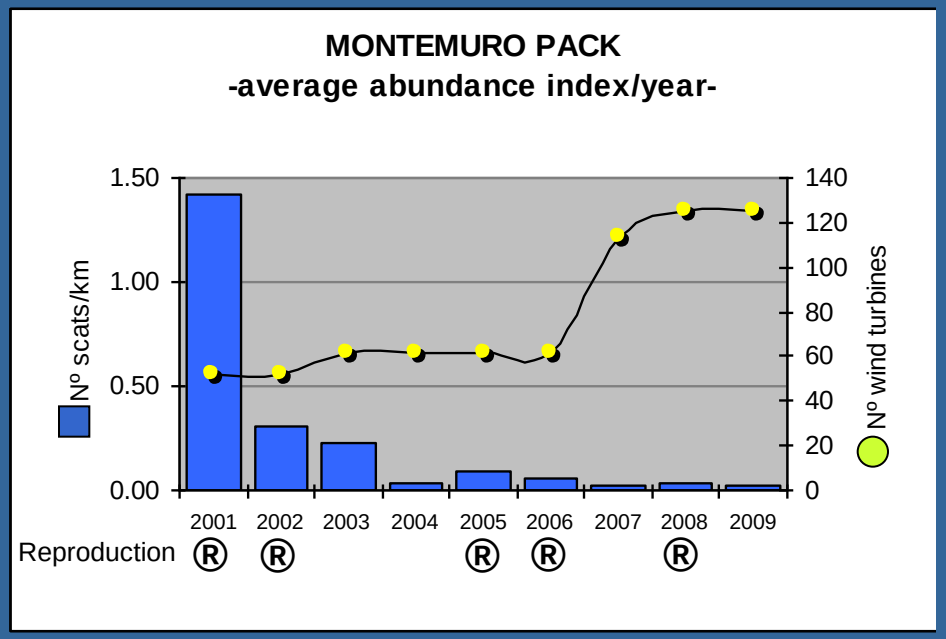
Wolf presence vs wind power plants

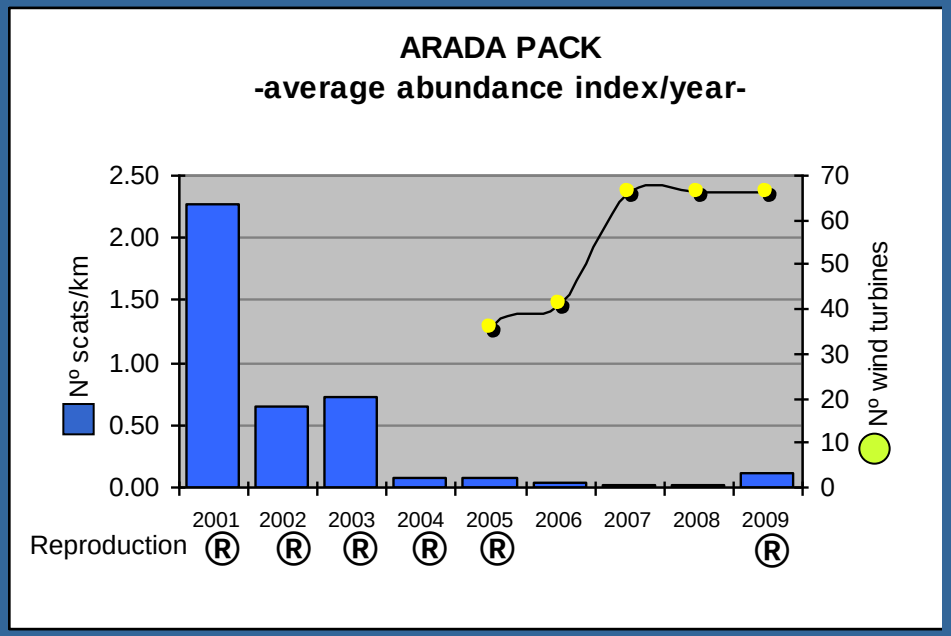




Construction seems to induce a decrease in wolf presence (abundance and predatory activity) in the proximity of wind power plants, which is restored during operation

Pack responses vs wind energy development





Packs continue to be present and breed in territories containing up to 125 wind turbines (0.4 wind turbines/km^2)

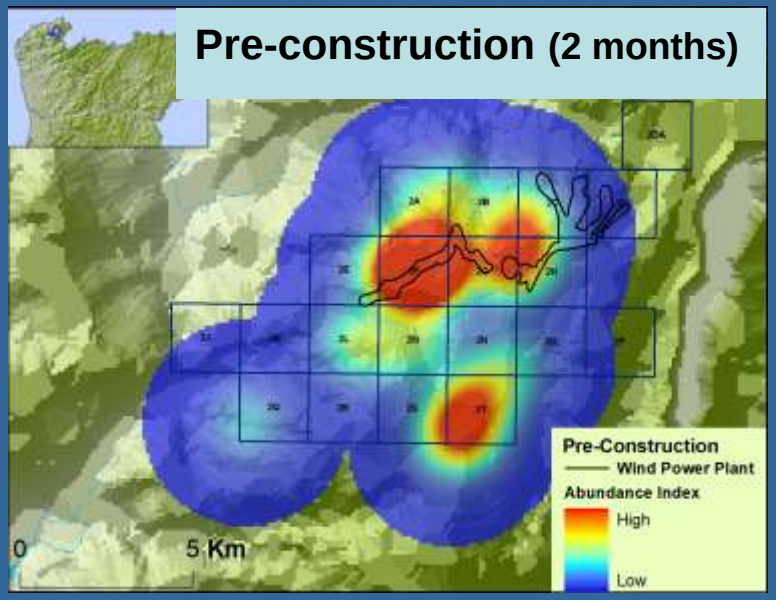
Cumulative number of wind turbines within a pack territory apparently leads to a decrease in wolf abundance and reproduction success

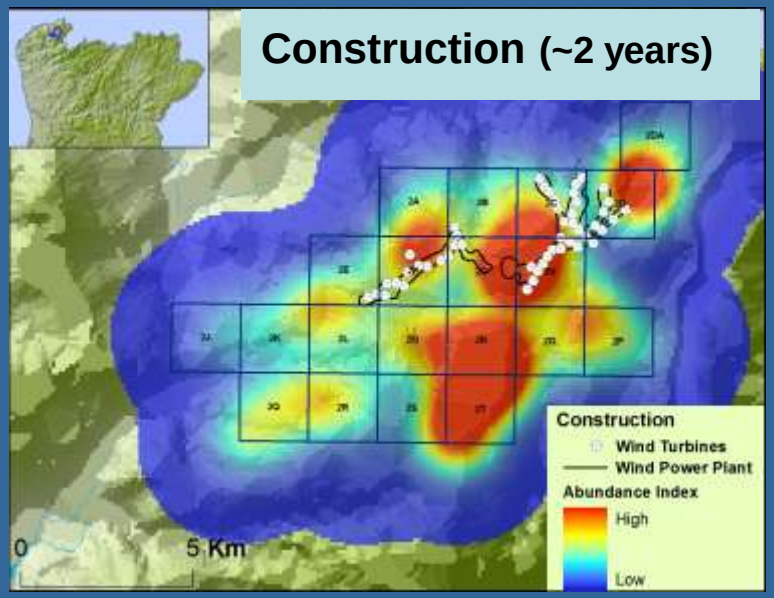
Rapid increase in number of wind power plants within the territory of most packs hampers evaluation of ecological responses

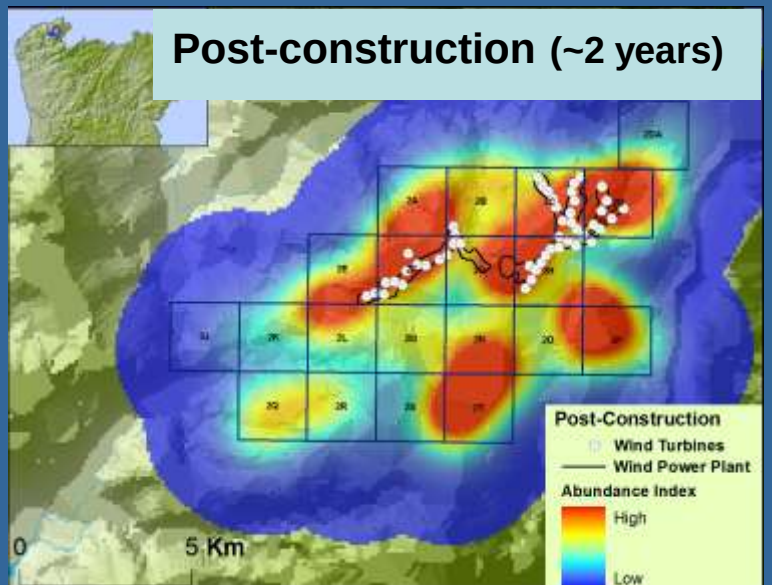
Case study for ecological responses

Wolf pack affected by a single wind power plant with 49 turbines

Spatial responses: abundance indexes





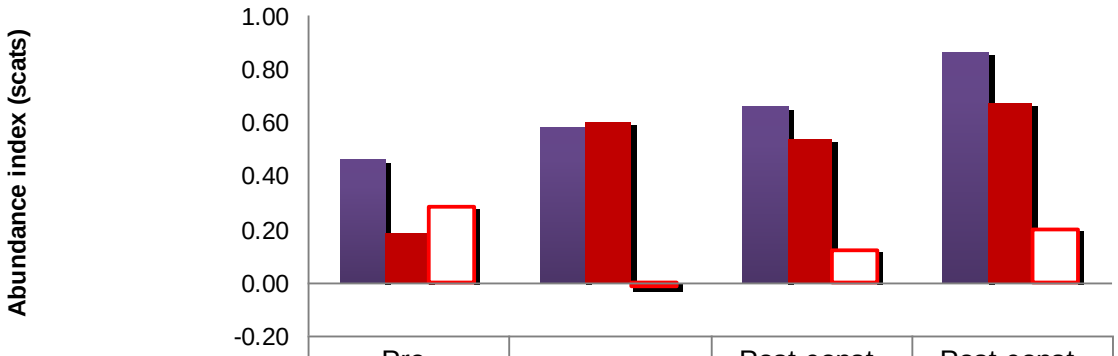


Kernel density distribution analysis of scat location data to identify core-areas within pack territory

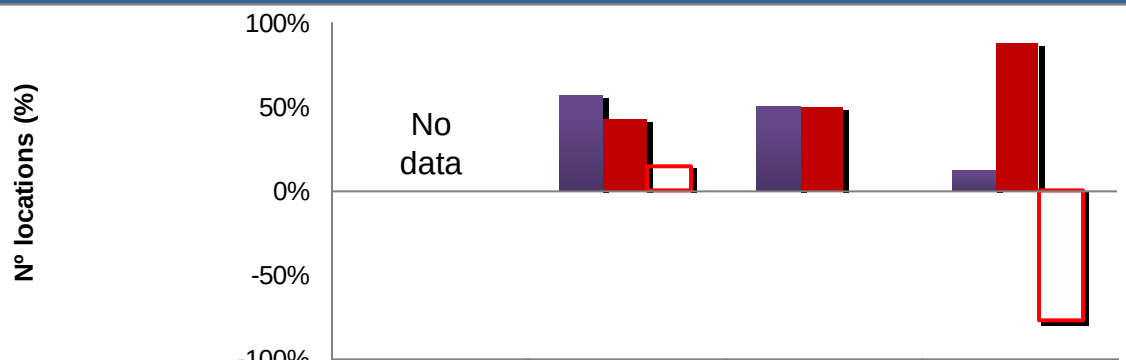
Pack core-areas are located near the wind power plant construction site

Wolves continue to use core-areas near the wind power plant, both during construction and operation (post-construction)

Spatial responses: Abundance indexes vs GPS locations



	Pre-Construction	Construction	Post-const. Year I	Post-const. Year II
IMPACT AREA	0.46	0.58	0.66	0.87
CONTROL AREA	0.18	0.60	0.54	0.67
DIFFERENCE	0.28	-0.02	0.12	0.20



	Pre-Construction	Construction	Post-const. Year I	Post-const. Year II
IMPACT AREA	-	57%	50%	11%
CONTROL AREA	-	43%	50%	89%
DIFFERENCE	-	14%	0%	-77%

Differential use between Impact and Control areas based on abundance indexes:

-decreases during construction;

- increases during operation, showing a similar pattern to pre-construction.

Different pattern based on GPS telemetry, specially during Year II of post-construction:

-increase in the use of Control area (remaining pack territory);

Scat abundance indexes may reflect scent-marking behaviour instead of actual intensity of use that is reflected by telemetry

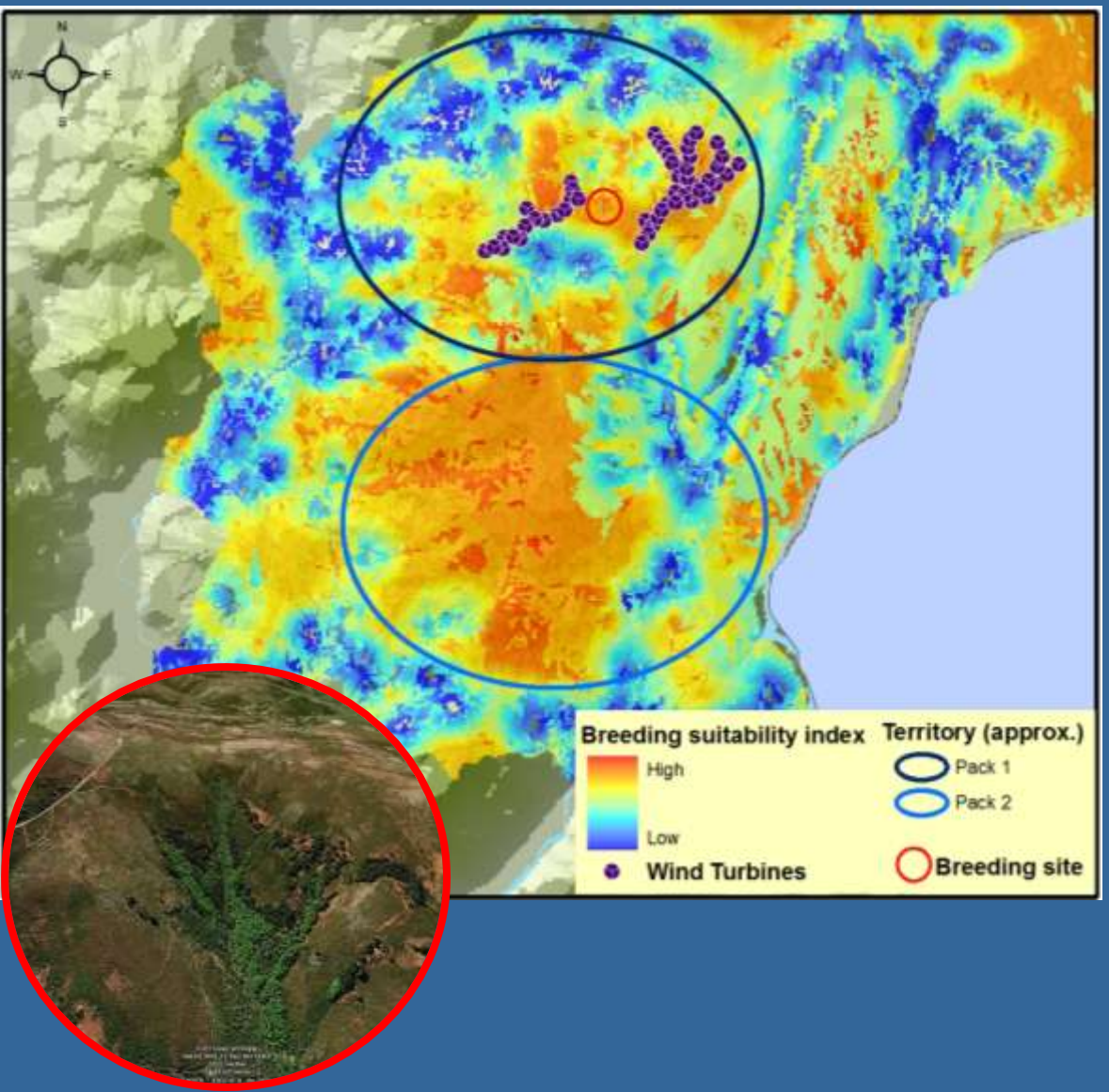
Reproductive patterns: reproductive success and site selection

Year	Wind farm installation	Reproduction	Breeding sites			
			A	B	C	D
1999	Pre-construction	Confirmed	X			
2000		Confirmed	X			
2001		Confirmed	X			
2002		Confirmed	X			
2003		Confirmed	X			
2004		Confirmed	X			
2005		Confirmed	X			
2006		Probable	?			
2007	Construction	Confirmed		X		
2008		No evidence				
2009	Post-construction	Confirmed			X	
2010		Confirmed				X

Each breeding site has different habitat features attending to:
i) vegetation cover; *ii)* altitude*; iii)* distance to roads and villages*; iv)* distance to water

Reproductive patterns: suitability of breeding sites

Pre-construction (1999-2006)



High fidelity to a single breeding site with high suitability:

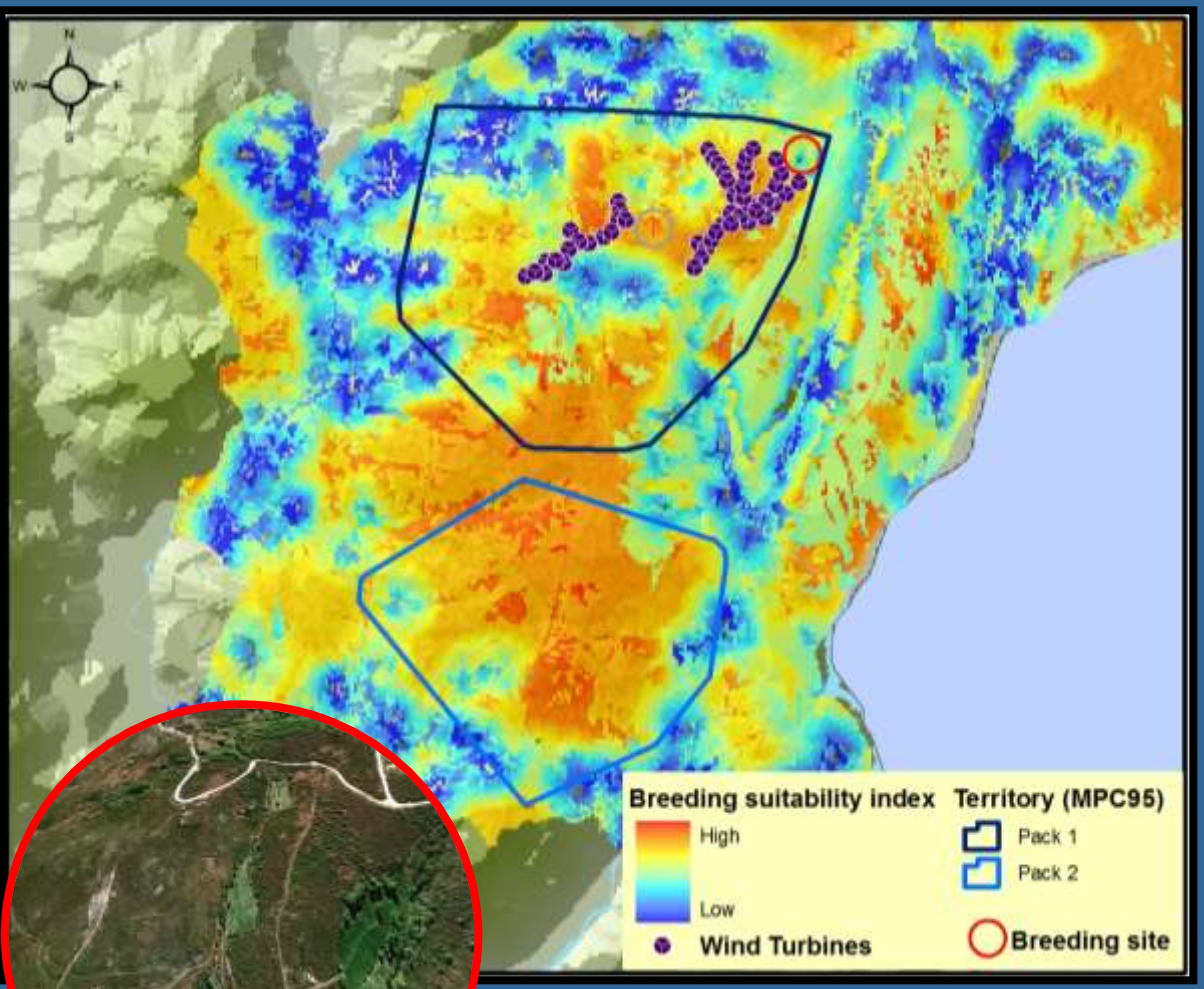
- shrubs (80%) and forest (20%)
- high altitude (~ 1000m s.l.)
- far from road/village (> 1300m)

High exposure to (future) wind turbines:

- central position in relation to all wind turbines;
- min. distance of ~800m
- small difference (10m) between linear and superficial distance to wind turbines (“flat area")

Reproductive patterns: suitability of breeding sites

Construction Year I – 2007



Selection of a different breeding site with low suitability:

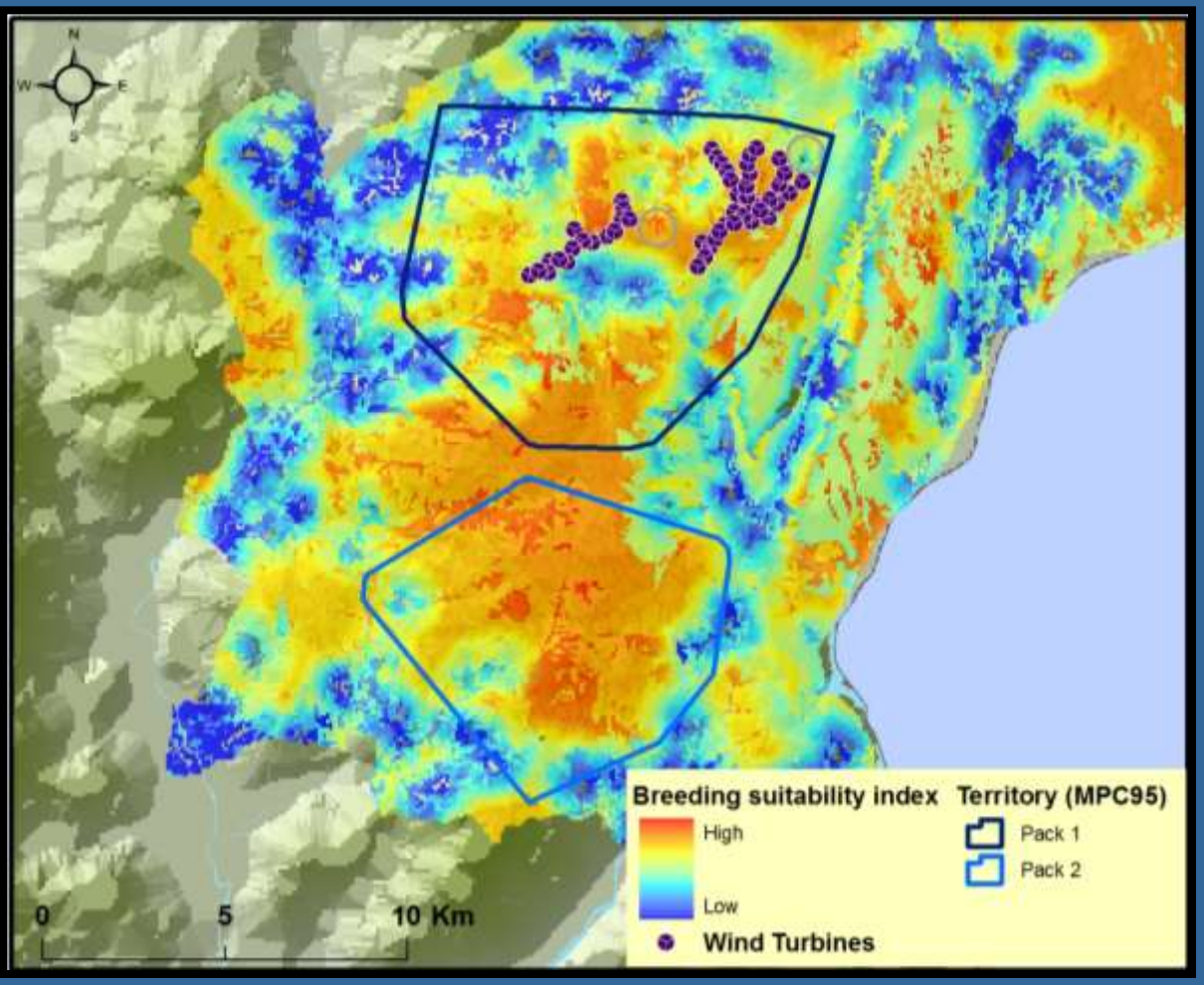
- agricultural land (~ 30%)
- low altitude (~ 800m s.l.)
- close to village (~ 100m)

High exposure to construction site and (future) wind turbines:

- marginal position in relation to all wind turbines;
- min. distance of ~700m
- small difference (5m) between linear and superficial distance to wind turbines (“flat area")

Reproductive patterns: suitability of breeding sites

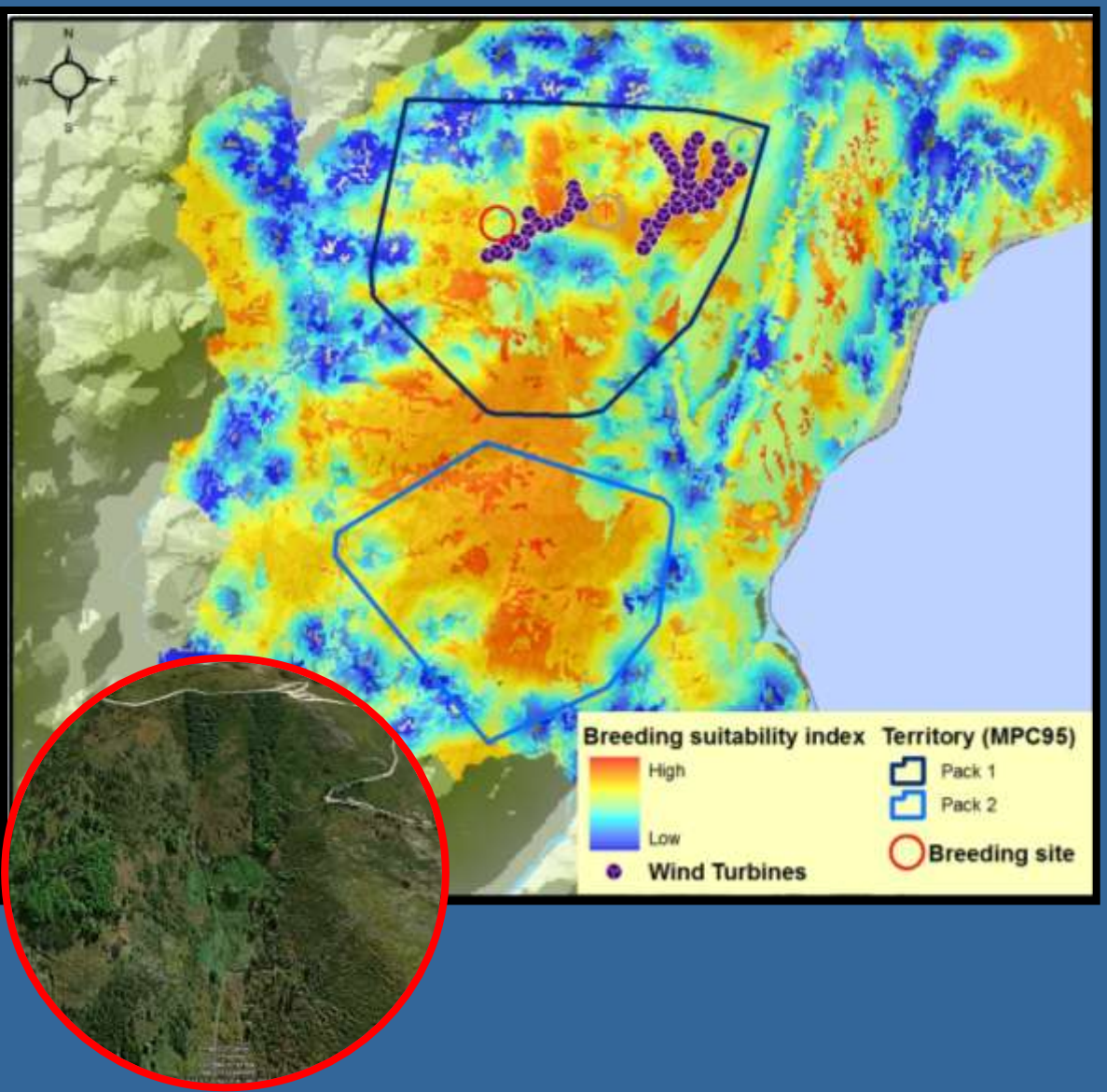
Construction Year II – 2008



No evidence of reproduction was detected

Reproductive patterns: suitability of breeding sites

Post-construction Year I – 2009



Selection of a different breeding site with low suitability:

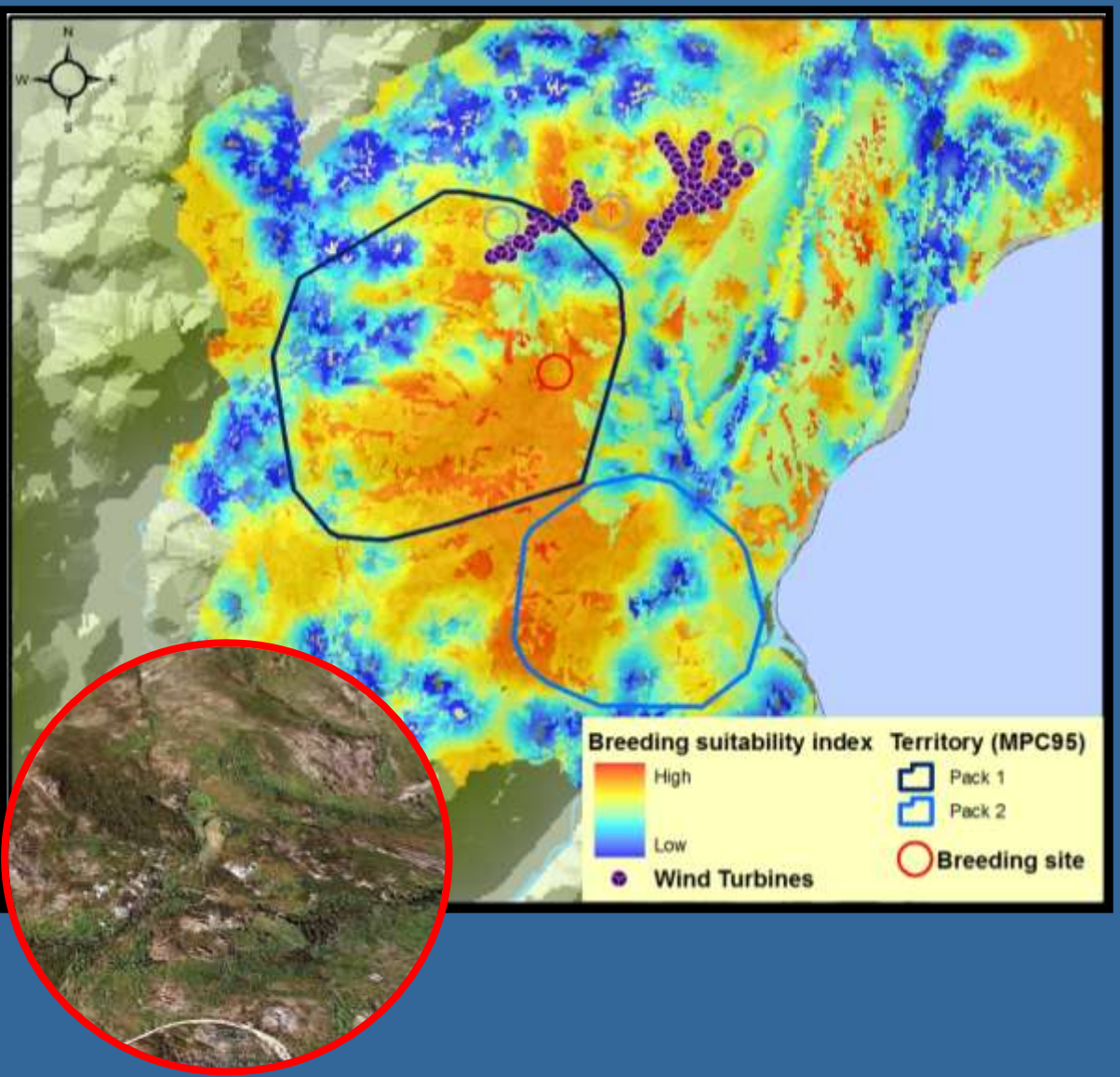
- agricultural land (~ 10%)
- low altitude (~ 800m s.l.)
- close to paved road (~ 400m)

High exposure to wind turbines:

- marginal position in relation to all wind turbines;
- min. distance of ~600m
- bigger difference (40m) between linear and superficial distance to wind turbines (“higher slope")

Reproductive patterns: suitability of breeding sites

Post-construction Year II – 2010



Selection of a different breeding site with high suitability:

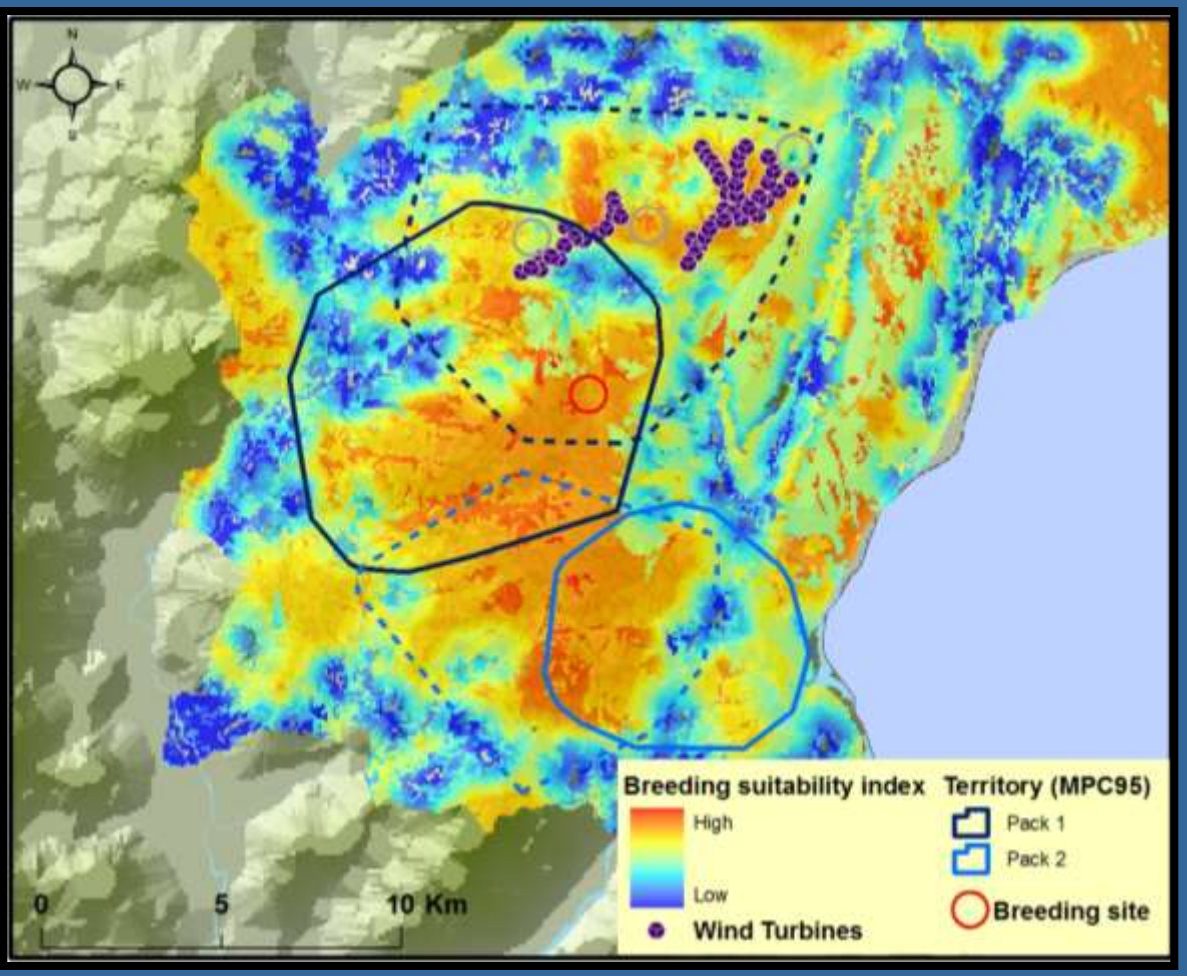
- mostly shrubs (~ 90%)
- high altitude (~ 1100m s.l.)
- far from road/village (> 3000m)

Low exposure to wind turbines:

- min. distance of ~3800m

Reproductive patterns: suitability of breeding sites

Post-construction Year II – 2010



Selection of a different breeding site with high suitability:

- mostly shrubs (~ 90%)
- high altitude (~ 1100m s.l.)
- far from road/village (> 3000m)

Low exposure to wind turbines:

- min. distance of ~3800m

Selection of a breeding site far from wind turbines and with a higher habitat suitability was associated with a spatial reconfiguration of packs' territories

Conclusions and Conservation implications

Wind farms appear to induce important changes in wolf:

i) space use; ii) selection of and fidelity to breeding sites

- Keep using areas with wind power plants;

- Presence tends to decrease during construction and with the cumulative number of wind turbines within a pack territory;

- Abandon or do not regularly use breeding sites located ≤ 1km of wind turbines;

- May select breeding sites less suitable after wind power plant construction;

Need for long-term monitoring during post-construction to access possible effects on reproductive success and population viability

These ecological responses may increase exposure to other threats or sources of disturbance, especially in already highly humanized and heterogeneous landscapes such as Portugal

Mitigation and compensation

Based on these preliminary findings, several preventive **mitigation measures** have been applied during EIA and pre- and post-construction of wind power plants:

- Closing road net-work built for wind-power development in order to reduce traffic and direct human disturbance

- Total protection to pack breeding sites during site selection and construction period (through the definition of exclusion areas of >2 km radius)

In addition, several **compensatory measures** have been applied and focused mainly on habitat improvement and management

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