

Friday 20th April

CRANBROOK LECTURE

Big Changes for Small Carnivores – a brief ~20,000 years of mustelids in the British Isles

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Although the British Isles are home to only seven* native and non-native species of mustelid, there is great variation in their histories of population change in these islands. We will explore these species' histories, taking diverse approaches and adopting a range of perspectives. We will sample 20,000 years of change, from the post-glacial origins of this subset of the European fauna, through factors driving their ups and downs over centuries, decades and years up to the present time, with an analysis of more contemporary processes of decline, recovery, expansion and contraction. We will address the current threats they face, the threats they present and the challenges they create. Throughout, we will acknowledge the uncertainty and technical difficulties of determining their changing population status. We will reveal that this select group of small carnivores provides an effective and extraordinarily comprehensive set of models of anthropogenic influences on populations and of the challenges of wildlife conservation and management.

*arguably eight, if we include feral ferrets, which we do at some points in the lecture!

Saturday 21st April

SESSION 1

The Mammal Society population review and red listing for British mammals

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How many grey squirrels are there? Is the distribution of dormice declining? These questions are not only regularly posed by journalists, but they are also at the heart of much decision making about population management and conservation action. It is perhaps surprising therefore that the last comprehensive review of the status of British Mammals was published more than 20 years ago. We have recently completed a new Review, commissioned by the Statutory Nature Conservation Organisations, and have also written

the first ever Red List for British Mammals, which assesses the short-term extinction risks of our native and naturalised mammals. This presentation will explain the methods used to derive the assessments, which included the analysis of > 1,000,000 data records provided by volunteers. It will also consider the very important knowledge gaps that remain, and discuss how to improve data collection for the future.

SESSION 2

Effects of pine marten re-introduction on grey squirrel populations in Wales

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The grey squirrel (*Sciurus carolinensis*) is an invasive species in the UK and its range in Europe is increasing, threatening native flora and fauna. Recent studies in Ireland suggest the pine marten (*Martes martes*) negatively impacts grey squirrel populations on a landscape scale. Decline of the grey squirrel would be advantageous to the recovery of the native red squirrel (*Sciurus vulgaris*). Existence of an interaction could have major ramifications for the forestry sector and approaches to grey squirrel control. Here, we studied this relationship further during a pine marten reintroduction project in mid-Wales. Translocated pine martens and resident grey squirrels were GPS tracked to establish ranging behaviour and reveal any potential spatial interactions. This work considers novel approaches towards invasive species control and investigates the role of native small carnivores in the UK, particularly in restoring ecosystem balance.

The role of European pine marten (*Martes martes*) in control of invasive grey squirrels (*Sciurus carolinensis*) and conservation of native red squirrels (*Sciurus vulgaris*): direct predation and landscape of fear

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Eastern grey squirrels (*Sciurus carolinensis*) pose a serious ecological threat, leading to regional extinctions of native red squirrels (*Sciurus vulgaris*), and causing extensive economic damage in forestry. Recent research suggests a negative correlation between the European pine marten (*Martes martes*) and grey squirrels. The mechanism remains unclear

but may be due to predation and/or differences in response to the presences of a novel predator. We investigated the incidence of squirrel species in scats of the pine marten and behavioural responses of both species to chemical cues of pine martens. Grey squirrels occurred more frequently in the diet and were evident only in spring and summer. Red squirrels demonstrate a landscape of fear in response to pine marten scent while Grey squirrels did not demonstrate any behavioural response. The present results suggest that pine martens target juvenile grey squirrels with high predation rates facilitated by a lack of behavioural response.

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

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Although conservation translocations are increasingly being used to reinforce or re-establish threatened species, the majority of translocations are ultimately unsuccessful. Two factors that may compromise the outcome of translocations but have been largely overlooked, are the stress response and individual personality of the animals involved. The Vincent Wildlife Trust's Pine Marten Recovery Project provided the opportunity to study these factors in the first group of 19 pine martens translocated from Scotland to Wales. Results suggest that there is marked variability in both these traits between individual pine martens. This variability has been quantified from observations and sampling during the translocation process, and was significantly associated with dispersal and post-release movements of the martens. We discuss the implications for future translocation attempts.

RAPID FIRE

Declining hedgehog numbers in the city of Zurich, Switzerland

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While European hedgehogs *Erinaceus europaeus* were common in an extensive inventory in the city of Zurich, Switzerland in 1992, recent research indicates that the situation has changed significantly. In a citizen science project, we assessed (as a comparison to the 1992 study) the current hedgehog population with footprint tunnels and a capture-mark-recapture study.

Our findings show that the relative density of hedgehogs varied greatly between study areas. Most alarming were urban areas that once had numerous hedgehogs, but now contained very few. Our results indicate that the current hedgehog population lies well below the previous density. In a preliminary analysis, the amount of green space and barriers did not explain this decline. We discuss the occurrence of badgers, effects of increased road traffic and the degradation of green spaces as possible factors affecting hedgehogs. With the on-going densification of cities, understanding declines is essential for the conservation of urban wildlife.

The effects of housing density on the European hedgehog (*Erinaceus europaeus*)

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A key conservation objective for hedgehogs is the maintenance of populations in urban habitats.

Using camera traps, a Random Encounter Model (REM) was employed to generate hedgehog density estimates in high-, medium- and low-density housing sites in Oxfordshire. Occupancy Modelling (OM) was used to assess the influence of garden attributes on garden preference.

The REM demonstrated a significant negative relationship between hedgehog density and housing density. Hedgehogs were absent from only one low-density housing site, where badgers were also recorded. Hedgehogs were largely absent in high-density housing.

Housing density covariates were included in the top-ranked OM, and broadly agree with the REM, showing a negative relationship between hedgehog occupancy and housing density. Open gardens were also included within the top-ranked model. Boundary type and provision of supplementary food had no effect on occupancy.

Conservation efforts should promote: 1) delivery of new housing at low densities; and 2) retrospective provision of open gardens within dispersal corridors between source populations.

Hedgehogs and development: how to factor hedgehogs into the planning system

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Hedgehogs are thought to have declined by a third since the Millennium and are considered to require conservation action. However, there is currently no legislative obligation to protect or provide habitat for hedgehogs, making it difficult to manage our green space effectively for the species.

With funding from the British Hedgehog Preservation Society, the Warwickshire Wildlife Trust has established two Hedgehog Improvement Areas (HIAs) with dedicated Hedgehog Officers. The HIAs aim to help conserve local hedgehog populations through community engagement, surveying and habitat improvement. The Officers liaise with communities, ecologists, developers, planners and Local Authorities to make both residential and non-residential green space hedgehog-friendly.

The Rugby HIA has resulted in changes to Local Authority management of green space, design plans for new developments, and statements in local policy. Learning from the successes and challenges should be considered a priority, given the declining status of hedgehogs in the UK.

Volunteers illuminate the nocturnal activities of hedgehogs

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Understanding the impact of artificial light on the activity, behaviour and physiology of plants and animals is an area of increasing scientific interest. Following on from the first year of running the successful Hedgehog Watch Survey in 2016, The Mammal Society asked members to film hedgehogs feeding in their gardens under normal lighting or artificial lighting conditions using camera traps. They were also asked to carry out invertebrate surveys using pitfall traps. Here we report on whether the presence or absence of artificial light influenced the feeding behaviour of hedgehogs, and indicate directions for future, follow-up studies.

SESSION 3

Population trends of the Western polecat (*Mustela putorius*) across Europe: a neglected and declining species?

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The Western polecat *Mustela putorius* has a widespread distribution across Europe and is currently listed as Least Concern by the IUCN Red List of Threatened Species. A paucity of data means that range-wide population trends are poorly understood. We reviewed information on the polecat's status and population trends across its range. In countries where trends were identified, the population is known or suspected to be declining in 20 countries, is reported to be stable in six countries and increasing in two countries, whilst in the rest, data are insufficient to discern population trends. The drivers of polecat decline are poorly understood, but may include competition with invasive carnivores; habitat degradation; changes in prey availability; secondary poisoning; harvesting and killing of polecats; and hybridisation. There is an urgent need to establish robust methods and systematic monitoring programmes to gather accurate data on polecat population trends across the species' range.

Long-term increase in secondary exposure to anticoagulant rodenticides in the European polecat (*Mustela putorius*) in Great Britain

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The European polecat *Mustela putorius* is recolonising Britain after a population decline during the nineteenth and twentieth centuries (Langley & Yalden 1977). Previously 31% of polecats were found to be secondarily exposed to second generation anticoagulant rodenticides (SGARs), probably resulting from eating contaminated rats (Shore et al. 2003). Polecats are now expanding into parts of the country traditionally associated with higher SGARs usage, which may pose a risk to their recovery in these areas.

We evaluated the current risk of secondary exposure to SGARs by analysing polecat carcasses collected between 2013 and 2016. Using the stable isotope nitrogen, we explored the relationship between the rate of detection and polecat diet. 79% of polecats had been exposed to SGARs. There was no evidence of spatial or temporal variation in detection rates. Total concentrations were higher in older animals, in animals collected from arable habitats and in the west of the polecat's range.

RAPID FIRE

Locating horseshoe bat roosts in Wales using infant bat calls and adult social calls

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Rhinolophid bat roosts have been routinely verified by recording the echolocation frequencies of *R. ferrumequinum* (83-84 kHz) and (*R. hipposideros*) (110-114 kHz) but identification of a nursery roost or a hibernaculum has been confirmed by entering the roost and disturbing the bats. A survey of ten *R. hipposideros* roosts showed that infant bat ultrasonic calls can be used to identify dates when births started and infants began flying. The ideal time for static pre-set extended periods of time expansion detector recording is from 20.00h – 08.00 h GMT in June and July. Ultrasonic calls with fundamental frequencies between 15-42 kHz with 2-7 harmonics were identified as 7 categories of infant development calls and 15 categories of adult ultrasound social calls. Ultrasonic recording of adult social calls and infant development calls at the roost exit hole is a quick and non-invasive method of identifying a nursery roost and / or hibernaculum.

The potential of environmental DNA metabarcoding for monitoring the distribution and abundance of elusive and invasive mammals in the British Isles

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The use of environmental DNA (eDNA) metabarcoding has become a vital tool for determining the distribution of a wide variety of species but mammals have so far been relatively neglected in eDNA studies in aquatic and terrestrial environments. It has the potential to provide data on the distribution of several elusive mammalian species, particularly species of conservation concern such as the water vole (*Arvicola amphibius*) in Britain and the pygmy shrew (*Sorex minutus*) in Ireland, and could provide early detection of invasive species such as the American mink (*Neovison vison*) and the greater white-toothed shrew (*Crocidura russula*). Our primary aim in this pilot study is to test the utility of eDNA to determine the presence/absence and abundance (using extensive field data as a comparison) of these species in sites in Ireland and the UK.

South Cumbrian Species Restoration Project: Understanding community values

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Species reintroduction and restoration are becoming commonplace tools in tackling the precipitous decline in biodiversity. With an increasing focus on landscape scale approaches, the South Cumbria Species Restoration Project proposes a multi species restoration of a range of taxa across the heterogeneous area of Morecambe Bay. Species are identified as absent at a local or regional scale and mammal species of interest include the pine marten, dormouse and water vole. Restoration projects have the potential to increase baseline knowledge and involvement within the community. There is also increasing recognition of the importance of incorporating societal values in improving the success of conservation solutions. This multi species reintroduction project provides a novel opportunity to assess criterion based decision making in stakeholder groups to form a better understanding of the social value of species diversity and reintroductions.

The Devon Harvest Mouse Project

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Despite their charisma, harvest mice are vastly under-recorded and possibly declining. Devon Harvest Mouse Project was set up by Devon Mammal Group to assess the status of harvest mice in the county in order to fill these gaps in distribution data. Over the course of the winter of 2017/18, we have been utilising nest searches and trapping to gather records, and training these techniques to a wide network of volunteers of different backgrounds,

from ecology to farming. Our final aim is to achieve a clearer picture as to how this charming mammal is faring locally, and build strong community support for their conservation.

25 years of surveying for otters in Cambridgeshire

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We, that's the Bedfordshire, Cambridgeshire and Northamptonshire Wildlife Trust and the Cambridgeshire Mammal Group, started to survey for otters in the county in 1992 - surveying in January/February every five years for signs (as in spraint and prints) under and very near a randomly selected group of 290 bridges throughout the county. The protocol was (and still is) very straightforward. The presentation will describe the results found every 5 years since 1992 until 2017 and some of the successes and problems encountered.

Sunday 2nd April

SESSION 4

Nutkin ventured, Nutkin gained: A non-invasive platform for tomorrow's surveillance

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Current squirrel testing protocols promote both transmission electron microscopy, polymerase chain reaction (PCR) and enzyme linked immunosorbent assays for SQPV and adenovirus surveillance using appropriate tissue matrices. We propose a novel non-invasive approach applicable to both large scale live animal surveillance and mortality studies, avoiding a need for licencing and welfare requirements. We have evaluated a single matrix for multi-viral testing, utilising the grey squirrel as the sample template with PCR as a multi-residue assay platform and we present data on viral detections that provide a landscape picture of infection presence in animals often sympatric with small numbers of red squirrels. Red squirrel data from other locations is also presented and we compare these data with

traditionally used matrices and offer a range of scenarios where the proposed approach would benefit both live animal surveillance and trans-location and re-introduction studies.

Archaeological perspectives on wild mammals management, conservation and re-wilding

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Invasive and endangered species and issues of 're-wilding' are high-profile topics in modern scholarship and politics. Policies concerning these issues abound, with decision about conservation and management often being driven by a species' native or alien status. However, for many species, native/alien designations are based not on empirical data but rather received wisdom, much of which is entirely erroneous.

The archaeological record offers the potential to establish the bio-cultural history of wild mammal species and model the dynamics of human-animal-environment relationships over millennia. This paper will present a number of case-studies (e.g. fallow deer, brown and mountain hare, wolves, and wild and domestic cat) to demonstrate how archaeological studies that integrate faunal remains analysis with genomic and isotopic approaches can provide the evidence base upon which policy can be built.

An ecosystem engineer, the Eurasian beaver, restored to Scotland: Recent progress and what happens next?

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In November 2016 the Scottish Government stated they were minded to allow existing Eurasian beaver populations to remain in Scotland, and that the beaver will become a European Protected Species (EPS). This was a historic announcement, in effect the first ever formal reintroduction of a mammal species in the UK. Attention then switched to the practical biological, socio-economic and legal challenges that have to be addressed to reduce the risks and maximise the opportunities associated with the reintroduction. Over the last year this has included undertaking Habitat Regulations Appraisals, developing a pragmatic licensing framework, setting up management guidance and support systems, evaluating management techniques, developing expertise capacity, re-assessing the current status of populations and their natural colonisation potential, reinforcing the Knapdale population, developing cost-effective monitoring methods and predictive modelling tools, and supporting research priorities. A new Scottish Beaver Forum, involving key stakeholders, has been established to help inform this process.

International consensus principles for ethical wildlife control

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Human-wild mammal conflicts are commonly tackled by a variety of methods but declining wild mammal populations, a lack of efficacy of control methods in achieving desired outcomes, and changes in how people value animals, have triggered a need for ethical and evidence-based approaches to managing such conflicts. International perspectives and experiences were explored in a two-day workshop to develop consensus principles for ethical wildlife control. The seven proposed principles are: (1) begin wherever possible by altering the human practices that cause human-wildlife conflict; (2) be justified by evidence

that significant harms are being caused to people, property, livelihoods, ecosystems and/or animals; (3) have measurable outcome-based objectives that are clear, achievable, monitored and adaptive; (4) predictably minimize animal welfare harms to the least number of animals through the selection and application of methods; (5) be informed by community values as well as scientific, technical and practical information; (6) be integrated into plans for systematic long-term management; and (7) be based on the specifics of the situation rather than broad categories applied to the target species. These principles could guide development of international and other standards, local control decisions, and certification systems for commercial control companies.

SESSION 5

Retracing the history and planning the future of the red squirrel (*Sciurus vulgaris*) in Ireland using non-invasive genetics

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The red squirrel's history in Ireland is largely unknown, but the original population is thought to have gone extinct in the 17th Century. Multiple records exist for its reintroduction in the 19th Century. It is currently unknown how these reintroductions affect the red squirrel population today, or into the future. We report on the development of a non-invasive genetic toolset that facilitates assessments of contemporary and historical diversity and movements. Our findings demonstrate that the population is at a national

level genetically diverse, but locally contains relatively low levels of genetic diversity. This is likely an artefact from the introduction of small numbers of animals from different sources, and a lack of continuous woodland cover that restricts further gene flow. The population also contains mtDNA haplotypes of both a British and Continental European origin. The implications for conservation and management of the species in Ireland will be discussed.

Feeding wildlife: the effects of supplementary feeding on urban mammal behaviour

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Over the last few decades there has been an increase in the number of people who provide food for wildlife in the gardens. Supplementary feeding can have both positive and negative effects on wildlife. It can provide benefits to wildlife by providing reliable resources during periods of food shortages, they it may also cause changes in species spatial behaviour and species aggregations to focal points which could alter the risk of predation, intra and interspecific-conflict and disease transmission. In this talk we present some of our primary findings on how people feed wildlife in urban areas and the impacts of this behaviour and supplementary food availability on urban mammal populations, behaviour and interactions.

Next-generation phylogeography and signatures of adaptation in the red fox (*Vulpes vulpes*) in Europe

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The advent of next-generation sequencing techniques has the potential to revolutionize our understanding of phylogeographic and adaptive processes in mammals at the continental scale. A total of 524 red foxes (*Vulpes vulpes*) were genotyped in populations distributed from Ireland to Siberia using genotype-by-sequencing (GBS) to identify phylogeographic patterns and signatures of selection in red foxes across Europe. Over 20,000 single nucleotide polymorphisms (SNPs) were identified and mapped to the dog reference genome. Levels of genomic diversity were similar among most populations, but were

generally lower in the most northerly populations in Scandinavia and the British Isles. Bayesian analyses identified eight genomic clusters in Europe, corresponding to known glacial refugial areas in Europe, but also identifying distinctive groups in the British Isles. SNPs were identified as being under selection in different genomic regions associated with immunological, metabolic, physiological and cellular processes.

Did the bat cross the road: Impact of traffic noise on bat activity

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Increasing levels of man-made noise is creating new soundscapes that have the potential to negatively impact wildlife across the globe. Roads are a major source of anthropogenic noise yet it is difficult to separate the effect of noise from other features associated with roads such as habitat structure and quality. The impacts of road noise on wild mammals are therefore poorly understood. Here we present the first controlled field experiment to examine the potential impacts traffic noise can have on bats. Using both acoustic and ultrasonic recordings we created a 'phantom road' along linear features at 7 sites known to be used by bats, and documented changes in the activity of five UK bat species, including the greater horseshoe bat (*Rhinolophus ferrumequinum*). Our findings, based on more than 20,000 bat calls, demonstrate a profound negative impact of road noise on bat activity. Further research is now required to understand whether bats can habituate to this stimulus.