Assessing trends in mammals in areas under land use change

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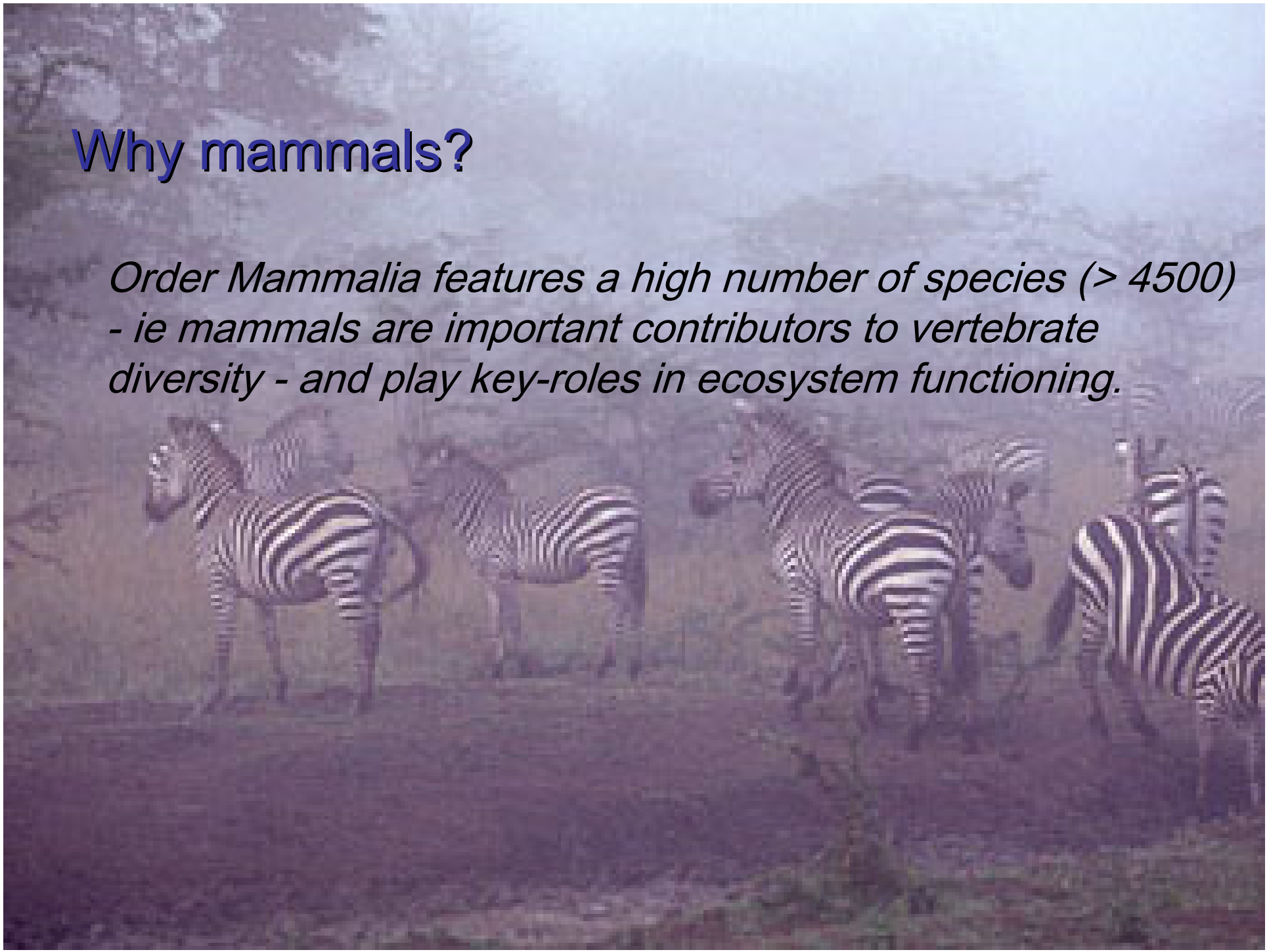
Why mammals?

Order Mammalia features a high number of species (> 4500) - ie mammals are important contributors to vertebrate diversity - and play key-roles in ecosystem functioning.



Why mammals?

Mammals are characterised by different life history strategies

r- or k-selected

Why mammals?

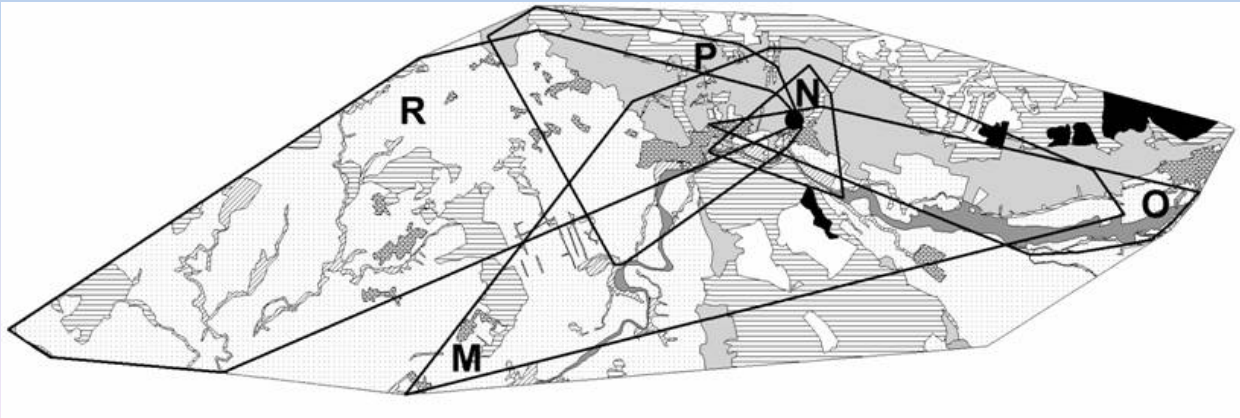
A variety of perception scales

- Across species

Talpa europaea – HR = 0.02-0.2 ha

Canis lupus – HR = 130-13000 km^2

- Within species



Rhinolophids heavily rely on hedgerows and other linear landmarks for commuting

Why mammals?

- Life span and birth rates greatly differ across species

- Speed of environmentally-induced demographic changes varies accordingly

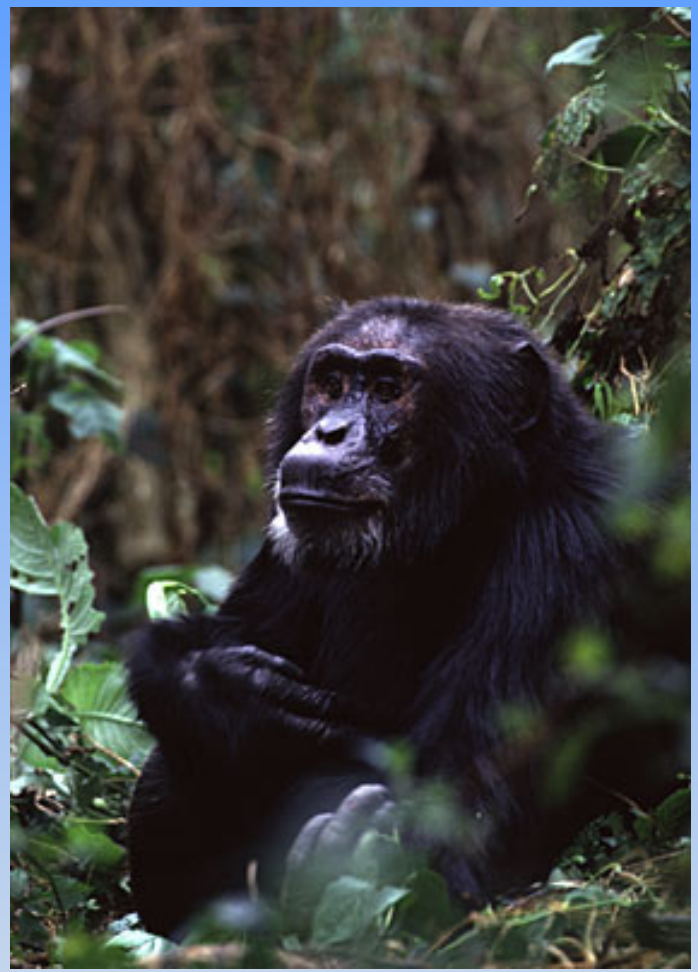
- Rapid reactions in species with high population turn-overs (rodents)

Why mammals?

Well-known animals

Rarely overlooked – (large species)

Potentially exposed to direct interactions with human activities (human dimension issues)



Mammals are potentially good tool species to explore the effects of changes in habitats/landscapes, and related resource availability

1) following land use change, mammal species will exhibit different responses linked with their specific life traits (taxonomy, ecological role)

2) integration of reactions by individual species and effects on ecological relationships (e.g. prey-predator interactions) will shape the general mammal community response (effects on diversity)

3) space for identification of bio-indicators marking ecological changes

4) significant interaction with human activities

This review will focus on different taxa to highlight diversity of reactions

Small mammals

Very general definition

Corresponds to a wide range of species (Insectivora, Rodentia)

Noticeable variety of life strategies

-highly opportunistic (most rodents)

-highly specialised (several insectivores)

-Also sensitive to climate – species assemblages reflecting local climate

Can small mammals be employed as bioindicators to detect land use differences in space and trends over time?

Owl's pellet analysis

How does it work?

Owl's pellet analysis

- Easy to carry out

- Pellets preserve skull structures bearing diagnostic features

- Even suitable for DNA analysis

- If bird has broad trophic niche, diet may at least partly reflect prey relative abundance

- Biomass may be estimated from prey remains for assessment of energy transfer in food webs

Owl's pellet analysis

Barn owl (*Tyto alba*)

-generalist (frequent tool species)

-often found in farmland

-variation in diet has been used to assess micromammal faunal changes in areas with different degrees of agricultural intensification

Trends in space

Common patterns in agricultural intensification

- Size of parcels enlarged
- Woodlots and hedgerows removed
- Natural meadow areas reduced
- Large use of chemicals
- Increased mechanisation

Norma Milĺan de la Peña *et al.* (2003). **Response of the small mammal community to changes in western French agricultural landscapes.** *Landscape Ecology* **18:** 265–278, 2003.

Western France (departments of 'Côtes d'Armor' and 'Ille et Vilaine', Brittany).

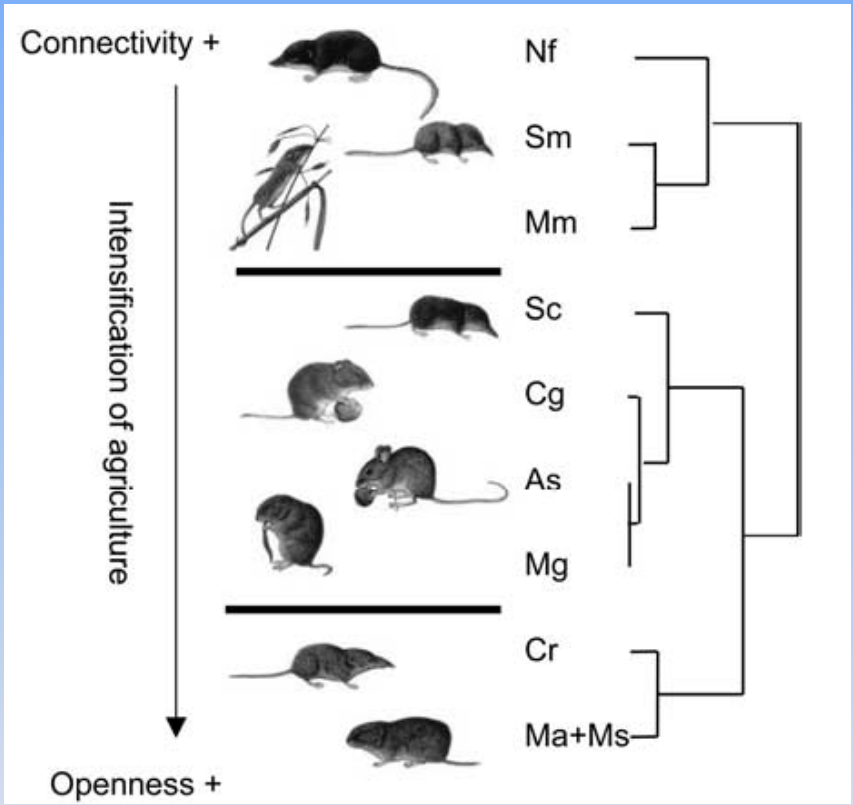
Trends in space

Hypotheses:

- species diversity influenced by the degree of agricultural intensification

- rarefaction or prevalence of some species related to a given agricultural context.

Trends in space



- *Microtus arvalis* (Ma)
- *Microtus agrestis* (Mg)
- *Microtus subterraneus* (Ms)
- *Clethrionomys glareolus* (Cg)
- *Apodemus sylvaticus* (As)
- *Micromys minutus* (Mm)
- *Crocidura russula* (Cr)
- *Sorex coronatus* (Sc)
- *Sorex minutus* (Sm)
- *Neomys fodiens* (Nf)

Richness and specific composition of the small mammal community not affected by the degree of cultivation

but

Variations in species frequency were observed and dominant species linked with different degrees of intensification

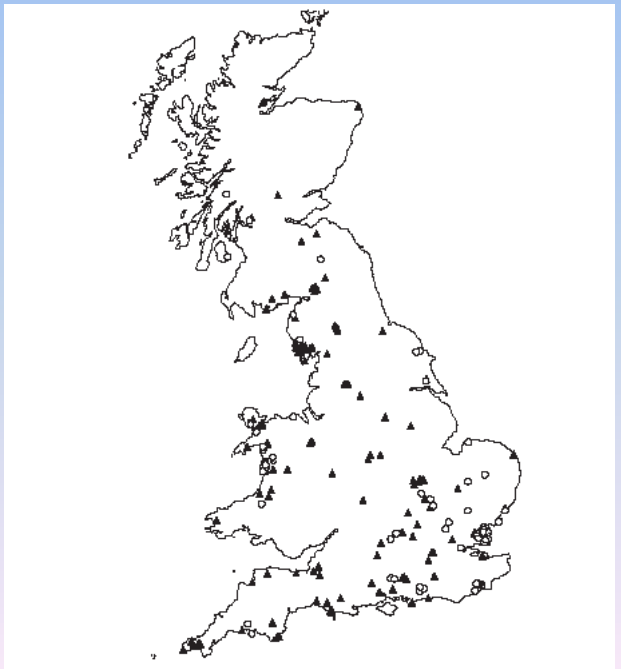
After: Norma Milĺan de la Peña *et al.* (2003).

Trends over time

Love et al. (2000). **Changes in the food of British Barn Owls (*Tyto alba*) between 1974 and 1997. *Mammal Review* 30: 107-129**

Britain undergone to strong intensification (23% hedgerow decrease in 1984-1990)

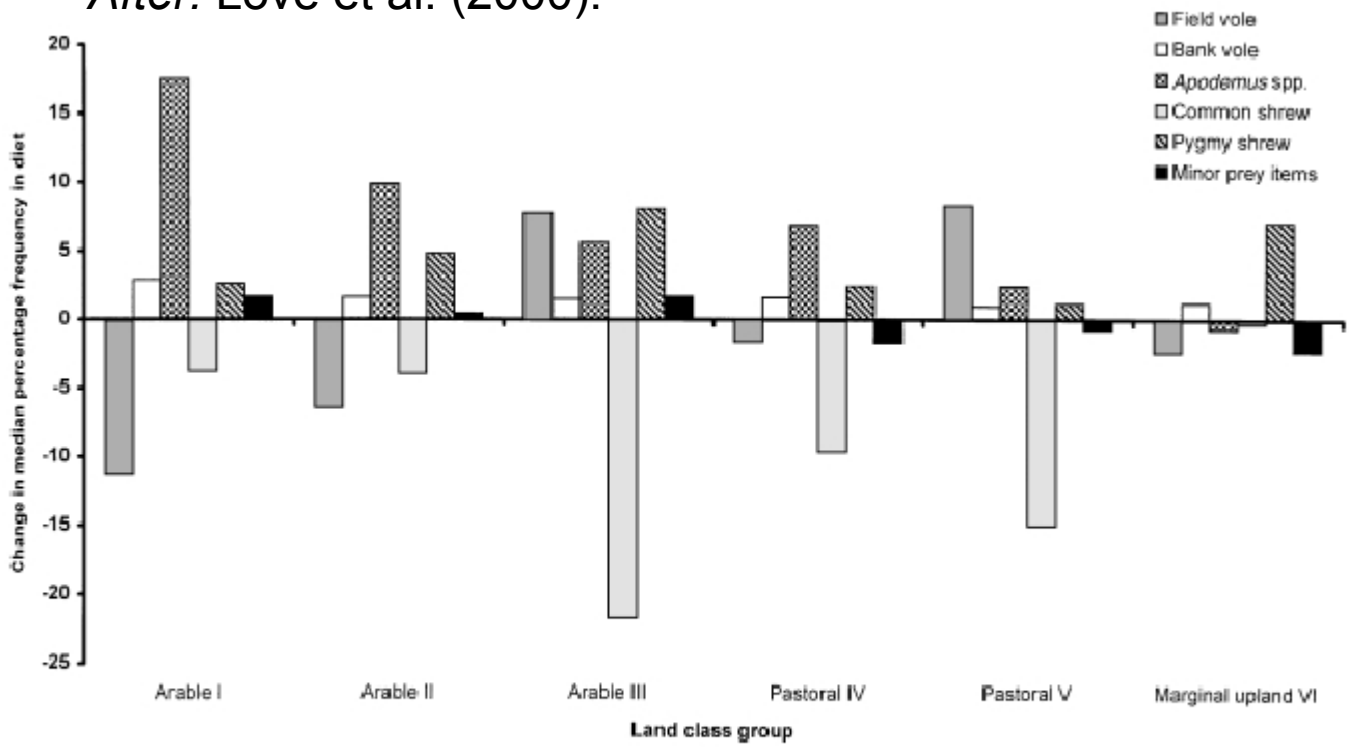
Results of a Mammal Society 1993–97 Barn Owl Tyto alba pellet survey vs. those of a similar survey (BTO) from 1956–74



Trends over time

Decrease in common shrew *Sorex araneus*
Increase in *Sorex minutus, Apodemus sylvaticus, A. flavicollis and Clethrionomys glareolus*

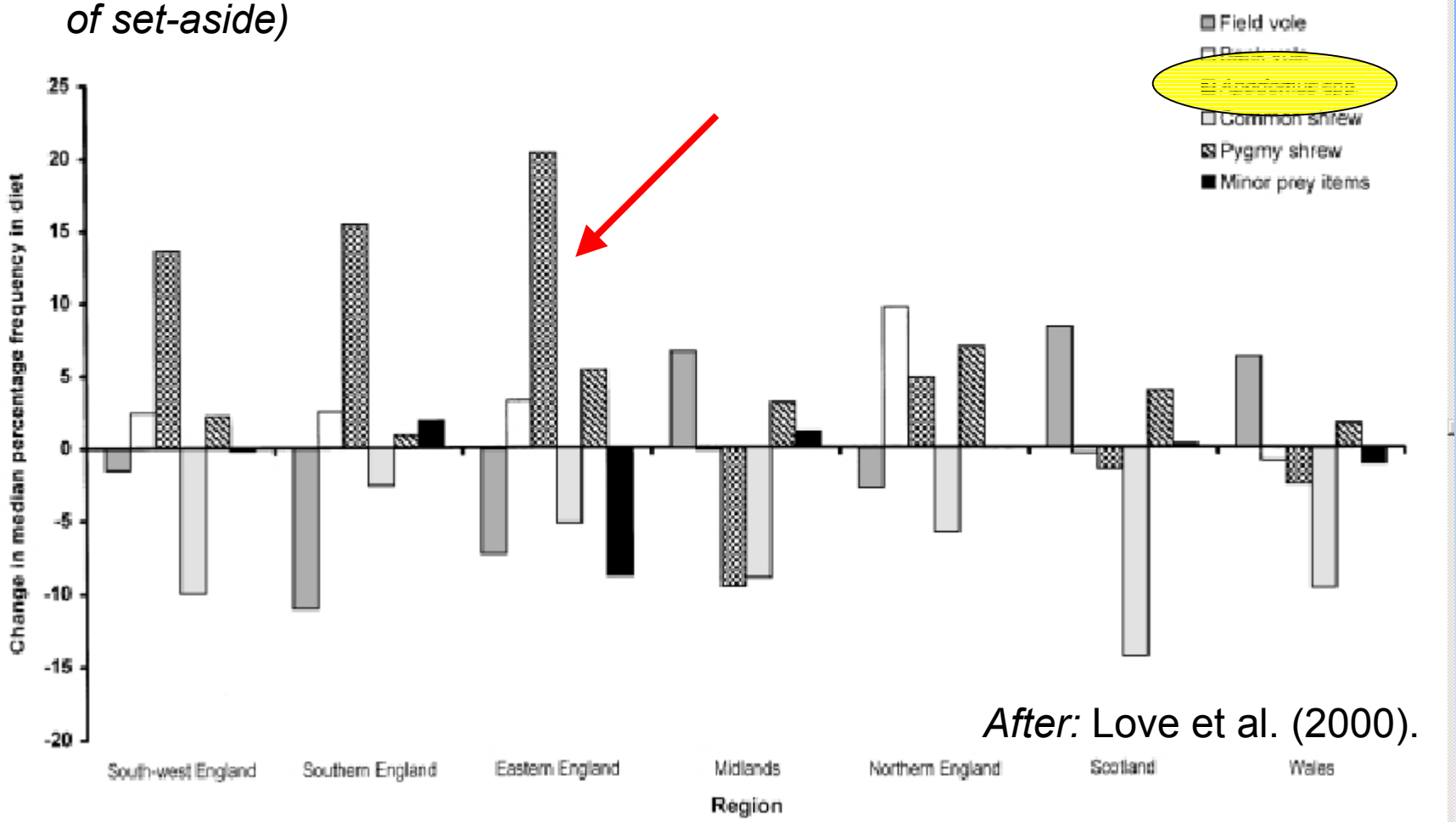
After: Love et al. (2000).



Change in median percentage frequency of main prey types in Barn Owl diet in each land-class group between the 1974 and 1997 surveys.

Trends over time

Regional effect only found in *Apodemus (influence of set-aside)*



After: Love et al. (2000).

	Dietary diversity B_s	
	1974	1997
Survey total	0.18	0.21
South-west England	0.19	0.22
Southern England	0.18	0.22
Eastern England	0.20	0.24
Midlands	0.19	0.20
Northern England	0.18	0.27
Scotland	0.16	0.17
Wales	0.19	0.16
Arable I	0.20	0.27
Arable II	0.19	0.23
Arable III	0.15	0.20
Pastoral IV	0.20	0.19
Pastoral V	0.18	0.19
Marginal Upland VI	0.14	0.17
Upland VII	0.21	

Diversity increase between 1974-1997 due to greater predation on *Apodemus* and minor items

Diversity decrease since late '800: wider prey range formerly available

Changes in Barn Owl dietary diversity since the late nineteenth century

Study	Study period	Location	Dietary diversity (B_s)
Adams (1898)	pre1898	Various	0.32
Glue & Jordan (1989)	pre1913	Hampshire	0.53
Collinge (1927)	pre1924	Unknown	0.39
Ticehurst (1935)	pre1935	Various	0.24
Webster (1973)	1968	Cumbria	0.14
BTO survey	1960–74	National	0.18
Buckley & Goldsmith (1975)	1964–71	Norfolk	0.19
Yalden (1985b)	1967–82	Peak District	0.14
Taylor (1994)	1979–91	Southern Scotland	0.15
The Mammal Society survey	1993–97	National	0.21

Trends over time

Conclusions

- Changes in small mammal relative abundance over time

- Similar changes across land class groups (changes at finer habitat scale?)

- *Apodemus* relative increase (generalist)

- Did this determine under-representation of *Sorex araneaus* in diet?

- Why did *Sorex minutus* increase?

- Increased predation due to fragmentation: *Arvicola terrestris* and *Mycromis minutus*?

A FEW RELEVANT POINTS ON SMALL MAMMALS AND LAND USE CHANGE

In general, small mammal responses linked with habitat or landscape changes

no clear bio-indicators of different intensification stages

studies show some controversial results (pygmy shrew!)

a better understanding of mammal ecology needed to interpret results

Barn owl behaviour critical if predator used to sample mammal communities – always easy to understand?

Bats

Many bat species exhibit sharp responses to land use change

-exceptionally long life span
-low reproduction rate
-dependance upon insect prey
-association with specific habitats
-multi-scale perception of landscape

Bats

-Some species opportunistic
-Many others selective
-Strong decline observed in European populations over the last 40 years

Bat life cycle: a synthesis

May-August

NURSERY

Births

April

August-October

Mating

Hibernation

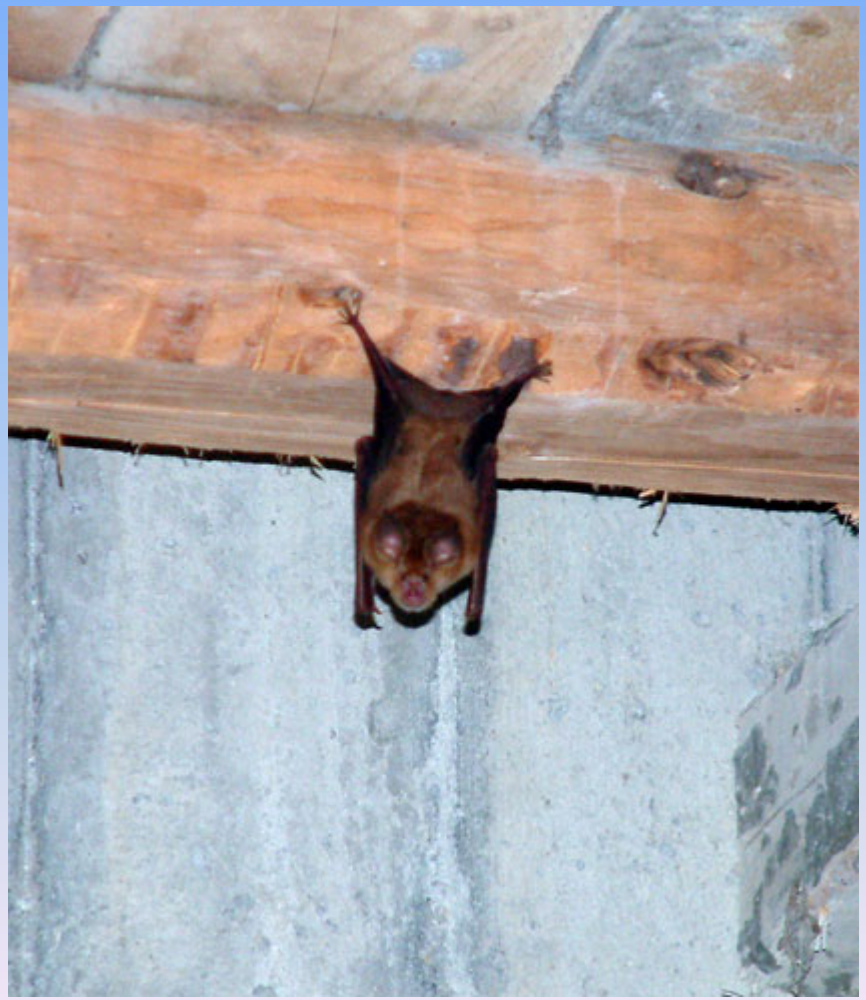
HIBERNACULA

November-March

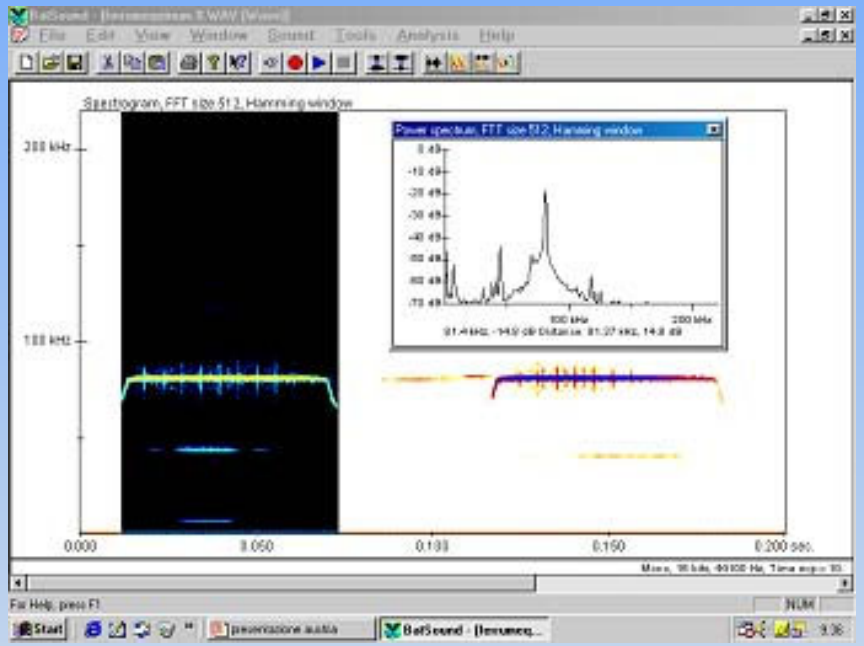
Sensitive areas for impact of land use change

Roosting preferences

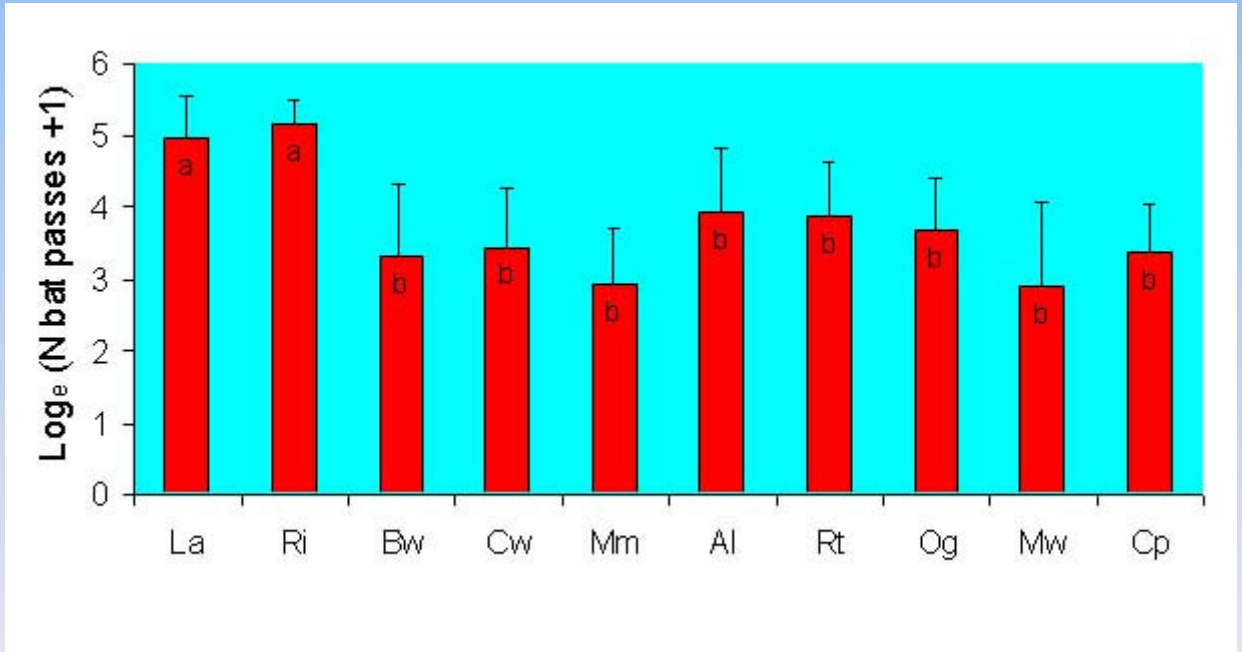
Foraging requirements



Acoustic surveys



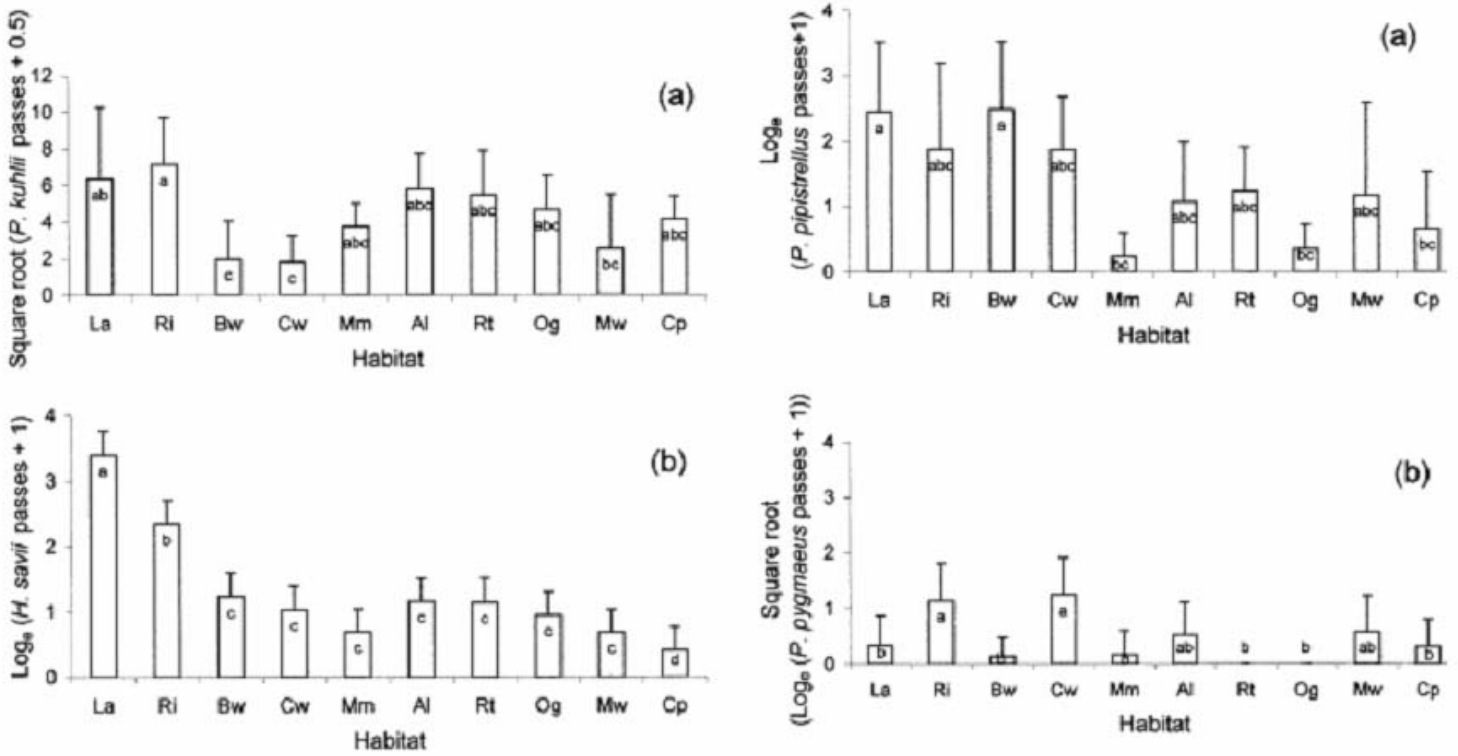
Riparian habitats and bat foraging



ECOGRAPHY 26: 197–209, 2003

Use of foraging habitats by bats in a Mediterranean area determined by acoustic surveys: conservation implications

Danilo Russo and Gareth Jones



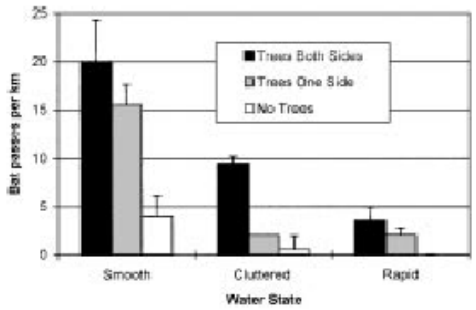
La = lakes, Ri = rivers, Bw = beech woodlands, Cw = chestnut woodlands, Mm = Mediterranean macchia, Al = arable land, Rt = rural towns, Og = olive groves, Mw = Mediterranean and sub-Mediterranean woodlands, Cp = conifer plantations.

Habitats in which no significant difference in bat activity was detected are labelled with the same letter. Standard deviations are shown.

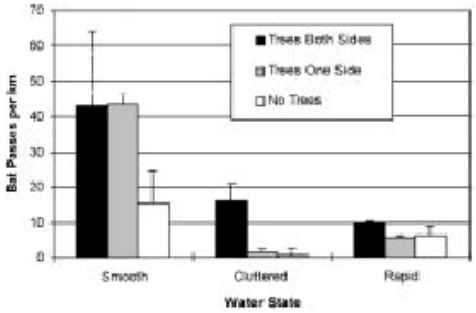
Is bat activity influenced by transformation of riparian habitats?

Engineering for flood alleviation, agricultural drainage, erosion reduction
Removal of sediment
Pollution
……..

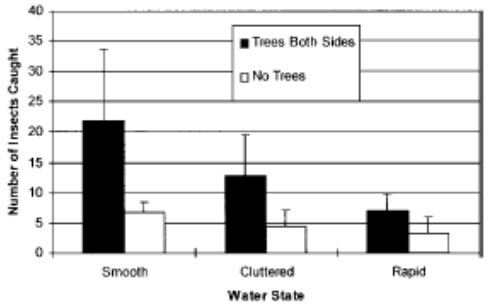
Riparian vegetation



Mean and standard deviations of the number of passes of the 45 kHz phonic type of *P. pipistrellus* on the outward leg of the transect.



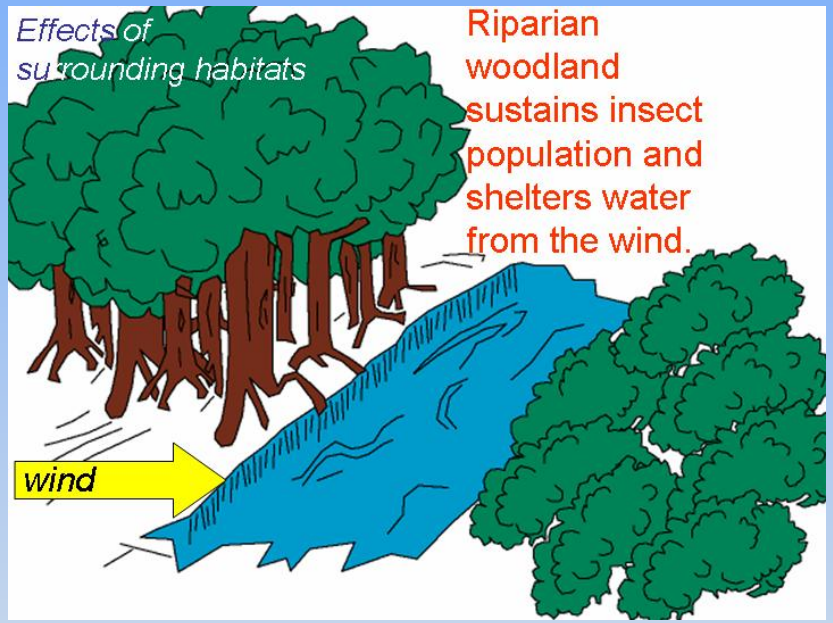
Mean and standard deviations of the number of passes of the 45 kHz phonic type of *P. pipistrellus* on the return leg of the transect.

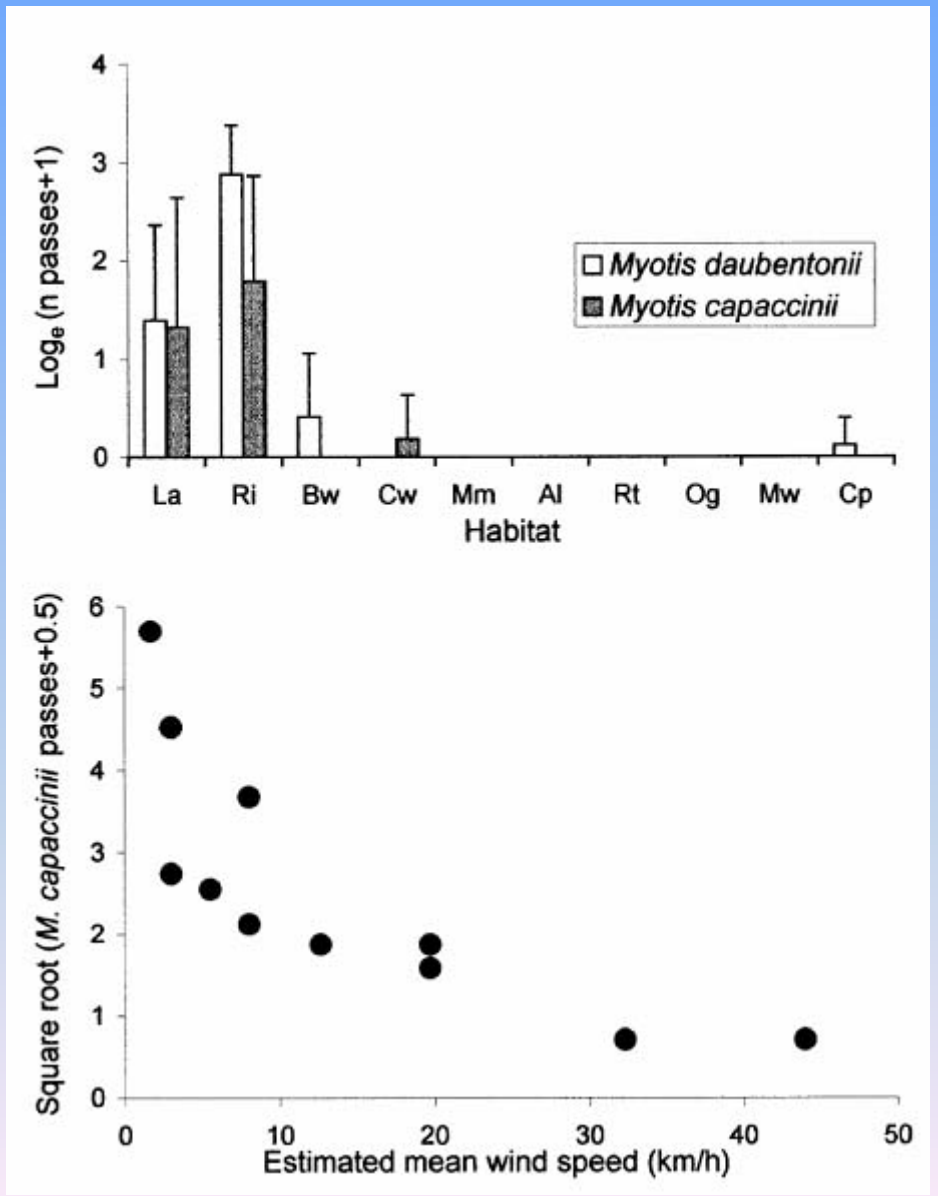


Mean and standard deviation of number of insects caught with habitat category.

Warren et al. (2000). *Biological Conservation* 92: 85-91

Effect of wind on foraging activity by trawling bats





ECOGRAPHY 26: 197–209, 2003

Use of foraging habitats by bats in a Mediterranean area determined by acoustic surveys: conservation implications

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Pollution

Biological Conservation **78** (1996) 337–343

0006-3207/96 $15.00 +.00

ELSEVIER

PII: S0006-3207(96)00009-2

EFFECTS OF SEWAGE EFFLUENT ON THE ACTIVITY OF BATS (CHIROPTERA: VESPERTILIONIDAE) FORAGING ALONG RIVERS

Nancy Vaughan, Gareth Jones & Stephen Harris

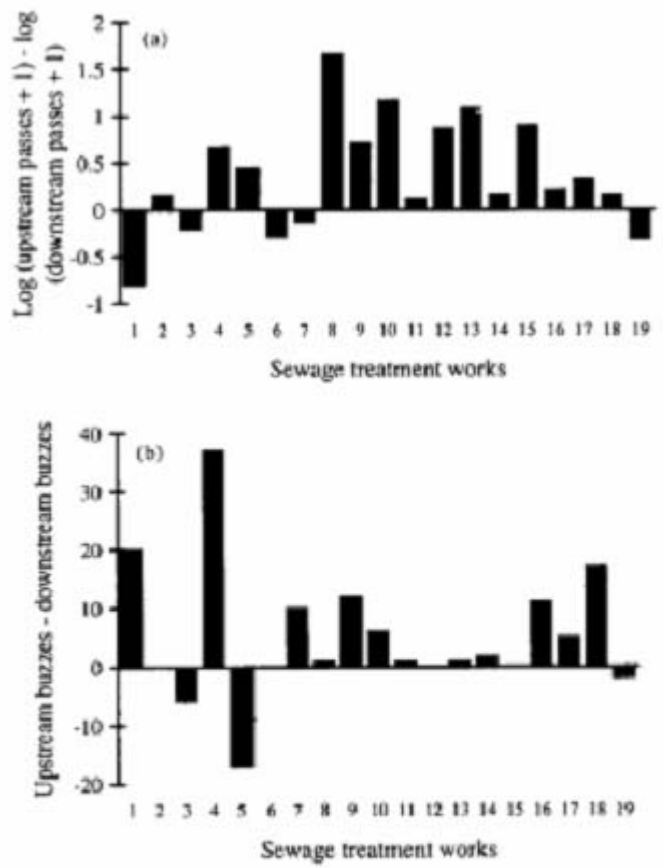


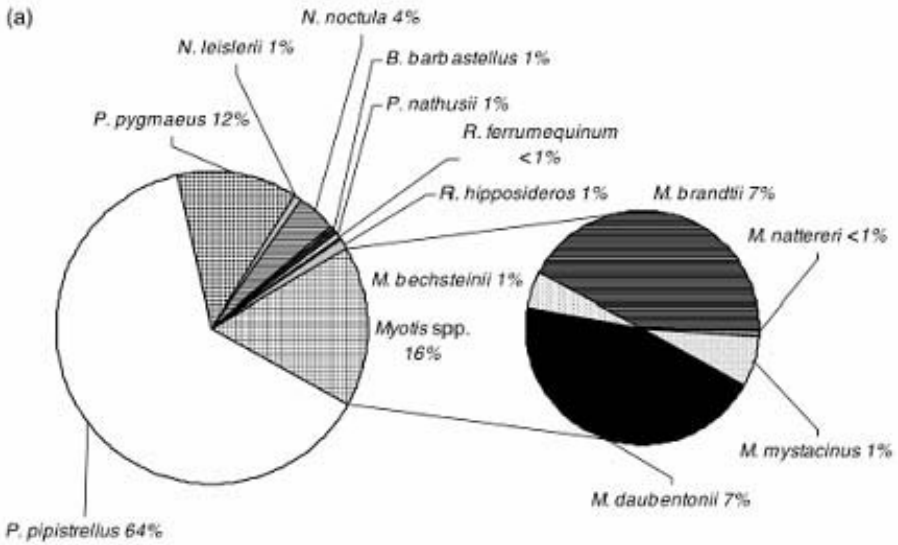
Fig. 1. The differences in (a) log bat passes (upstream minus downstream) at the 19 sewage treatment works. A negative value indicates that bat activity was higher at the downstream site than at the upstream site. Bats were significantly more active upstream than downstream (t = 2·553; p <0·05) and (b) in terminal buzzes counted (upstream minus downstream) at the 19 sewage treatment works. Bats made significantly more attempts at prey capture at upstream sites than at downstream sites (Z = −2·019; p <0·05).

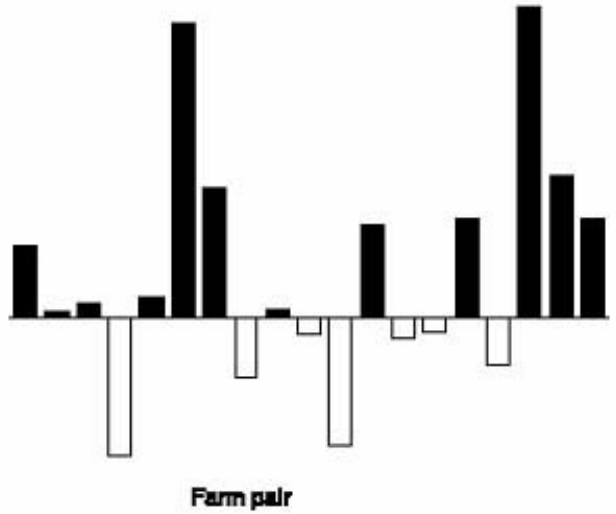
Responses to agricultural changes

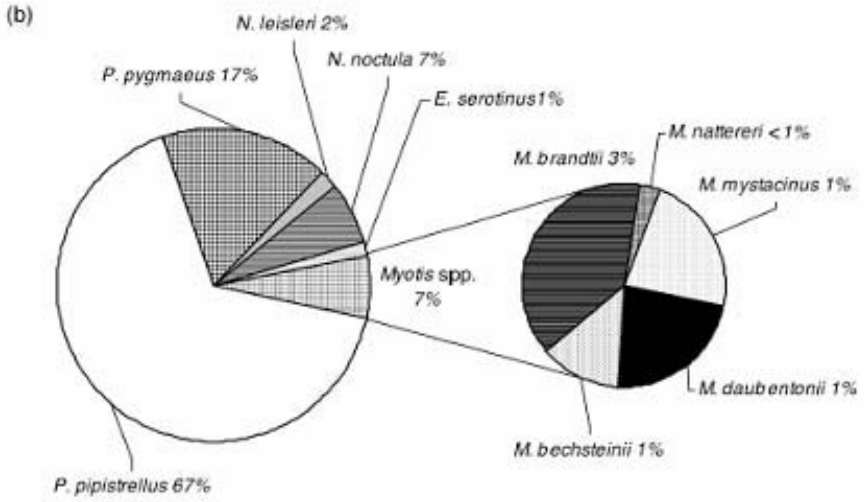
Journal of Applied Ecology 2003
40, 984–993

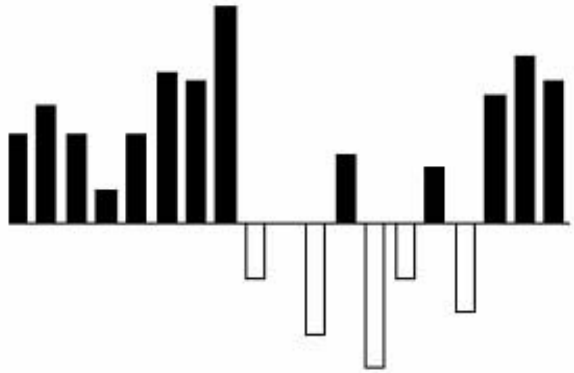
Bat activity and species richness on organic and conventional farms: impact of agricultural intensification

LIAT P. WICKRAMASINGHE, STEPHEN HARRIS, GARETH JONES and NANCY VAUGHAN









Rhinolophids and farmland

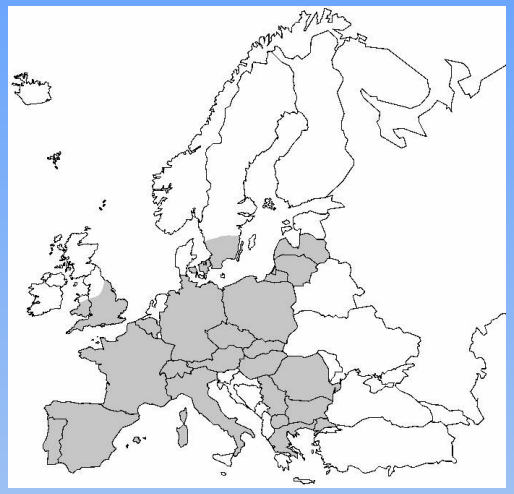
R. euryale selects “traditional landscapes” made of complex mosaics of olive groves and broadleaved woodland

Avoids more intensively farmed areas with low structural diversity

D. Russo, G. Jones & A. Migliozzi, Biol. Conserv. 107: 71-81

Bats and forestry: the influence of forest management

Barbastella barbastellus (Schreber, 1774)



-Mainly found in Europe – widespread but fragmented distribution.

- Considered ‘Vulnerable’ on an international scale (IUCN)

- One reproductive population known in peninsular Italy

ECOGRAPHY 28: 1–8, 2005

Spatial and temporal patterns of roost use by tree-dwelling barbastelle bats *Barbastella barbastellus*

Danilo Russo, Luca Cistrone and Gareth Jones

Russo, D., Cistrone, L. and Jones, G. 2005. Spatial and temporal patterns of roost use by tree-dwelling barbastelle bats *Barbastella barbastellus*. – Ecography 28: 000–000.

We evaluated the spatial and temporal patterns of roost switching behaviour by a tree-dwelling population of barbastelle bats *Barbastella barbastellus* in a beech forest of central Italy. Switching behaviour was common to both sexes and did not depend on group size. We observed both individual and group switching, the latter often involving the abandonment of a roost tree on a single night. We suggest that behaviours such as flight activity around roosts or cavity inspection by bats play a role in recruiting group mates and coordinating their occupation of another site. Bats almost never crossed mountain ridges to use roosts located beyond them, possibly because ridges are regarded as boundaries delimiting main roosting areas. The rate of switching was lowest during the middle of the lactation period, probably to minimise problems related to the transportation of non-volant young by their mothers. Although the maintenance of social relationship among bats spread over large forest areas may partly explain the occurrence of roost switching, the persistence of this behaviour in solitary bats and the movement of entire groups best fit the hypothesis that roost switching represents a way to maintain or increase knowledge of alternative roosts.

Available online at www.sciencedirect.com
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Biological Conservation 117 (2004) 73–81
BIOLOGICAL CONSERVATION
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Roost selection by barbastelle bats (*Barbastella barbastellus*, Chiroptera: Vespertilionidae) in beech woodlands of central Italy: consequences for conservation

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Received 31 January 2003; received in revised form 6 May 2003; accepted 12 May 2003

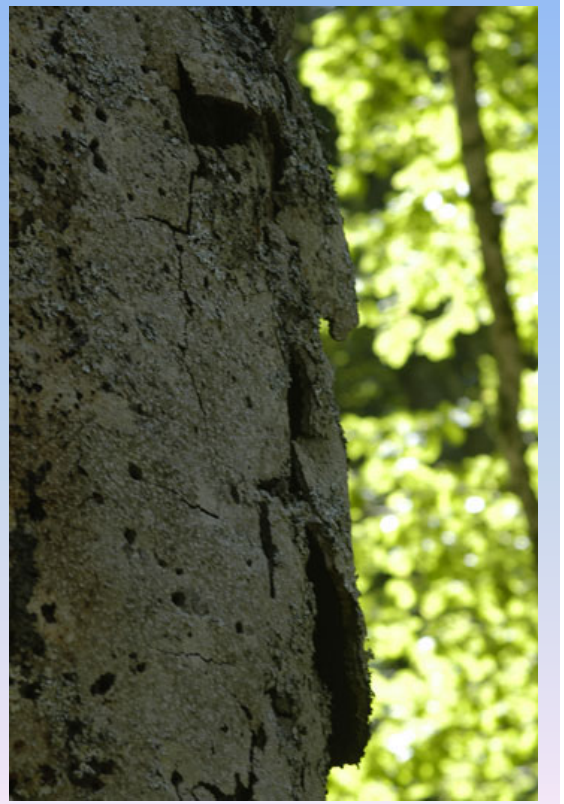
Abstract

We investigated roost selection by *Barbastella barbastellus* in a mountainous area of central Italy. Twenty-five bats, mostly lactating females, were radio-tracked to 33 roost trees. Trees in unmanaged woodland were favoured as roost trees; woodland subject to limited logging was used in proportion to availability, and areas where open woodland and pasture occurred were avoided. Selection depended on tree condition (dead beech trees were preferred) and height (roost trees were taller than random ones). Cavity selection was based on cavity type, height and entrance direction: roost cavities were mainly beneath loose bark, at a greater height above ground and facing south more frequently than random cavities. Untouched areas of mature woodland should be preserved to provide roosting conditions for *B. barbastellus*. In logged areas, harvesting protocols should save dead and mature trees; frequent roost switching and small colony size imply that large numbers of roost trees are needed.

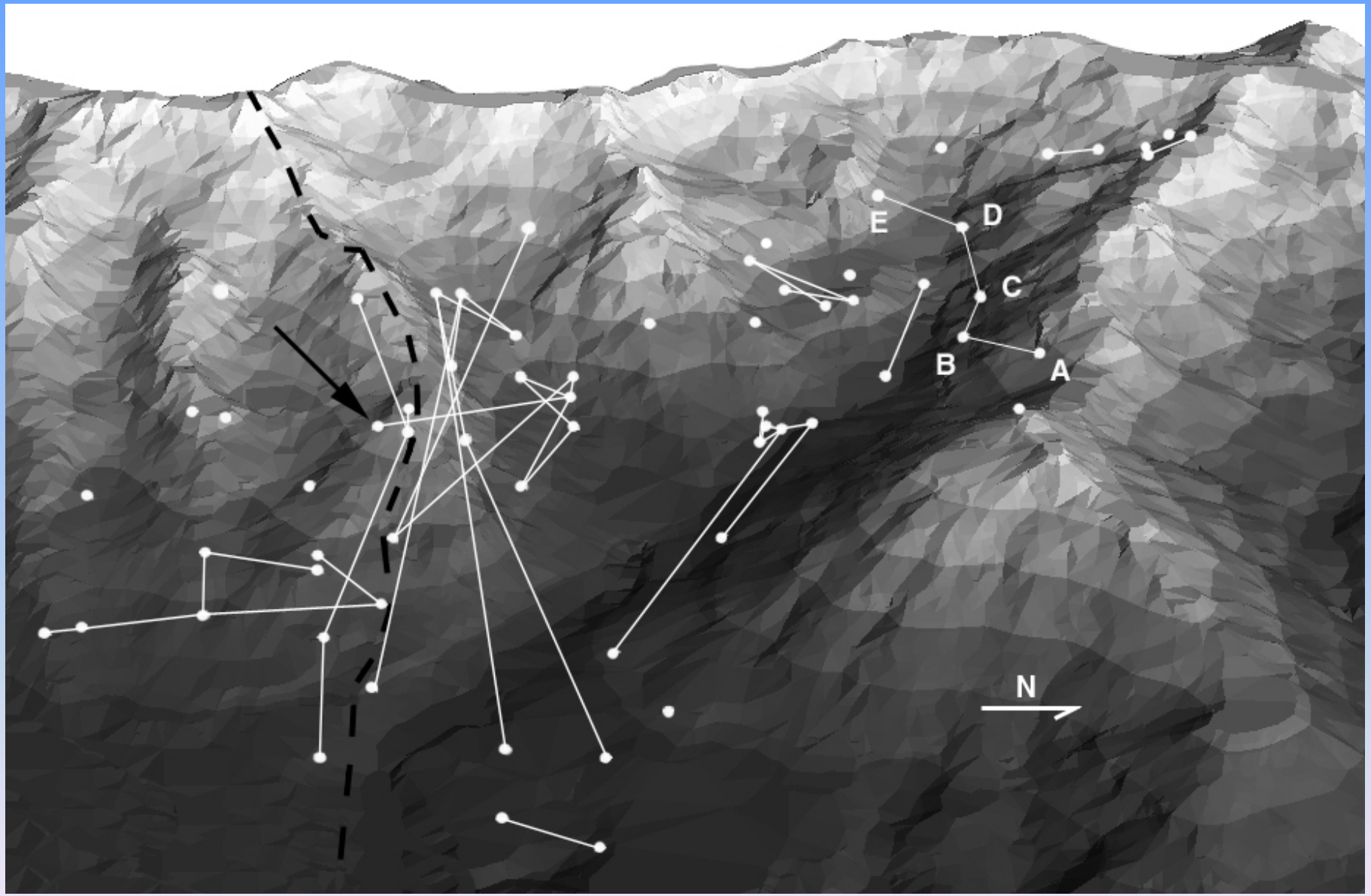
Barbastelle prefers unmanaged forest, avoids woodland-pasture association,
uses selectively logged woodland according to availability

Trees selected for height and condition (dead trees preferred)

Preferred cavities: beneath loose bark, at higher height and more frequently facing south than those available at random



Roost switching



At least in the Italian Apennines, barbastelles are associated with unmanaged forest patches where large numbers of dead trees are available.

The species may persist in areas where selective logging occurs

Current species rarity possibly due to widespread, intensive forms of forest management

Barbastelles as indicators of forest management/quality?

Reactions by large predators to changing landscapes

Sensitivity due to top predator role

Significant human-predator interactions

Fast rate of response in carnivore body size

Functional Ecology 2003
17, 323–327

Body sizes of carnivores commensal with humans have increased over the past 50 years

Y. YOM-TOV

Improved nutrition may cause an increase in body size in animals, while increased ambient temperature may result in a decrease in body size, as expected from Bergmann's rule.

In Israel, during the last 50 years both food availability for animals commensal with humans and ambient temperature have increased.

GARBAGE DUMPS
CROPS
LIVESTOCK
FIELD PESTS (INSECTS, RODENTS)
ROAD KILLS

An increase in body length was found in four species, and appears to be related to improved nutrition owing to a substantial increase in the amount of garbage and agricultural crops available to commensal mammals that has occurred since the establishment of the State of Israel in 1948.

The larger species were more affected than the smaller ones, apparently because of their higher position in the feeding hierarchy or because of having larger home ranges.

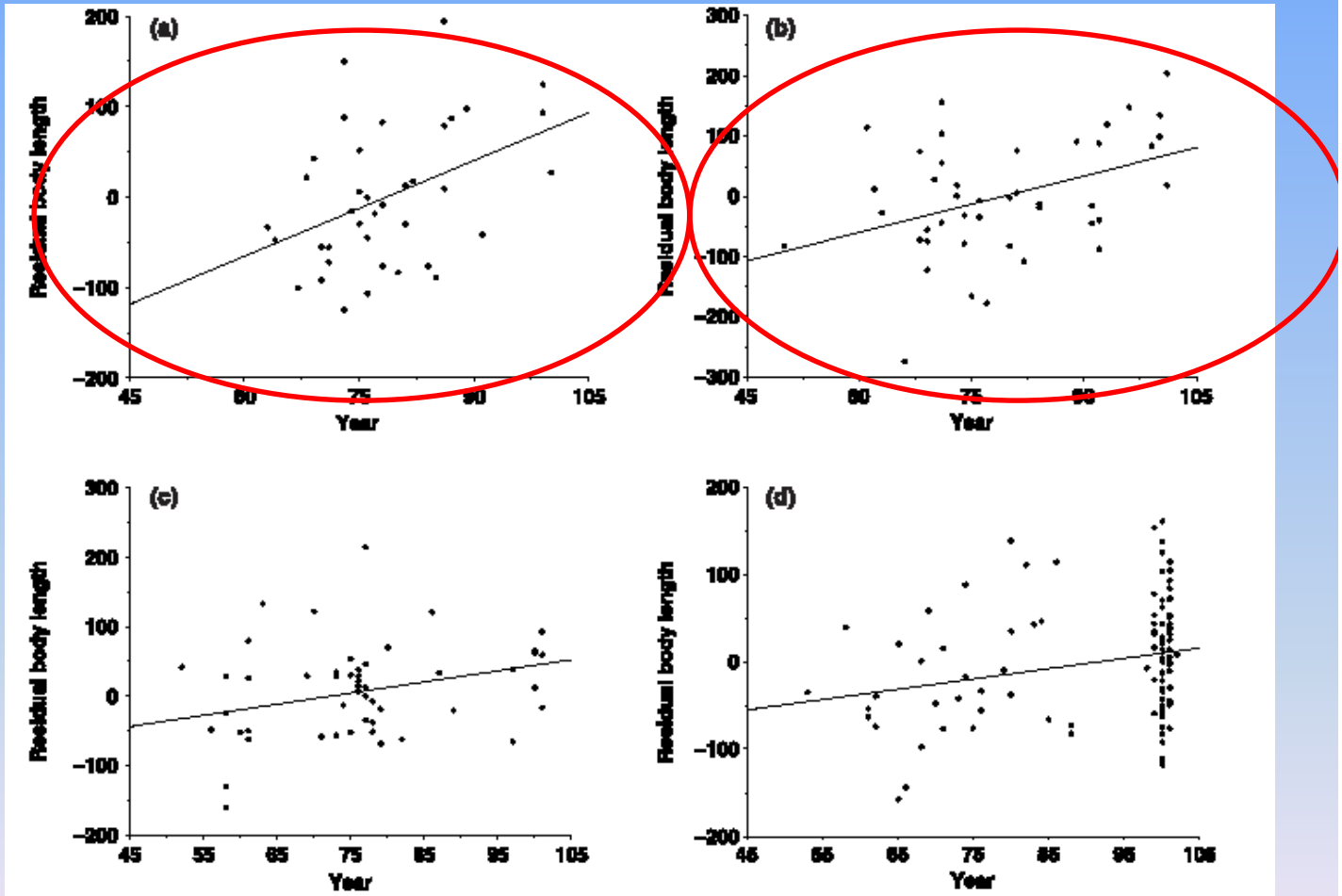
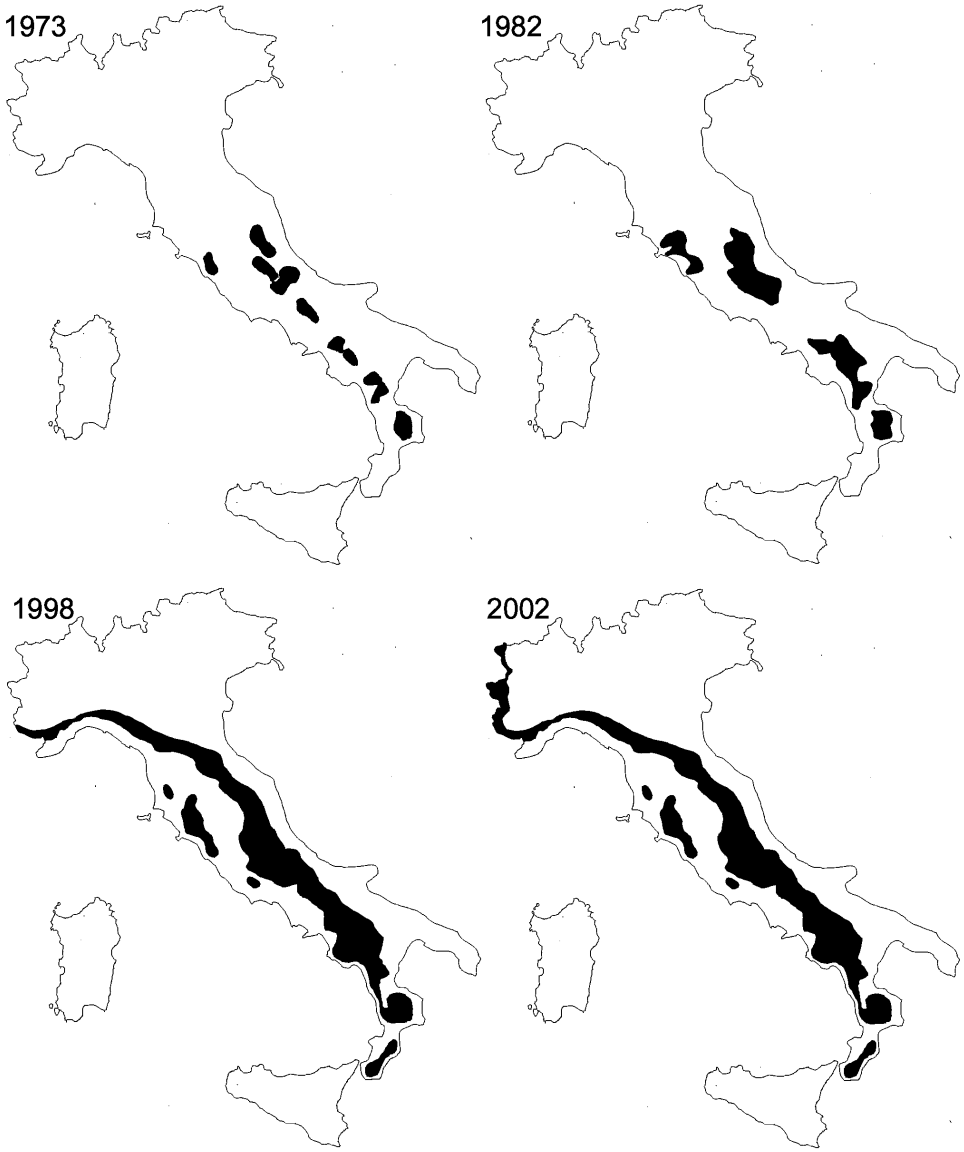


Fig. 1. The relationship between body length (in mm, controlled for sex, month of collection and latitude) and year of collection (50 = 1950, 100 = 2000) in the (a) Striped Hyaena ($n = 38$, $r^2 = 0{\cdot}176$, $P = 0{\cdot}0088$; $Y = -277{\cdot}57 + 3{\cdot}532$ * year); (b) Wolf ($n = 43$, $r^2 = 0{\cdot}160$, $P = 0{\cdot}0079$; $Y = -247{\cdot}39 + 3{\cdot}123$ * year); (c) Golden Jackal ($n = 54$, $r^2 = 0{\cdot}094$, $P = 0{\cdot}0241$; $Y = -115{\cdot}78 + 1{\cdot}599$ * year); and (d) European Badger ($n = 109$, $r^2 = 0{\cdot}061$, $P = 0{\cdot}0094$; $Y = -0{\cdot}15 + 0{\cdot}002$ * year). For the fox (not presented in the figure) $n = 47$, $r^2 = 0{\cdot}002$, $P = 0{\cdot}7416$; $Y = 9{\cdot}74 - 0{\cdot}131$ * year.

Recent expansion of wolves



Factors determining the expansion

FOOD RATHER THAN HABITATS CRUCIAL !

protection

reintroduction of ungulates

land abandonment, which means:
1) increased woody vegetation leading to recovery of wild prey
2) decreased contact with humans

Different management options in neighbouring countries

In some cases (France) selective culling programmes started to control wolf impact on livestock

Eradication/control of species protected for long raised concern in public opinion and shocked many environmentalists

Trans-national management advisable

Preference for wild prey

Value of traditional defense

A few final points

-Studies show land use change considerably affects mammal species/communities

-Factors involved include habitat type, landscape structure and resources

-Life history tracts important in shaping species response

-Reactions may be rapid

- Important conservation consequencies (EC policies)

- Land management options crucial

-Conservation value of mammals enhanced by their “flag species” and “umbrella species” roles

Implications for ecosystem dynamics and human dimension

-Effects on keystone species

-Impact on ecosystem services (pest control by insectivorous mammals, carnivore seed dispersal, etc.)

-Expansion of opportunists (e.g. rodent populations may boost in abandoned land)

-Conflict (return of large predators)

Conclusions

Limits in using mammals as indicators of land use change

Spatial and temporal patterns in mammal species/ communities are often evident so may provide effective picture of land use dynamics at several resolution scales

but

Trends are not always obvious to interpret

- info needed on mammal ecology

- important to know limits and perspectives offered by different methods employed in surveys (see small mammal cases)

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