

Saturday 1st April

SESSION 1

What works in mammal conservation?

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In this lecture I will explain how I think we should be able to review the global literature in hours rather than months. I will show how we are using www.conservationevidence.com to collate the evidence on bats and are very keen to extend this to other groups. I will show how you can take the global evidence and then apply it to the local problem that concerns you and finally make a call for routine testing of the effectiveness of interventions by practitioners. Finally I will welcome collaborators who wish to transform conservation practice.

SESSION 2

A round up of Mammal Society research projects – past and future

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I will give an overview of the exciting research lead by the Society over the past year, including the Mammal Review project and our National hedgehog watch survey, with some preliminary results and findings. I will then present projects that are in the pipeline for the coming months, such as a new water vole data repository and new citizen science surveys to help us collect data for conservation where it is really needed. I will tell people how they can get involved and help us to conserve British mammals.

Results of a replicated experiment on the impact of displacement via vegetation removal on water voles

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Results of a replicated experiment on the impact of displacement via vegetation removal on water voles.

This study follows the introduction of a Natural England class licence to allow the displacement of water voles from short sections of bankside habitat, combined with a research recommendation in the recent Water Vole Mitigation Guidelines highlighting the lack of information regarding the efficacy of this approach. We undertook a replicated experiment to radio-track water voles before and after vegetation removal. This talk will outline the findings of our study in relation to the current guidelines, and highlight future considerations for a practical and proportional response that helps maintains a positive water vole presence in these areas.

Landscape use by translocated pine martens as revealed by radio and GPS tracking

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In autumn 2015, 20 pine martens were translocated from Scotland to mid-Wales as part of the Vincent Wildlife Trust's Pine Marten Recovery Project. A year later, a further 19 pine martens were released in the same area. All of the animals were radio-tracked for up to 12 months after release to monitor their movements and ranging behaviour. This is the first time that ranging data have been collected on a translocated population of pine martens in the UK during the critical post-release establishment phase. This talk describes what the data reveal about how the animals used the habitats in the release area, how they established territories in both unoccupied and subsequently occupied landscapes and the challenges of using GPS technology for nocturnal, forest-dwelling, small mustelids.

RAPID FIRE

Monitoring pine marten populations in Northern Ireland using citizen scientists

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Monitoring a species' distribution is fundamental to its effective conservation and management. However, conventional monitoring methods can be expensive, time consuming and require specialist training or techniques. We present a simple method that

overcomes these limitations and has been effectively utilized by "citizen scientists" to rapidly assess the distribution of pine marten (*Martes martes*) in Northern Ireland. Over 3 months, 70 citizen scientists used camera traps and feeders in combination to survey over 300 sites across NI. Pine marten were recorded in 20% of sites visited and in over 25% of 10 km squares surveyed. Our results reveal how a simple methodology, combined with enthusiastic citizen scientists, has produced a baseline that will be the basis for future monitoring of this enigmatic and increasingly controversial species.

Ireland's wild mammals literature; a review

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The scientific literature about Ireland's wild mammals has increased. There are now four editions of Irish Wild Mammals: A Guide to the Literature the first two were drawn together by James Fairley, who passed the data on. From this we show that there were 970 items in the year 1972, to 1389 in 1992, to 2,616 in 2011 to well over 3,000 in 2016. We put this in a historic perspective with political and biological events. Clearly recent current circumstances have encouraged such research. We 'cut out' four topics; endemic mammals, overall populations, applied genetic work, and electronic tracking. We discuss how the application of the latter two subjects, may help in resolving problems with estimating both local and national populations. The data will be digitally tagged and online at the National Biodiversity Data Centre (www.biodiversityireland.ie). It is also available in book form.

Variation in the population density of pine marten, a recovering carnivore in Ireland

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Pine marten (*Martes martes*) have undergone a recent range expansion and consolidation in Ireland. There is a general lack of understanding on many aspects of the species ecology, which is an impediment to management of the population. In the current study, a large scale standardised non-invasive survey was undertaken in multiple study sites throughout Ireland to determine the magnitude of variation in pine marten density. Combining hair tubes, molecular techniques and spatially explicit capture recapture analyses the results of this study will be outlined in terms of the range of pine marten densities that were determined, and implications in terms of the conservation management of the species.

Monitoring otters (*Lutra lutra*) in Cork City – a history and future perspective

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Otter are common throughout the urban area of Cork, and other Irish Cities. They can readily adapt to, and even thrive, in an urban environment. With otter populations recovering in Britain, and elsewhere Europe, urban otters may become common. We use a mix of sign surveys, camera traps along with DNA and diet analysis for research on Cork City's otters. Much of this is done by citizen science, which along with visits to schools and local promotion has made these otters a well-known part of the local biodiversity. They have become important for scientific outreach, in the promotion of wildlife conservation, and have potential for ecotourism.

Using trail cameras to assess daily activity rhythms of the Eurasian otter (*Lutra lutra*)

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There is considerable anecdotal information that otters are now being seen more often during the day than in the past. Results from trail cameras at two sites in Suffolk, the RSPB Reserve at Minsmere and a non-tidal stretch of the River Blyth, are compared. There is considerable diurnal activity at Minsmere but none on the Blyth. Foraging in salt water and those in fresh water being diet related. Diet from spraint analysis at the two Suffolk sites is compared. The species caught are broadly similar although the proportions differ. Information is given from the two sites relating to habitat, disturbance and otter density. No conclusions are reached but a plea is made for the more structured use of trail cameras that are now widely owned by amateur naturalists. Warnings about the results from trail cameras are also given.

SESSION 3

Population genetic structure of Bechstein's bat (*Myotis Bechsteinii*) across Europe and Britain

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The Bechstein's bat is one of Britain's rarest mammals and monitoring their populations is extremely challenging. Acoustic methods are unable to distinguish the species reliably and direct counts are time consuming. In this talk I will focus on how we used molecular tools to determine genetic diversity, population structure and the phylogeographic pattern of this species.

We have analysed data on 330 individuals from eight sites in Britain and seven in Europe. The analysis of 757bp of mitochondrial DNA and 14 species-specific microsatellites indicated high genetic diversity at a nuclear level and very little genetic differentiation at a mitochondrial level. These results suggest that the Bechstein's bats range has been expanding since the last ice age. We also found that although this woodland bat has maintained high levels of diversity throughout its range, the British population lacks of genetic diversity and certain populations are showing signs of isolation.

Grey squirrel behaviour influences culling patterns

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Maximising the effect of grey squirrel control effort is vital in their management, particularly at the interface with the remaining red squirrel populations. Control using baited traps is undertaken by a variety of practitioners at different intensities and durations which we hypothesise will target different demographics of squirrels. We monitored squirrel behaviour in response to bait and found spatiotemporal differences within demographic groups of a grey squirrel. A male and adult bias is predicted from the behavioural responses to baited food sources. Following a complete cull of the same population we found behaviour influenced the trapping sequence of squirrels. Survival analysis confirmed adults had an increased trapability and juveniles were typically captured later in the process. Changes to the demographic structure of a population through partial control regimes could

impact the subsequent movement and recolonization patterns of remaining squirrels and has implications for disease spread.

Effects of selective hunting on pride size in the African lion (*Panthera leo*) and subsequent reduction in megaherbivore predation

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The African lion (*Panthera leo*) has experienced a 43% reduction in distribution across Africa. The African wild dog (*Lycaon pictus*) is a vulnerable species, facing many threats to its persistence. Overall population decrease and range reduction are recorded for both species, but little information is available on trends in group size. A meta-analysis showed pride size of lions has decreased from 1830 to 1997 ($p \leq 0.001$). Wild dog pack size has decreased between 1900 and 2009 ($p \leq 0.001$). Decrease in group size may partially be a result of selective hunting. Selective hunting can cause morphological changes such as reduction in body mass, but effects on behavioural characteristics, such as megaherbivore predation, are less well-known - particularly in lions and wild dogs. Trends in lion and wild dog group size, and behavioural changes including megaherbivore predation, have not previously been discussed in the literature

RAPID FIRE

Landscape scale habitat configuration and its influence on the distribution of bat roosts in the UK

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Possibly the most conspicuous way in which humans have altered landscapes is through the construction of road networks. Roads have wide ranging impacts on the landscapes through which they are built, reducing both the availability and quality of habitats in their vicinity.

We examined the potential for roads to influence the distribution of bat roosts across the UK mainland. In ArcGIS, we divided the UK into “accessible areas” or fragments, defined by major roads. We then plotted the locations of 2018 bat roosts, obtained and used with permission from the Bat Conservation Trust. Finally, we quantified measures of habitat quality such as the area of broadleaved woodland and the density of minor roads within each accessible area. Accessible areas were assorted by size before being aggregated into four groups. The first group contained the smallest fragments, the second and third groups consisted of intermediate sized fragments, whilst the fourth group contained the largest fragments. The combined area of fragments in each group was approximately one quarter of the area of the UK mainland. In this way, we controlled for the effects of area on sampling bias. The proportion of fragments in each category increased dramatically as size class increased, demonstrating that bats prefer or persist in larger fragments. In each category, there was more broadleaved woodland in the fragments occupied by roosts than unoccupied fragments suggesting that roads determine access to resources which may in turn either influence the persistence of local populations or roost selection by bats. In the smallest fragment category, occupied fragments had significantly lower minor road density than unoccupied fragments whereas the pattern was reversed for the three larger fragments categories. This suggests that there may be a threshold: bats may persist in smaller fragments as long as minor road density does not further reduce habitat quality.

Surveying small mammals in urban hedgerows

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Hedges are an important component of the English landscape. Our landscape is becoming more urban; these woody, vertical structures offer important wildlife habitat within otherwise potentially hostile built environments and they should be viewed as potentially important to urban biodiversity. Hedges are well known to support small mammal biodiversity in rural environments (e.g. Gelling et al. 2007; Hinsley & Bellamy 2000; Michel et al. 2006); this study assesses whether urban hedges offer similar value to small mammals. We assessed the use of non-invasive mammal survey methods for their reliability and suitability for use in urban environments. New, more reliable, methods of hair sample identification are investigated and evaluated. Hawthorn hedges were found to be particularly important as evidence of mammals was found in 80% of those surveyed. Over 63% of all study hedges showed evidence of small mammals, suggesting that urban hedges are important and should be preserved, preferably increased.

Morphological adaptation to temperature in the American red squirrel (*Tamiasciurus hudsonicus*)

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Temperature is a critically important environmental variable impacting organisms including mammals. Anthropogenic climate change makes an understanding of adaptation to temperature particularly important. I have examined thermal adaptation in the very widespread American red squirrel. A species distribution model showed that the three major predictors of species distribution reflected temperature: mean annual temperature, minimum temperature of the coldest month and maximum temperature of the warmest month. Museum data revealed morphological adaptations: whole body and skull dimensions vary with temperature, with larger animals being found in colder areas. This is consistent with Bergmann's Rule where larger individuals are expected in colder climate to minimize heat loss. However, with regards to Allen's Rule which predicts larger appendages in warmer climate to maximize heat dissipation, changes in nose length did not reflect temperature gradients. Overall American red squirrels are found to live within limits determined by temperature.

Modelling the distribution and habitat impacts of an expanding roe deer population in Wales

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The roe deer (*Capreolus capreolus*) is a charismatic and ecologically significant species native to the UK. Deer have an aesthetic value and stalking for management or recreation can provide a profitable and sustainable source of game meat. Deer are also considered a keystone species and are important drivers of nutrient cycling and ecosystem habitat structure. Roe deer populations have expanded over the past four decades and the species is now abundant throughout Scotland and England. Although deer densities in Wales are comparatively low, populations are predicted to increase. Previous attempts to model roe deer distribution have been hindered by a paucity of high resolution data. This study uses spatially explicit population modelling to provide a more accurate assessment of current distribution and expansion in Wales. Focussing on this issue now, whilst roe populations are low, should facilitate the development of a more effective and cost efficient, proactive management strategy.

KESS II Funded Project in partnership with the Deer Initiative (www.thedeerinitiative.co.uk)

Aggressive interactions between Eurasian otters in the UK; temporal, spatial and biotic variation in fighting injuries

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Intraspecific aggressive interactions within Eurasian otters are poorly understood, and previous studies were limited by sample size and geographic area. Here, 1,728 deceased otters collected from across England and Wales from 2005-2015 have been examined. A generalised linear mixed model tested associations between fighting injury prevalence and a wide range of variables including biotic, temporal and spatial factors (including a novel index of otter population density). Total prevalence was 23%, suggesting that aggressive interactions are a significant social interaction in Eurasian otters, occurring at a higher rate than anecdotal observation has previously indicated. Model results show that fighting is significantly more common in males than females, and in sub-adults than juveniles or adults, and is negatively associated with body condition; no density dependence or seasonality was found. The analysis has provided a more in-depth understanding of social interactions in this highly elusive solitary species.

Sunday 2nd April

SESSION 4

Wild Rovers: seasonal ranging of European badgers in Ireland is affected by climate change

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Understanding how animals use their environment is central to understanding their biology. We monitored 39 GPS-collared European badgers over three years to examine their ranging. Unsurprisingly, home ranges differed between seasons, since badgers exhibit winter 'lethargy'. Adult males showed a spring/autumn peak in ranging, while females ranged more in summer but held smaller home ranges than males. However differences between the

sexes did not emerge until they were in their third year. Female badgers changed their ranging behaviour very little between warmer and colder years, but in mild winters males ceased to show winter lethargy. With continued climate change, Europe will experience milder winters more often. Our data suggest this will promote increased winter activity in male badgers, promoting winter mixing between neighbours and so increased disease transmission, including TB. More mobile males will leave pregnant and nursing females undefended in their home setts during winter, potentially affecting breeding success.

Super-territoriality in male European badgers in Ireland

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The European badger exhibits territorial plasticity that would appear to be related to local population density. In high density populations, home ranges of social group members overlap closely with one another, but not with badgers from adjacent social groups, and territory boundaries tend to be well-defined and stable. In low density populations, territories are more loosely defined, with non-contiguous or indistinct borders, and males may even range over the home ranges of females from different social groups. In Ireland, where populations are of intermediate densities and territories are contiguous, we might expect social groups' territories to be exclusive. For the most part, this is the case. However, GPS tracking data has revealed the existence of "super-males" i.e. males that expand their range beyond the bounds of their own social group's range, sometimes encompassing the ranges of several females from several social groups. These super-territories may persist for a year or more.

Cummulative reproductive costs on current reproduction in wild yellow-bellied marmots

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Life-history theory predicts that reproductive costs may accumulate over an individual's lifetime. Yet few studies have tested for cumulative reproductive costs in natural populations, especially in species with high variation in offspring numbers. We quantified effects of previous short-term and cumulative long-term reproduction on current reproduction probability and litter size in wild female yellow-bellied marmots (*Marmota*

flaviventris), living in two different environments. We provide evidence for cumulative long-term effects: females that had both reproduced frequently and weaned large litters in previous years had decreased current reproduction probability, and females with high previous reproductive frequencies weaned smaller litters in the current year, but only in the harsher, higher elevation environment. We found no evidence for short-term costs between reproductive bouts. Our results suggest that a female's long-term reproductive history has environment-dependent effects on her current reproductive success. Trans-generational studies are now required to elucidate ultimate fitness costs incurred by reproducing females.

RAPID FIRE

Bat emergence and weather conditions in Central Scotland

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Bat activity has been correlated with weather conditions, including temperature. The Bat Conservation Trust recommends surveys are conducted at no less than 10°C. However, more recent evidence (Slack and Tinsley, 2015) suggests bat activity ends at 6°C, with wind speed of importance. The majority of this study occurred in England, with sites also in the Scottish Borders. The aim of the study was to establish bat activity against meteorological conditions within a site in Central Scotland. Precipitation, wind strength and cloud cover were recorded using guidelines from the National Bat Monitoring Programme, whilst temperature data was accessed online. Canonical correspondence analysis was then carried out on the data collected. The analysis suggests that temperature and precipitation were the two most important weather variables. The lowest maximum temperature bats were recorded at was 11°C, confirming the recommendations of the Bat Conservation Trust.

A 20-year study on the influence of weather on a population of pipistrelle bats (*Pipistrellus pygmaeus*) shows that monitoring periods need to be reviewed

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A nursery roost of *Pipistrellus pygmaeus* was monitored continuously from 1983 to 2002 between 1 April to 27 September. Analysis showed that the year-to-year change in population size of female *P. pygmaeus* (ΔN) and the time of the peak exit count of the

females from the roost in May to June could be predicted from the integrated air temperature (degree days, D) between 1 January and 31 March. Rising temperatures in this period were found to be detrimental to the *P. pygmaeus* population. When integrated air temperatures were high the peak exit counts occurred in early May. Monitoring has continued and between 1983 and 2016 the integrated air temperature (°C) from January to March rose 1.25 degree days p.a. Since the population trend is linked to environmental changes it would be advisable to monitor from the 2nd week in May in addition to the current monitoring periods in June.

Hedgehog improvement areas: understanding the impact of community driven hedgehog conservation

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The hedgehog is a charismatic, unique and popular mammal. Known to be in serious decline across the UK, converting public passion for this umbrella species into positive conservation action could be a powerful vehicle for change. With funding from the British Hedgehog Preservation Society, the Warwickshire Wildlife Trust has established two Hedgehog Improvement Areas (HIAs). The HIAs aim to empower people to make lasting changes for hedgehogs, by taking responsibility for their local population and improving both habitat and connectivity across the landscape. Because community engagement forms the basis of the HIAs, measuring direct outcomes on hedgehog abundance is difficult, especially in highly fragmented urban and suburban landscapes. Given the status of hedgehogs in the UK, uncovering methods to establish the effectiveness of community outreach work should be considered a priority.

Biotic and abiotic influences on the bodyweight of the European badger (*Meles meles*). How many seasons does a badger experience?

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While temperate latitudes experience clear changes in temperature, rainfall and resource abundance, these changes do not necessarily require four strategies for our classic four seasons. A meta-analysis of badger bodyweight data from the UK and Ireland indicated three general strategies across the year; bodyweight gain (during autumnal bounty), bodyweight loss (during winter lethargy) and lean bodyweight maintenance (between the periods of loss and gain). It follows that any comparisons of badger bodyweights between populations are likely to be most meaningful during the period of lean bodyweight maintenance, as badgers will be carrying fat reserves at other times of year. Comparisons of English and Irish badgers showed English badgers were heavier and more sexually dimorphic than Irish badgers. Our analyses reinforce the skeletal differences found between English and Irish badgers. Such differences have implications both for the management of wild badgers and the control of TB in badger populations.

SESSION 5

Regional variations in hazel dormouse nesting activity and implications for nest tube surveys

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The thoroughness of a hazel dormouse nest tube survey is frequently assessed using an index of the likelihood of recording dormice in any one month, based on the proportions of new nests recorded each month in the South West of England (Chanin and Woods 2003). In 2016, the Essex and Suffolk Dormouse Group sought to replicate the earlier study, to investigate whether hazel dormice in the East of England have a similar pattern of nesting activity. The findings of our survey revealed significant differences which are likely to be related to variation in climate between the two regions. This work has implications as to how dormouse surveys should be planned in terms of duration and timing in the East of England.

The NBN Atlas and the lifecycle of a record

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The formation of the National Biodiversity Network in 2000 brought structure and direction to the previously “diverse and uncoordinated network of data bodies [which] should be improved to cope with the increasing amount of biological information”. Following the Mammal Society winning the John Sawyer Open Biodiversity Data Award 2015, the NBN Secretariat discuss how far we have all come in sharing our collective data holdings, and most importantly, how these combined data holdings offer benefit to the hundreds of data users accessing these data daily by following the life of a record from collection through to use via the NBN Atlas.

The implications of adenovirus infection for management of United Kingdom captive red squirrel (*Sciurus vulgaris*) collections

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Transmission electron microscopy (TEM) and polymerase chain reaction (PCR) assays for adenovirus (ADV) were undertaken on samples obtained between 2002 and 2016 from 26 United Kingdom (UK) captive red squirrel (*Sciurus vulgaris*) collections. Of 181 carcasses received, 129 underwent post mortem with ADV detected in 92 animals from 23 collections. Two ADV enteritis cases were histologically confirmed with another 39 considered clinically-significant ADV cases from TEM and PCR analyses, but autolysis precluded confirmatory histological diagnoses. ADV-associated clusters were recorded with evidence suggesting ADV infected inter-collection donor animal movement triggered recipient collection mortalities. Cause of death was indeterminate in most cases, but a range of diagnoses recorded in 26 animals. UK captive red squirrel husbandry implications are discussed, recommendations made that squirrels be tested prior to collection movements and

protocols developed to minimise probable intra-species ADV infection and to highlight potential risks from contact with ADV infected wood mice (*Apodemus sylvaticus*).

History and biology coincide: explaining the ‘Celtic Fringe’

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The Celtic people (Scots, Irish and Welsh) of the British Isles are found in the western and northern periphery, while the English are found in eastern and central parts of Britain. Intriguingly there are small mammals that also display a ‘Celtic Fringe’ with their peripheral (‘Celtic’) genetic forms contrasting with their central genetic forms in the British Isles – pygmy and common shrews, house mice, and bank, field and water voles. The British Isles periphery is higher altitude/more severe/remote. I argue that the peripheral forms in general are early colonists, and the central forms later colonists which replaced the first colonists from lowland areas but not the more severe/remote peripheral areas. This applies to humans and most of the small mammals, but not house mice, which were later colonists accidentally transported by Norwegian Vikings. Thus, the history of humans and small mammals are intertwined extraordinarily in explaining their individual ‘Celtic Fringes’.