

# Effects of rat eradication on lizard populations

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ASSISES MEDITERRANEENNES DES PETITES ILES  
Six-Fours – du 7 au 10 Octobre 2009

## The case of the Balearic lizard, *Podarcis lilfordi*

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- The effects of introduced rats on lizard populations
- The effects of eradication programs on lizard populations



Rats can act as predators  
and/or competitors of  
lizards



Presence/absence of rats should  
have an effect on lizard's density

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A main antipredatory behaviour is the  
modification of activity and  
locomotor patterns to avoid attacks



When rats are present, there  
is a direct effect on time  
budgets of lizards

Martín & Salvador (1997)  
McAdams & Kramer (1998)

*Amo et al.* (2007)

Antipredatory behaviours are energetically costly. Thus, lizards submitted to a higher predation pressure would suffer a loss of body mass →

Body condition can have a direct effect with poorer immune response and higher susceptibility to parasites

Martín & López (1999)  
Pérez-Tris *et al.* (2004)

- Cooper *et al.* (1985)
- Smallridge & Bull (2000)
- Amo *et al.* (2007)



Effects of  
rats



Effects of  
eradication

↓ lizard density ↑ ↓

↑ predation pressure ↓

tail autotomy  
body condition  
parasite load  
time budgets



# Balearic Islands

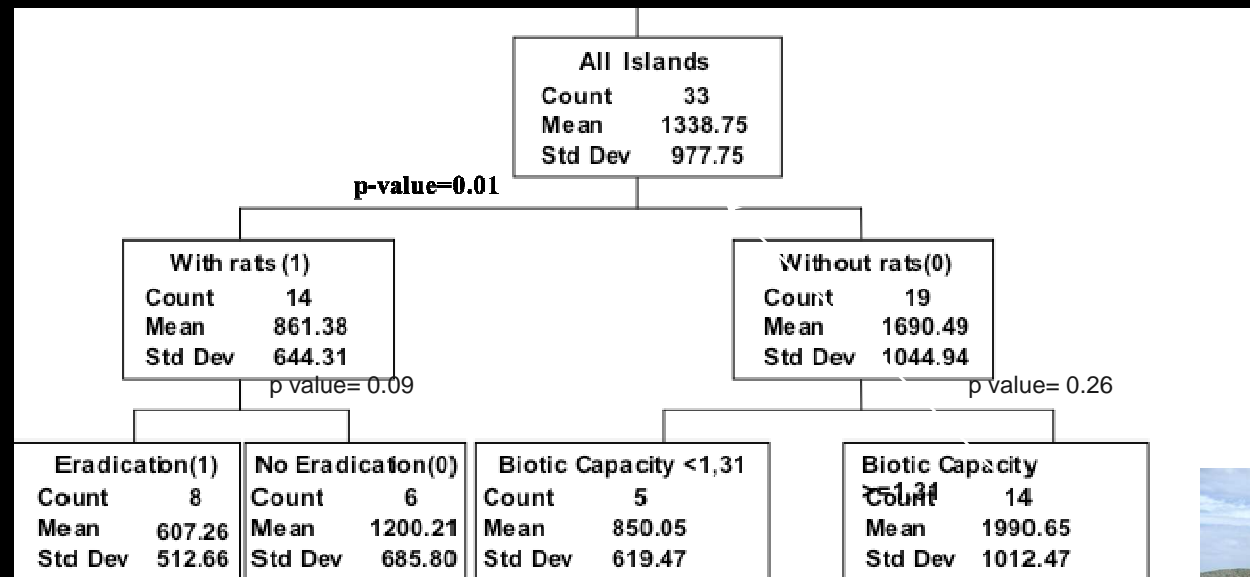
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- Presence/absence of rats and breeding seagulls
- Island surface and topography
- Vegetal cover diversity
- Genetic diversity of lizards
- Arthropod availability (subsample)

A general survey of populations  
of the Balearic lizard, *Podarcis lilfordi*



# *Podarcis lilfordi* at Balearic Islands



Exclusion of some islets from the sample due to an extremely low lizard density





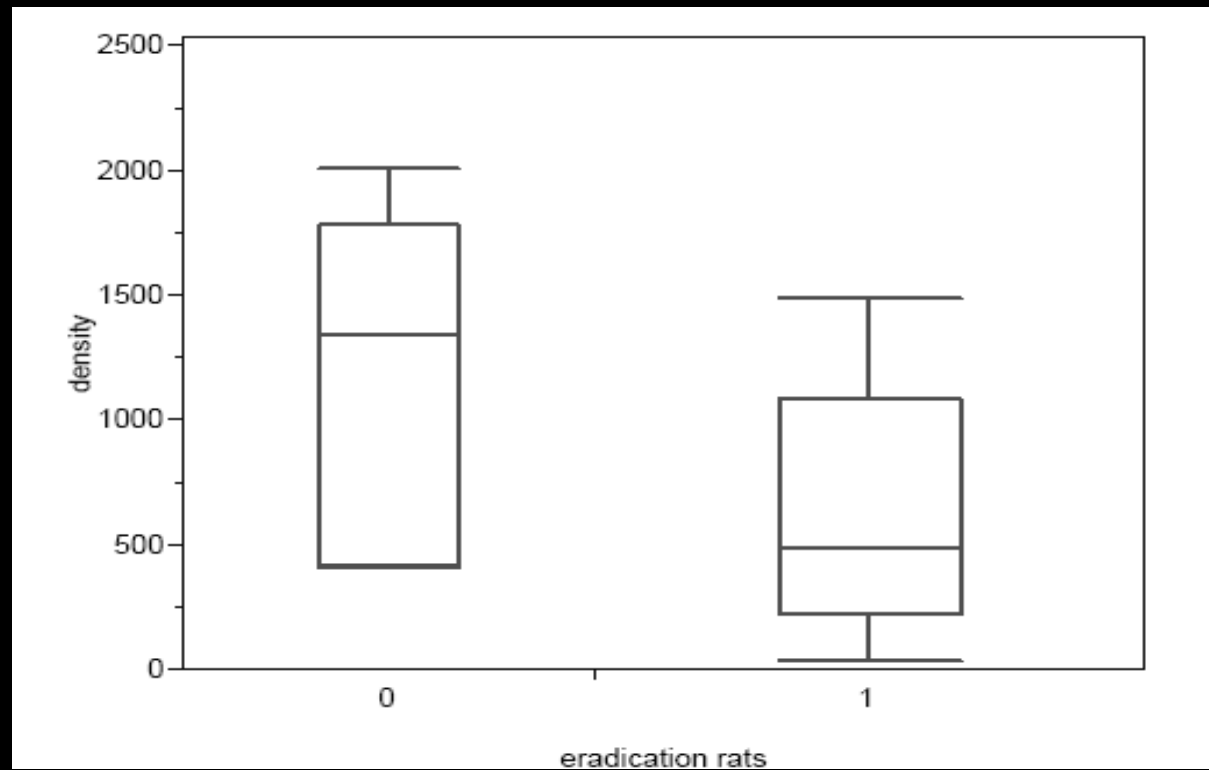
Islands without rats showed higher lizard densities

one-way ANOVA,  $F_{1,31} = 5.60$ ,  $P = 0.02$

Islands with an eradication program showed a marginally significant difference in density

one-way ANOVA,  $F_{1,12} = 3.45$ ,  $P = 0.09$

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↓ lizard density





## ...a different result

Colom Island (Menorca)  
2005

Effects of breeding seagulls  
and rats on lizard population



## Relative abundance of *Rattus rattus*

11 samples of 1 m<sup>2</sup>  
at each area

North

$64.72 \pm 23.09 / \text{m}^2$

East

$16.63 \pm 12.66 / \text{m}^2$

Central

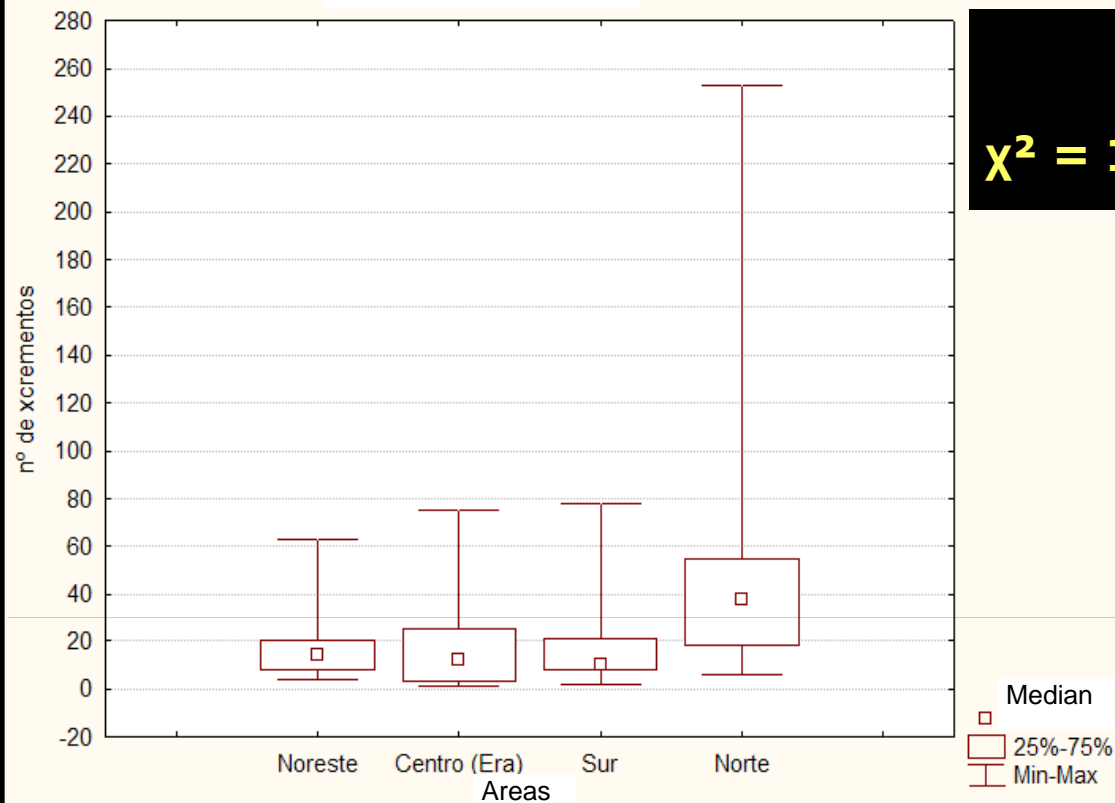
$17.63 \pm 6.30 / \text{m}^2$

$18.36 \pm 6.68 / \text{m}^2$

South



Faeces of *Rattus rattus*



## Kruskal-Wallis test

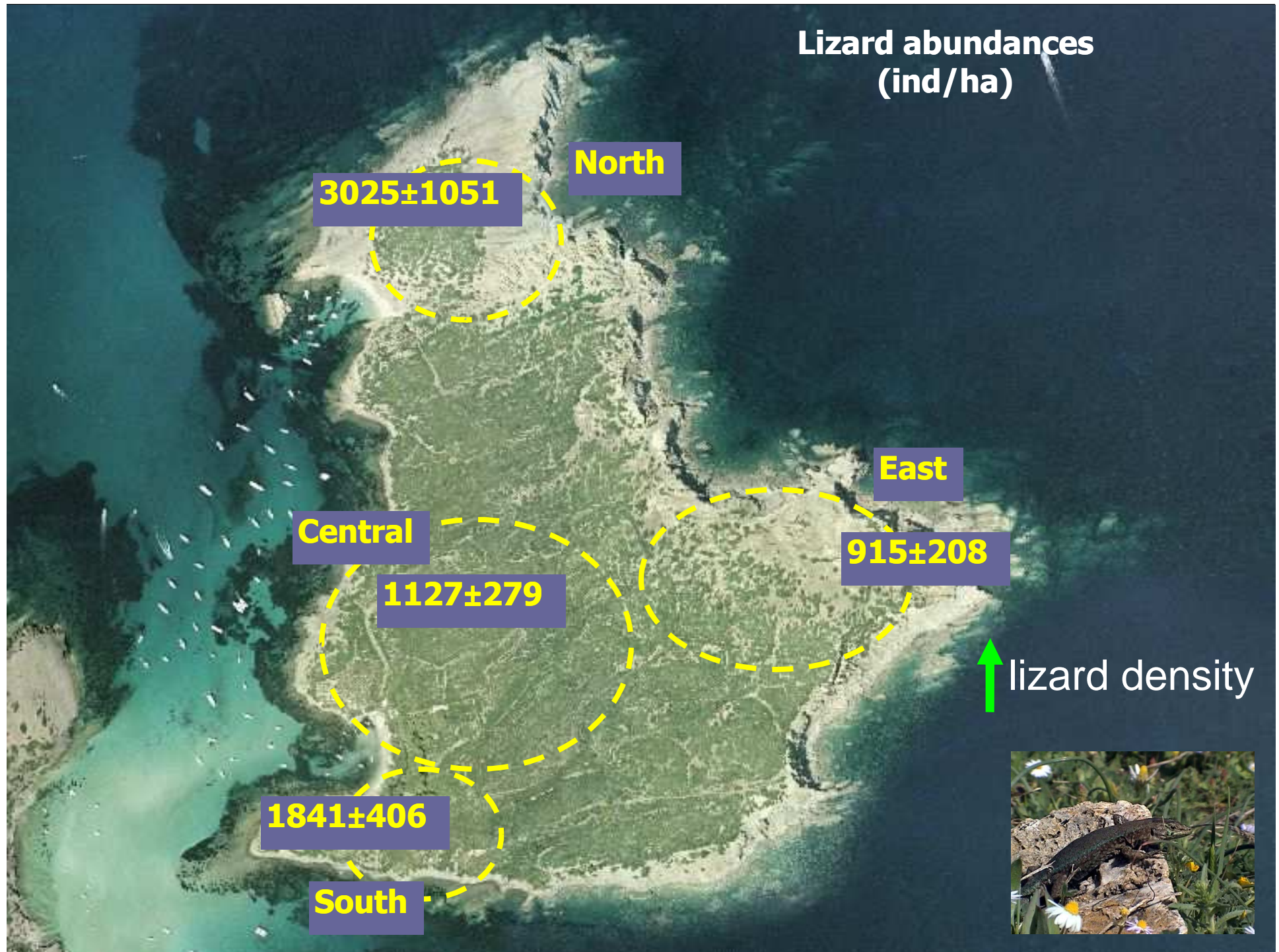
$$\chi^2 = 11.2049, \text{ g.l.}=3, p=0.0107$$

**Only we found significant differences  
between North area and the rest of  
studied areas  
(Mann-Withney U test)**





**Lizard abundances  
(ind/ha)**



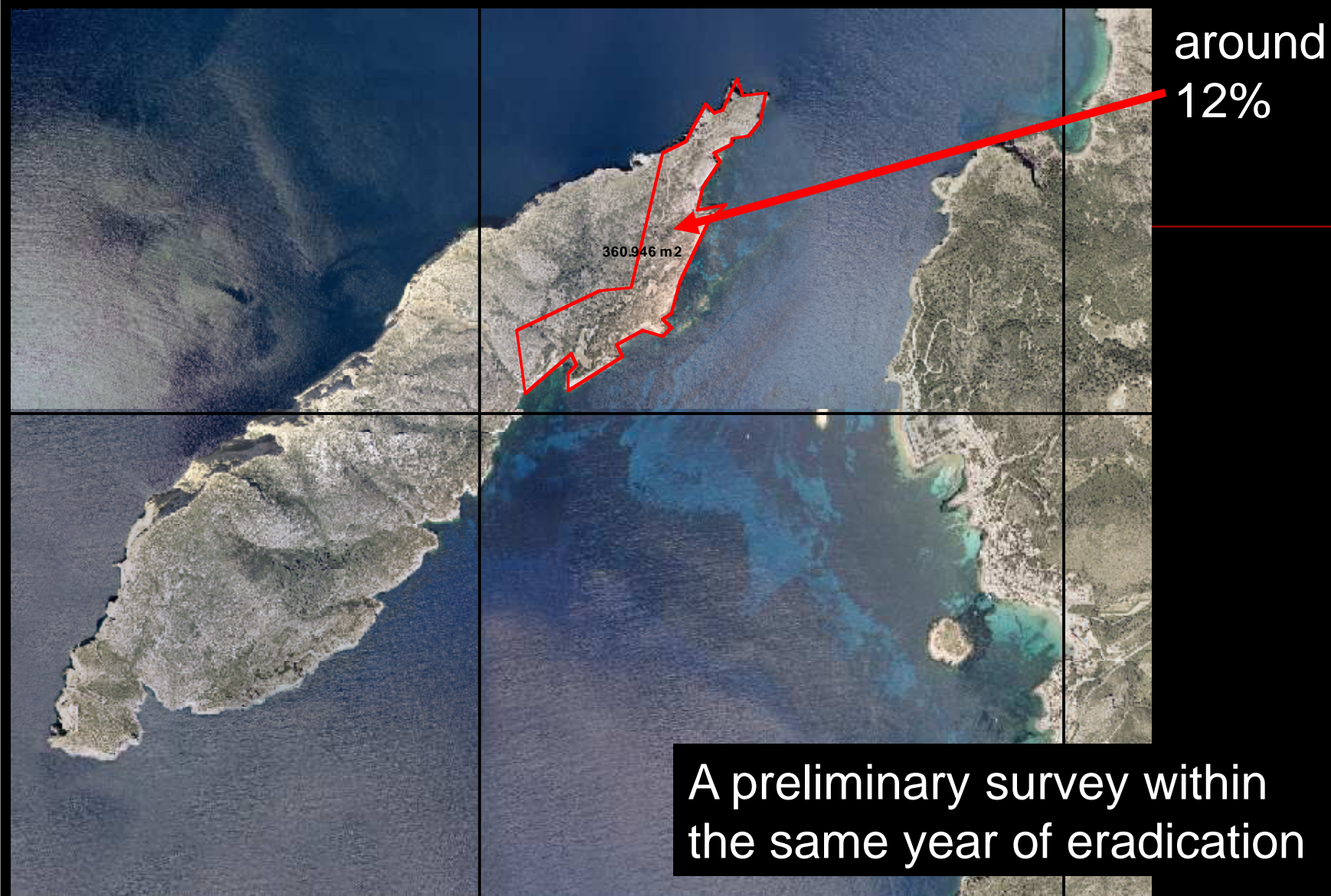
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288 ha.

**Dragonera Island (Mallorca)**

***Parc Natural de Sa Dragonera***

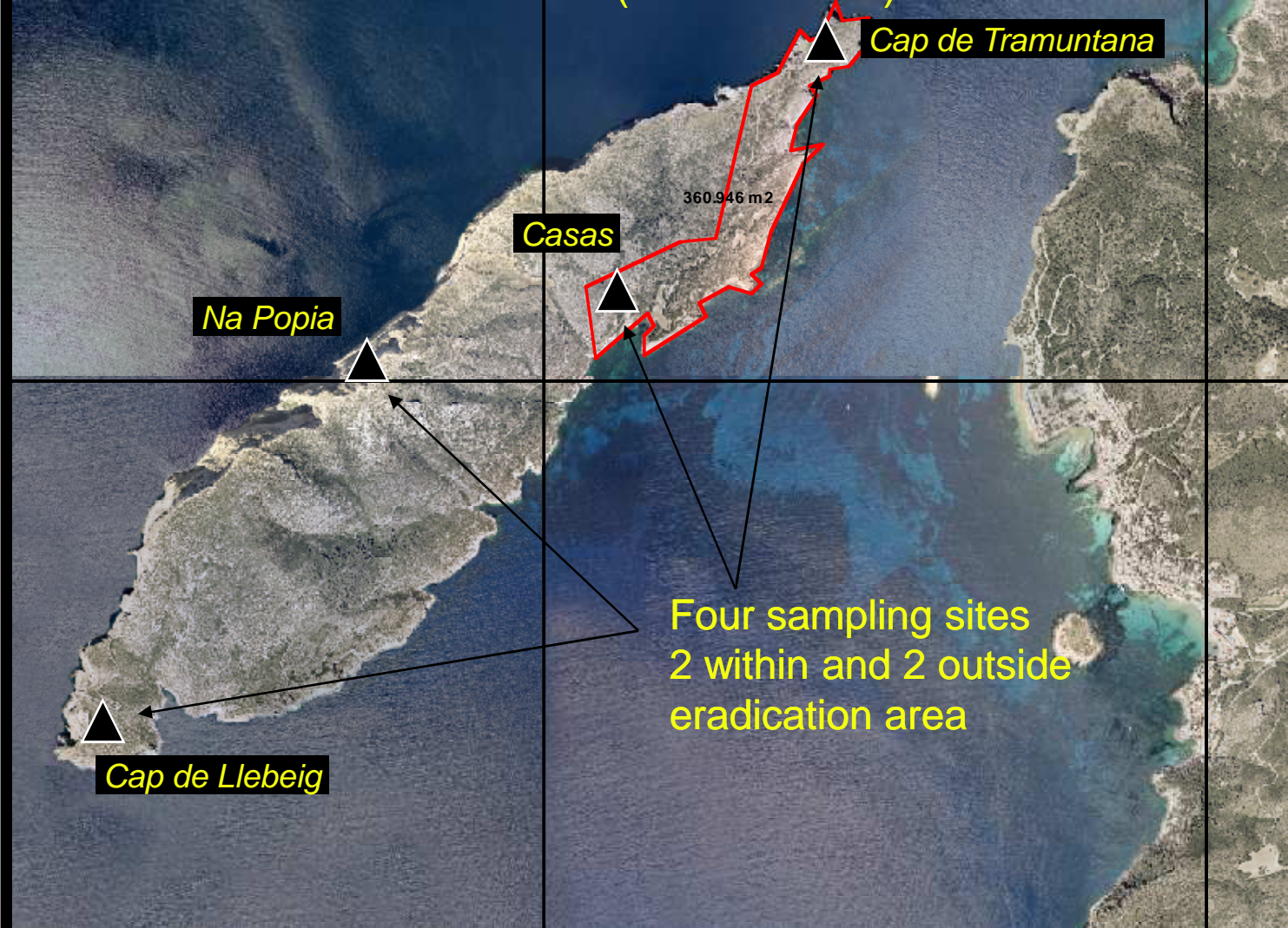




Rat eradication program during summer 2008



Two sampling periods (April and September 2008)  
before and after rat eradication (summer 2008)



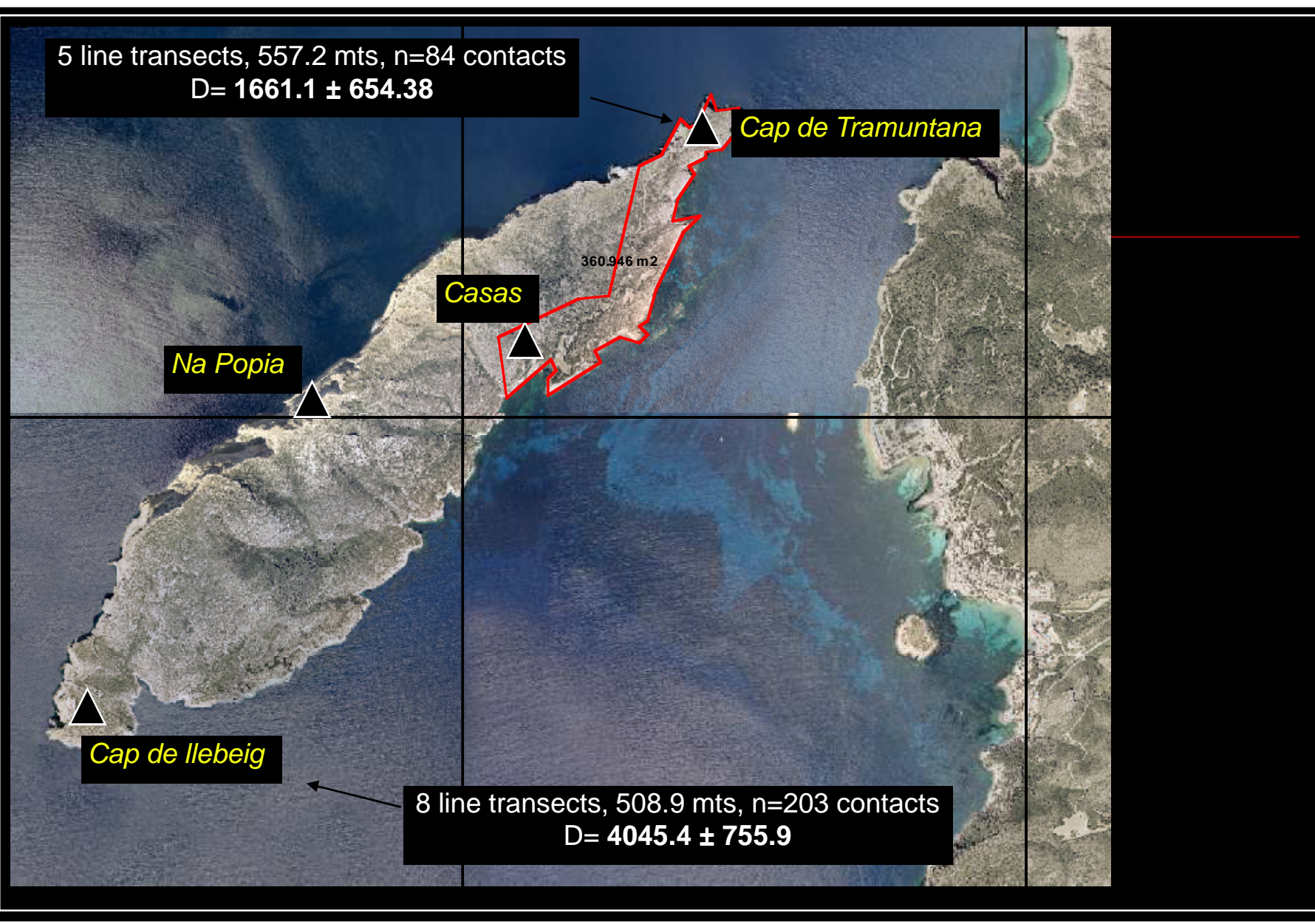
Rat eradication program from *Espais de Natura Balear* (Govern de les Illes Balears)



## Potential effects of rats and/or rat eradication on lizard populations

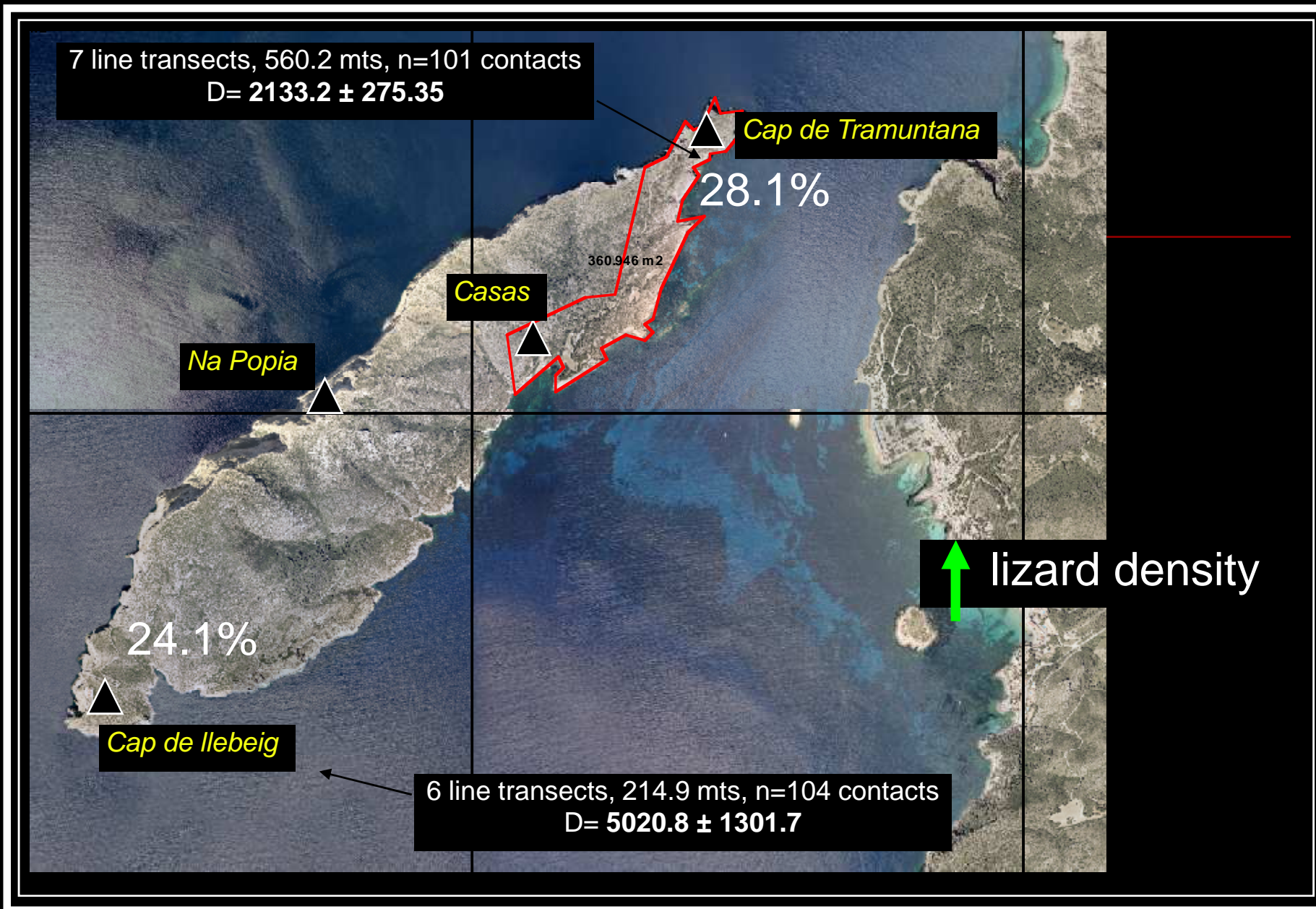
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- Lizard densities ( 26 line transects with 492 contacts)
  - Lizard body size
  - Body condition (residuals of weights)
  - Proportion of regenerated tails
  - Parasite load (ticks)
- (211 lizards)
- Foraging activity and time budgets (115 focal samples)



April 2008 (before eradication)

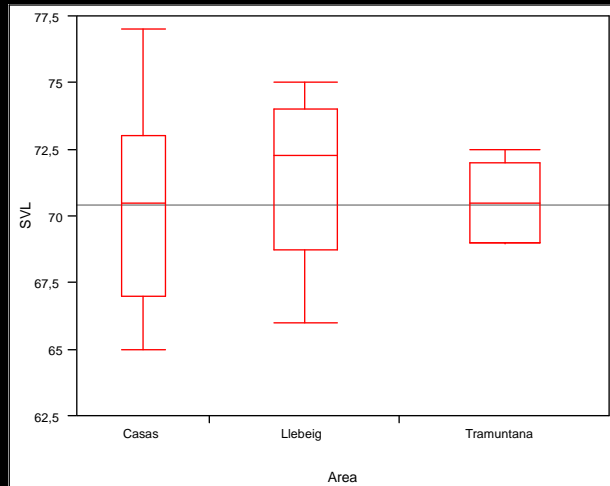




September 2008 (after eradication)

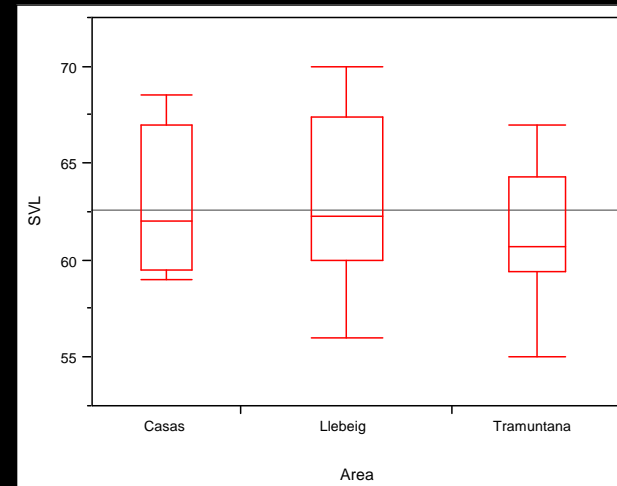
# Body size (SVL) of lizards

Adult males, April



One-way ANOVA,  $F_{2,25} = 0.7763$ ,  $p = 0.4709$

Adult females, April

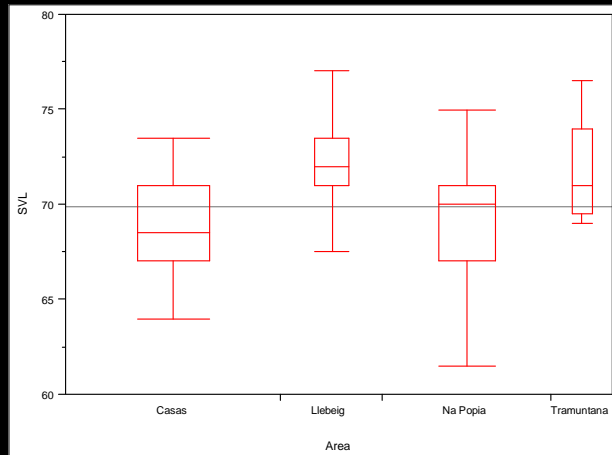


One-way ANOVA,  $F_{2,22} = 0.6237$ ,  $p = 0.5452$



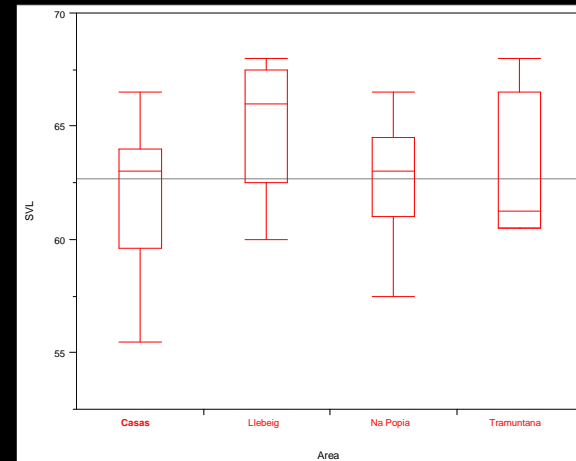
# Body size (SVL) of lizards

Adult males, September



One-way ANOVA,  $F_{3,77} = 3.8316$ ,  $p = 0.013$

Adult females, September

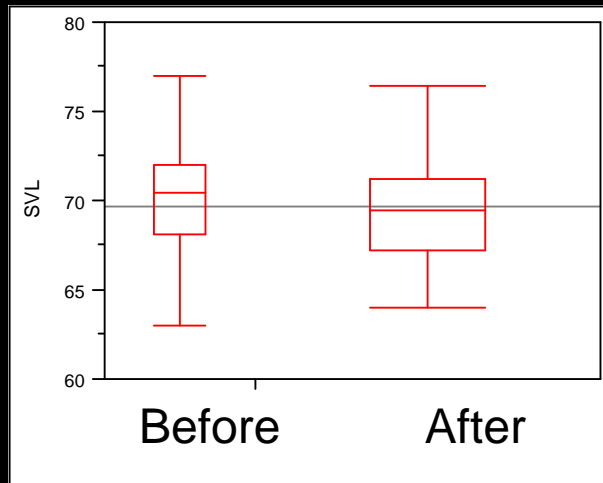


One-way ANOVA,  $F_{3,50} = 2.1598$ ,  $p = 0.1044$



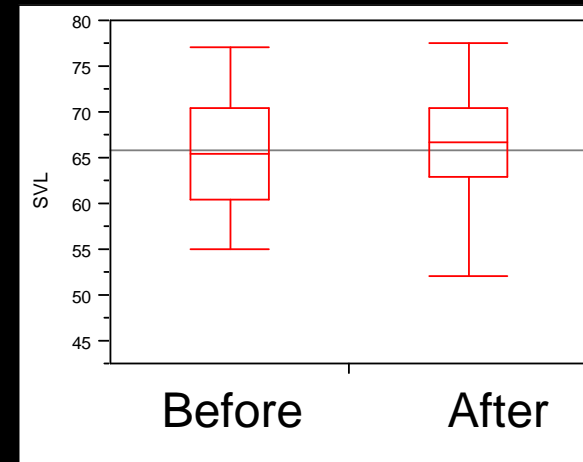
# Body size (SVL) of lizards

Adult males



One-way ANOVA,  $F_{1,57} = 0.1598$ ,  $p = 0.6909$

Adult females

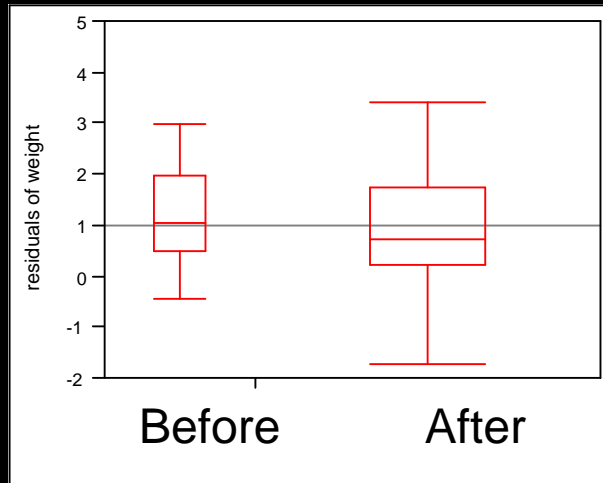


One-way ANOVA,  $F_{1,37} = 0.000$ ,  $p = 0.9971$

Before and after the eradication program, adult lizards  
are almost identical in body size in areas under  
treatment

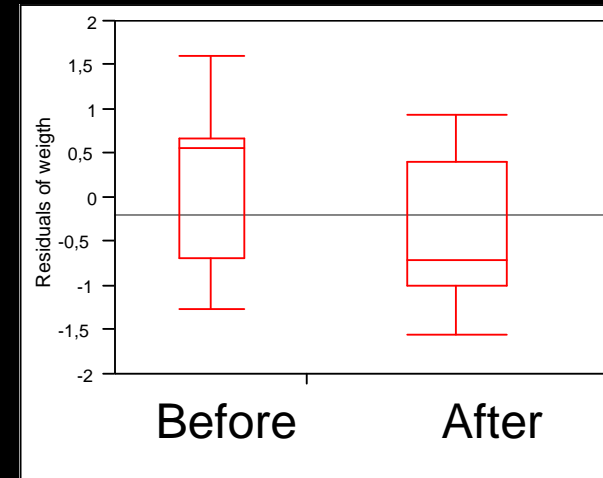
# Body condition of lizards (residuals of weight)

Adult males



One-way ANOVA,  $F_{1,57} = 2.5573$ ,  $p = 0.1153$

Adult females



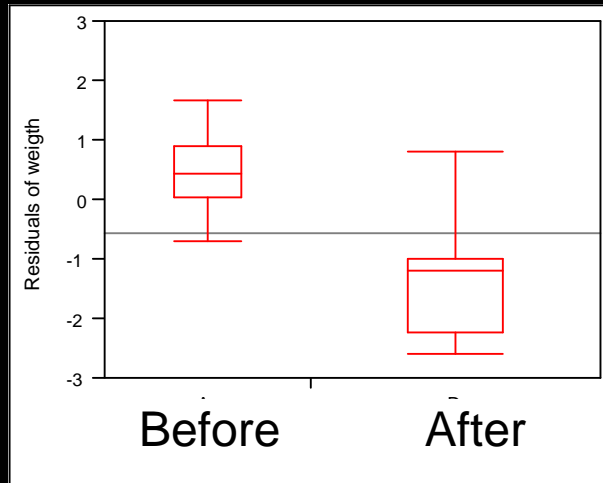
One-way ANOVA,  $F_{1,36} = 9.1088$ ,  $p = 0.0047$

After the eradication program, adult lizards showed a lower body condition in areas under treatment



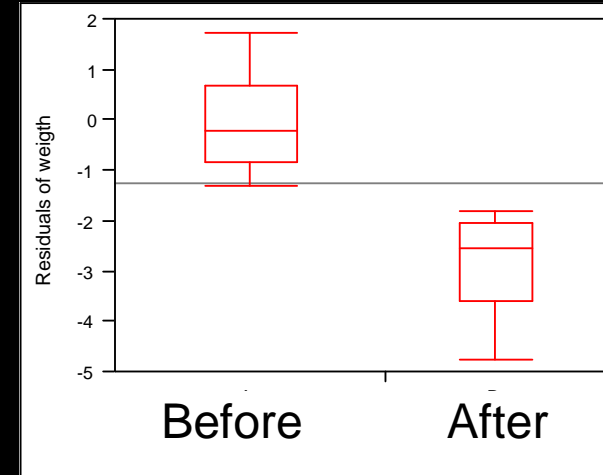
# Body condition of lizards (residuals of weight)

Adult males



One-way ANOVA,  $F_{1,22} = 28.0762$ ,  $p < 0.0001$

Adult females



One-way ANOVA,  $F_{1,16} = 31.8198$ ,  $p < 0.0001$

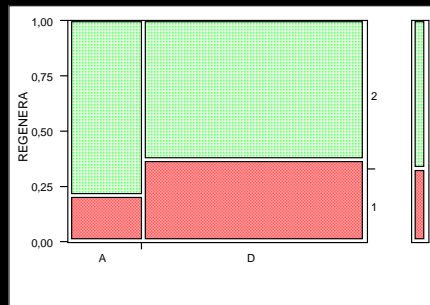
After the eradication program, adult lizards  
also showed a lower body condition in areas **without**  
treatment

## Regenerated tails

Multiple logistic regression:  $\chi^2 = 8.9233$ ,  $p = 0.3488$   
(variables: treatment, sex, age, season)

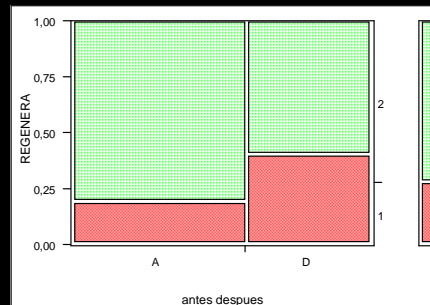


Casas



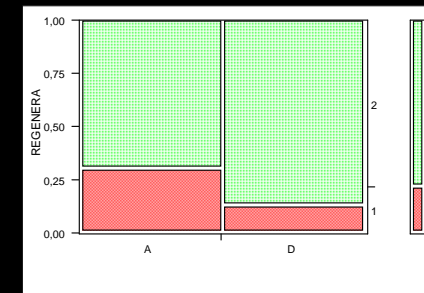
$G = 1.7$ ,  $p = 0.1923$

Tramuntana



$G = 2.091$ ,  $p = 0.1482$

Llebeig



$G = 1.9$ ,  $p = 0.1681$

eradication

no eradication

No effect in the proportion of regenerated tails

## Parasite load (proportion of parasitized lizards)

Multiple logistic regression:  $\chi^2 = 14.2665$ ,  $p = 0.0065$   
(variables: treatment, sex, age, season)

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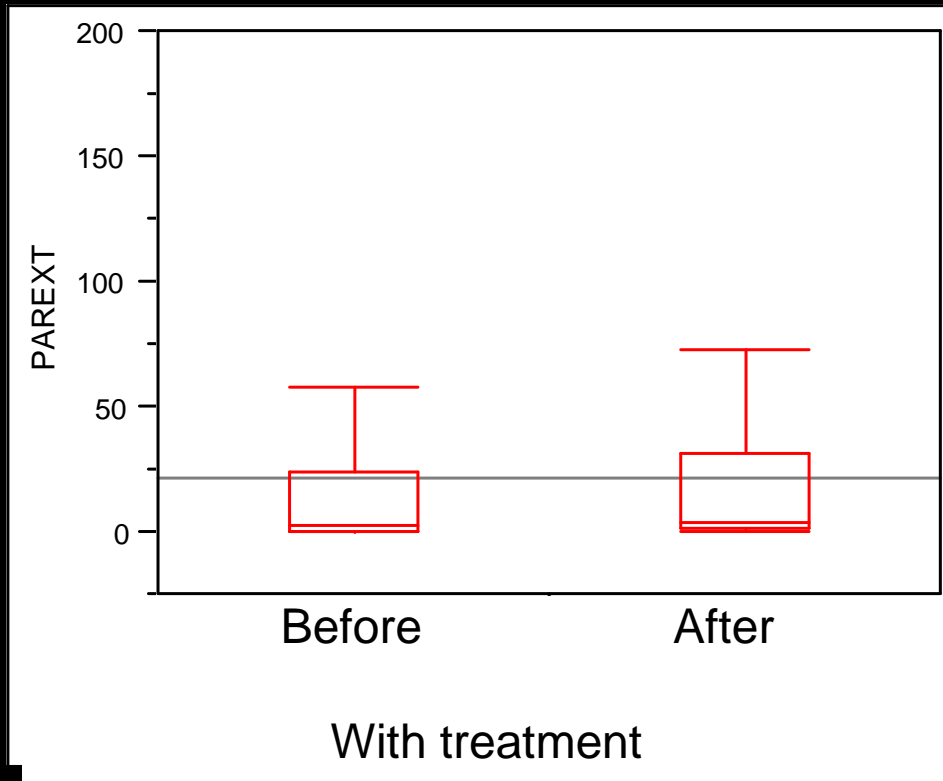
Parameters estimates:

Treated/untreated	$\chi^2 = 4.72$ , $p = 0.0299$
Before/after treatment	$\chi^2 = 9.48$ , $p = 0.0021$
Age	$\chi^2 = 0.73$ , $p = 0.3916$
Sex	$\chi^2 = 0.06$ , $p = 0.8021$



An effect of eradication on lizards?

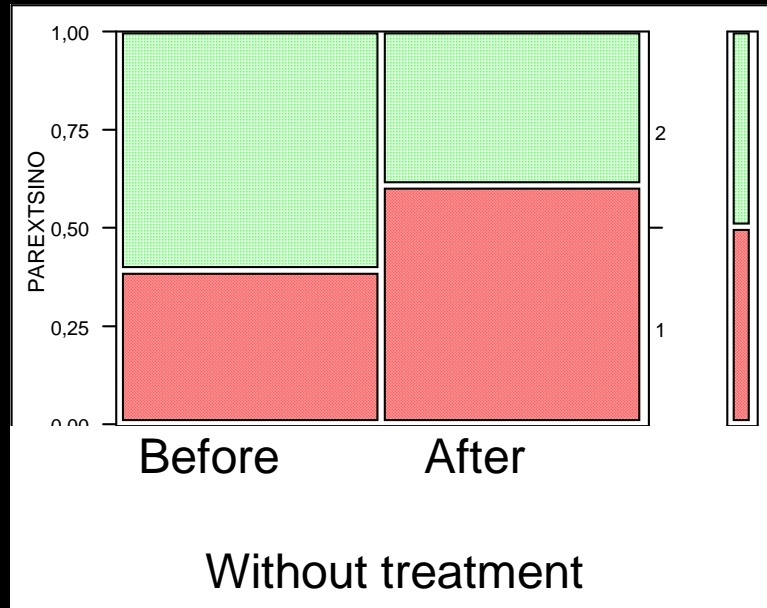
## Intensity of parasite load



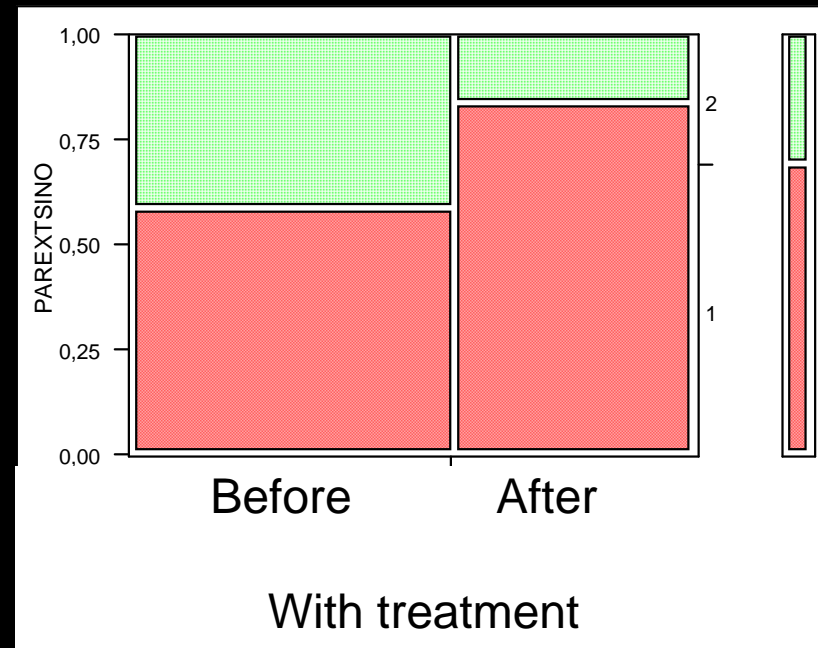
One-way ANOVA

$F = 0.0004$ ,  $p = 0.98$

## Proportion of parasitized lizards



$\chi^2 = 2.191, p = 0.1388$

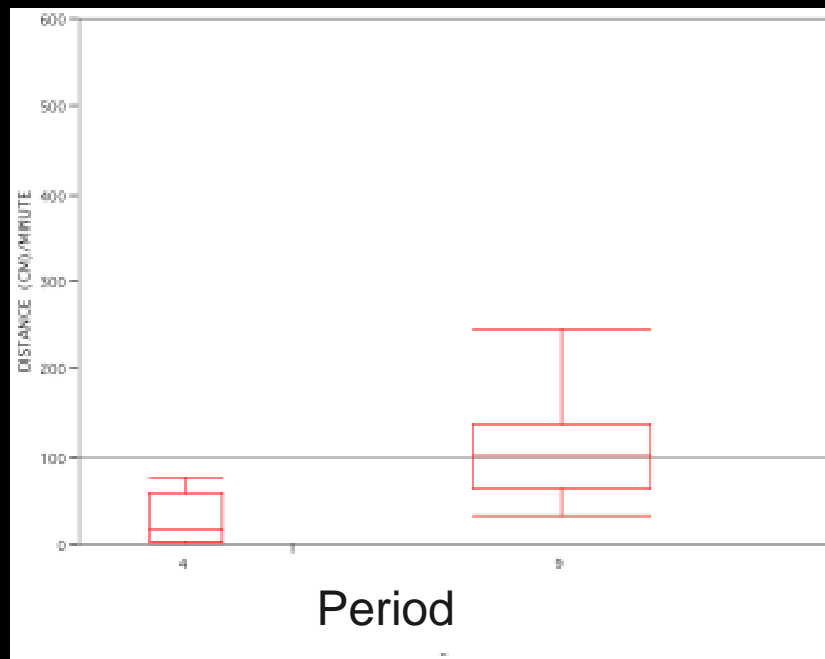


$\chi^2 = 4.981, p = 0.0256$

↑ parasite load

# Activity and time budgets

Distance moved by lizards per time unit



In Llebeig the distance moved per time unit is longer during September

one-way ANOVA,  $F_{1,40} = 5.1995$ ,  $p = 0.028$

We do not detect significant differences in treated areas

## Activity and time budgets

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Only in Llebeig the percentage of time moving is higher during September

one-way ANOVA,  $F_{1,40} = 5.9092$ ,  $p = 0.0196$

Only in Llebeig the number of moves per time unit is higher during September

one-way ANOVA,  $F_{1,40} = 23.3978$ ,  $p < 0.0001$



# Conclusions

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**Lizards from Dragonera Island do not exhibit lower densities in treated areas, and we were unable to detect any effect directly attributable to the rodent control.**

**Only we observed a higher parasite load after rodent control, which could be related to a situation of greater environmental stress due to the eradication program.**

**The elimination of rats does not have any significant effect on the lizards, reinforcing previous observations that the ship rat exerts, in a short term, probably a weak or no effect on the populations of the Balearic lizard.**





**We need long-term surveys to establish the true effects of eradication programs on insular populations of native lizard species**

**Monitoring should start from next months after the eradication program, to detect immediate effects on lizard's behaviour (time budgets) and health indicators (immune response and parasite load)**