



33rd European
Mustelid
Colloquium
8-11 October 2019

Book of Abstracts

Faculdade de Ciências da Universidade de Lisboa

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 33rd European Mustelid Colloquium

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Welcome

We are delighted to welcome you all to the 33rd European Mustelid Colloquium in Lisbon.

This is the second time that the Colloquium has been held in Lisbon (the previous one being held in 2009) and we're pleased to be joined by almost 100 delegates from 19 countries within Europe and further afield. We hope that this Colloquium will provide an opportunity to meet with colleagues and friends, share research findings and ideas, and discuss opportunities for future collaborations.

Over the three days of the Colloquium, we're looking forward to 25 oral presentations, 26 poster presentations and a field trip to address common themes and issues in mustelid research and conservation throughout Europe and beyond. We're pleased to welcome our four keynote speakers who, between them, will be covering a wide range of topics on mustelid ecology, research and conservation. We're particularly excited to be joined by Professor Carolyn King who is travelling all the way from New Zealand to be with us, bringing over five decades of mustelid experience with her!

The planning and implementation of the Colloquium has been the result of a Portuguese-British collaborative effort between The Centre for Ecology, Evolution and Environmental Changes (cE3c) at Faculdade de Ciências da Universidade de Lisboa and Vincent Wildlife Trust. We are very grateful to the following institutions that have sponsored the Colloquium: Faculdade de Ciências da Universidade de Lisboa, Museu de Lisboa (Palácio Pimenta) and Companhia das Lezírias, S.A.

We are also grateful to the scientific committee, who contributed to planning the Colloquium and reviewed the submitted abstracts. The Book of Abstracts was designed by Julia Bracewell (Vincent Wildlife Trust).

We look forward to meeting you all over the coming days and hope you have an enjoyable, productive and inspiring time at the Colloquium.

Steve Carter and Lizzie Croose, **Vincent Wildlife Trust, UK**
Margarida Santos-Reis, Luís Miguel Rosalino, Gonçalo Curveira-Santos, Raquel Mendes,
Paula Gonçalves and Sandra Alcobia, **cE3c, Faculdade de Ciências da Universidade de Lisboa**

With grateful thanks to our sponsors for this year's Colloquium



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ULisboa
Faculdade
de Ciências
da Universidade
de Lisboa



Committees

Organising committee

- **Margarida Santos-Reis** University of Lisbon
- **Luís Miguel Rosalino** University of Lisbon
- **Steve Carter** Vincent Wildlife Trust
- **Lizzie Croose** Vincent Wildlife Trust
- **Julia Bracewell** Vincent Wildlife Trust
- **Paula Gonçalves** University of Lisbon
- **Gonçalo Curveira-Santos** University of Lisbon
- **Raquel Mendes** University of Lisbon
- **Sandra Alcobia** University of Lisbon

Scientific committee

- **Prof Margarida Santos-Reis** University of Lisbon, Portugal
- **Dr Luís Miguel Rosalino** University of Lisbon, Portugal
- **Dr Steve Carter** Vincent Wildlife Trust, UK
- **Lizzie Croose** Vincent Wildlife Trust, UK
- **Dr Johnny Birks** Swift Ecology, UK
- **Dr Sébastien Devillard** Laboratoire de Biométrie et Biologie Evolutive, France
- **Professor Robbie McDonald** University of Exeter, UK
- **Dr Catherine O'Reilly** Waterford Institute of Technology, Ireland
- **Dr Sandrine Ruelle** ONCFS, France
- **Dr Izabela Wierzbowska** Jagiellonian University, Poland

Important information

Colloquium Welcome Reception

The Welcome Reception will take place at 17:00 on Tuesday 8 October at Palácio Pimenta, Museu de Lisboa located at Campo Grande, 245.

Colloquium Lunch

This year, the traditional Colloquium Dinner will be a Colloquium Lunch as part of the Field Trip on Thursday 10 October. Please note, the Field Trip is only available to delegates who have pre-booked. Transport to the Field Trip will be by coach.

Raffle

During the colloquium lunch, we will be holding a raffle. Ticket price will be 1 or 2 euros and this will go towards student bursaries for the next colloquium. Conference delegates are invited to bring a small contribution from their country as a prize in the raffle. Contributions of a mustelid nature are particularly welcome!

Registration

The Registration Desk will be open from 17:00 to 19:00 on Tuesday 8 October at the Welcome Reception and from 08:00 to 09:00 on Wednesday 9 October at the Auditorium of the Caleidoscópio Academic Center in Campo Grande Garden.

Information for speakers

Speakers should come to the lecture theatre five minutes before the start of their session to meet the Chair and to have a quick introduction to the presenting equipment.

Social media

We encourage people to tweet about the Colloquium using the official hashtag #33EMC. If you would not like photographs or information from your presentation shared on social media, please state this at the start of your talk, either verbally or by having a 'No Social Media' symbol visible on your presentation... or both!

Information for poster presentations

Posters can be put onto boards on Wednesday 9 October from 08:00 onwards. During the poster session, authors are requested to stand by their posters.

Prizes for best presentations

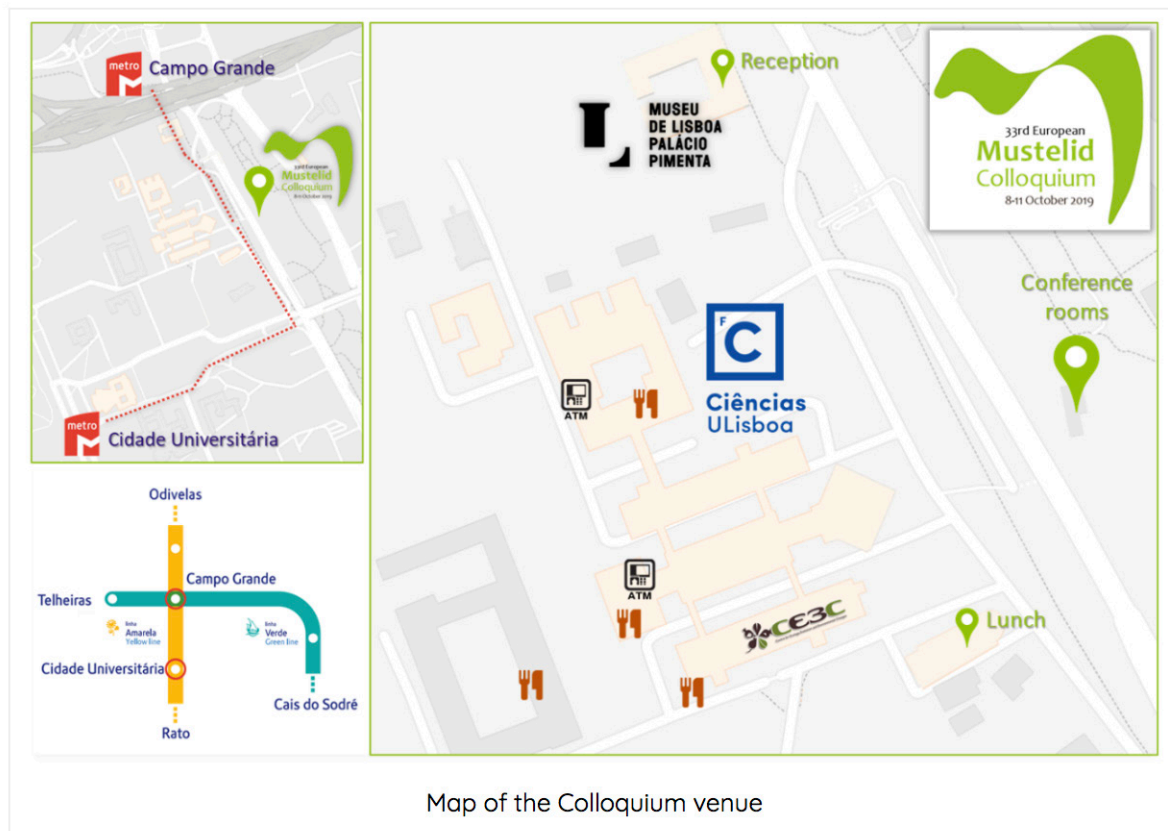
We will be awarding a prize for the best oral and poster presentations.

Colloquium venue

The 33rd European Mustelid Colloquium will be held at

Auditorium of the Caleidoscópio Academic Center in Campo Grande Garden (or Mário Soares Garden) on 9th and 11th October.

Lunches are included in the conference fee and will be served in building C7, at the Faculty of Sciences of the University of Lisbon (FCUL) 9th and 11th October. It is a 1-2 minute walk (100m) from the Caleidoscópio Auditorium to the Faculty.



The Welcome Reception will be held at

Museu de Lisboa at the Palácio Pimenta site.

Campo Grande, 245
1700-091 Lisboa
Tel: 217 513 200



Keynote speaker biographies



Carolyn King, University of Waikato, Hamilton, New Zealand

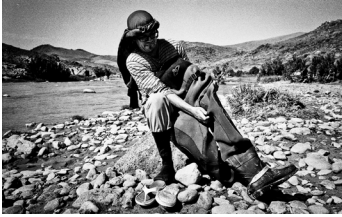
Carolyn (known to friends as Kim) studied at Liverpool University and at Oxford. Her DPhil was the first full-length field study of the ecology of British weasels. In 1971 she emigrated to New Zealand to join DSIR Ecology Division as a scientist specialising on introduced predators. Her research started with stoats and wild house mice, and later added feral ferrets and ship rats. Between 1977 and 1994, when family concerns took priority, she wrote papers and edited scientific journals for the Royal Society of New Zealand. Her two best-known books, *The Natural History of Weasels and Stoats* (1989) and *The Handbook of New Zealand Mammals* (1990), began then, and both went into second editions with Oxford University Press (in 2007 and 2005 respectively). A recent addition was *The Drama of Conservation* (Springer Verlag, 2015), a comprehensive history of a tree-sitting protest that ended the logging of native forest in Pureora Forest Park, and thence throughout New Zealand. From 1995 to 2018 she taught zoology and conservation biology at Waikato University, where she now continues writing full time. Her current book with Palgrave Macmillan is part of their series *Studies in World Environmental History*, and is entitled *Invasive predators in New Zealand: Disaster on Four Small Paws*. She received the Silver Medal of the Mammal Society in 2005, and was elected to the Fellowship of the Royal Society of New Zealand in 2018.



Dr Tiit Maran, Tallinn Zoological Gardens, Estonia

Tiit is the director of the Tallinn Zoological Gardens in Estonia. He completed his PhD on the conservation biology of the European mink, investigating the cause of the decline and extinction of mink populations. He has also worked at the Wildlife Conservation Research Unit (WILDCRU) at Oxford University and was an associate professor at the Estonian University of Life Sciences and Tallinn University. For many years, Tiit has been involved in captive breeding initiatives and reintroduction programmes for European mink. Notably, Tiit has worked on the reintroduction of captive-bred mink to Hiiumaa island in Estonia where since 2000, almost 600 mink have been released and monitored extensively. He is also a member of the IUCN small carnivore specialist group and has contributed to the assessment of several mustelid species for The IUCN Red List of Threatened Species.

Keynote speaker biographies



Dr Miguel Clavero, Doñana Biological Station, Spain

Miguel is a researcher at the Doñana Biological Station - CSIC, based in Sevilla, Spain. He has worked in several research lines involving a variety of organisms (freshwater fish, crayfish, mammals, birds, freshwater mussels), which share the focus on the responses of populations and communities to landscape gradients and human impacts and on biodiversity conservation. Some of his main interests include invasion processes and their impacts, the conservation of Mediterranean freshwater ecosystems and the description of long-term species distribution changes and their causes based on the analysis of historical sources. He did his PhD on the ecology of coastal populations of the Eurasian otter, and has kept working on this species since then (and occasionally on other aquatic or semiaquatic mustelids), mainly in the Iberian Peninsula and Morocco, analysing the variability in otter presence and trophic habits at different spatial scales.



Dr Fernando Ascensão, CIBIO/InBIO, Portugal

Fernando is a post-doctoral researcher at the Centre for Ecology, Evolution and Environmental Changes (cE3c) at the University of Lisbon. He holds a PhD from Lisbon University and a Masters from Évora University, both in Conservation Biology. His work is focused on landscape ecology, particularly road ecology. His research involves investigating the biology, population dynamics, genetic isolation and the behaviour of various wildlife species and groups, and also finding solutions that enable a sustainable coexistence between roads and wildlife. He is currently researching mustelids and roads.

Scientific and Social programme

8 October (Tuesday)

17:00-19:00 Welcome reception (Museu de Lisboa)

9 October (Wednesday)

08:00-09:00 Registration

09:00-09:15 Welcome address (FCUL Director) and Opening Remarks, Margarida Santos-Reis (Organising Committee)

09:15-12:20 **SESSION I: Conservation of Polecats and Pine Martens** Chair Margarida Santos-Reis

09:15-10:00 **Keynote Lecture:** Stoats, weasels and ferrets in New Zealand: the least welcome but best-known small mustelids - Carolyn King, University of Waikato

10:00-10:20 Landscape and biotic interactions influences on a declining European polecat population - Salvador Salvador Allué, Universitat de Girona

10:20-10:40 Artificial den boxes aid monitoring of pine martens and improve habitat in commercial forests - Johnny Birks, Swift Ecology

10:40-11:10 **COFFEE BREAK**

11:10-11:30 Polecats in Sweden: current, past and future - Tim Hofmeester, Swedish University of Agricultural Sciences

11:30-11:50 The role of personality in wildlife translocations: lessons from a pine marten population reinforcement in Wales - Jenny MacPherson, Vincent Wildlife Trust

11:50-12:10 New records reveal a wider range of the steppe polecat (*Mustela eversmanii*) in Romania - Zsolt Hegyeli, Milvus Group Bird and Nature Protection Association

12:10-12:30 www.pinemarten.ie: using the internet to meet the conservation challenges of a recovering native carnivore - Ruth Hanniffy, Vincent Wildlife Trust

12:30-14:00 **LUNCH**

14:00-15:50 **SESSION II: Conservation of European Mink** Chair Steve Carter

14:00-14:45 **Keynote Lecture:** Conservation of the European mink - and lessons learned - Tiit Maran, Tallinn Zoological Gardens

14:45-15:05 The critically endangered European mink in Spain: results of decade-long monitoring in the Ebro basin - Madis Põdra, TRAGSATEC

15:05-15:25 New hope for the European mink in Spain: eradication of recently established American mink population in the Ebro river basin - Asun Gómez, TRAGSATEC

15:25-15:50 **COFFEE BREAK**

15:50-16:10 Does thwarted territorial behaviour explain ex situ abnormal behaviour during breeding season in the critically endangered European mink? - Maria Díez-León, Royal Veterinary College, University of London

16:10-16:30 LIFE VISON, conservation programme for the European mink in the Charente basin, a major project: presentation and first outcomes - Ingrid Marchand, Ligue pour la Protection des Oiseaux

16:30-18:30 **POSTER SESSION and WINE TASTING**

Scientific and Social programme

10 October (Thursday)

08:00-18:00 Field trip and colloquium lunch with tombola/raffle

11 October (Friday)

09:00-12:20 **SESSION I: Research Methods** Chair Izabela Wierzbowska

09:00-09:45 **Keynote Lecture:** Global change, the freshwater biodiversity crisis and semi-aquatic mustelids - Miguel Clavero, Doñana Biological Station

09:45-10:05 Comparing the efficacy and cost-effectiveness of sampling methods for estimating population abundance of the pine marten - Lizzie Croose, Vincent Wildlife Trust

10:05-10:25 What does metabolomics say about Neotropical Mustelids? - Lana Resende de Almeida, University of Rio Grande do Sul

10:25-10:45 Otterly delicious: investigating the diet of the Eurasian otter (*Lutra lutra*) using high throughput sequencing and stable isotope analysis - Lorna Drake, Cardiff University

10:45-11:15 **COFFEE BREAK**

11:15-11:35 Who is present? - individuality in call structure of the Eurasian otter (*Lutra lutra*) - Dominik del Castillo, University of Zurich

11:35-11:55 In-vivo, x-ray imaging of mustelid reproductive biomechanics - Emma Clear, Manchester Metropolitan University

11:55-12:15 Going the extra mile: GPS tracking reveals the extent of movement during badger dispersal - Aoibheann Gaughran, Trinity College, Dublin

12:15-13:45 **LUNCH**

13:45-16:40 **SESSION II: Ecology and Evolution** Chair Johnny Birks

13:45-14:30 **Keynote Lecture:** Towards a worldwide risk assessment of road-related impacts on mustelid species - Fernando Ascensão, CIBIO/InBIO, Portugal

14:30-14:50 Phylogeography and population genetic structure of the European polecat (*Mustela putorius*) - Mafalda Costa, Cardiff University

14:50-15:10 Seasonal coat colour polymorphism in the least weasel: dissecting the evolution of a locally adapted trait - Inês Miranda, Universidade do Porto

15:10-15:30 Spatial variation of density in a social and widespread species: the relative role of sett density and social group size in European badgers - Mickael Jacquier, Université Claude-Bernard Lyon

15:30-16:00 **COFFEE BREAK**

16:00-16:20 Free movement across borders: extra territorial excursions by European badgers in a medium density population - David Kelly, Trinity College, Dublin

16:20-16:40 Population genetic changes during recolonisation of the UK by the Eurasian otter (*Lutra lutra*) - Nia Thomas, Cardiff University

16:40-17:00 **Awards and closing remarks**



Photo: Robert Cruickshanks

Stoats, weasels and ferrets in New Zealand: the least welcome but best-known small mustelids

Carolyn King

University of Waikato, Hillcrest Road, Hamilton, New Zealand. cmking@waikato.ac.nz

Keywords: introduced predators, protection of native species, ecological adaptation, dietary niches, cyclic population dynamics

Three species of small mustelids have adapted to life in a strange, isolated world totally different from their homelands. New Zealand is a land without their major prey, the small mammals native to Europe (shrews, voles, woodmice and lemmings).

Stoats, weasels and ferrets were brought to New Zealand in the 19th century to control rabbits. They failed in that task but are now serious pests of NZ endemic species, including our national icon, the kiwi. Our history illustrates very well the potential consequences of cross-habitat translocations for biological control programmes.

Research in New Zealand illustrates the great flexibility of mustelid populations in adapting to the environment and food resources available in New Zealand. Stoats are now common in forests almost everywhere, whereas weasels, originally introduced in far greater numbers, are rare. Ferrets are largely confined to open country. The different dietary niches of these species, not their release areas, control their present distributions, body sizes, productivity and pest status. Defining a safe distance offshore for island refuges or seabird colonies depends on new data implying that stoats can swim up to c. 5km.

Stoats and ferrets in New Zealand are probably better known than are their ancestral populations in UK, and some of the work we have done on them is relevant to European interests in the population dynamics of cycles, the loss of DNA during translocations, interspecies competition, and why biogeography and history are needed to inform our understanding of contemporary populations.

Rational population management of pest mustelids depends on details of their age-specific fertility and mortality rates. Our substantial work defining those parameters could be useful when applied in reverse to the conservation of rarer mustelids.

Landscape and biotic interactions influences on a declining European polecat population

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Keywords: *polecat; decline; habitat; rabbit*

The distribution of the European polecat (*Mustela putorius*) in Catalonia (NE Spain) has fallen below 10% of its historical range over the past 40 years. We studied the remaining populations for five years to identify the drivers of this decline and the key factors that determine their survival.

We deployed camera traps at 254 localities, using a 500m buffer around each camera location to characterize environmental variability. We also compiled the locations of 36 recent (<10 years) polecat road kills and generated 260 random points distributed along the local network of roads, characterizing environmental variability as for camera trap localities. Finally, we analyzed the content of the digestive tracts of ten dead polecats to identify consumed prey, chiefly by the identification of hair samples.

Almost 90% of the road kills and camera trap records were concentrated in coastal floodplains occupied by a heterogeneous mosaic of farmland, marshes and forest patches. Nonetheless, the detection of a few individuals in forested montane ecosystems corroborates the ecological plasticity of this species. Polecat presence tends to occur in non-protected, sparsely afforested lowlands with irrigation crops.

Although stomach content analyses showed that amphibians (ie aquatic prey) are a prominent prey for polecats, results of the camera trap survey suggest that the polecat might be excluded from major water courses through interactions with the invasive American mink (*Neovison vison*) and/or the Eurasian otter (*Lutra lutra*). Polecat presence was associated to European rabbits (*Oryctolagus cuniculus*), as well as to other rabbit predators, such as foxes (*Vulpes vulpes*) and badgers (*Meles meles*).

Artificial den boxes aid monitoring of pine martens and improve habitat in commercial forests

Johnny Birks^{1*}, John Martin², Lizzie Croose³, Gareth Ventress⁴

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⁴Forestry and Land Scotland, Inverpark, Dunkeld, PH8 0JR, UK

Keywords: *pine marten, den box, forestry, monitoring, habitat enhancement*

A long-running (2003 onwards) study in Galloway Forest Park in south-west Scotland has shown that pine martens (*Martes martes*) readily use artificial, tree-mounted den boxes for resting and breeding in commercial conifer plantations where natural, elevated arboreal cavities are scarce or absent (Croose et al. 2016). The need to establish a high density of den boxes (one per 2 km²) in a 10,000ha block of conifer plantations drove development of a lightweight design known as the Galloway Lite. Annual monitoring in May revealed typically 40-50% of boxes with evidence of recent occupancy by pine martens (up to 78% after severe cold weather). This study revealed 100% cumulative occupancy of 50 den boxes over a five-year period (2014 - 2019). Further design improvements led to the first record of a pine marten breeding successfully in a Galloway Lite den box in 2019. There are now 142 pine marten den boxes of two designs installed in Galloway Forest and checked annually for occupancy. Integrating these with routine forestry operations and avoiding offences under wildlife legislation requires good communication with forestry officers.

Systematic installation of den boxes in commercial forests has provided opportunities to monitor pine marten populations at various levels of invasiveness. There is some evidence that provision of a high density of den boxes in one part of the forest has maintained habitat quality for pine martens during a phase of intensive timber harvesting.

References

Croose E., Birks, JDS & Martin J. (2016). *Den boxes as a tool for pine marten Martes martes conservation and population monitoring in a commercial forest in Scotland*. Conservation Evidence 13, 57-61.

Polecats in Sweden: current, past and future

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Keywords: *Mustela putorius*; population status; monitoring

European or western polecat (*Mustela putorius*) populations are reported to be declining in a large part of its range, but good monitoring methods are lacking. In Sweden, the only available data comes from 1) (professional) hunters that report their bags to the Swedish Association for Hunting and Wildlife Management and 2) sightings data. Here, we used these data to quantify the current status of the Swedish polecat population and present an ongoing project where we are developing a new monitoring method to monitor Swedish polecats. Nationally, the number of reported polecats was constant from 1945-1987 after which there was a threefold increase from 1987-1993. From 1993-2017 the number reported decreased again to numbers similar to those prior to 1987. These fluctuations coincide with a decrease and subsequent increase in the red fox (*Vulpes vulpes*) population due to scabies in the same period. Analyses on county level indicate a northward expansion in recent years, which is in contrast to the overall declining trend in bag statistics since 1993. It is, however, unclear if this declining trend is a consequence of changed hunting practices or an actual response to the population size of polecats. The apparent northward expansion might be related to less harsh winter conditions in northern Sweden in recent years. To get better data on the status of the Swedish polecat population we started a monitoring project using camera traps in combination with hair traps to estimate polecat densities. So far, we have captured few polecats on camera and were unsuccessful with the hair traps, but we aim to continue our efforts. Our ultimate goal is to combine local density estimates from cameras and hair traps with national sightings and hunting data to estimate the population size of the Swedish polecat population over time.

The role of personality in wildlife translocations: lessons from a pine marten population reinforcement in Wales

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²Environment and Sustainability Institute, University of Exeter, Penryn Campus, Penryn TR10 9FE, UK.

Keywords: *personality, behaviour, translocation, reintroduction, pine marten, Martes martes*

Although conservation translocations are increasingly being used to reinforce or re-establish threatened species, the majority of translocations are ultimately unsuccessful. One factor that may compromise the outcome of translocations, but which has been largely overlooked, is the personalities of the animals involved, and how this affects their behaviour. Vincent Wildlife Trust's Pine Marten Recovery Project provided the opportunity to study the personalities and behaviour of 19 pine martens during their translocation from Scotland to Wales. Results suggest that there is variability in the exploratory tendencies of individual pine martens. This variability has been quantified from observations and sampling during the translocation process, and suggests that a) we are able to quantify the exploratory behaviour of individuals before they are trapped, and b) this variability is reflected in the pine martens' response to captivity during soft release, and affects the degree to which they disperse in the immediate period following their release at the recipient site. We discuss the implications of this for future translocation attempts.

New records reveal a wider range of the steppe polecat *Mustela eversmanii* in Romania

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Keywords: *steppe polecat, distribution survey, roadkill*

The steppe polecat (*Mustela eversmanii*) is a mustelid with Palearctic distribution, its range stretching from Mongolia and China to Central Europe. On its vast range the species occurs in a variety of habitats, however chiefly favouring open areas. In the steppes and forest-steppes of Europe two distinct populations (also described as separate subspecies) are found, their distribution range being disconnected by the Carpathians. While Romania holds both eastern and western populations, the status of the species here is rather obscure, and before the late 2000s most published material had treated this small carnivore as occurring exclusively in Dobrogea region.

Here, we review the distribution data of steppe polecat in all regions of Romania. Between 2006 and 2019, 103 records of the species' occurrence have been collected. This was predominantly achieved by conducting opportunistic or systematic roadkill surveys, and by interviewing field biologists and photographers. Forty-two percent of the records confirm the presence of steppe polecat east and south of the Carpathians, while 58% originate from the Carpathian Basin. Two thirds of all records are observations of roadkilled individuals, while the rest pertain to sightings or other observations.

Species identification was based on external traits, cranial features or, to a lesser degree, molecular markers. In most regions of the country, the species is sympatric with the European polecat *Mustela putorius*, excepting the Transylvanian Basin, where only the latter species is encountered. Even though the species' distribution map still exhibits vast white spots, this mustelid is expected to widely occur in all steppe and forest-steppe regions outside the Carpathians, albeit with varying abundance. At the same time, the value of roadkill surveys as a means of detecting steppe polecat should be further emphasized.

www.pinemarten.ie: using the internet to meet the conservation challenges of a recovering native carnivore

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Keywords: *pine marten, website; online, journalists, facts*

The pine marten population in Ireland has recovered from the brink of extinction in the 1970s to the situation now, where it is routinely observed by members of the general public. Despite being one of Ireland's few positive wildlife conservation stories, its recovery has been marred by misinformation and unsubstantiated claims about the animal's behaviour. These are presented as facts across print and online journalism and have impacted on the genuine issues faced by people as a result of the species' recovery. Two such concerns are its increasing use of attics as denning sites (due to a lack of suitable woodland habitat), and the necessity for game keepers (in Ireland primarily local gun clubs) to enhance existing game release pens to exclude pine martens.

In response to the need for a range of reliable material on the pine marten, we developed a website - www.pinemarten.ie - in partnership with the National Parks and Wildlife Service. This provides factual information targeted at four groups: Journalists; Householders; Gun Clubs and Poultry Keepers; and Foresters and Farmers. Journalists can use the website to easily access evidence-based data and licenced photographs when writing their articles. Individuals from the other three groups often have direct contact with the species, so the website contains instructions for reducing potential conflict during these encounters, as well as guidelines to improve habitat for the species. Additional information is provided on the marten's place in Irish history and folklore and the potential for ecotourism. Visitors to the site can also log sightings and leave queries.

We hope this national resource will address the needs of the public and help to lessen negative attitudes towards the pine marten, so that the recovery of this species will be viewed as a conservation success story in an age of biodiversity crises.

Colloquium Abstracts

Conservation of European Mink



Photo: Andrew Harrington

Conservation of the European mink – and lessons learned

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Keywords: *Mustela lutreola*, conservation breeding, Hiiumaa Island

The European mink conservation has a long history. It started in 1970s in Russia and is now going on with ups and downs in several European countries. In Estonia, the conservation actions date back to 1980s. The conservation breeding and establishment of secure island populations have been the core in its conservation. I review the process of conservation breeding and the establishment of wild population in Hiiumaa Island, but also research resulted from both. Finally, I come to lessons learned in the course of all this.

The critically endangered European mink in Spain: results of decade-long monitoring in the Ebro basin

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Keywords: *Mustela lutreola*; live-trapping, distribution area

Spain is one of the few countries where wild European mink are still present. The small population has remained in the north of the country in the Ebro basin, threatened by the invasive American mink. While the remarkable effort to eradicate the alien mink species undertaken in the last decade has proved successful in some rivers, the status of the European mink population has not been assessed consistently in over 15 years.

Here, we present data from live-trapping obtained in 2007-2018 in three regions (Álava, La Rioja, Aragón) to assess distribution and relative density of the European mink. The study area covers almost half of the current distribution area of the species, potentially reflecting the situation in the rest of the territories. Trapping campaigns were carried out for two purposes: (1) monitoring of the European mink and (2) eradication of the American mink. During monitoring, these three regions were surveyed at least twice (time intervals vary per region); the population trend was characterized by presence data and trapping efficiency index (ind. captured/100 trap-nights). Monitoring results were supplemented with data obtained from annual American mink eradication campaigns, where European mink were occasionally captured.

Results show a negative trend both in distribution and relative density in the European mink population in the sampled area. In border areas, the population remained either stable (Aragón), or showed signs of recovery after local eradication of the American mink (Álava). Overall, density was low in most rivers in both areas. In La Rioja, which represents the central part of the distribution area, a significant decline was detected following recent invasion of the American mink. Despite eradication efforts here, no signs of recovery have been observed yet. The results in the three sampled regions suggest that the Spanish European mink population is likely in decline.

New hope for the European mink in Spain: eradication of recently established American mink population in the Ebro river basin

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Keywords: *Neovison vison*, *Mustela lutreola*, mink raft, live-trapping

Spain currently holds one of the last wild populations of the critically endangered European mink. In recent years, the species' status has drastically worsened due to the invasion of the alien American mink. The impact of conservations measures (namely, culling campaigns) implemented since the early 2000s has been insufficient to stop the expansion of the invasive mink and the subsequent decline of the native species.

In 2014, as a part of the project LIFE LUTREOLA SPAIN (2014-2019), an experimental trapping campaign was carried out to compare the efficiency of two different methods: conventional (terrestrial) live-trapping and mink raft method. The use of mink rafts was determined to be approximately seven times more effective to capture American mink and, therefore, it was used as the principal method in eradication actions thereafter.

More than 1200 mink rafts (1 raft/1km of river) were installed between 2015 and 2017 in whole project area, 557 of which were placed in the European mink core distribution area, the Ebro river basin. As a result, the American mink was successfully eradicated in the area between 2015 and 2016. Our results show that eradication of the local American mink population can be a viable and achievable objective when both adequate trapping strategy and effective method (mink raft) are involved.

Does thwarted territorial behaviour explain ex situ abnormal behaviour during breeding season in the critically endangered European mink?

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Keywords: *European mink, abnormal behaviour, territoriality, ex situ breeding, conservation*

The conservation of the critically endangered European mink (*Mustela lutreola*) relies on successful ex situ breeding. However, a significant proportion of captive-bred males are not able to breed, with unsuccessful males behaving abnormally aggressive/passive towards breeding partners. Abnormal behaviours can arise from 'frustrated' natural behaviours within the constraints of captivity.

In the wild, male mink territories overlap with those of several females, with conspecific interactions occurring predominantly during the breeding season, when males actively search for females. We hypothesise that male European mink behave abnormally during breeding season because of frustrated motivations to either search, access females, and/or fight intruder males. To test these hypotheses, we recorded stereotypic behaviours (SB) - abnormal behaviours negatively linked to home size range, reproductive behaviour, and aggression in other carnivores - both during and outside of the breeding season. We recorded SB frequency, SB severity, and number & sex of neighbours within visual range of 79 mink (34 males, 45 females) during breeding season (ON) and of 83 mink (40:43) outside breeding season (OFF); 51 mink (25:26) were recorded both times. ON, males stereotyped more than females ($F_{1,75}=14.7$, $p<0.001$).

Furthermore, the more male neighbours, the more both sexes tended to stereotype ($F_{1,75}=3.08$, $p=0.08$). Male neighbour density also positively correlated with severity of males' SB ($F_{1,32}=5.35$, $p<0.05$). In contrast, OFF, there were no sex or neighbour sex effects on either SB levels or severity. Data from the same individuals recorded on both seasons revealed that both males and females were three times as likely to stereotype ON than OFF ($F_{1,49}=9.83$, $p<0.01$), with their stereotypies also being harder to interrupt ON ($F_{1,49}=11.22$, $p<0.001$). Our results suggest that male European mink SB might stem from frustrated territoriality; future analyses will determine whether SB predict levels of aggression and copulatory failure in this species.

LIFE VISON, conservation programme for the European mink in the Charente basin, a major project: presentation and first outcomes

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Keywords: *European mink, critically endangered, Life programme, conservation, Charente basin*

The European Mink (*Mustela lutreola*), small mustelid only present in wetlands, is one of the three most endangered mammals in France. Since 2011, the IUCN has listed this species as 'Critically endangered' at the national and global levels. In France, it was only present in 7 departments in the South-West at the end of the 20th century, but nowadays, the last populations seem particularly fragmented.

Habitat destruction, degradation and fragmentation, expansion of the invasive American mink, and road traffic collisions are the main factors which have led to the species' decline. The LIFE VISON programme, a five-year project, coordinated by the LPO, in partnership with the Charente-Maritime Departmental council and the GREGE, has been launched in September 2017 to respond to the immediate threats that the European mink face in its last stronghold area in France: the Charente basin. This territory remains a strategic area for priority conservation actions as it is still free of American mink population.

The main objective of the project, which fits with the National Action Plan actions with a more complete implementation, consists on maintaining and, ideally, increasing the European mink population in the Charente basin. More specifically, this programme will enable to enhance knowledge about the species in this area (current distribution, breeding areas), to limit the causes of mortality, to increase the availability of suitable habitats and to integrate this species' conservation within the local management policies.

The development of innovative detection, management and conservation techniques is then a significant component of this programme: footprint tunnels, baited equipment, telemetry tracking, underpasses restored on existing bridges and management measures for the European mink. Thus, initial data from this detection equipment deliver very valuable information about the detectability of the species and other mustelids that occur.

Colloquium Abstracts

Research Methods



Photo: Frank Greenaway

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Keywords: *semi-aquatic mustelids, freshwater biodiversity, mustelid conservation*

Freshwater biodiversity is declining at much higher rates than that of terrestrial and marine environments. In this presentation, I summarize the main drivers of biodiversity loss in freshwater ecosystems and how their relative importance has changed through time. I then relate the resulting changes with the distribution and ecology of semi-aquatic mustelids, namely otters and minks. I will describe threats for mustelid conservation, but also complex situations in which pervasive drivers of freshwater biodiversity loss are not necessarily negative for mustelids living in freshwater environments as well as others in which mustelids are themselves drivers of change.

Comparing the efficacy and cost-effectiveness of sampling methods for estimating population abundance and density of a recovering carnivore: the European pine marten (*Martes martes*)

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Keywords: *pine marten, population abundance, population density, non-invasive, trapping*

Many methods are available to gather data on wildlife population parameters, such as population abundance and density, yet few have been compared or validated. We compared the efficacy of three survey methods (live trapping, hair tubes and scats) for estimating abundance and population density of the European pine marten (*Martes martes*) in Galloway Forest, Scotland. We evaluated these methods by, firstly, comparing the accuracy of the population estimate derived from each method and, secondly, comparing the financial cost of each method. Molecular analysis of samples from all three methods was used to determine sex and individual genotype. Population abundance estimates were derived from capture-recapture programme Capwire. The non-invasive methods (hair tubes and scats combined) detected 81% of known individuals, although hair tubes and scats performed poorly alone, detecting 48% and 52% of individuals, respectively. Live trapping was the individual method that detected the most individuals (77%). Hair tubes were the most expensive method, both in financial cost and personnel hours, whilst scat sampling was the cheapest method. There was a highly significant association between the sex of the animal and the total number of detections by method. The population abundance estimate from all methods combined was 32 (95% CI 31-35) and the population density estimate was 0.27 martens/km². This study indicates that a combined sampling approach comprising hair tubes and scats maximises the number of detections and provides a viable alternative to invasive live trapping.

What does metabolomics say about Neotropical Mustelids?

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Keywords: *chemical ecology, Carnivora, Brazil, Mustelidae*

Chemical signs act on a wide range of intra and interspecific interactions (Wyatt 2014). In mammals they consist of a complex mixture of volatile and non-volatile compounds. The latter are associated with territorial marking and resource use due to their continuous signaling capacity (Alberts 1992). Chemical profiles from non-invasive biological material, such as feces, have great potential to contribute to ecological knowledge, mostly for species showing elusive behavior or low population densities (Saraiva et al. 2014). Using Neotropical Mustelidae as model we developed a non-invasive methodology for species identification, as well as to investigate the chemical diversity of non-volatile components in fecal samples. We collected 75 fecal samples from captive individuals of four mustelids occurring in Brazil: *Lontra longicaudis*, *Eira barbara*, *Galictis cuja* and *Galictis vittata*; these were analyzed by liquid chromatography coupled to high-resolution mass spectrometry. Multivariate data analysis (PCA, PLS-DA and HCA) successfully discriminated the three genera, revealing a chemical similarity between the species of *Galictis*. We identified over 100 compounds in the fecal samples, including bile acids and food components. Our results suggest that chemical profiles from non-invasive fecal sampling allow species-specific identification within the *Mustelidae* and potentially within the *Carnivora*, allowing fast confirmation of the presence of rare or elusive species, contributing for better supported wildlife management plans.

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Otterly delicious: investigating the diet of the Eurasian otter (*Lutra lutra*) using high throughput sequencing and stable isotope analysis

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Keywords: diet, high-throughput sequencing, *Lutra lutra*, stable isotope analysis

Generalist opportunistic predators feed on a broad range of species, making studying their diet difficult. One such species is the Eurasian otter (*Lutra lutra*), an apex predator in freshwater habitats, which has a diet that varies over a range of spatio-temporal scales (e.g. seasonality and coastal proximity) and is thought to largely reflect prey availability. Previous dietary analyses have focused on microscopic identification of hard remains in spraint or stomach contents. This can misidentify or fail to detect prey species if hard-parts are lacking (e.g. lamprey and earthworms), prey are only partially consumed (eg large salmon) or hard-parts are cryptic (eg Cyprinidae).

Spraint studies also often lack individual information, therefore neglecting niche separation between groups (eg sex/age-class) and individual specialisation. To overcome this limitation, we collected faeces and vibrissae from 300 otters post mortem, sampling from across England and Wales over a ten-year time period (2007-2016). High-throughput sequencing on DNA extracted from faecal samples was conducted to provide greater resolution for species consumed, whilst stable isotope analysis of vibrissae was used to show broad scale variation in diet and individual specialisation. Here we present our findings for otter diet and how it varies across spatial, temporal and biotic variables.

Further investigations will expand on this study by analysing high-throughput sequencing and stable isotope data alongside contaminant data to investigate how trophic pathways may interact with contaminant acquisition in a top predator of aquatic ecosystems.

Who is present? – individuality in call structure of the Eurasian otter (*Lutra lutra*)

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Keywords: *bioacoustics, monitoring, Mustelid, animal behaviour*

In conservation management, the knowledge about abundance and presence of a species is crucial. However, the monitoring of elusive species is challenging. An approach to survey such species can be through acoustic means where calls can be extracted and assigned to individuals. The survey of the cryptically living Eurasian otter (*Lutra lutra*) is so far relying on indirect observations, such as spraints and tracks. In this project we use the novel approach of passive acoustic monitoring for otters. For this, the calls of 12 otters harboured in Swiss zoos and wildlife parks have been recorded using stationary recording devices. Over 500 calls were recorded, with whistles and cries being the most common call types. Preliminary acoustic analyses suggest that the Eurasian otters show individual differences in the fundamental frequency of their loudest whistle calls, being transmitted over several 100 meters. The results indicate a potential for acoustic monitoring of otters in the wild, thus complementing the existing survey methods.

In-vivo, x-ray imaging of mustelid reproductive biomechanics

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Keywords: *morphology, baculum, copulation, imaging, Mustela*

The baculum (os penis) is a mineralized bone located in the glans penis of nine orders of mammal and has been shown to be under direct sexual selection (Stockley et al. 2013). Mustelids possess well-developed bacula characterised by wide variability across the group, ranging from slender, rod-like bone to more complex overall shapes, yet the biomechanical role of the baculum during mating remains unclear. We present the first attempt to quantify the 3D kinematics of non-human mammal genitalia during copulation using the domestic ferret, *Mustela putorius furo*. We capture the motion of the pelvic girdle and baculum using a live biplanar x-ray imaging system.

Ferrets were chosen due to their relatively large, well-defined baculum, predictable breeding season and well-established husbandry practices. Individuals were housed at a BIAZA-accredited zoo (Williamson Park, Lancaster) in suitable groupings throughout their natural breeding season. Males were vasectomised to ensure no offspring occurred following experimental matings. Ferret pairs were mated inside a customised Perspex enclosure. Biplanar x-ray videos (25 Hz) were captured at short intervals throughout the extended phase of copulation and synchronised with two standard light videos collected continuously. Preliminary analyses suggest the in-vivo motion of the male baculum is readily discernible from biplanar footage. Baculum motion appears more tightly coupled to the male pelvis than female, suggesting movement of the bone within the vaginal tract. During periods of mate-guarding, the baculum remains quiescent relative to the female.

A better understanding of the in-vivo kinematics of ferret genitalia will resolve the longstanding debate regarding the biomechanical function of the carnivoran baculum, and the specific mechanics adopted used to encourage ovulation/fertilization. This work will complement the field of mammalian reproduction and inform captive breeding programmes for similar species in the future.

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Going the extra mile: GPS tracking reveals the extent of movement during badger dispersal

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Keywords: *Meles meles*, dispersal, GPS tracking, tuberculosis, disease transmission

European badgers (*Meles meles*) are implicated in the spread of bovine tuberculosis to cattle and act as a wildlife reservoir for the disease. In badgers, only a minority of individuals disperse from their natal social group. However, dispersal may be extremely important for the spread of TB, as dispersers could act as hubs for disease transmission.

We monitored a population of 139 wild badgers over seven years. GPS-tracking collars were applied to 80 different individuals. Of these, we identified 25 dispersers. Thirteen badgers were wearing collars as they moved, allowing us to describe the process of dispersal in much greater detail than ever before.

We show that dispersal is an extremely complex process, and measurements of straight-line distance between old and new social groups severely underestimate how far dispersers travel. Such assumptions of straight-line travel also underestimate the potential for direct and indirect interactions and opportunities for disease transmission. For example, one female disperser that eventually settled 1.5km from her natal territory travelled 308km and passed through approximately 22 different territories during the dispersal process. Knowledge of badgers' atypical ranging behaviour during dispersal is crucial to understanding the dynamics of TB transmission, and for designing appropriate interventions, such as vaccination.

Colloquium Abstracts

Ecology and Evolution



Photo: Frank Greenaway

Towards a worldwide risk assessment of road-related impacts on mustelid species

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Keywords: *Belt and Road Initiative, landscape connectivity, population depletion, road ecology, roadkill*

Transportation infrastructures, especially roads, are the most common man-made infrastructures in the world, spreading over almost all its surface. Despite their value to human life and economic development, roads can be responsible for significant and deleterious impacts on biodiversity, of which roadkill is probably the most visible and significant one. Mustelids are no different in this respect, with some species being heavily impacted by the negative effects of roads.

In this presentation, I briefly summarize current knowledge of Road Ecology in Mustelids and emphasize the need for a global risk assessment of road-related impacts on these species. I present a methodological approach to this assessment and its main results, distinguishing areas with high/low conservation value and high/low exposure to road effects. Overall, Eastern Europe, Northeast Asia, and North America are the three regions where the highest risk areas are concentrated. These three regions contain large areas where high conservation value and high exposure to roads overlap, suggesting that they should be prioritized in road mitigation management. However, together with South America and Central Asia, they also encompass areas where high conservation value is threatened by the largest wave of infrastructure development, the China's Belt and Road Initiative.

Such massive growth of linear infrastructures requires a careful planning of transportation development, particularly in more sensitive areas. I end up discussing ways to prioritize road mitigation areas as well as ways to improve the planning of new transport infrastructure in areas that are important for conservation.

Phylogeography and population genetic structure of the European polecat (*Mustela putorius*)

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Keywords: *European polecat, phylogeography, mitochondrial DNA, microsatellites, glacial refugia*

It is now well recognised the impact of the Pleistocene glacial cycles on the phylogeographic patterns and their role in shaping present-day range distributions and genetic diversity of several taxa. Here, we provide a detailed study of the phylogeography and population genetic structure of the European polecat (*Mustela putorius*), using a 506-bp fragment of the mitochondrial DNA and 12 microsatellite loci from 480 individuals sampled across 26 European countries.

Our results revealed a complex phylogeographic history for this species with Mediterranean and non-Mediterranean glacial refugia contributing differently to the recolonisation of central and northern Europe. We found evidence that the Iberian and Italian peninsulas acted as glacial refugia for the species, with Iberia exhibiting a pattern of 'refugia-within-refugia', but apparently neither of these populations contributed to the post-glacial recolonisation of northern territories. Instead, central and northern Europe seem to have been recolonised by polecat populations that survived in glacial refugia situated in south-eastern and west-central Europe.

The two waves of post-glacial recolonisation meet and form a contact zone in central Europe. Analysis of genetic structure identified five main polecat groups in Europe, which correspond largely to five biogeographical regions, and we argue that these groups should be considered in future conservation and management strategies.

Seasonal coat colour polymorphism in the least weasel: dissecting the evolution of a locally adapted trait

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Keywords: *Mustela nivalis*, population genomics, local adaptation, climate change

Seasonal colour change from summer-brown to winter-white coats is a remarkable adaptation to seasonality in snow cover, which allows the maintenance of camouflage year-round. This is an important phenological trait of over 20 vertebrate species, including three mustelids. However, snow cover decreases induced by climate change lead to coat-background colour mismatches, making winter-white individuals conspicuous on snowless backgrounds.

The disruption of camouflage is predicted to result in higher mortality rates, which may endanger the survival of these boreal populations. However, the existence of intraspecific polymorphism of winter coat colour, with winter-brown individuals occurring in regions with less snow, may provide the necessary standing variation to allow rapid adaptation to the changing climate.

In this work, we study the genetic basis and evolution of winter coat colour polymorphism in the least weasel (*Mustela nivalis*). In Europe, two colour morphs exist, with populations presenting either white or brown winter coat colour and transition zones where both morphs coexist. Whole-genome sequencing data was generated from samples covering two transition zones, in Sweden and Poland, to dissect the genetic basis of winter coat colour polymorphism. We conduct genome-wide scans of association and natural selection to map candidate genomic regions to underlie the alternate winter morphs, in the context of the population evolutionary history. Our results dissect the evolution of this crucial adaptive trait, which may prove fundamental to promote the conservation of the species facing climate change.

Spatial variation of density in a social and widespread species: the relative role of sett density and social group size in European badgers

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Keywords: *camera trap, genetic, group size, Meles meles, population density*

Population density is a key parameter in both fundamental and applied ecology, as it affects population resilience to density-dependent and stochastic events (Saether 1997). Deriving efficient management measures (eg disease and pest control) or species conservation program thus require accurate estimates of population densities and their spatial variations (Lawton 1993), especially for continuously distributed species.

Here, we aimed at determining European badger (*Meles meles*) local densities using a standardized combination of non-invasive methodological approaches in 13 contrasted sites across France. We estimated sett density using distance sampling, through walked transects surveys in suitable habitats for badger settlement. We determined the mean social group size of badgers per complex of neighbouring setts, using camera trapping and hair trapping for genetic identification. We then derived a composite estimate of population density based on sett complex density, social group size and the proportion of occupied sett complexes.

Over all study sites, the sett complex density ranged from 1.50 to 6.83 per km², the social group size ranged from 1 to 11 badgers, and the proportion of occupied sett complexes ranged from 0.25 to 0.89. Therefore, adult density ranged from 0.99 to 7.81 per km² and was mostly dependant of sett complex densities, while social group size and proportion of occupied sett complexes were poorly related to adult density. In addition to these endogenous factors of variation, forest fragmentation also explained the spatial variations of population density.

Besides the ecological implications of these results, we further discuss them in light of the ecological importance of badgers in bovine tuberculosis (bTB) transmission, which has been found in cattle and badgers in France (Payne et al. 2013). These results can guide management of badgers in France, and highlight the importance of good estimates of population density to investigate host-parasite relationship in the context of bTB.

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Free movement across borders: extra territorial excursions by European badgers in a medium density population

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Keywords: *European badger, movement ecology, contact networks, tuberculosis*

European badgers (*Meles meles*) in medium and high density populations show strong territorial behaviour. Territories in these populations are contiguous, well-marked and often unchanging over many years. However, badgers do not always stay within their territorial boundaries. In our medium-density population, most individual badgers made extra-territorial excursions (ETEs) throughout the year (from 59% in December to 100% in September). ETEs were most frequent between April and September and least frequent in December and January (the period of winter lethargy). Male badgers made longer and more frequent ETEs than females (especially between January and March, and in autumn). Breeding females made longer ETEs than non-breeding females in late autumn. While these peaks correspond with the main mating seasons, it does not explain ETEs throughout the year. The shorter, but more frequent, ETEs in summer months may serve a monitoring purpose, rather than simply providing additional mating opportunities with badgers from outside the 'home' social group.

We discuss these findings in relation to current hypotheses regarding territoriality in badgers. In addition, we found that young badgers did not make regular ETEs until the summer of their second year. If badgers could be vaccinated as cubs, this would reduce any potential risk of TB spread during ETEs.

Population genetic changes during recolonisation of the UK by the Eurasian otter (*Lutra lutra*)

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Keywords: *population expansion, spatial, temporal, DNA, Lutra lutra*

Anthropogenic pressures have caused many species to experience dramatic population declines in the 20th century. Some of these populations are now recovering due to effective protective legislation. According to population genetic theory, as populations expand and fragmented populations re-connect, it is predicted that genetic diversity will increase and genetic structure will decrease as gene flow among sub-populations is re-established. Empirical studies are, however, rare particularly for populations at large spatial and temporal scales.

Re-expansion of the Eurasian otter (*Lutra lutra*) in the UK, following a severe decline, is associated with changes in water quality and protective legislation, provides an excellent natural experiment to test these predictions of population genetic theory. Here we present findings from the temporally and spatially most comprehensive study of UK otter population genetics to date. Otters in the UK exhibit spatial genetic structuring which reflects the known population history of stronghold areas and population reinforcement via captive releases. To explore population structure changes over time during re-expansion, we genotyped tissue from over 400 road-killed otters spanning 20 years (1994 to 2014) at 15 microsatellite loci.

Our results provide a rare empirical case study that describes changes to genetic diversity over time and space in an expanding carnivore population in the UK. Despite increases in both otter presence throughout the UK and gene flow between regions, we find that historic population genetic structure persists. This highlights that spatial connectivity is not indicative of genetic connectivity, providing essential information which could be applied to the monitoring and management of the many large carnivore species currently recolonising extirpated landscapes.

Colloquium Posters



Photo: Frank Greenaway

European badger and stone marten's contrasting response to different management regimes in a Mediterranean landscape

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Keywords: *Montado, mustelids, management options, occupancy modelling*

Land cover changes and management activities are expected to influence mustelid species. Nonetheless, the human activities of the traditional montado create heterogeneity that might be beneficial (Rosalino et al. 2009). In these systems, agricultural and forestry practices, livestock production and anthropogenic disturbance affect species occupancy. Our goal was to test how different management options might affect the mustelids' occupancy and abundance, using as a proxy intensity of use.

Therefore, we compare two ecologically similar areas with distinct management regimes, at a local scale. Campo de Tiro (CT) is a military unit dominated by cork oak montado and the main anthropogenic activities are localized military operations (eg aerial shooting and bombardment). Companhia das Lezírias (CL) is next to CT and the habitat matrix is composed by cork oak montado with different shrub densities, interspersed with patches of pine and eucalyptus stands. The management for agriculture, forestry and cattle raising creates a heterogeneous and complex mosaic.

We hypothesize that 1) the landscape heterogeneity resulting from the management activities in CL promotes higher resource diversity resulting in a more diverse and abundant carnivore community; specifically, 2) European badger is more abundant in the mosaic landscape of CL but avoids areas of cattle raising (Mullen et al. 2013) and 3) the stone marten avoids permanent human disturbance in CL (Santos et al. 2010), being more abundant in CT.

Given the two areas are ecologically similar, differences between carnivore communities are probably due to contrasting habitat management. As hypothesized, habitat variables were more relevant at CL, while at CT disturbance variables were the main predictors of habitat use. The European badger was more abundant at CL but positively associated with cattle and wild boar. The stone marten was more abundant at CT, with higher occupancy at montado and eucalyptus patches.

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Monitoring and status of the Eurasian otter (*Lutra lutra*) in Denmark 2004-2017

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Keywords: *Eurasian otter, monitoring, DNA, conservation status, Denmark*

A systematic monitoring programme for species listed on the EU Habitat Directive, including the Eurasian Otter (*Lutra lutra*), was initiated in 2004 in order to provide an assessment of their conservation status. The otter suffered serious declines in Denmark during the 1960s and 1970s. A series of conservation actions were initiated to protect the remnant population, including a management plan for the otter in Denmark in 1996.

The recovery of the otter in Denmark was described by six national field surveys since mid-1980s. The surveys document a substantial increase in range and the otter now occupies the whole of mainland Jutland - reflecting an increase in population size as well. DNA analysis of spraints found in 2011 and 2017 documents that otters are recolonizing the island of Funen in the middle of Denmark.

On the island of Zealand in eastern Denmark a survey in 2006 conducted by NGO - including many kilometres of coherent watercourses - showed the presence of otter on several localities. However, in 2017, the used standard method for the first time was able to prove the presence of otter here. This may indicate an increase in the local populations of otter, as it is well known, that the standard method is not suitable to detect small and fragmented populations (Madsen & Gaardmand 2000).

The 2017-survey shows that status of the otter population in Denmark has improved significantly since the 1990s and all suitable habitats in mainland Jutland are now occupied by the species. In parallel with the expansion of the otter in Denmark, DNA analysis of otter carcasses in North Germany and from neighbouring populations in Denmark and eastern Germany shows that the Danish otter population is no longer isolated (Honnen et al. 2011).

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The European mink in France – current knowledge and conservation strategy

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Keywords: *European mink, Mustela lutreola, conservation, distribution*

European mink (*Mustela lutreola*) is one of the most threatened mammals in Europe. One of the last five populations is still present in France (<250 individuals) but dramatically decreasing (ONCFS, 2018). Because of the major role of France in its conservation, action plans have been implemented since 1999 by the ministry of ecology.

Since 2015, DREAL Nouvelle Aquitaine have managed a new plan (DREAL and ONCFS, 2015). ONCFS and the NGO Cistude Nature implement actions, classified in three objectives: i) updating the European mink distribution, ii) coordinating fighting programs against threats (American mink competition, road kills...) and iii) leading a conservation breeding strategy. At the same time, the NGO LPO and the research office GREGE have implemented a European Life program 'VISON' since 2017. It is a tool to support and go further in conservation actions in the centre of European mink distribution: the Charente basin.

The poster presents preliminary results of actions led during previous action plans (ONCFS, 2019) and the Life program, and perspectives for the future plan 2020-2030:

- A prospection programme has been initiated in October 2016 (533 campaigns; 1 campaign = 10 active traps during 10 nights). On 31 March 2019, 65% of the planned campaigns were realized. Twelve campaigns allowed 35 captures of at least 12 individuals in two areas of the Charente basin.
- The distribution map of American mink, published in 2015, was used to define a culling programme. From winter 2016-2017 to the end of 2018, we deployed 466 traps in areas of putative presence of both minks. Eight individuals were caught. The 2019 data will be available soon.
- In 2014, the breeding centre was built in the zoological garden Zoodyssée. The first individuals arrived in 2015 from other centres of the EEP. We observed first reproduction behaviours in 2019.

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Impact of mustelid predation on birds' breeding success: is predator control still a valuable management tool?

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Keywords: *Mustelids, predation, birds, mesopredator release*

The removal of most top predators from vast land areas has brought about a mesopredator release from which mustelid species have benefited. The population dynamics of the mustelids has since become mostly resource-driven (constrained by habitat and prey availability), following the disappearance of top-down control. Here, based on a bibliographical review, we expose the predation risk caused by mustelids on their prey species, especially during years of low rodent density. Hence, clutches of ground nesting birds are easy targets for mustelids, but the latter can also access nests located up in trees, especially cavity nests.

While mustelids have been reported to be the main nest predators of common goldeneyes and Tengmalm's owls (Sonerud 1985), they can also dramatically affect the breeding success of western capercaillies (Moreno-Opo et al. 2015), northern lapwings and godwits (Teunissen et al. 2008). This can have long-term consequences on small philopatric populations that, despite a poor breeding success, will return to the same breeding area every year, which then turns into an ecological trap. Since reintroducing top predators to regulate mesopredators does not seem appropriate in our anthropogenic systems, we propose that the conservation of prey species should also be considered where mustelids benefit from conservation plans.

By encompassing the different rungs of the trophic network in a greater conservation scheme, we hope that all species could benefit from combined management strategies that include habitat restoration, changes in agricultural practices and, if necessary, predator deterrence or control methods (Moreno-Opo et al. 2015).

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Spraint DNA analysis reveals the secret life of the Eurasian otter in the Peak District National Park

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Keywords: *Eurasian otter, non-invasive, population size, spraint DNA analysis, territory sizes*

Otters are slowly returning to the England after crash in the 1980s caused by pollution, which destroyed habitats and ecosystems. Otters are still rare in northern England and this, alongside their nocturnal and elusive behaviour, makes them difficult to study. We therefore used non-invasive microsatellite profiling of individuals using the DNA in their spraints to study otter numbers and movements.

Approximately 50 km of waterways in the Peak District were surveyed for signs of otters between April 2018 and April 2019. Cameras were set up at sprainting locations. Spraint and anal jelly samples were collected. Video records were used to identify the species and age of the sample since fresh spraint should give higher DNA yields. The spraint DNA was expected to be degraded so microsatellite markers were redesigned to amplify small fragments.

Over 100 video clips of otters were recorded and 150 samples collected. The majority of film clips were of single otters, however, occasionally two otters were seen together. In March 2018 an otter and single cub was filmed. This was the first evidence of otters breeding in the peak district. The otter mother and cub were filmed multiple times during nine months and spraint collected multiple times that belonged to the mother based on video footage. When two adult otters were recorded, they were normally peaceful but two otters were recorded fighting on one occasion.

One hundred and fifty samples were genotyped with seven microsatellite markers in triplicate and a consensus genotype created. Analysis of the genotypes will reveal the numbers of otters in the area studied and their movements through the Peak District during a year. We will compare movements to seasonal prey availability and mating activity.

Massive predation on exotic carps carried out by otters (*Lutra lutra*) in an urban park in the Costa del Sol (Málaga, Spain)

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Keywords: *otter, urban environment, common carps, Koi fishes, summer predation*

Between 2017 and 2018 we monitored the survival of two populations of carps released in two ponds in an urban park in the municipality of Benahavís (Málaga, Spain). The park was near to an area with otters (the Guadalmina River). Since these mustelids can use artificial ponds as pantries during the Mediterranean summer, we expected to find predation episodes. In the first pond were released 30 Common carps (*Cyprinus carpio*; 16 ± 0.5 cm head-tail sized; mean \pm SE) on first May 2017. In the second pond 35 Koi fishes (*Cyprinus carpio koi*; 72 ± 0.8 cm head-tail sized) were released on late April 2018. The park was fenced and one of the ponds (the one with Koi fishes) too. We used direct sightings and a photo trap set to monitor the ponds.

Predation during 2017 started in middle July and took up 148 days. Only two carps survived. Otters captured 89% of fishes. Predation on Koi fishes during 2018 also started in middle July. It took up 157 days (to the first of October). Otters were responsible of 100% of captures (up to 3 Koi during the same night). Ten Koi survived and it was because park managers decided to relocate them to other pond far away from the otter home range. We did not found rests of the Common carps eaten, but otters used to leave Koi fishes near the pond just after a few bites in the neck or eat only fat under the skin. Pond fence (1.5-meter-high) was not a barrier for otters. Our results confirm that summer drought drives otters to find food resources were available and that urban parks near inhabited areas and within the home range of these mustelids can be successfully exploited.

Monitoring weasels (*Mustela nivalis*) and stoats (*Mustela erminea*) with wildlife cameras

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Keywords: *camera trap, monitoring, time-to-event*

Up-to-date, objective information is fundamental for any active management of wildlife. Weasel and stoat are widespread in Europe, but the two species are notoriously difficult to detect and little is known about their status (Fehrmann 2016, Croose & Carter 2019). Camera trapping has become an important tool in ecological research, especially for monitoring rare and elusive species. We tested wildlife cameras as a operational method to monitor weasel and stoat.

Cameras were deployed for 1-2 month each season in seven study areas. The cameras were mounted 50 cm above ground on trees or poles and faced a small arena with low vegetation (Smith & Weston 2017). Cameras were placed along forest edges, streams, hedgerow, etc, in semi-natural habitats. Detections of a species within five minutes at a camera were considered as one event.

Twenty-six weasel and five stoat events were recorded during 5,536 camera trap days. Weasel and stoat were recorded at 19% and 4% of the camera positions. On average, we had 0.47 weasel event and 0.09 stoat event per 100 camera trap days. If multiple weasel or stoat events were recorded at a camera position in a survey session, they typically occurred within 1-3 days. The time to first record of a weasel varied from 2 to 53 days since activation of the cameras. Mean time to first detection was 25 days for weasels. Stoats were recorded after 15 to 55 days.

The detection rates of weasels and stoats were low with cameras, but the detection rates and identification were better than tracking tunnels (Fehrman 2016, Smith & Weston 2017). Camera trapping has potential for surveys but optimum placement is probably crucial. The detection rates and time to first detection with the cameras were equivalent to recorded with box-camera-traps (Croose & Carter 2016).

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Post-bottleneck European polecat populations show high degrees of genome introgression

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Keywords: *European polecat, domestic ferret, introgression, hybridization*

The domestic ferret (*Mustela putorius furo*) was domesticated from the European polecat (*M. p. putorius*) around 2,500 years ago, probably to hunt rodents and small game. The European polecat is a widespread carnivore of much of the Western Palearctic. Once common across much of the United Kingdom, by the end of the 1800's persecution found it restricted to a small refugia in central Wales. At the same time, domestic ferret started to establish feral populations across the UK. Since then, legal protection has allowed the polecat to expand its range and is now found across much of its former territory. During this range expansion, European polecats came into contact with feral domestic ferret and hybridised.

Here we use whole genome sequencing to examine the degree of genome introgression in both the hybrid populations and (phenotypically) British European polecats. We compared the genomes of European mainland polecats, British polecats, domestic ferrets and polecat-ferret hybrids to compare the degree of genome introgression within and between populations. We find that the degree of introgression varies between hybrids and that phenotypically wild British polecats (even those close to the original refugia) show genome introgression with domestic ferrets, whereas European polecats from mainland Europe do not.

Eurasian otters as 'urban adapters': diet variation along a forest-urban environmental gradient on the River Segura (SE Spain)

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Keywords: *feeding habits, urban areas, alien species, Lutra lutra*

As human population spreads, a growing number of carnivorous mammals will come into contact with anthropogenically altered landscapes (Bateman and Fleming 2012). While some generalist, behaviourally flexible mustelids currently live successfully in farmland and suburbs, relying on pet food and synanthropic prey, Eurasian otters (*Lutra lutra*) generally avoid human settlements and usually do not use anthropogenic resources. Nonetheless, ongoing otter recovery and spread of urban areas are resulting in increasing otter presence close to human settlements, where freshwater fish assemblages have been deeply altered by the combined effects of pollution and introductions. The otter has shown to be capable of adapting to anthropogenic changes in food availability, although diet shift may entail naïve threats, such as microplastics (Smiroldo et al. 2019).

Flowing through one of the driest European areas, the River Segura crosses a diversity of habitats, from forests to agricultural and urban areas. Currently the otter is reported for a 230 km long stretch of the river and steadily occurs in the metropolitan area of Murcia. To explore otter ability to adapt to man-altered landscapes, we analysed and compared its diet, as assessed by the analysis of spraints collected in 2016-2018, in both forest (N = 310) and urban (N = 66) habitats.

No significant differences were recorded: in both 'natural' and urban areas otters mostly preyed on invasive alien crayfish (*Procambarus clarkii*) - percent mean Volume (%mV) = 48.1 and 37.3, respectively - and fish - %mV = 42.4 and 49.2 -, *Luciobarbus sclateri* being the most eaten fish species in both areas. Results suggest that introductions have altered prey availability throughout the watercourse, while otters have readily adapted to rely on alien species and can successfully thrive in altered landscapes.

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Eurasian otter response to habitat restoration: monitoring the success of LIFE RIPISILVANATURA (NE Spain)

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Keywords: *habitat management, alien species, Arundo donax, Lutra lutra*

Despite freshwater biodiversity constitutes a valuable and critical natural resource, rivers have experienced long-standing human pressures which have caused the impairment of aquatic habitats. The current spreading of exotic species is a major threat to these vulnerable habitats. One the 100 most dangerous invasive species worldwide, giant reed (*Arundo donax*), has progressively colonized the Mediterranean basin.

LIFE13BIO/ES/001407 RIPISILVANATURA (2014-2019) aims to control the giant reed in the catchment of the River Segura, by applying soft-engineering techniques. Till now, the effects of restoration actions have been tested using aquatic macroinvertebrates and birds as indicators of stream health (Bruno et al. 2018). Eurasian otter (*Lutra lutra*), being a top-predator of aquatic habitats, is particularly sensitive to the environmental variations, and may represent an effective bio-indicator.

To test for this hypothesis, from April 2016 to July 2018, we monitored 42 sampling stations (mean length \pm SD = 0.5 \pm 0.2 km) on a 110km long stretch of the river using the 'standard method' for otter surveys. Otter marking activity was expressed as percentage of surveys positive for otters (P%) and mean number of spraints/100m (MI). For each transect, 11 habitat variables potentially affecting otter distribution were recorded. P% kept constant (ca 80%) throughout the study period, while MI increased, on average, from 0.81 spraints/100m in 2016 to 0.88 and 1.25 in 2017 and 2018, respectively. Mean MI was higher in restored transects (1.2 spraints/100m) than in unmanaged stretches (0.75 spraints/100m), being inversely related to the percent cover of giant reed. Otters preferred stretches surrounded by natural vegetation, while tended to avoid polluted waters, supporting the effectiveness of ongoing habitat management.

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Wye otters: reflections of social and environmental change

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Keywords: *River Wye, Wales, Lutra lutra, population change*

The river Wye in mid-Wales has long been famed for its wildlife and landscape and has the highest European conservation designation. The otter (*Lutra lutra*), a key element in that designation, is the top predator on the river and as such reflects the cumulative changes within the riverine food chain. Historically, it lived in a river of such salmonid abundance that many poor families relied on salmon as their main protein resource with plenty left for a thriving otter population. Land use change leading to siltation of the salmon spawning grounds resulting in the loss of feeding resources followed by the effect of agrochemicals on otter reproduction resulted, on the Wye as elsewhere, in the species' decline. The recovery of the otter population has been well documented by regular survey complemented by postmortem analyses and the recovery has been accompanied by a greater awareness of the wider needs of the species as reflected in the provision of artificial holts and in underpasses etc, in new road developments.

A survey of European otter (*Lutra lutra*) presence and diet in Penwith, Cornwall

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Keywords: *otter; diet; spraint; Cornwall; Natura 2000*

Following the organochlorine pesticide-related decline of the European otter (*Lutra lutra*) in the UK since the 1950s, the species has been encouraged back to much of its original range by extensive conservation efforts, legal protection and designation of Natura 2000 sites. National otter surveys have monitored the success of these measures since 1977 (Lenton et al., 1979), but omitted Penwith in west Cornwall.

This study analyses the presence and diet of European otter in Penwith via surveys and spraint analysis. A diet analysis is completed by identifying prey remains in spraints and calculating the percentage frequency of occurrence to test the hypothesis that *Salmo* species [salmonids, comprising Atlantic salmon (*Salmo salar*) and brown trout (*Salmo trutta*)] are the prey group taken most frequently by European otter in Penwith. The results are compared with a similar dietary study of this species in the River Camel catchment, east Cornwall (Lowe, 2005) to explore the habits and ecology of European otter across the county. Penwith has a well-distributed population of European otter.

The hypothesis is proved, with salmonids constituting 50% of the diet and European eel (*Anguilla Anguilla*) (13%), bullhead (*Cottus gobio*) (8%), three-spined stickleback (*Gasterosteus aculeatus*) (7%), European perch (*Perca fluviatilis*) (3%), northern pike (*Esox Lucius*) (1%), common carp (*Cyprinus carpio*) (1%) and Eurasian minnow (*Phoxinus phoxinus*) (1%) constituting the remainder of the fish portion of the diet, which represents 84% of the diet overall. Crustaceans (8%), amphibians (5%) and mammals (3%) also constitute important prey resources. The significance of other factors such as anal jelly presence, mink, road casualties, anthropogenic disturbance and pollution are discussed in relation to other studies. Disturbance, pollution and mink presence were not seen to affect otter presence in Penwith. Road collision remains the species' main threat, and persecution is ongoing.

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Spatial mixing of mitochondrial lineages and greater genetic diversity in some invasive populations of the American mink (*Neovison vison*) compared to native populations

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Keywords: *American mink, mitochondrial genes, genetic diversity, native range, Iberian Peninsula*

The genetic characteristics of introduced populations have a relevant impact on their ability to establish and spread. The American mink (*Neovison vison*), native to North America, is an important invasive species in the Iberian Peninsula. Here, we used mitochondrial DNA sequences data to investigate the genetic diversity and phylogeographic structure of invasive versus native populations of this species. We also evaluated whether genetic diversity in invasive populations could be explained by the genetic characteristics of the native sources from which they derived. Phylogenetic analysis revealed two major lineages in the native range, which indicated a clear separation between western and eastern populations. On the contrary, we found no evidence of genetic structure in the invasive range. This was probably the result of the diverse origins of the released specimens and the rapid expansion and encounters of the introduced populations. We detected spatial mixing of both North American lineages in several sampling localities of the north central area of the Iberian Peninsula, giving rise to high levels of genetic diversity in some areas compared to North American populations. This could potentially lead to higher fitness of these individuals and thus increase the population viability and invasiveness of this species. These results point to the need to better study the populations in which lineages mix and, if necessary, intensify control efforts in them.

Not only predator – the importance of European badger (*Meles meles*) for ecosystem functioning

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Keywords: *badger, ecosystem engineer, plant, animal, diversity*

The European badger is known as a medium-size carnivore that plays an important role in prey-predator interaction with special focus on prey as earthworms and game animals. The badger is also known as an important vector in dispersal of seeds from fleshy-fruits. Nevertheless, the badger as predator plays many more relevant roles in ecosystem functioning. There are two special traits in its ecology that confirm it: food opportunistic strategy with great quantity of fleshy-fruits in the diet (Kurek 2015) and inhabiting of large and extensive burrows called setts that are that are their dwellings for many years where social life of badgers is focused. Therefore badgers setts are characterised by huge amounts of dug soils with spoil heaps at the sett entrances. It results in physico-chemical changes in soil properties and thus in different flora assemblages on spoil heaps. Setts are characterised by higher species diversity of vascular plants (13.8 species) than on adjacent and intact reference areas (8.2 species) (Kurek et al. 2014). Such changes concerns also other groups of plants and even soil invertebrate fauna (ie Rola et al. 2017). Bare ground among setts are convenient places for germination of seeds from fleshy-fruits transported here with faeces. Badger may disperse via endozoochory seeds of many fleshy-fruited plant species (Kurek 2015). Data mentioned above are best proof that the role of badgers in ecosystems are much broader than we expected on prey-predator interaction.

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Visual, olfactory and acoustic cues modify the inspection behavior of the environment in the European mink

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Keywords: *Mustela lutreola*, antipredatory response, behavior, noise disturbance, predator threat, signals

Antipredatory response to visual, chemosensory and acoustic signals from predators involves a compromise between survival and feeding or reproduction in the natural environment (Navarro-Castilla et al. 2019). However, selective pressure from predation is absent in captive individuals, leading to inhibition of certain behaviors that it would otherwise develop in natural habitat.

In this study we evaluated the behavior of 25 European minks in captivity, exposed to a visual stimulus (mirror) simulating a context of intraspecific competition; two olfactory stimuli (feces of real owl and dog) simulating risk of predation for two potential predators; and two acoustic stimuli (road traffic noise and community noise caused by human voices) corresponding to anthropogenic disturbances, in order to determine which factors influenced behavioral responses related to foraging. In order to do this, the frequency was recorded in which the individuals carried out inspection behaviors of the installation being subjected to the different treatments (olfactory and acoustic stimuli) according to the phase (visual stimulus: with and without mirror).

The inspection rate observed in the presence of visual stimulus was lower in females than in males, and this fact is probably because they avoid forced encounters with larger and more dominant males in non-breeding season (intersexual competition) (Zschille et al. 2010). Both sexes showed a similar inspection rate in control and olfactory stimuli while females significantly decreased their inspection rate in the acoustic stimuli as an antipredatory response to an unknown threat. Community noise was determinant by its own way being the inspection rate very low in both phases. These results should be taken into account in future reintroduction projects to reduce mortality due to predation.

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A spotlight on mustelids of the Southern Mongolian Forest

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Keywords: *Mustelids, Mongolia, hotspot*

Little is known about the mustelids status and distribution in Mongolia: twelve native species occur in the country (Batsaikhan et al. 2014). Only *Martes zibellina* is locally threatened, while the data related to the most of the species are deemed deficient (Clark et al. 2006). Between August and October 2018, a camera trapping survey was conducted in the Khangai Nuuru National Park, which hosts the southernmost forest, in Mongolia. The study area includes forest patches, grassland and alpine vegetation above the tree line.

We sampled approximately 60 km², displaying 40 camera traps in front of mid-large carnivores marking points and animal trails, keeping a minimum distance between cameras of 800 m. The results demonstrated the area provides a rich carnivore guild with a surprisingly high density of mustelid species, other than canids and felids (five other species). In fact, on a minimum explored area of 15 km², seven species were detected, the 58.3% of those occurring in the country. The species list includes: *Gulo gulo*, *Martes foina*, *Mustela eversmanni*, *Meles leucurus*, *Mustela sibirica*, *Mustela erminea* and *Mustela nivalis*. Furs from all of them have been found in the herders' houses, as well as in markets and shopping malls of Ulaanbaatar, underlying the strong hunting pressure still present.

The study area can be considered a mustelid hotspot due to the high density in a such limited area (which should host also *Mustela altaica*). The high variety of mustelid species could let infer an intraguild low competition, probably related to the differences in body size, food specialization and largely differentiated prey availability (eg Aunapuu & Oksanen 2003). We strongly encourage a study aimed to assess the status and the conservation effectiveness of mustelids in the Central Mongolia, to address local institutions towards the proper protection actions.

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The Mostela: an adjusted camera-trapping device, a promising monitoring tool to study common weasel (*Mustela nivalis*)

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In many countries, the population status of weasel (*Mustela nivalis*) and stoat (*Mustela erminea*) is uncertain due to the difficulty of monitoring these species. In our study area near Dieren, the Netherlands, we tested the efficiency of a recently developed camera-trapping device, the Mostela, as a new monitoring technique for small mustelids. During March - October 2017 and February - October 2018, we placed Mostelas in linear landscape features and other microhabitats thought to be frequented by weasels. We tested for yearly and seasonal differences in trapping rate and detectability using an occupancy-modelling framework.

We found:

- 1 a higher trapping success and naïve occupancy in 2017 than 2018;
- 2 a clear difference in detection probability between seasons;
- 3 the highest detection probability in summer 2017 and autumn 2018.
- 4 that in summer and autumn a Mostela placed in the field for 2 weeks gives a 95-98% probability of detecting a weasel if the species is present in the micro habitat;
- 5 that the Mostela technique generates useful ecological data on activity patterns and recognition of individual weasels.

Concluding, the Mostela shows great promise as a monitoring tool to study the occurrence and ecology of common weasels. Further development of individual recognition from images would enable using the Mostela for density estimates applying spatially-explicit capture recapture.

Distribution of the alien fish in the diet of the Eurasian otter (*Lutra lutra*) in the south-western Poland

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Keywords: *carp family, fisheries farm, spraints, stone moroco (Pseudorasbora parva)*

The aim of the study is to present the distribution of the alien fish in the otter diet in three fish farms (FF) located in south-western Poland: Fish Farm 'Przyborów' (Wisniowska 1996), Fish Farm 'Zator' (Wisniowska 2002) and Fish Farm 'Potasznia' (Orłowska and Frankowska 2013). The study was conducted in October 1993 to March 1994 - FF 'Przyborów', October 2000 to March 2001 - FF 'Zator' and October 2008 to March 2009 - FF 'Potasznia'. The otter spraints (*Lutra lutra*) were collected in the study areas: 211, 489 and 202, respectively. Particular vertebrate preys were identified in the laboratory through the characteristic parts of skeletons. Fishes were present in 94.3% (FF 'Przyborów') to 100% (FF 'Potasznia') of spraints. RFO for the carp family (*Cyprinidae*) was 65.5% - FF 'Przyborów'. The breeding species (ie carp and tench) occurred in 21.8% and 8.5% of spraints, respectively. RFO for *Cyprinus carpio* was 10.4%, RFO *Tinca tinca* - 4.1%. In addition, commercial importance fish species in the otter diet, alien species were present: ie stone moroco (*Pseudorasbora parva*) - 24.6% in faeces but RFO for these species were 11.7%. In the FF 'Zator' fishes were present in 97.95% of spraints, RFO for carp family = 54.7% and RFO stone moroco = 0.1%. In the FF 'Potasznia' fishes were present in all faeces. RFO carp family = 52.1%, and those of the stone moroco - 7.7%. The data collected indicates that, in standing waters, otters may prey on *Pseudorasbora parva*, however their potential limiting effect on distribution and numbers of this invasive species require future studies.

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Atlantic or Celtic badgers? Preliminary results of a morphological approach

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Keywords: *European badgers, weight, geographic variation*

The European badger has a wide distribution range, having been the target of many studies regarding eg distribution, abundance, population dynamics, ecology and morphological traits. In a recent study, a correlation was established between badgers' body size and latitude with the biggest badgers being those from populations within the core of the species distribution area, and the smallest from the south Mediterranean populations.

The Iberian Peninsula encompasses at least two very distinct climatic areas (Mediterranean and Eurosiberian - Atlantic area) and, as distinct climatic conditions/drivers, may induce different eco-morphological responses from animals inhabiting those regions. In this context, we aim to compare two Iberian badger populations inhabiting different climatic zones - Galician (Iberian Northwest corner, Atlantic climatic area) and Portuguese (Iberian South East, Mediterranean climatic area) and evidence if they have distinct morphological traits (namely weight) that could be a result of climatic stressors.

From 1999 to 2016, 145 road-killed adult badgers were collected (116 - 59 ♂; 57♀ - in Galicia and 29 - 14 ♂; 15♀ - Portugal). While we did not detected any seasonal effect, Galician population's mean body weight (10.46 kg (SD 1.99) ♂; 9.24 kg (SD 2.03)♀) were significantly higher than those from Portuguese populations (8.09 kg (SD 1.64) ♂; 7.57 kg (SD 1.48) ♀), which show similar values to that of other Mediterranean Iberian populations, all significantly less heavier the ones from the Galician population. Such results suggest that in the Iberian Peninsula we may have two distinct badger morphotypes and that these coincide with the two main Iberian climatic regions: Mediterranean and Atlantic. When analysing this data in an European context, reviewing data from other published studies, we could define at least three groups of badger populations based on body weight, ie Mediterranean, Atlantic and Continental. Galician Badgers are heavier than the other Iberian Mediterranean populations and than the other Atlantic populations along Western Europe, reaching weight values close to those published for central European core populations.

A deepen analysis should be implemented to uncover the driver(s) of such variation pattern, but candidate factors should include climate and food availability/diet dependent of climate characteristics.

Combining non-invasive methods for assessing individual candidate bait uptake for oral vaccination of badgers against bovine tuberculosis

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Keywords: *badger, bovine tuberculosis, bait delivery, hair trapping, Rhodamine B*

Although France is officially declared free of bovine tuberculosis (TB) *Mycobacterium bovis* infection is still observed in several regions in cattle and wildlife, including badgers (Réveillaud et al., 2018). In this context, vaccinating badgers appears as a promising strategy to prevent *M. bovis* transmission between badgers and the other populations within the TB hosts community, especially cattle.

An oral vaccine consisting of live BCG contained in bait is currently under development (Gowtage et al., 2017), for which testing bait deployment in the field and assessing bait uptake by badgers are required.

This study aims at evaluating the candidate bait uptake by badgers and determining its drivers in a French TB infected area (Burgundy, north-eastern France). We selected 15 setts, located in the vicinity of pastures within the infected area, where badger culling has been intense in the last ten years. Pre-baits followed by baits (containing a biomarker and no BCG vaccine) were delivered, either down holes or at their entrance, in spring and summer 2018. Bait uptake was estimated as the proportion of badgers consuming baits marked by the biomarker Rhodamine B, per badger territorial group. The consumption of the marked baits was assessed by detecting fluorescence, produced by Rhodamine B, in hair collected on hair traps positioned at the setts and along the closest pastures. Collected hairs were also genotyped to differentiate individuals using 24 microsatellites markers and 1 sex marker (Jacquier et al. in prep.). 108 individuals were identified out of 581 collected hairs. 42% (45/108) of individuals were positive to the biomarker, with an average per set of 40% +/- 33%. Analyses are ongoing to determine which factors drive these variations among setts.

This study is the first one conducted in France on bait deployment in a badger population of intermediate density after several years of intensive culling. Results are expected to provide valuable information towards a realistic deployment of oral vaccine baits to control TB in badger populations.

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Otters (*Lutra lutra*) using a fishing port as a feeding area in the Costa del Sol (Málaga, Spain)

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Keywords: *otter, urban environment, marine habitat, fish unloading*

In 2012, a video was uploaded to a social network in which a pair of otters were eating in a fishing port of southern Spain. We tried to find out if this was an isolated episode or something more habitual and if it was still happening. Between 2017 and 2019, we visited this port looking for otters and their traces. We also carried out interviews with fishermen and the port night watch service. During almost two years of monitoring, we found evidences that otters were still using the port. They take advantage of catches thrown to the water accidentally while unloading and handling of fishes during the arrival of vessels at the port. The presence of otters (a pair until one of them appeared dead floating in harbor waters one year ago) in the harbor cove was more frequent in summer and spring, although they could be present all the year. The most likely place of origin of these otters was the Guadalobón river, 2km far from the harbor entrance. To reach the breakwaters that protect the harbor entrance, otters have to take a swim trip along an urbanized coast. Halfway, 900meters, they find a dune area with another breakwater that connects the harbor cove with the nearby beach. We found footprints, droppings and marine prey remains both in the river mouth and along the middle breakwater. Harbor docks and breakwaters offered temporary shelter to otters, although they showed an indiscreet behavior while feeding, being easily seen (always during the night) near the boats and the docks. Our results confirm the ecological plasticity of otters and their ability to use marine and urban habitats. The most frequent use of the port in summer suggests the pantry hypothesis related to the Mediterranean seasonal stress and also an opportunistic behavior.

Two non-invasive methods for estimating social group size in European badgers (*Meles meles*): camera and hair trapping, which one is the best?

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Keywords: *camera traps, hair traps, genetics, Meles meles*

Population size is a basic attribute of populations and its estimation is of central importance in conservation and wildlife management. The Eurasian badger generally lives in mixed-sex, communally breeding social groups, with relatively large differences of social group size and group ranges throughout its distribution.

Here, we aimed at determining European badger (*Meles meles*) mean social group size in 11 contrasted sites of 50km² across France, by using two non-invasive methods ie camera trapping and hair trapping for genetic identification. We deployed camera traps between April and June for two weeks and hair traps for two other weeks on 18 (± 4 SD) selected occupied setts per study site, alternating trapping method between setts to avoid biases. We used between 1 and 15 hair traps per sett and collected hair samples every two or three days. Hair samples were genotyped at 24 microsatellite markers and one sex marker (Jacquier et al. in prep) and individual identification of consensus genotypes was performed using the GIMLET v1.3.3 software. Among the 1081 hair samples obtained, 823 were genotyped and allowed the identification of 284 badgers (145 males and 139 females).

Setts were also monitored by 1 to 5 infrared camera per sett, depending of the sett size. We retained the picture or video on which the maximum number of individuals was seen together to estimate the maximum number of individuals living on a sett.

The mean trapping effort per study site was 515.2 (± 77.4 SD) and 881 (± 300.3 SD) days, respectively for camera and hair traps. Hair traps provided the same or greater group size estimations in 46 % of the setts. On small setts, group sizes of one to two individuals were best detected using camera trapping. The two methods provide complementary information on structure of the groups, ie sex ratio for genetics and age class for camera traps.

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Local population structure and micro habitat of the feral Japanese marten in Hokkaido, Japan, based on fecal DNA analysis

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The Japanese marten (*Martes melampus*) is an endemic omnivorous species in the main islands of Japan. Around the 1940s, this marten was introduced to Hokkaido Island from Honshu Island, for fur production. After then, they spread their habitats in southwestern Hokkaido and they now have a competition with the sable (*Martes zibellina*), which is native to Hokkaido. On 2015, the Ministry of Environment listed the feral Japanese marten as an invasive alien species threatening biodiversity, human health and/or economic development in Japan. However, still now the ecological status of feral Japanese martens within Hokkaido is unclear. Therefore, we studied the local population structure of feral Japanese martens using fecal DNA analysis.

The surveys were carried out 66 times from June 2016 to March 2018 along the transect route of approximately 4km in Nishioka area at Sapporo City, Hokkaido. Of 245 marten-like fecal samples collected in field, 207 were assigned to the Japanese marten with partial mitochondrial DNA sequences, which were divided to two haplotypes. Then, the microsatellite genotyping showed that 73 of the 207 fecal samples originated from 17 martens, which consisted of 15 males, one female and one unknown sex. The inbreeding coefficient of the Nishioka population was not statistically significant, and the population structure changed annually. It could result from the fact that the Nishioka area is not geographically isolated from the surrounding areas. The Geographic Information System analysis of both grid and transect scales showed that the plantation of the Todo fir tends to be preferable habitats for martens. In general, the coniferous forests such as the Todo fir provide their cover and resting sites. The result suggests Japanese marten's adaptation to the low temperature and deep snow in Hokkaido.

Diet analysis of the European badgers (*Meles meles*) in Norway

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The European badger is widely distributed in Europe and some parts of Asia and is commonly observed in urbanized areas. The species is classified as a generalist and an opportunistic forager using a wide variety of food resources, both locally and seasonally. Although badgers are known for using food of anthropogenic origin, detailed studies on urban badgers' diet are uncommon. In Scandinavia, where the populations of badgers has expanded in the last century, little is known concerning their trophic habits and dependence on anthropogenic resources. The aim of our study was to explore trophic adaptations of badgers inhabiting urban and rural habitats in Norway in relation to the season and sex.

The animals were mainly road kills. In total, 159 adult badgers (85 males, 74 females) were examined. For each, the date, location of collection, gender, body mass data were recorded. The badgers' mean body mass differed significantly between seasons, with an increasing trend throughout the year from spring, summer, until autumn, and sex with males heavier than females. We identified 12 unique food categories in badgers' diet that was dominated by earthworms, followed by insects, fruits and cereals. The trophic niche breadths of the badgers varied between habitat type with $B=5.49$ in urban habitat vs $B=6.61$ in rural habitat. Badgers' diet overlapped highly between both gender $Ojk=0.97$ and habitat type $Ojk=0.96$, but had a lower overlap between seasons. Males more often than females supplemented their diet with anthropogenic food and the use of this food category was also different between habitats.

The diet of badgers significantly differed between seasons. In spring, they ate most commonly earthworms. In summer, insects, birds, small mammals dominated in their diet, whereas in autumn the badgers consumed fruits, cereals and anthropogenic food.

Restoration of corridors under the motorway A63 Landes: efficiency of underpasses implemented on existing bridges for the European mink

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Creation of underpasses on roadways is a main action for reducing wildlife road mortality and habitat fragmentation, particularly for the critically endangered European mink (*Mustela lutreola*).

As part of the carriageway widening of the motorway A63, a major axis between Bordeaux and Bayonne, 33 existing hydraulic bridges were rehabilitated to implement underpasses from 35 to 90 meters long, through 104km of the remaining French European mink population in south-western France. Various types of passageways were built using diverse materials and techniques specially adapted to the local characteristics of each bridge, considering the hydraulic constraints and the limitation of impacts on watercourses and habitats during the fieldwork: concrete steps, wooden steps, wooden walkways and pontoons.

Use and effectiveness of 31 underpasses were evaluated in 2013-2014 and 2016-2017, through the monitoring of 86 passageways using ink footprint traps. Sixteen species or species-groups were identified, showing the crossing of mammals through all underpasses and on each passageway. Small carnivores were detected in 30 underpasses, among which 17 including otter (*Lutra lutra*) and 15 including European mink (*Mustela lutreola*) or American mink (*Neovison vison*).

Three indicators were used to determine the level of utilization of the passes by the fauna: the rate of crossing of small carnivores, the specific diversity of small carnivores, and the total specific diversity. This level was estimated 'middle' to 'good' for 2/3 of the underpasses. Moreover, a raise was observed between 2013-14 and 2016-17 for 9 underpasses showing a 'very low' to 'low' level of utilization during the first years.

After 40 years of partitioning by the former road RN10, these rehabilitations confirm the possibility of adapting the underpasses to all the types of existing bridges, and their effectiveness, since we break pre-conceived ideas and since the design and the fieldwork are accompanied by a mammal specialist of these topics.

