

# Splitting hares: advances in the ecology and genetics of the Irish hare



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# Outline of talk - researchers

- The Irish hare – brief introduction
- Groundwork – Karina Dingerkus
- Long term population changes – Neil Reid
- Spatial ecology – Neil Reid
- AES and coursing – Neil Reid
- Phylogeography and population genetic structuring – Maria Hughes and Paulo Prodohl
- Concluding remarks



# The Irish hare

- Only native lagomorph in Ireland
- Irish endemic -  
sub-species (*Lepus timidus hibernicus*)  
species (*Lepus hibernicus*)
- Phenotypically unique
- Behaviourally unique



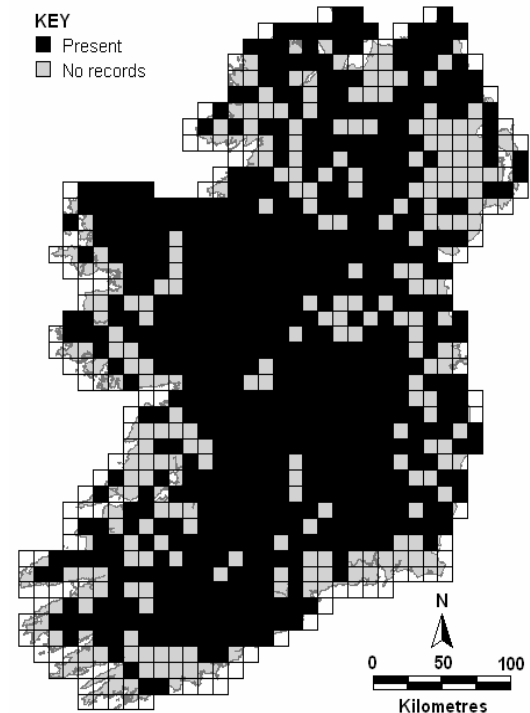
## KEY

- Mountain hare allopatry
- Sympatry
- Brown hare allopatry

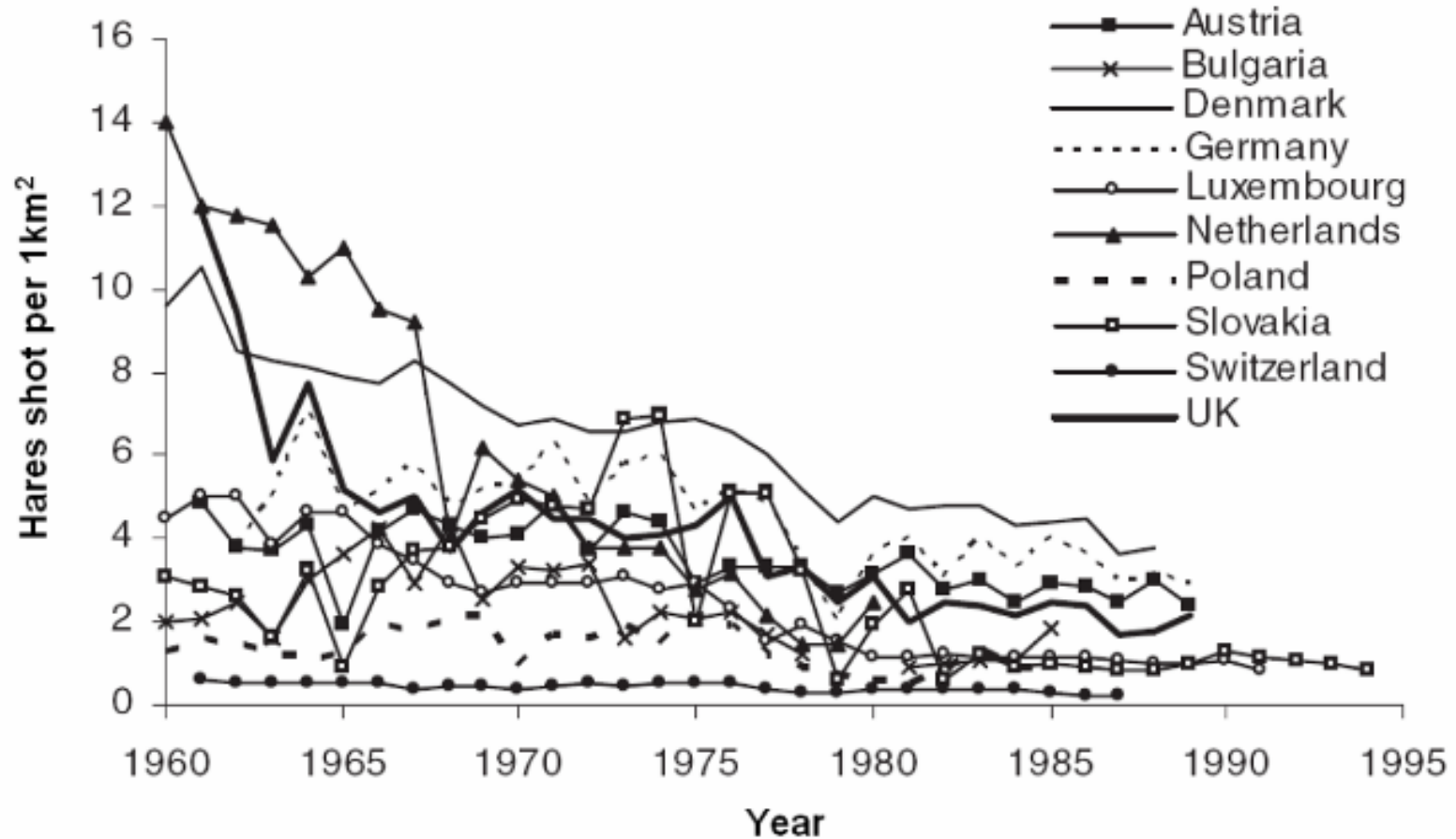


# Status/conservation importance

- Perceived population decline
- Bern Convention (1979)
- Irish Red Data Book (Whilde, 1993)
  - “Internationally important species”
- European Habitats Directive (EEC 43/92)
- All-Ireland Species Action Plan (NPWS/EHS, 2005)

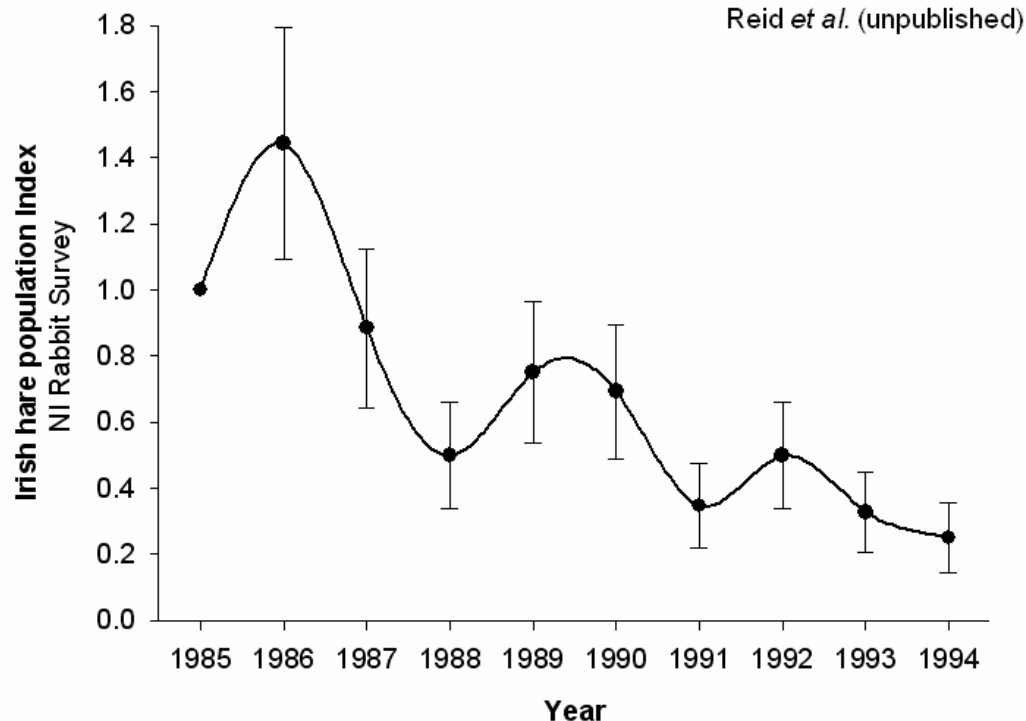


# Decline in hare numbers in Europe



# Has there been a decline in Irish hare numbers?

**NI Rabbit Survey 1986-1995 - 6 counties 72 sites**



**Dingerkus 1994-1996 diurnal walks <1 km<sup>2</sup>**  
**Numbers higher in past at least at some sites**

# Improving methodology

Nocturnal driven counts

Population estimation using 'Distance' sampling

Improving model fit using more realistic algorithms





Photo : Mathieu Lundy

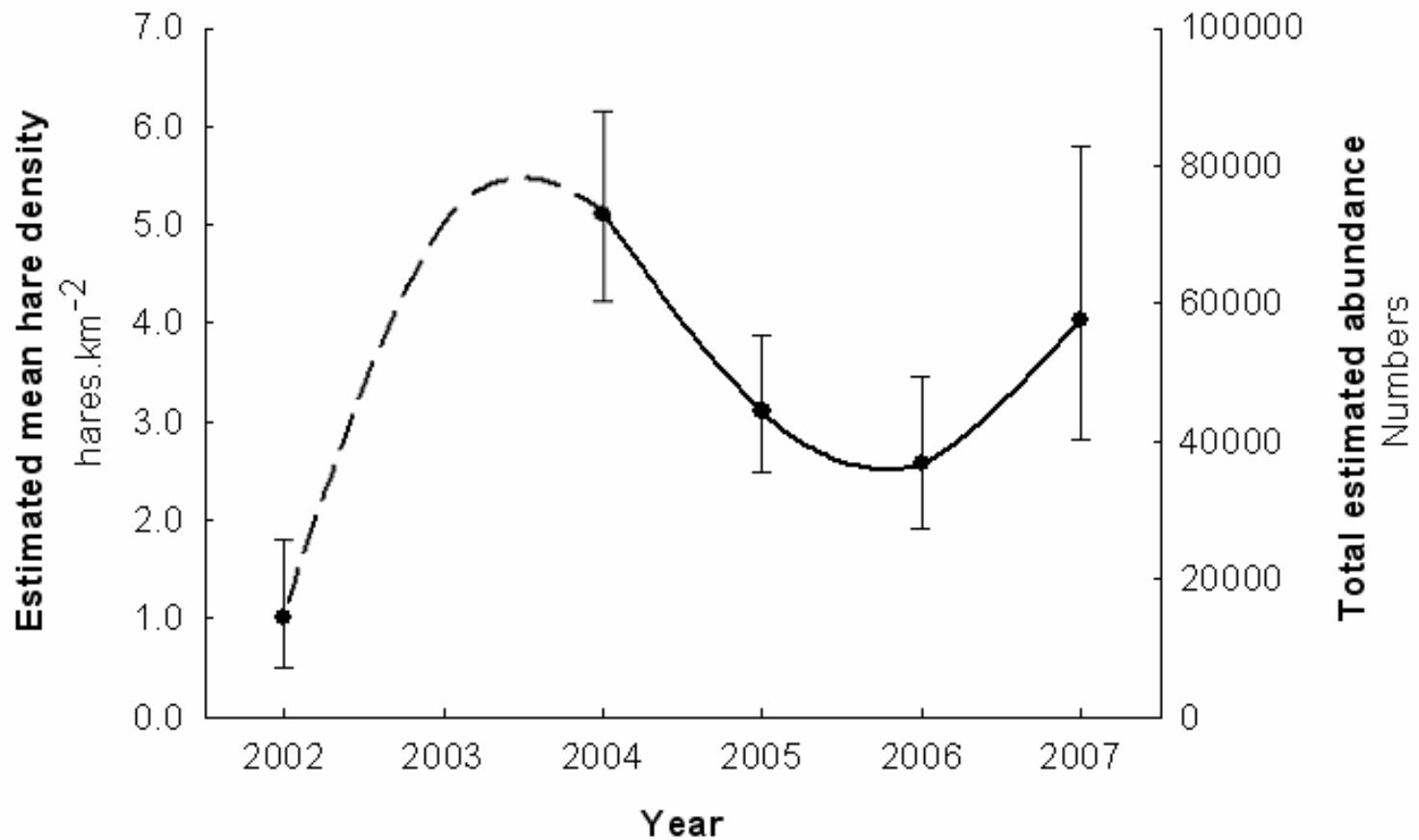


Photo : Mathieu Lundy



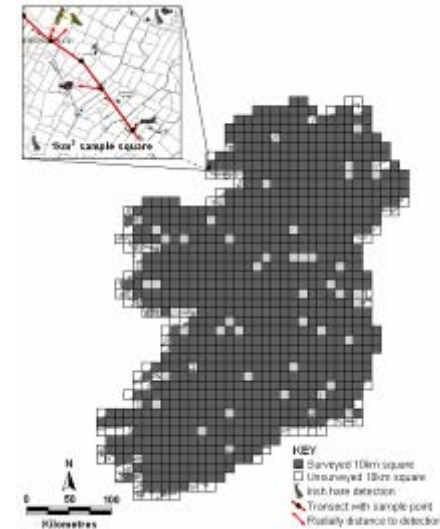
Photo : Mathieu Lundy

# Increase in hare abundance?



# All island status

Point based distance sampling  
 Northern Ireland hare survey 2007  
 Hare Survey of Ireland 2006/07



(f) Region	2006		2007	
	Mean density (hares/km <sup>2</sup> )	Mean abundance (95% CI)	Mean density (hares/km <sup>2</sup> )	Mean abundance (95% CI)
<i>Northern Ireland</i>	3.29 (1.92-6.25)	47,000 (27,000-89,000)	7.99 (4.18-14.46)	113,000 (59,000-205,000)
<i>Republic of Ireland</i>	3.33* (1.97-6.21)	233,000 (138,000-434,000)	7.66* (4.83-14.29)	535,000 (338,000-998,000)
<i>West and North-west</i>	2.62 (1.30-4.67)	59,000 (29,000-105,000)	7.63 (4.58-15.19)	172,000 (104,000-343,000)
<i>East</i>	4.20 (2.32-8.20)	97,000 (53,000-189,000)	9.13 (4.66-17.56)	210,000 (107,000-404,000)
<i>South-west</i>	3.16 (1.35-6.78)	77,000 (33,000-165,000)	6.31 (3.08-11.81)	153,000 (75,000-287,000)
<b><i>Ireland (All regions)</i></b>	<b>3.32*</b> <b>(1.96-6.20)</b>	<b>280,000</b> <b>(165,000-521,000)</b>	<b>7.72*</b> <b>(5.47-11.07)</b>	<b>648,000</b> <b>(432,000-1,200,000)</b>

\*Indicates significantly different density estimates between within regions between years.

# Irish hare dynamics - lessons

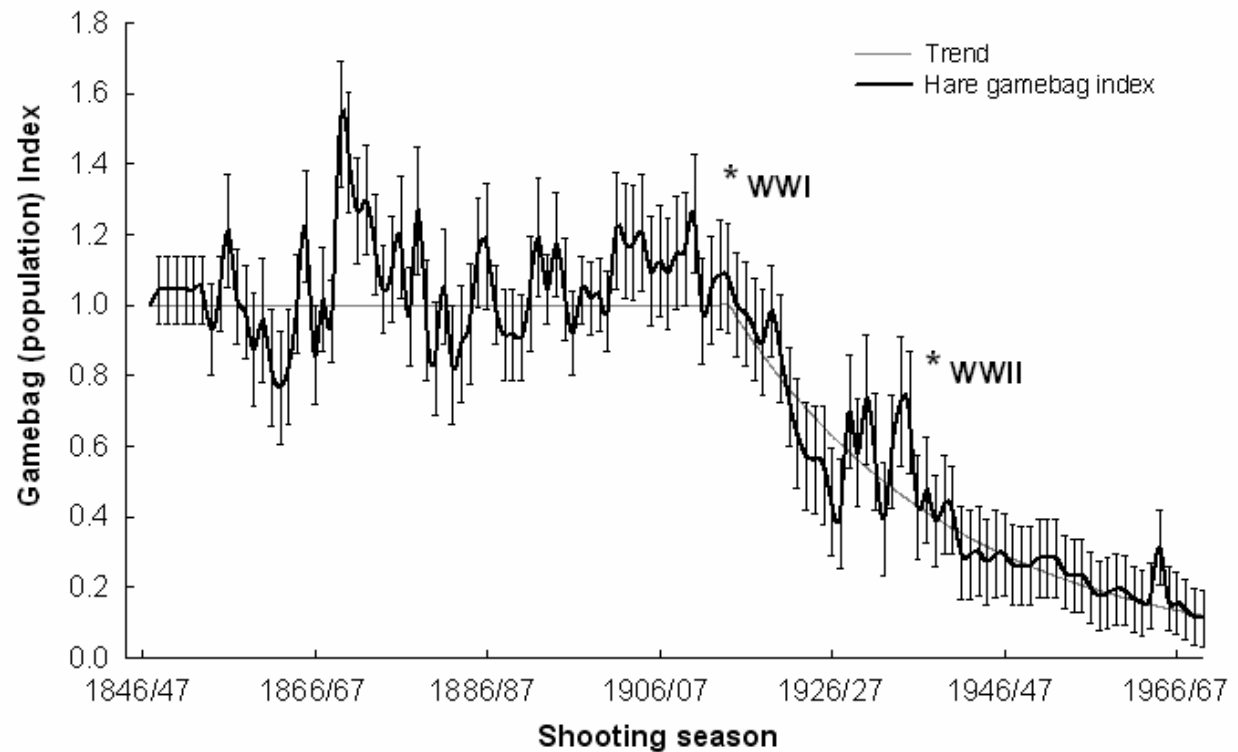
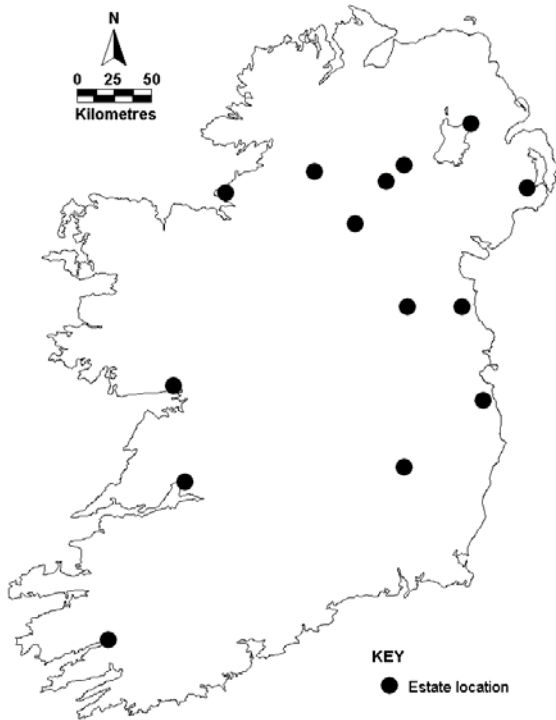
- It takes time to develop robust, efficient, accurate precise methods of population estimation
- Numbers are not always low
- Numbers can rise and fall sharply
- But - need long-term data on population change
- Only possible using historical data i.e. gamebag data



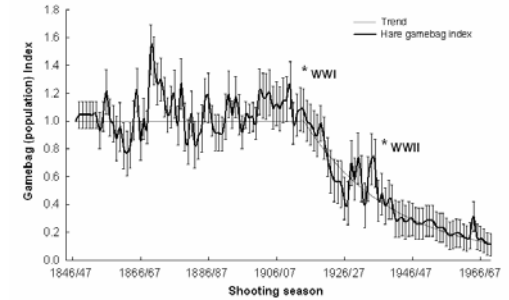
# Irish gamebag data

14 shooting estates

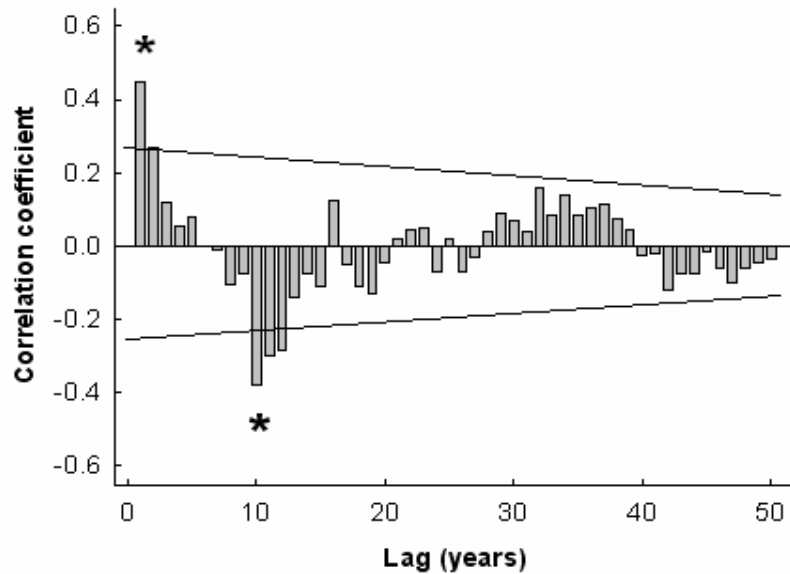
340 bag records spanning 124 years - 1846-1970



# Irish hare bags are cyclic

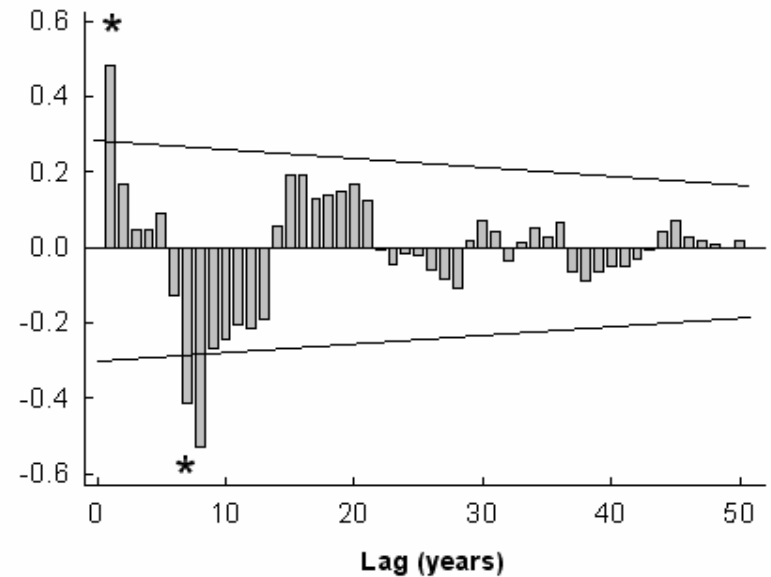


(a) Pre-1914



Lag 1 and 10 years

(b) Post-1914 (detrended)

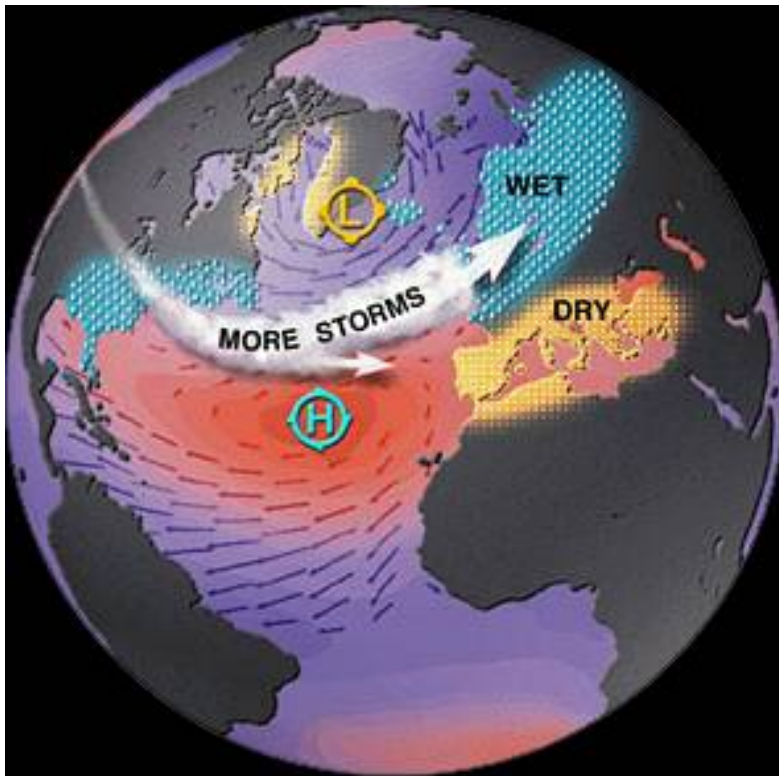


Lag 1 and 7 years

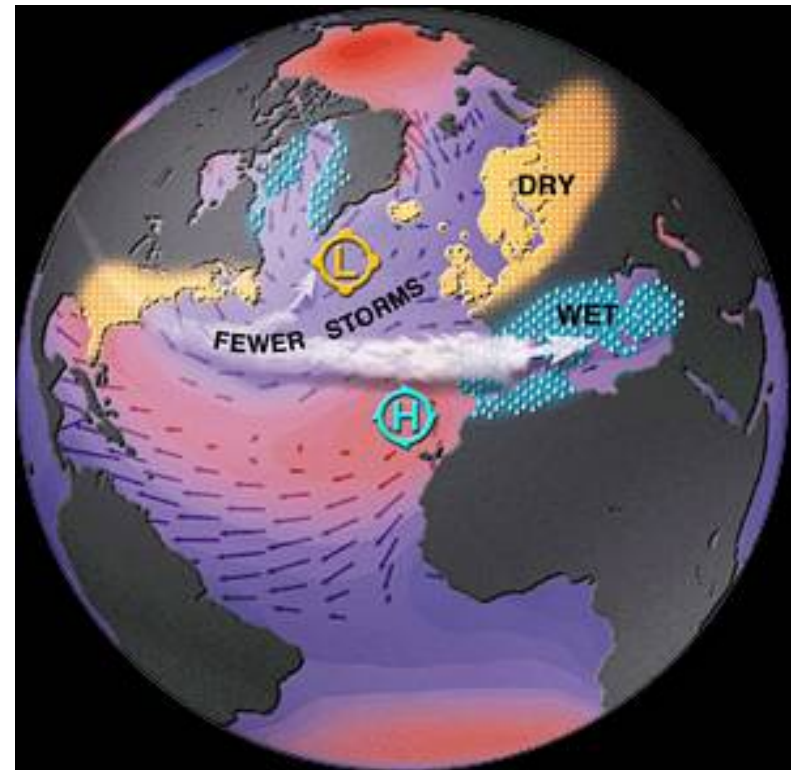
# What drives Irish hare cycles?

Northern Atlantic Oscillation (NAO) - differences in air pressure between Iceland and the Azores/Iberia - exhibits 10yr cyclicality

High NAO Index



Low NAO Index

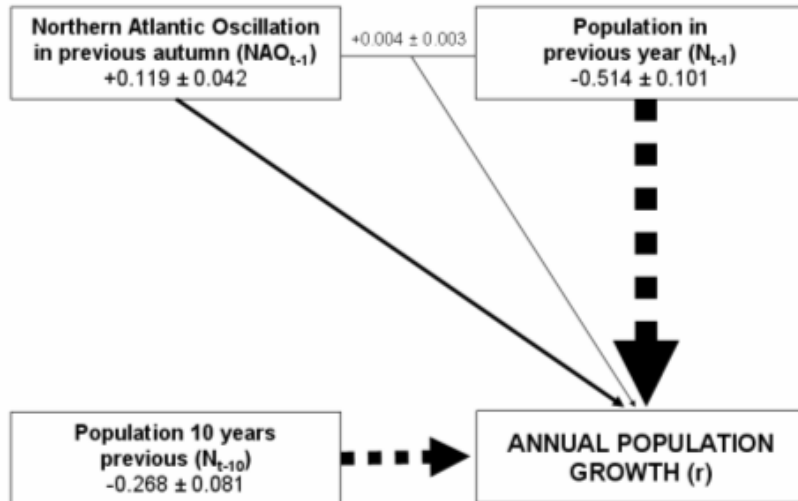


# Irish hare cycles have gears

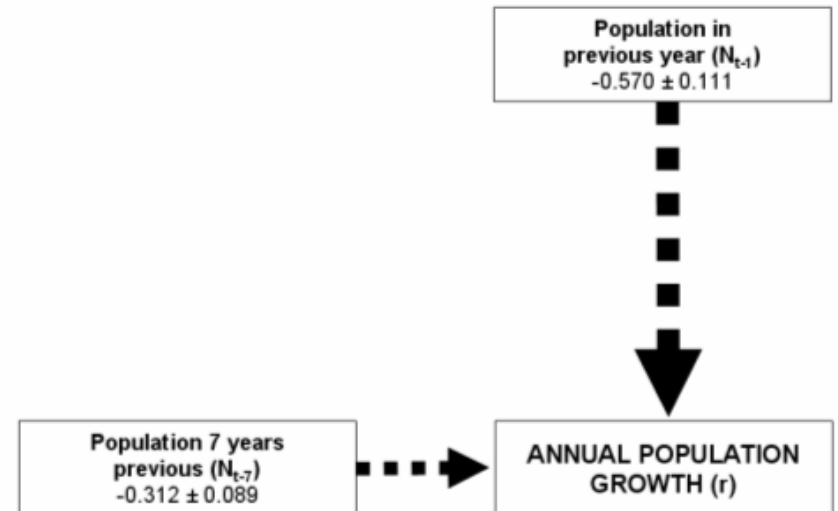
Population change ( $r$ ) related to  $N$  in previous year ( $N_{t-1}$ ), significant autocorrelated lags at  $N_{t-10}$  (pre 1914) and  $N_{t-7}$  (post 1914) plus.....

*Climatic forcing* – Autumn NAO in  $t-1$  in pre 1914 period

(a) Pre-1914

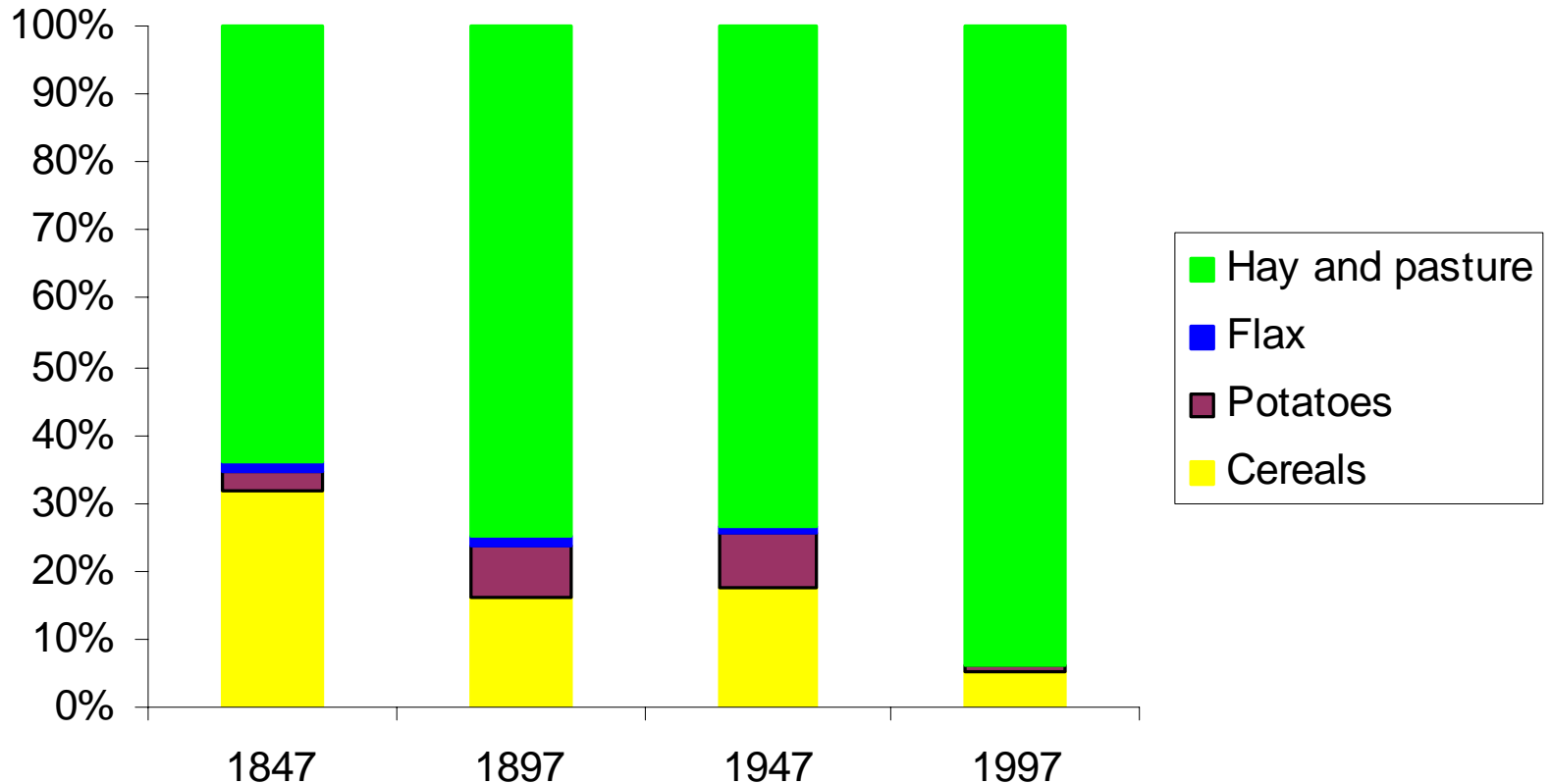


(b) Post-1914 (detrended)

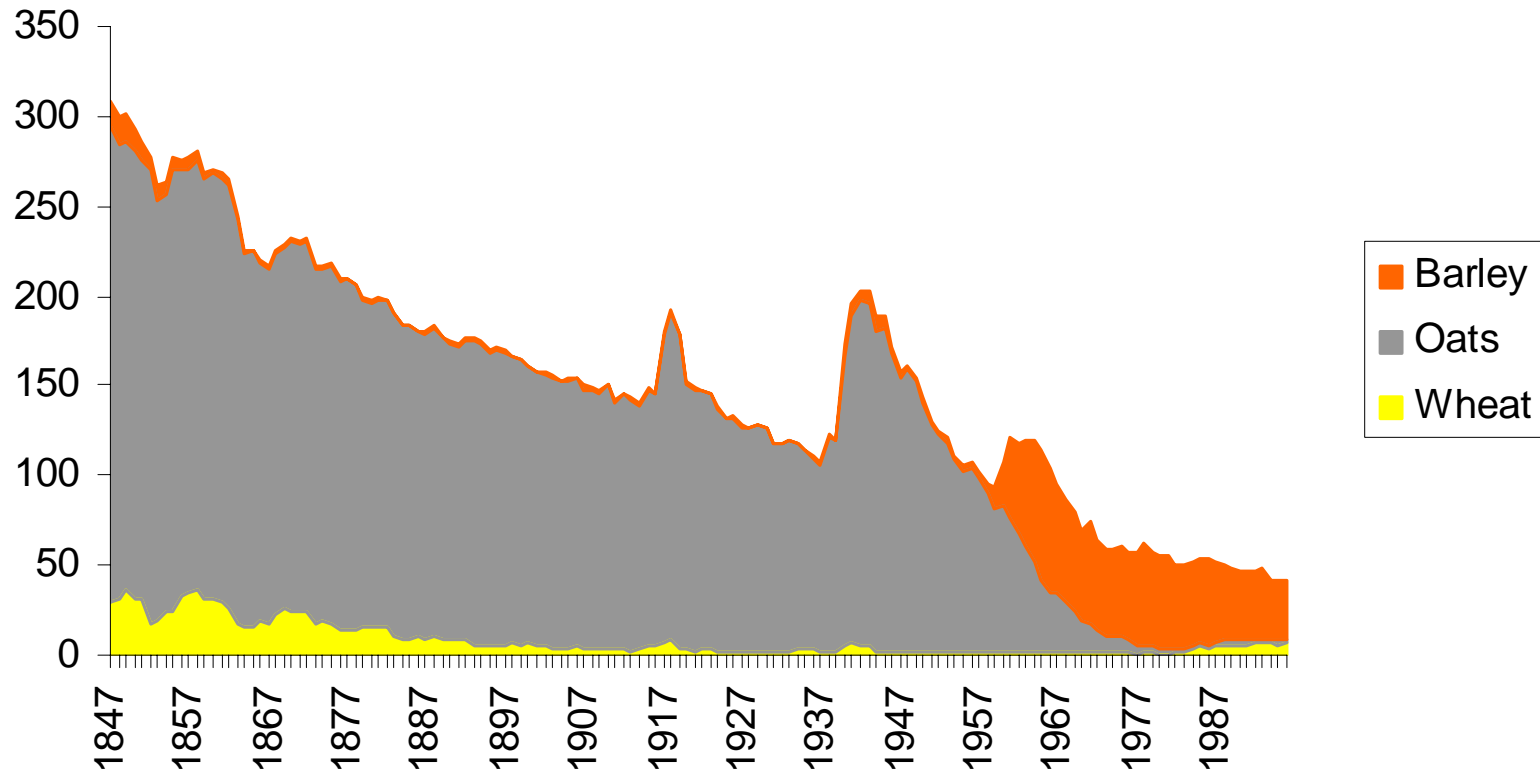


.....and are influenced by a changing environment

# Changes in agriculture



# Changes in cereal production

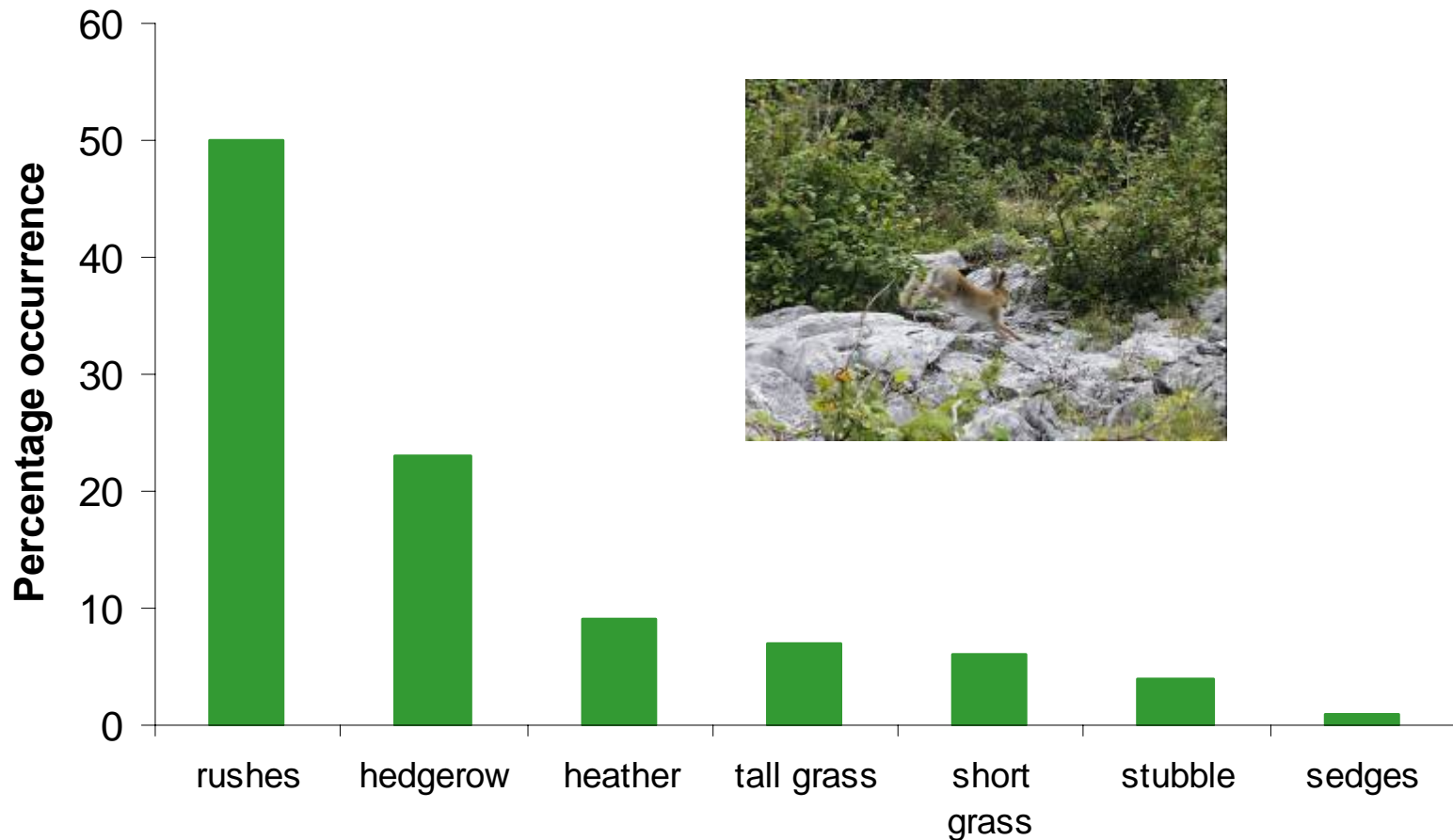


**If we want to understand these long term effects then we have to look more closely and the ecology of hares**

# Diet - percentage Gramineae and numbers of plant taxa

<b>Location</b>	<b>Percentage Gramineae</b>	<b>Number of plant taxa</b>
<b>Coastal site</b>	<b>72.5</b>	<b>22</b>
<b>Lowland farmland</b>	<b>74.7</b>	<b>29</b>
<b>Upland farm</b>	<b>64.1</b>	<b>26</b>
<b>NILC IV low</b>	<b>64.8</b>	<b>17</b>
<b>NILC V low</b>	<b>66.4</b>	<b>17</b>
<b>NILC VII high</b>	<b>32.2</b>	<b>22</b>
<b>NILC VIII high</b>	<b>37.2</b>	<b>26</b>

# Cover - habitats from which Irish hares flushed in diurnal survey



# Radiotelemetry study of habitat use

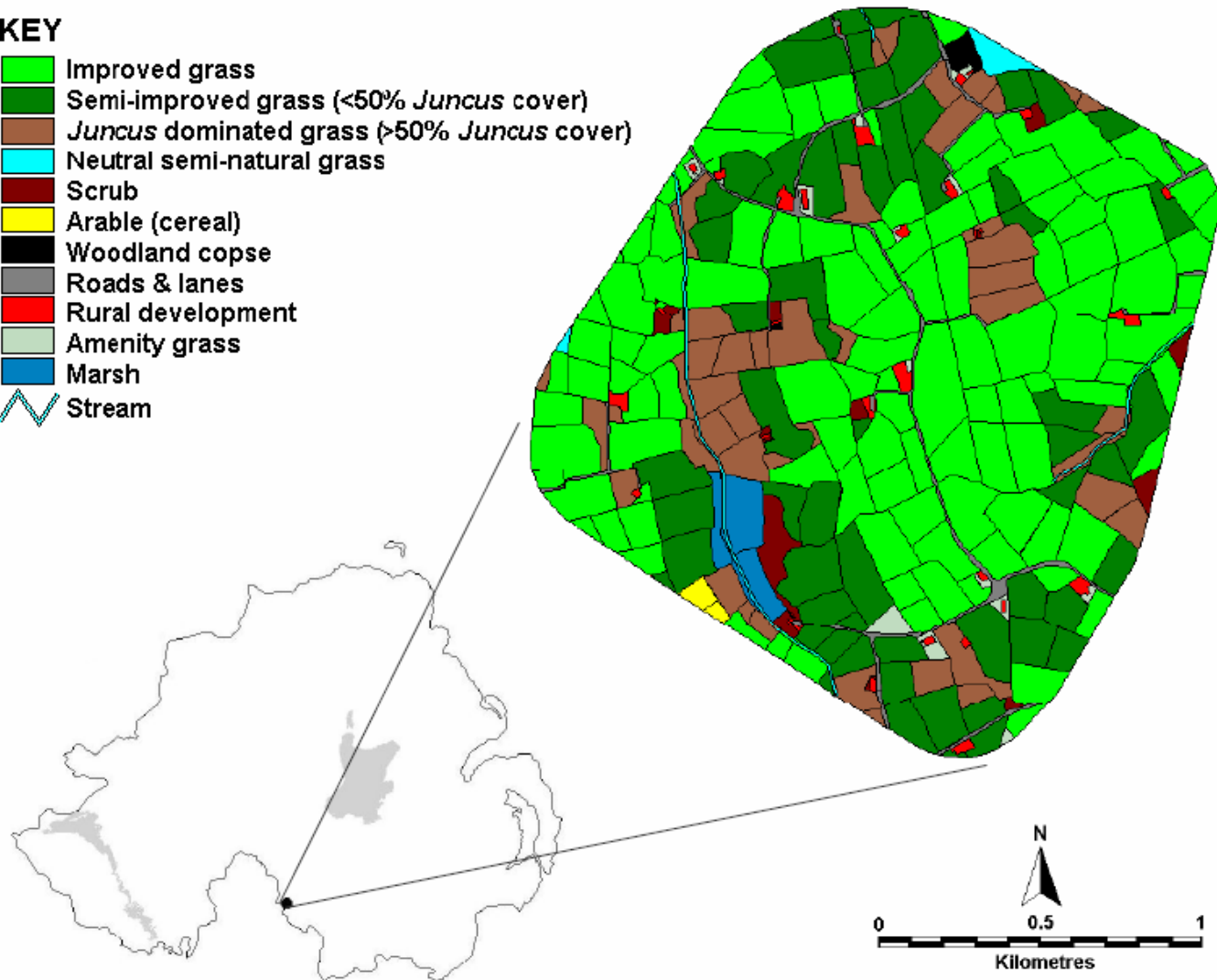
Home ranging behaviour of 17 independently tracked individuals over one calendar year



# 3 main habitats: improved, semi improved with rush, rush dominated grass

## KEY

- Improved grass
- Semi-improved grass (<50% *Juncus* cover)
- Juncus* dominated grass (>50% *Juncus* cover)
- Neutral semi-natural grass
- Scrub
- Arable (cereal)
- Woodland copse
- Roads & lanes
- Rural development
- Amenity grass
- Marsh
- Stream

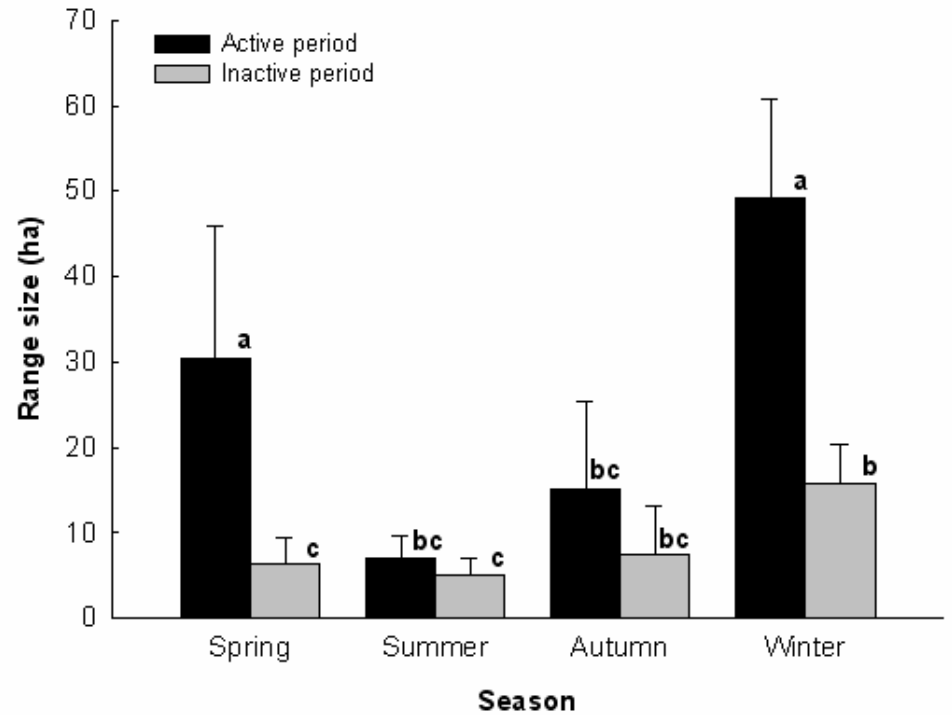
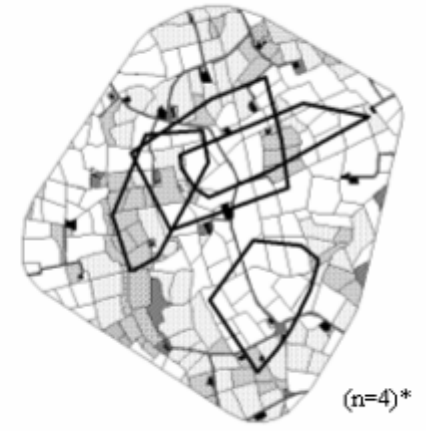
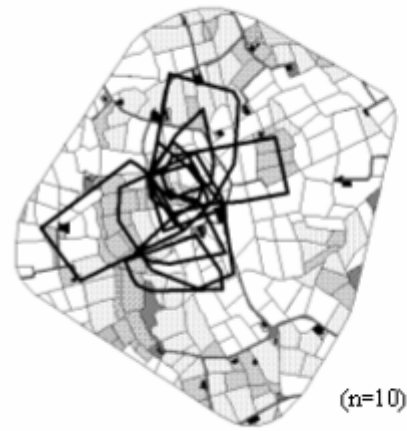
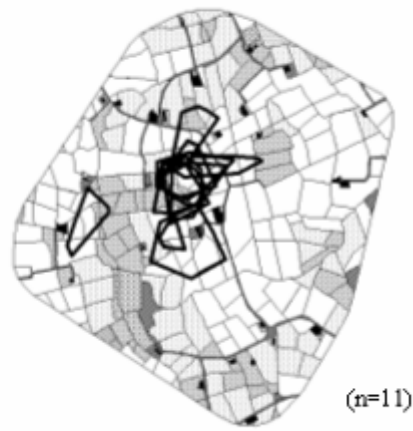
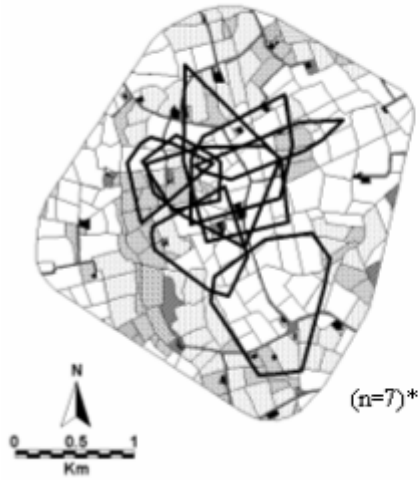


Spring

Summer

Autumn

Winter



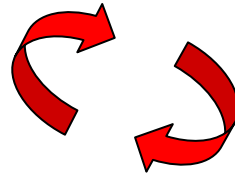
# Use of habitat

- **Males and females similar range areas, overlapping**
- **Seasonal variation – peak winter/spring**
- **Larger active (nocturnal) than inactive (diurnal)**
- **Homogeneous habitat can satisfy heterogeneous requirements of hares**
- **Irish hares require a ‘patch-work’ of improved grassland and...**
- **Suitable habitat providing shelter eg rushes, long grass**



**But.....**


**during peak birthing  
period cover  
requirements are met by  
silage**



**And.....**



**mechanised harvesting can cause significant  
mortality of leverets**

# Do ESAs enhance hare numbers?



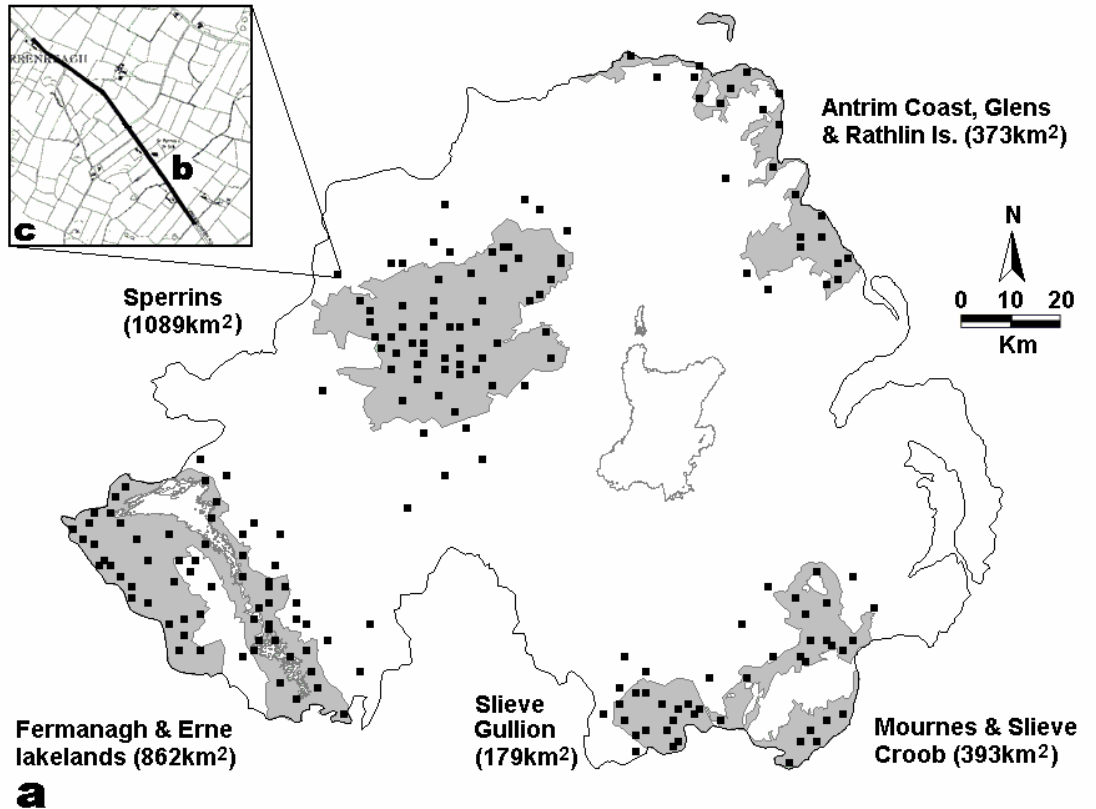
**All-Ireland Species  
Action Plan**

Irish Hare  
*Lepus timidus hibernicus*

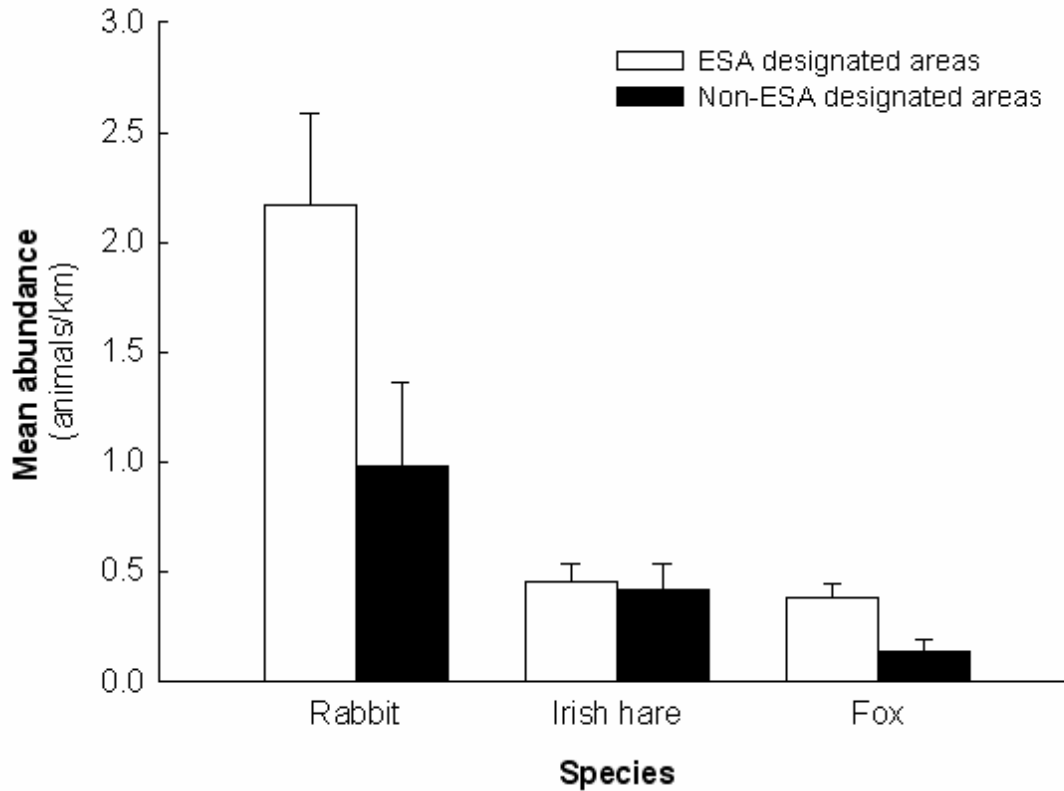


Environment &  
Heritage Service  
www.eh.sir.gov.uk

Environment  
www.eia.gov.uk



# Not so far.....



**Rabbits affected by ESA designation, uptake, distance into the area, boundaries, species rich swards**

**Foxes affected by ESA designation, boundaries, rabbit abundance**

**Hares unaffected by ESA designation; require grassland and scrub patch-work**



# But....

- **AES prescriptions bring greater benefits to species that are already common**
- **AES have been shown not to work for species of conservation concern unless species specific measures are implemented**
- **AESs such as ESA schemes are not likely to deliver SAP goals unless a specific Irish hare measure is introduced**
- **This is now underway**



# Conservation and welfare issues in hare coursing

- Ancient sport dating back 3000yrs
- Test of speed and agility between two dogs (usually Greyhounds)
- The object is to judge dogs on how they turn a hare around a field

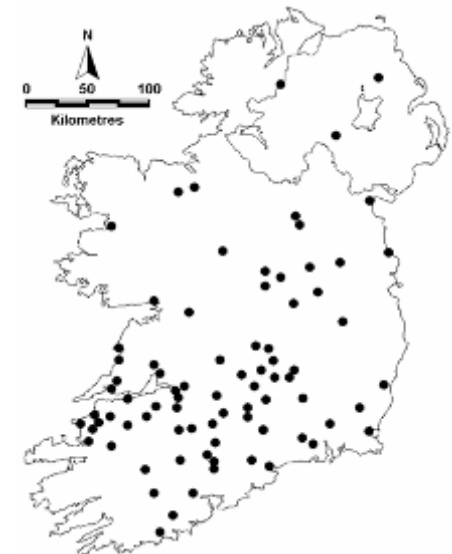
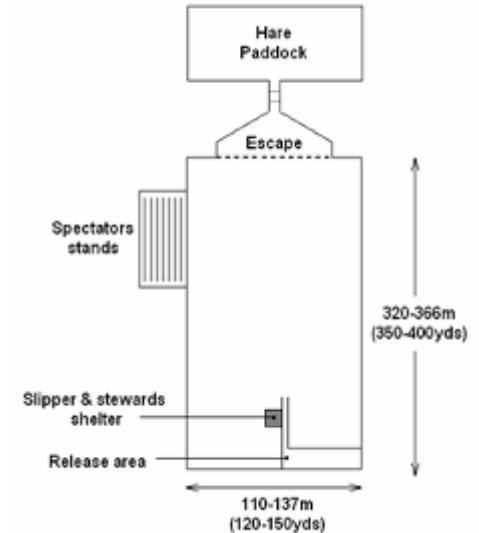


Statutory Rule 2003 No. 534

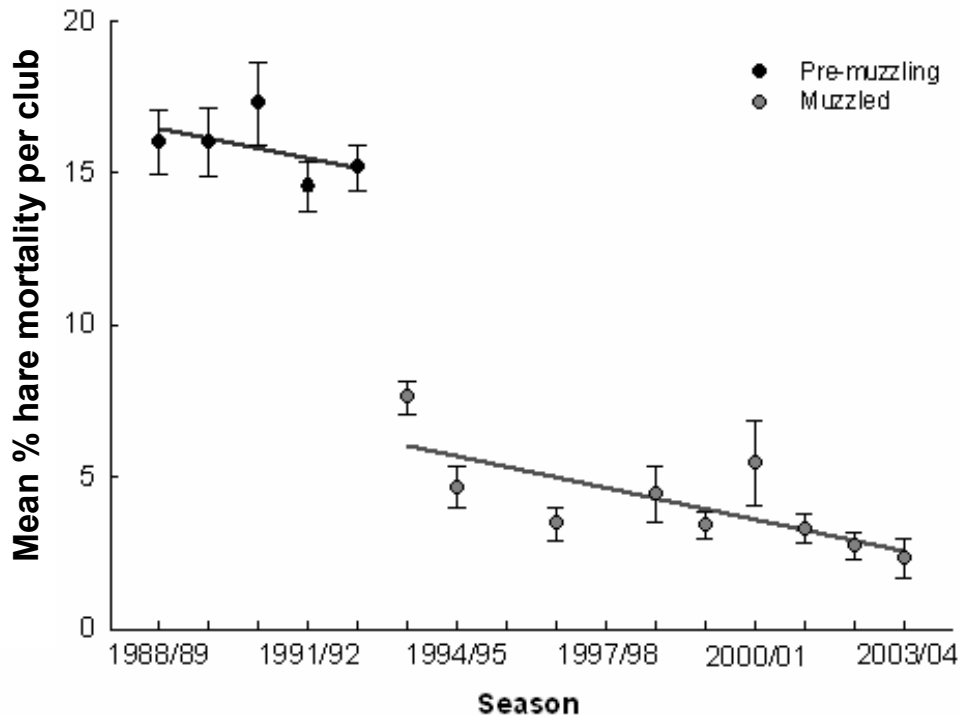
Game Preservation (Special Protection for Irish Hares) Order (Northern Ireland) 2005

# ICC and data

- Each hare should be coursed once a day
- Dogs muzzled
- Hares released back into the wild
- Official coursing records (NPWS)
- Data analysed for: 81 coursing clubs  
1220 coursing meetings  
16 coursing seasons



# Results



**Wider impact on survival, reproduction and genetic population structure remain uncertain – but coursed hares can resume spatial behaviour, survive and reproduce**

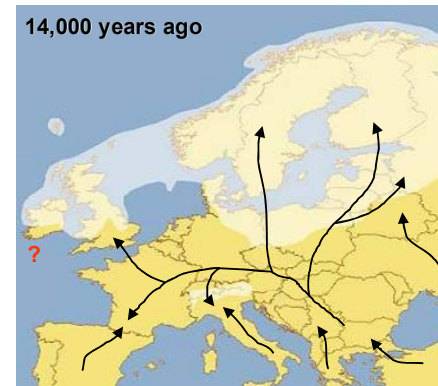
- **Muzzling significantly improved survival**
- **Improved hare husbandry may also benefit survival**
- **Mortality around 240 hares/yr**
- **Irish Hare coursing removes <0.1% of the total**
- **Hare populations resilient to 30-40% culling**

# Endemic but where did it come from and what is it?

Hypothesis one:

Present populations descendants of earliest colonists following ice retreat

*Prediction: Low genetic diversity, similar to other *L.timidus**

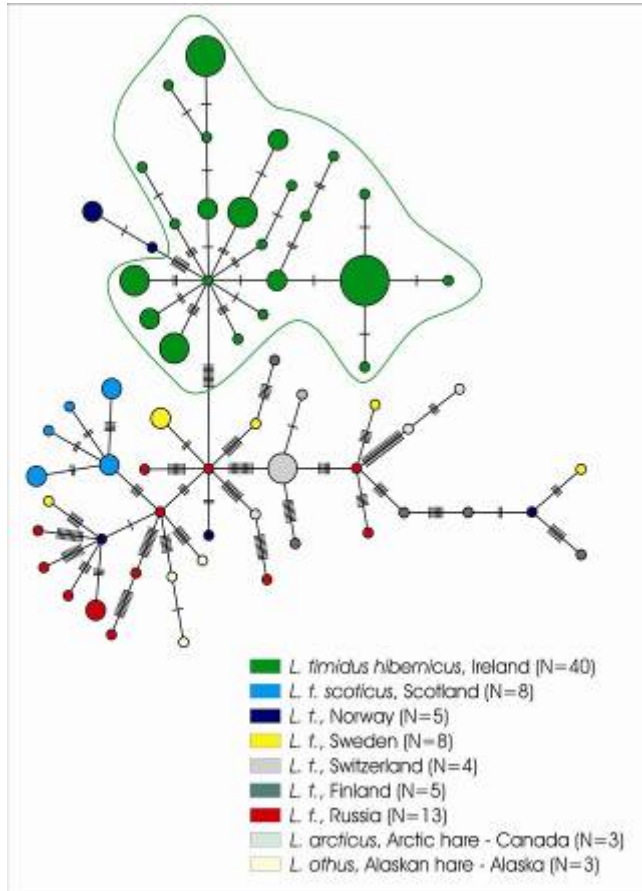


Hypothesis two:

Irish hares survived in a cryptic refuge that potentially existed in or near southern Ireland

*Prediction: High genetic diversity, unique from other *L.timidus**

# Phylogeography



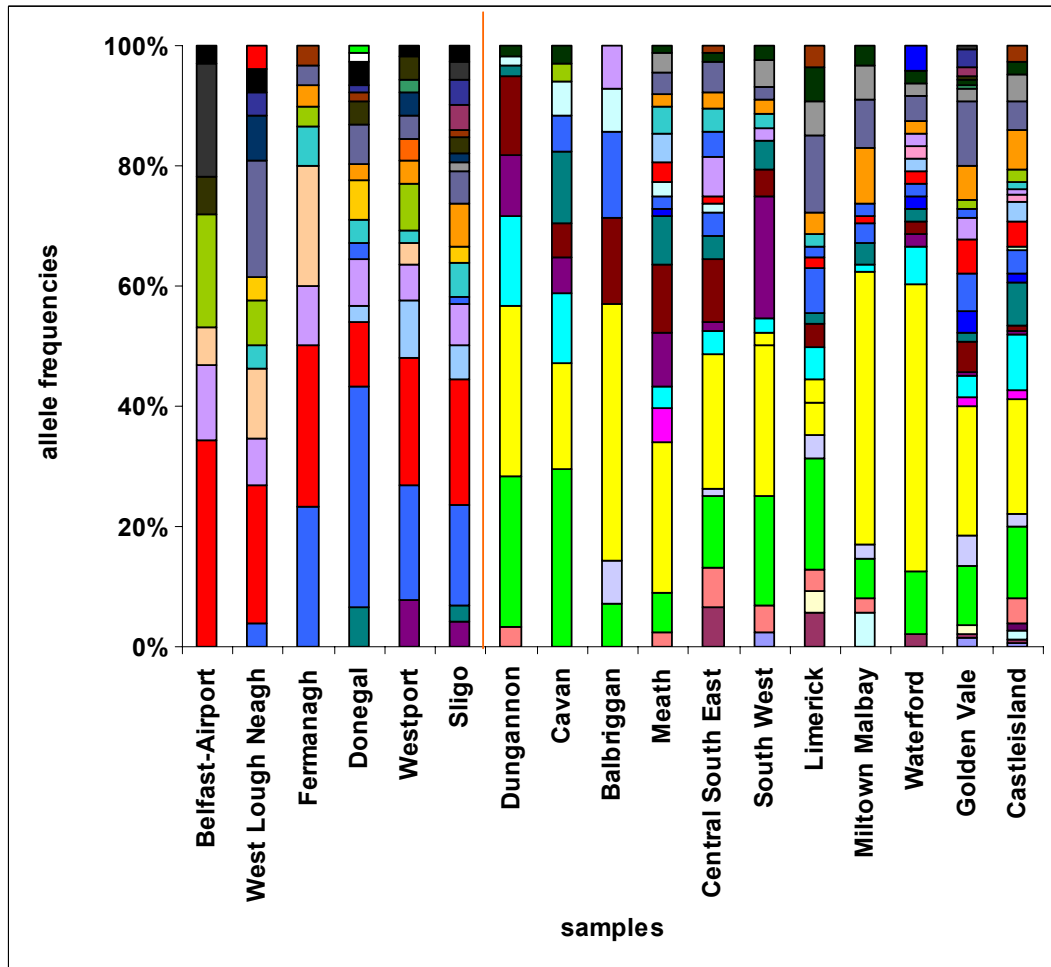
Evolutionary relationships to other *L. timidus* by sequencing 37 Irish hares for 3215bp of mtDNA comprising D-loop, Cyt b, ND4/5 (*left*), and the nuclear gene Transferrin (405bp).

Irish hare haplotypes cluster separately from other mountain hares.

Although nucleotide diversity between Irish and other mountain hares is low ( $\pi = 0.0025$ ) there are a number of fixed mutations that act as diagnostic markers between these lineages indicating a long time since separation from a common ancestor

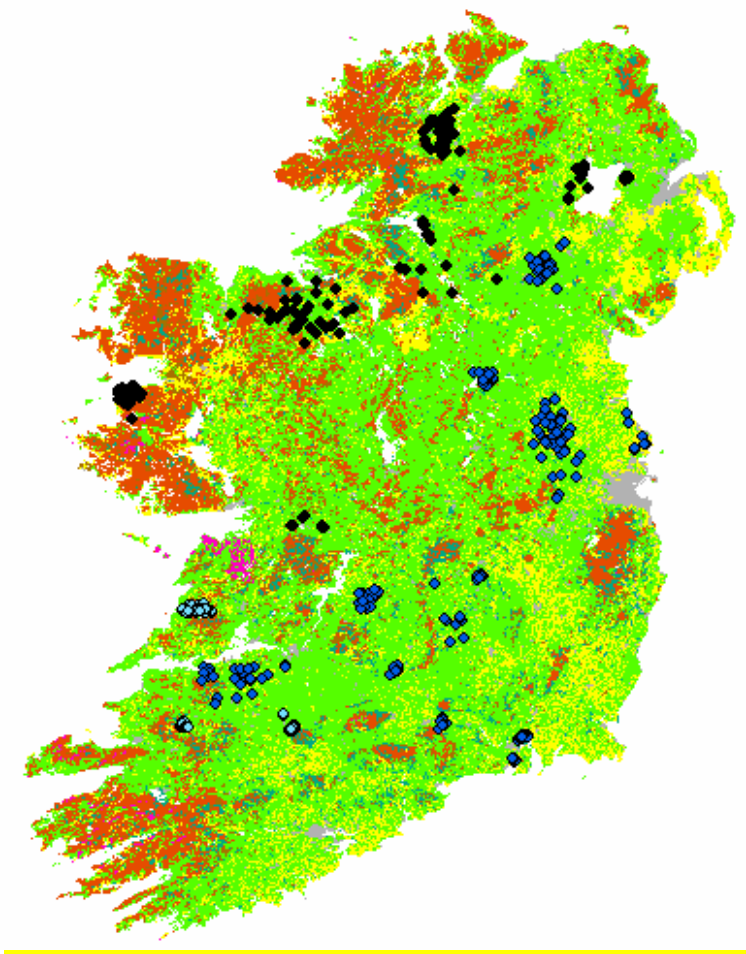
Irish haplotypes actually comprise 43% (23/56) of the total haplotypic diversity in the *L. timidus* species complex.

# Population differentiation – genetic fingerprinting



- No evidence of recent population crashes
- High level of genetic diversity (no inbreeding)
- Most 'populations' share common genetic make up

# Population differentiation – spatial genetic structuring



- **Small but significant level of population structuring**
- **No correlation between genetic make up and geographical distance**
- **Apparent low level of gene flow between some areas**
- **Some regional groupings of more recent origin as population fragments**

# So.....?

- Irish hares survived in and expanded from a cryptic Irish refuge
- Time since most recent population expansion is estimated to have occurred 57,700 – 35,450 years ago
- The Irish lineage may have once been widespread in Europe
- There is evidence of genetic structuring within Ireland both in mtDNA and genetic fingerprinting
- Given its genetic, morphological and ecological distinctness, the Irish hare should be regarded as a separate species *Lepus hibernicus*, as originally proposed by Bell (1837)

**As an endemic species it is critical we conserve both its abundance and its genetic integrity**

# Irish hares/Brown hares

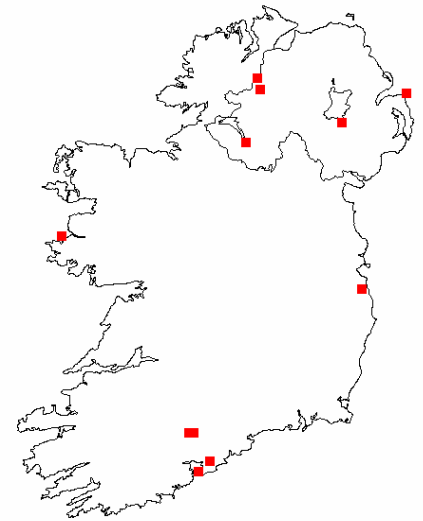
- 14 recorded introductions between 1848-1890s
- Only two reliable records published
- European Brown hare (*Lepus europaeus*) is a successful invasive species
- Strong interspecific competition with native mammals



**Irish hare**



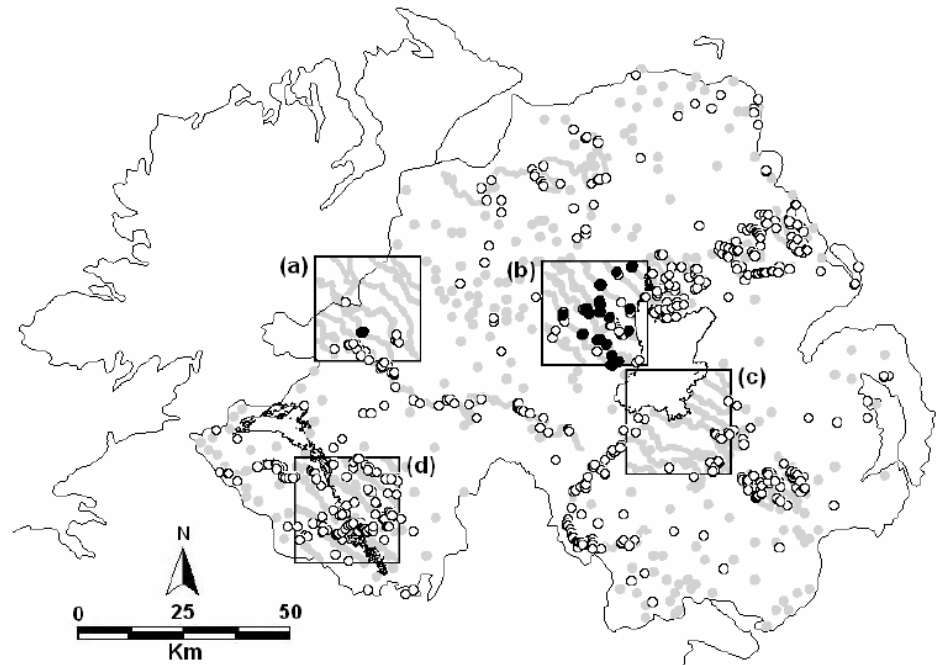
**Brown hare**



**Known introductions**

# Current distribution/abundance

Driven nocturnal  
transects/distance  
sampling



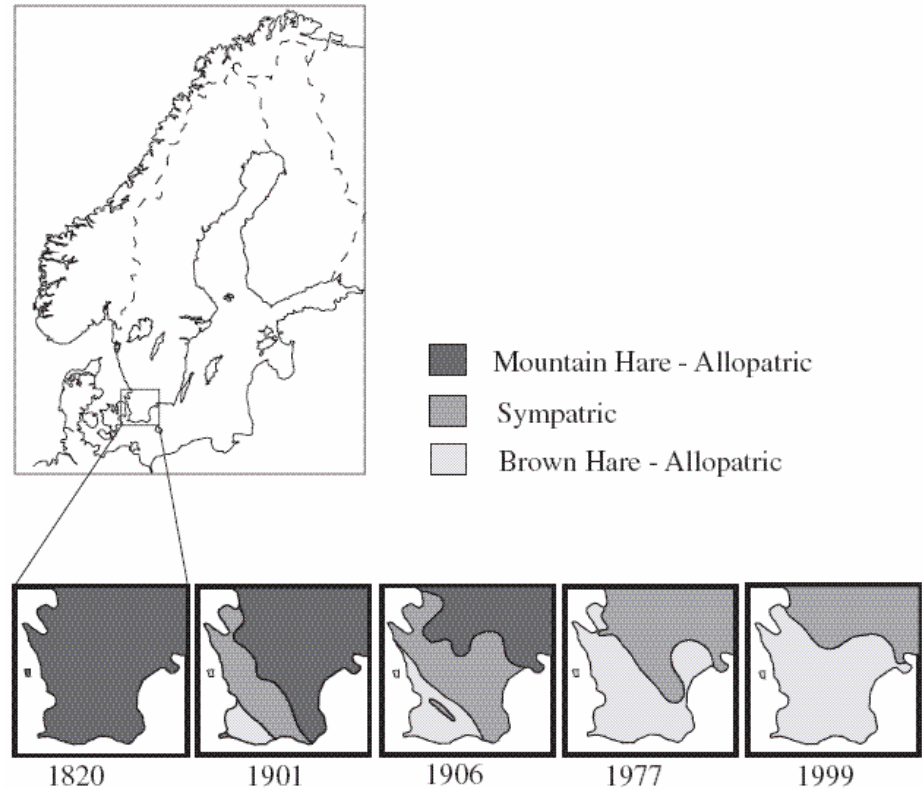
	Spring 2005		Autumn 2005	
	Irish hare	Brown hare	Irish hare	Brown hare
Number of hares recorded	23	26	19	31
Percentage of sightings	46.9	53.1	38.0	62.0
Mean density (hares/km <sup>2</sup> )	1.46 (0.99–2.15)	1.65 (1.12–2.44)	1.23 (0.75–2.01)	2.01 (1.23–3.28)
Mean abundance	910 (616–1346)	1031 (697–1524)	769 (471–1255)	1254 (768–2047)

# **Brown hare status – a cause for concern?**

- **Brown hare is established in mid Ulster (600-2000 animals)**
- **In some areas up to 62% of hares sighted were brown hares**
- **Population may be expanding – not recorded by Dingerkus**
- **Potential for ecological competition between native and introduced species – similar diet, use of habitat and spatial ecology**
- **Climate change may facilitate their spread**

# A cautionary tale...

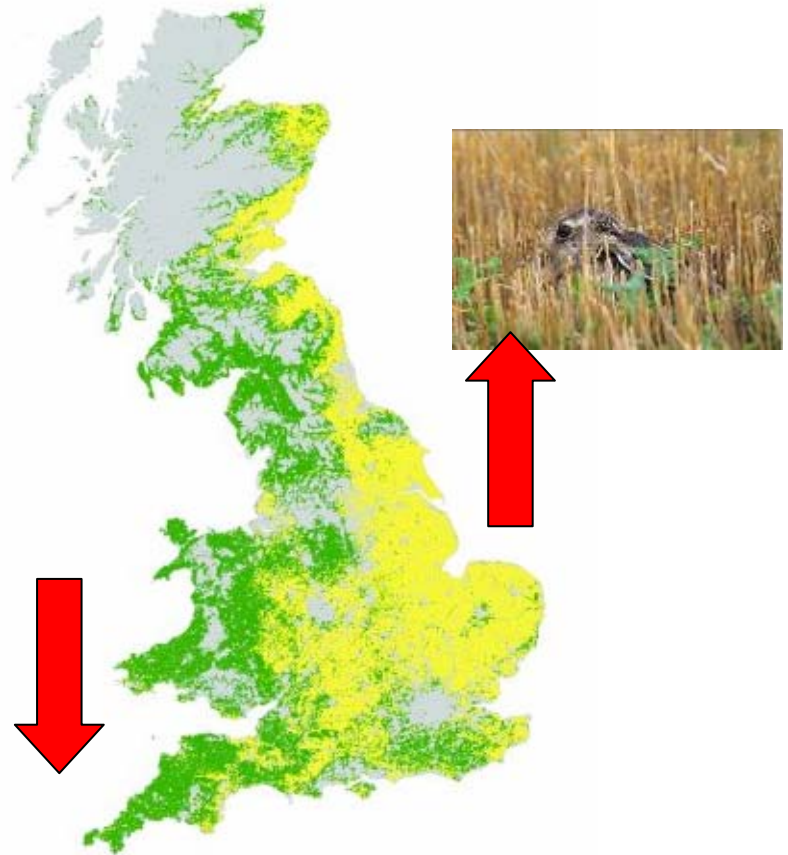
- **Brown hare introduction to Sweden 1800**
- **Replaced native mountain hare in >11,000km<sup>2</sup>**
- **Interspecific competition and hybridisation**
- **Climate conditions facilitate brown hare spread**



And.....

# Brown hares in Britain

- Highest Brown hare populations were agriculture is most intense (the east)
- Do well in west where pastoral has some cereal
- Climate change in Ireland and economic forces may favour Brown hares more than in past



# Brown/Irish hare hybridisation

- **17 Irish hares mid Ulster investigated in more detail than main study**
- **3 potential hybrids**
- **Bidirectional i.e. Brown hare (2) and Irish hare males (1) involved**
- **Where introgression occurs between *L.europaeus* and *L.timidus*, latter decline**
- **Limited material available**
- **Further research required**



# Summary

- **The Irish hare should be given full species status**
- **Irish hare populations have declined probably due to agricultural intensification & landscape homogenisation**
- **Populations show considerable interannual and multiannual fluctuations - driven by intrinsic density dependence and extrinsic climatic factors**
- **Hares require a patch-work of suitable habitats which is not provided by current conservation schemes**
- **Current farming practice with respect to silage production may set an ecological trap**
- **Mortality due to legal coursing activity is low and has negligible effect on hare numbers**
- **Brown hares have naturalised in Northern Ireland - pose a significant threat to the future ecological security and genetic integrity of the endemic Irish hare**

# Acknowledgements

- **EHS for funding and support**
- **NPWS for funding and support**
- **Irish Coursing Club and their members**
- **Numerous land owners for access and cooperation**
- **Numerous fieldworkers over 10 years**
- **Karina, Neil, Maria, Paulo**

