

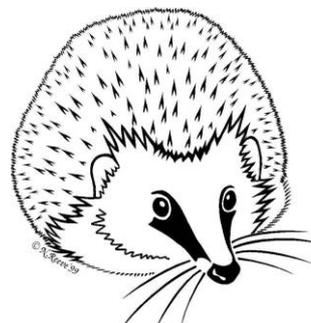
**8th International Workshop
of the
European Hedgehog Research Group**

22-23 February 2019: Hyde Park, London, UK



Abstract Book

Edited by Nigel Reeve & Tess Pettinger



**European
Hedgehog
Research
Group**

Foreward

The first workshop of the European Hedgehog Research Group (EHRG) was the brain-child of hedgehog researcher Beate Johansen and held in Arendal, Norway in April 1996. The EHRG was established as primarily a scientific research group, but with a key aim that scientists and wildlife rescue workers should exchange information and work together to improve our knowledge of hedgehogs. The EHRG has subsequently met in Vienna (Austria), London (UK), Lund (Sweden), Gemmano (Italy), Münster (Germany) and Wageningen (Netherlands).

There is now strong evidence of serious population decline of hedgehogs in the UK, as well as in other parts of Europe. Public and political awareness of the plight of hedgehogs (and other wildlife) has grown but positive action on the scale required is hindered by the complexity of negative anthropogenic factors involved, and a volatile political agenda that rarely prioritises wildlife conservation. There is much still to learn but we must be able to offer evidence-based solutions to key problems. Only robust research can provide what is needed and scientists working together with wildlife rescue workers and the wider community can not only help to provide some of the answers but also stimulate positive action for hedgehogs by householders, rural and urban land managers, developers and politicians.

The EHRG is not a funded organisation. It exists as a Google Group* for those seeking to foster, conduct and share the results of hedgehog research. Each workshop funds itself; depending on the work and generosity of individuals (including the speakers and delegates) and organisations. For hosting this 8th International Workshop we are enormously grateful to The Royal Parks, the charity for London's eight Royal parks, which has also facilitated a programme of research and positive park management in The Regent's Park that aims to conserve the last remaining hedgehog population in central London.

Nigel Reeve
February 2019

Copies of this book of abstracts may be downloaded from The Royal Parks website:
www.royalparks.org.uk/hedgehog

*The Google Group is kindly managed by the People's Trust for Endangered Species (PTES) based in the UK. To join, please contact the Hedgehog Officer, email:
hedgehog@ptes.org

Oral papers presented Friday 22nd February 2018

Abstract 1.

Hedgehog research in Britain: looking back, looking around and looking forward.

Keynote speaker: Pat Morris MBE

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Hedgehogs are not economically important nor very harmful, so there is never much need to pay for research. Hedgehogs were regarded as 'common and widespread', needing no money spent on their conservation. Consequently, research effort has been very patchy and spread over many decades, often forgotten or ignored on the assumption that it is out of date. Many studies have never been repeated but are the best we have. Numerous investigations of hibernation physiology in the laboratory contrast with lack of information about behaviour in the wild. Yet winter nesting is a key ecological necessity because hedgehogs spend nearly half their life in hibernacula. Similarly, there have been few studies of population structure and survival rates, yet these data are essential for modern population modelling. Accurate estimates of total numbers are impossible without reliable data on population density in different habitats, but little information has been published leading to absurdly unreliable estimates of how many hedgehogs there are. Perhaps population trends are more important and we have made progress in this by making regular roadkill counts, despite scepticism that counting dead hedgehogs is merely an inefficient way of measuring traffic density. That assumption has now been shown to be false and we have long-term roadkill datasets revealing a major population decline. This is supported by independent 'citizen science' projects recording relative abundance of hedgehogs as the internet makes it possible to harness the 'power of the people' in sufficient numbers to overcome the drawbacks of variable data quality. Using footprint tunnels offers a promising way to estimate population densities in different habitats and the total population size, a question posed persistently by the media. New GPS-based radio tracking offers a more efficient way to study home range size and habitat use. We need modern data on these topics as previous studies mostly focused on grassland (where hedgehogs can be studied easily), but what about hedgehogs in forest areas or hedgerows? We need to know more about hedgehogs in arable landscapes, including non-grain crops, since arable farming occupies so much of our modern countryside. Studies in grassland habitats create an impression that this is major hedgehog habitat, but modern grassland management, including recreational areas, may ruin apparently suitable habitat through specialist chemical treatments. We need to know more about this, and about the availability of macro-invertebrate food items in different habitats to get a better understanding of hedgehog ecology in the 21st century.

Abstract 2.

National Hedgehog Survey: The first field based national survey of hedgehogs in England and Wales.

Ben Williams

University of Reading, UK.

Agricultural landscapes have become increasingly intensively managed resulting in population declines across a broad range of taxa, including insectivores such as the hedgehog (*Erinaceus europaeus*). Hedgehog declines have also been attributed to an increase in the abundance of badgers (*Meles meles*), an intra-guild predator. The status of hedgehogs across the rural landscape at large spatial scales is, however, unknown. This is, in part, due to the lack of a suitable survey method.

In this study, we used a novel method, footprint tracking tunnels, to conduct the first field based national survey of rural hedgehog populations in England and Wales. Single and two-species occupancy modelling was used to quantify hedgehog occupancy in relation to habitat and predator covariates.

Hedgehog occupancy was low (22% nationally), and significantly negatively related to badger sett density and positively related to the built environment. Hedgehogs were also absent from 71% of sites that had no badger setts, indicating that large areas of the rural landscape are not occupied by hedgehogs.

Our results provide a robust baseline for future monitoring. Furthermore, the combined effects of increasing badger abundance and intensive agriculture may have provided a perfect storm for hedgehogs in rural Britain, leading to low levels of occupancy over large spatial scales.

Abstract 3.

Volunteer surveys reveal an uncertain future for the last breeding population of hedgehogs in central London.

John Gurnell¹, Nigel Reeve², Clare Bowen³ & Tess Pettinger³

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Since the early 1970s hedgehogs have disappeared from all central London Royal Parks except The Regent's Park. However, and despite casual reports of their presence, up until six years ago little was known about how many hedgehogs there were and where they lived in the park, and their risk of dying out. To address this lack of knowledge, since 2014 a series of studies have been carried out by a partnership of different organisations and volunteers. Here we present the results from twice-yearly systematic spotlighting surveys carried out within the park between 2014 and 2018. On two consecutive Friday nights each spring and autumn, up to 50 volunteers, in teams of 4-6 individuals, surveyed different zones within the park using torches and thermal imaging cameras, either between 21.00 and 01.00 (2014-2015) or 21.00 and 04.00 (2016-2018). Hedgehogs were captured by hand then sexed, weighed, examined for ectoparasites and injuries, and given a unique ID using coloured or numbered plastic sleeves glued onto their spines. The surveys have revealed that the numbers of hedgehogs are small, averaging just over 20 adults captured in each survey, with a low of just 12 individuals in spring 2016. Moreover, their distribution within the park is patchy and has changed over the course of the study. We consider the possible reasons for these findings and conclude that the small population of hedgehogs in TRP is vulnerable to extinction as a result of demographic stochasticity and possibly small population genetic effects.

Abstract 4.

Results from the London Hogwatch, a large-scale camera-trap survey of urban European hedgehogs.

Chris Carbone

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Preliminary results from the London Hogwatch, a camera-trap based survey of European hedgehogs in London parks, green spaces and private gardens will be presented. I will explore differences in hedgehog and fox ecology in order to gain greater insights into the differences in distribution and status of these two important urban mammals. One of the key challenges is to develop survey methodology that is effective and provides an accurate estimate of abundance and distribution in elusive nocturnal species which are located in public spaces intensively used by people. Citizen science elements of the project include, the use of volunteer networks from local conservation groups, and the use of citizen science data bases (e.g. the National Biodiversity Network) to develop a London-wide distribution map and target new camera trap survey sites; and surveys of private gardens to gain an understanding of the species' mobility and access to foraging sites.

Abstract 5.

Using camera trapping to estimate population densities of hedgehogs across urban and rural British landscapes.

Jessica Schaus-Calderon

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(PhD candidate, jointly funded by People's Trust for Endangered Species, the British Hedgehog Preservation Society and Nottingham Trent University)

Reliable population size and abundance are crucial for effective wildlife management. However, the biggest challenge for ecologists is to find standardised methods that can be implemented across different landscapes for the long-term monitoring of species. Camera trapping in combination with the Random Encounter Method (REM) is proposed as a cost-effective way of achieving this. This study compared hedgehog density estimates and survey effort costs generated from camera trapping and traditional spotlighting and capture mark recapture methods across nine urban and rural areas. A total of 937 cameras were deployed, resulting in 44655 hours of survey effort, and 1010 independent videos of hedgehogs were recorded. Repeated spotlight surveys resulted in 1360 km walked and a total of 131 hedgehogs being captured and marked. Both methods produced comparable density results across sites. However, start-up costs (equipment) and human resources were significantly higher for the camera trapping surveys, especially in urban areas. The implications of these results for estimating hedgehog densities in a cost efficient manner for monitoring are discussed.

Abstract 6.

The density and spatial ecology of the invasive hedgehogs on North Ronaldsay.

Richard Yarnell

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Hedgehogs were introduced to North Ronaldsay in the Orkney Islands in 1972, and by 1986 had increased in number to an estimated 500 individuals (Warwick 1986). Since then, the hedgehogs have been implicated as being predators of ground nesting birds on the Island and impacting on bird breeding success. This study aims to: 1) provide the first density estimate of hedgehogs on the Island since 1991 by using Spatial Explicit Capture Recapture Methods and; 2) to identify whether hedgehogs are selecting sensitive bird breeding areas during foraging via GPS tracking of 18 individuals. The results will demonstrate key habitat and movement features of hedgehogs shared with mainland counterparts, and will inform future studies that aim to quantify the risk that hedgehogs cause to ground nesting birds on North Ronaldsay.

Abstract 7.

Intra-guild Predation; a study of the European badger (*Meles meles*) and the European hedgehog (*Erinaceus europaeus*), identifying the limiting factors of their coexistence.

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(PhD candidate, jointly funded by People's Trust for Endangered Species and Nottingham Trent University)

Increasing badger numbers have been implicated in the decline of hedgehogs in the UK, although it is unknown whether direct predation or increased competition for food explains this negative relationship. This project will aim to determine what habitat features enable the two species to co-exist in rural areas in order to advise farmers how to sensitively manage the land to support both species. Preliminary results from a study of 10 rural sites across England and Wales will be presented, highlighting the numerical and spatial relationship between these species to date, with patterns of separation emerging within their local distributions and an overall negative correlation between badger and hedgehog density. The underlying mechanisms that are exerting this negative pressure, whether it be; food availability, habitat constitution, predator avoidance or predation itself, and the implications of each will be discussed.

Abstract 8.

Hedgehogs living in an urban system: The Project “Igel in Berlin”

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Keywords: urbanization, fragmentation, anthropogenic influence, genetic population structure

Urbanization is a global process of the Anthropocene that involves some of the most rapid and intense human-induced transformation processes impacting wildlife. It is crucial for the survival of individuals or species to cope with those changes in urban habitats.

The European hedgehog is under protection in main parts of Europe but has experienced a serious and continuous decline in its numbers during the last decades. Nevertheless, they have nowadays higher population densities in urban areas. Therefore, for the protection and management of this species, it is important to assess the adaptation capacity and limits of hedgehogs; particularly to the urban conditions. Related to this framework, we investigated the behaviour and genetic structure of the hedgehog population in the city of Berlin.

We give an overview of how we investigated hedgehogs in Berlin using different methods, ranging from capture-mark-recapture methods over biologging (VHF, GPS and/or accelerometer devices) to genetics (microsatellites). We present our improved method to attach devices on hedgehogs, as well as a summary of studies in which this method was used. In these studies, hedgehogs showed a change of home range size and movement behaviour. We share new ways of analyzing nesting behaviour using established survival analysis. Further, we explain how we collected genetics samples of more than 150 hedgehogs with the help of different stakeholders, and how three different clusters are distributed in Berlin. Our overall aim is to share our knowledge in investigating hedgehogs to improve methods as well as to replicate our findings in other European countries.

Abstract 9.

DNA footprints: Can slugs lead the way to elusive hedgehogs?

Simon Allen & Martyn Wood,

Gower Bird Hospital, Wales, UK

The Western European Hedgehog (*Erinaceus europaeus*) appears to be in decline across much of Europe. Monitoring of nocturnal species is notoriously difficult, with a number of limitations, principally among which lies the potential subjectivity, and therefore accuracy, of results gained. *Crenosoma striatum* is a common, widely distributed nematode lungworm, utilising hedgehogs as sole definitive hosts. The intermediate host range, however, is much greater, comprising numerous species within gastropoda, a much easier group to locate and sample in both urban and rural habitats. *C. striatum* and the closely related *Crenosoma vulpis* were collected post mortem from hedgehogs and foxes respectively, while slugs were collected from Skomer Island (n=21); which is known to be free of hedgehogs; and Pennard, Swansea (n=42); known to have a healthy hedgehog population; during two sampling sessions through spring and autumn. The second internal transcribed spacer (ITS-2) of parasite rDNA was used to develop a novel PCR based multiplex assay. DNA extractions from the slug samples revealed no *C. striatum* infection in Skomer samples, whereas overall prevalence in the Pennard samples reached 10%, with no difference detected between spring and autumn samples (p=0.67). One slug from the Pennard sample demonstrated simultaneous *C. striatum* and *C. vulpis* infection, no cross reactions were observed. This study demonstrates a proof of principle in using parasite DNA to confirm the presence of an elusive nocturnal species, and indicates that the methodology has great potential as an objective, molecular based approach to supplement and add to current survey methods.

Abstract 10.

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 dramatically. In a citizen science project during 2016/2017, we assessed the current hedgehog population in Zurich with footprint tunnels and a capture-mark-recapture study as a comparison to the 1992 study. In 2018, the footprint tunnel study was expanded to other Swiss cities and the entirety of Switzerland.

Our findings show that the relative density of hedgehogs varied greatly between study areas within the city of Zurich. Most alarming were central urban areas that once had numerous hedgehogs, but today contained only few or none. Our results indicate that the current urban hedgehog population lies well below the previously estimated density and lost one third of its area. In a preliminary analysis, the amount of green space and barriers did not explain this decline. Across Switzerland, hedgehogs still seem to occur more in areas with higher percentage of settlement. We plan to expand this analysis by incorporating an investigation on 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.

Abstract 11.

Detection of hybridization in European hedgehogs.

Kristýna Eliášová¹, J. Ignacio Lucas Lledó², Miroslava Loudová¹, José H. Grau³, Pavel Hulva¹ & Barbora Černá Bolfíková⁴

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- (4) Czech University of Life Sciences Prague, Prague, Czech Republic.

Hybridization between divergent lineages has gained considerable attention lately with expansion of next generation sequencing. The development of very sensitive methods, possible to detect even very old gene exchange revealed that hybridization took place often in the history of many species. We used RAD-Seq to study contact zone of two European hedgehog species, *Erinaceus europaeus* and *E. roumanicus*. Our dataset consist of 45 specimens sampled over geographical gradient across Europe and tens of thousands loci. Using D statistics implemented in ABBA BABA test we detected shared pattern between both species, indicating hybridization. The signal was stronger among sympatric populations from Central Europe then from population living in allopatry. We also sequenced one individual previously identified as of hybrid origin with majority of the genome belonging to *E. roumanicus*. We described the distribution and density of loci originated from *E. europaeus* and its contribution to the D statistic.

Keywords: *Erinaceus europaeus*, *Erinaceus roumanicus*, contact zone, hybridization, introgression, RADseq

The project is supported by GA UK 538218.

Abstract 12.

What we know so far about the evolution of a contact zone of hedgehogs: the land where East meets West.

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One decade of research of hedgehogs in Central Europe brought many interesting information about the closely related species living in sympatry. Secondary contact of the European Hedgehog (*Erinaceus europaeus*) and the Northern White-breasted Hedgehog (*E. roumanicus*) was established during the Neolithic deforestation. Genetic studies confirmed different recent population structure and different patterns of population trends within the species. Study of parasite fauna of both species in sympatry indicated that the species also differ in trophic niches as the most pronounced pattern was observed in the intestinal parasites. Morphometric study of skulls confirmed, that the species differ in size and shape of the skulls, but interestingly, in the sympatry, the species are more similar to each other than in allopatry. This trend is opposite to character displacement which is usually described in the transition zones. Genetic data based on the microsatellite markers showed that the recent hybridization is very rare in Central Europe, but we suggest that some level of gene flow was important during the formation of the contact zone. Project is supported by IGA CULS 20185018.

Oral papers presented Saturday 23rd February 2018

Abstract 13.

What has research ever done for us? (and what do we still need it to do?). An overview of past and potential contributions from science to wildlife rehabilitation practice.

Keynote speaker: Terri Amory, Chair, British Wildlife Rehabilitation Council, UK.

Wildlife rehabilitation protocols have often been developed by practitioners in relative isolation and based on 'common sense' and trial and error. In recent decades research has been carried out to try to provide an evidence base for continuation of the practice as a whole, as well as protocols within it – but on a limited scale, and most commonly through case study rather than controlled trials.

Monitoring of post-release behaviour and survival has been used to evaluate the success of wildlife rehabilitation in a limited range of species. Post-release survival has been demonstrated in species including hedgehogs, foxes, common seals, pipistrelle bats, polecats, woodpigeons and tawny owls though few studies go as far as to provide evidence of breeding and therefore perhaps full reintegration into a wild population (Grogan & Kelly 2013). While some work has been published on clinical diagnosis and treatment of wildlife casualties (Grogan & Kelly 2013, Mullineaux 2014) few studies have undertaken to compare different care or treatment protocols used prior to release.

A number of organisations have undertaken, independently and collaboratively, to interpret the results of research in formats intended to be more accessible to non-scientist or directly into practical advice. Actual protocols used in many centres are not known/ published outside of those centres, making it difficult to assess how much influence research results have had on rehabilitation practice in smaller organisations.

This presentation will examine if, and how, research into wildlife rehabilitation has contributed to wildlife rehabilitation practice in the UK. It will also identify areas where further research could contribute to improving the welfare of wild casualties in captivity, and the success of the wildlife rehabilitation process as a whole.

Abstract 14.

Should rehabilitated hedgehogs be released in winter? A comparison of survival, nest use and weight change in wild and rescued animals.

Dawn Scott

Authors: Richard W. Yarnell¹, Joanne Surgey¹, Adam Grogan², Richard Thompson³, Kate Davies⁴, Christina Kimbrough⁴ & Dawn M. Scott⁴

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The rehabilitation of sick or injured wildlife and their subsequent release back into the wild is considered important, not only for the welfare of the individual animal but also for the conservation and management of endangered and threatened wildlife. The European hedgehog *Erinaceus europaeus* has declined by 25% in Britain over the last decade and is the most common mammal admitted to wildlife rehabilitation centres in Britain, with a large proportion of individuals admitted to gain body weight overwinter prior to release in the Spring. Consequently, many thousands of hedgehogs are housed overwinter which incurs significant costs for rehabilitation centres, and has potentially animal welfare issues, such as, stress in captivity, reintroduction stress, increased mortality risk and impaired or altered behaviour. To determine if releasing rehabilitated hedgehogs during autumn and winter had an effect on their survival, body weight, or nesting behaviour, we compared these factors between 34 rehabilitated hedgehogs with 23 wild hedgehogs across five sites in England over a four different winters. Overwinter survival was high for both wild and rehabilitated hedgehogs, with a significant decrease in survival in Spring across both groups when hedgehogs became active post hibernation. We found no difference in the survival rates up to 150 days post release, weight change, or nest use between wild and winter released rehabilitated hedgehogs. Our results suggest that under the correct conditions, rehabilitated hedgehogs can be released successfully during winter, therefore avoiding or reducing time in captivity.

Abstract 15.

West European Hedgehog (*Erinaceus europaeus*) habitat selection and survival over-winter in arable dominated landscapes in the UK - initial findings.

Lucy Bearman-Brown^{1,2}, Richard Yarnell³, Antonio Uzal³ & Philip Baker¹

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With significant declines in hedgehog populations recorded nationally, particularly in arable farmland, this study explored overwinter survival and nest utilisation in an arable dominated landscape. Twenty-two hedgehogs were radio tracked over two winters, resulting in 1048 diurnal fixes and 482 nocturnal fixes. 137 nest sites were recorded between the two sites. The dominant structure for nests was hedgerow at the Brackenhurst Campus, and vegetation around buildings at Hartpury Campus. Survival of hedgehogs, quantified via Kaplan-Meier Survival Analysis, differed significantly between sites, although both sites demonstrated a decline in survival whilst hedgehogs were active rather than hibernating.

Abstract 16.

MRSA in Danish hedgehogs.

Sophie Lund Rasmussen

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In a Danish countrywide survey based on citizen's science, 697 dead European hedgehogs (*Erinaceus europaeus*) were collected by volunteers between May and December 2016. The volunteers were instructed to collect dead hedgehogs, record the date and location of the find, and deliver the hedgehog to the nearest of 26 collection stations, distributed all over the country.

Nasal swabs from the 188 dead hedgehogs out of 697 chosen for the study were extracted in order to determine the prevalence of methicillin-resistant *Staphylococcus aureus* (MRSA) in dead European hedgehogs. The 188 individuals selected for the study were chosen based on their geographical location to serve as representatives of the entire, Danish population of European hedgehogs.

Furthermore, 16 hedgehog rehabilitators volunteering at wildlife rehabilitation centres under the Danish Animal Welfare Society, were tested, since a case of zoonotic transfer of MRSA in hedgehogs to humans has previously been described.

The sex distribution of the 188 hedgehogs used in the study was 102 males, 56 females, and 30 individuals of unknown sex. 98 of the 188 hedgehogs were road-kills, 25 had died from natural causes in the wild, 16 had died in the wild from unknown causes and 49 had died in care.

A total of 114 (60.6%) individuals all carried mecC-MRSA. None of the nasal swabs from the 16 hedgehog rehabilitators tested positive for MRSA.

There was no difference in prevalence of MRSA between females/males, individuals dying in care/individuals dying in the wild, and neither between road-killed individual/individuals dying from natural causes in the wild or in care. Habitat type (rural or urban) did not seem to influence the prevalence of MRSA positive hedgehogs, and in general the MRSA positive hedgehogs appeared to be relatively evenly distributed across Denmark. Our suggestion is that Danish hedgehogs are natural reservoirs of mecC-MRSA.

Abstract 17.

Endoparasites in the digestive tract of the European hedgehog (*Erinaceus europaeus*)

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Van Hall Larenstein University of Applied Sciences, Netherlands.

Contact: merelklaarmond@outlook.com Dutch Hedgehog Working Group

European hedgehogs (*Erinaceus europaeus*) in the Netherlands are declining. Most hedgehogs die due to natural causes (59%), including endoparasitic infections. Endoparasites naturally occur in the digestive tract of hedgehogs without causing any health problems. Endoparasites, however, can get the upper hand in weakened individuals. Proper treatment may be necessary, as is a correct diagnosis. Misuse of deworming agents may cause resistance of the parasite. Because humans and hedgehogs live closely together and the hedgehog is host to a wide range of (endo)parasites, the species may play an important role in transmission dynamics of zoonotic pathogens, which can pose a threat to public health. Internationally, several studies have been conducted on endoparasites in hedgehog species. However, no current national knowledge of this is available in the Netherlands. The aim of this study is to provide insight into the prevalence of species of endoparasites in the digestive tract of European hedgehogs in the Netherlands, and to investigate whether there is a relationship between endoparasitic infections and landscape types, sex and life stage. Hedgehog faeces were collected from 16 hedgehog rescue centres in the Netherlands. The faeces were examined by means of the direct smear-, flotation-, sedimentation- and Baermann method. In total, 67% (n=101) of the hedgehogs examined were positive for one or more species of endoparasites. Three species of nematodes were found (*Capillaria* spp., *Crenosoma striatum*, *Physaloptera clausa*), two types of trematodes (*Brachylaemus erinacei* and *Isthmiophora melis*) and one species of protozoa (*Isospora* spp.). Hedgehogs acquire endoparasitic infections by eating the contaminated intermediate host, contact with contaminated hosts and their faeces, or other spreading mechanisms. Because many (intermediate) hosts occur in specific landscape types, it was expected that there is a relationship between landscape types and the presence of endoparasites. However, no significant effects were found for this. Female hedgehogs were found to have a greater chance of being infected with *Capillaria* spp. than male hedgehogs. Also, a relationship was found between life stage and the presence of endoparasites in the digestive tract of hedgehogs. Adult animals were more likely to be infected with endoparasites. In addition, adult animals were significantly more frequently infected with nematodes. Also, species-specific differences were found: adult animals had a greater chance of infection with *Capillaria* spp. than nonadult animals.

Abstract 18.

Citizen science as a tool for European hedgehog disease surveillance

Katharina Seilern-Moy, Vicky Wilkinson and Becki Lawson

Garden Wildlife Health, Institute of Zoology, Zoological Society of London, U.K

The Garden Wildlife Health (GWH) project is a national citizen science project which launched in 2013. The Zoological Society of London co-ordinates GWH in collaboration with the British Trust for Ornithology (BTO), Froglife and the Royal Society for the Protection of Birds. The aims of the GWH project are to monitor the health of, and identify disease threats to, British garden wildlife and promote best practice for garden habitat management to help safeguard wildlife health and welfare. Currently, this scanning surveillance project investigates infectious and non-infectious diseases of garden birds, birds of prey, amphibians, reptiles, and hedgehogs, relying on contributions from the general public and the BTO's Garden BirdWatch participants through a web-based reporting system (www.gardenwildlifehealth.org).

Citizen science offers a practical and cost-effective solution to conduct wildlife disease surveillance and is ideally suited to these charismatic species, many of which are of conservation concern, including the hedgehog. We aim to learn more about the impacts of disease conditions on hedgehog welfare and conservation, as well as any implications for captive animal and public health.

Since 2013, we have received over 750 disease incident reports involving hedgehogs, of which around 300 were subject to post-mortem examination. We have investigated the epidemiology and significance of several infectious agents in hedgehogs, for example *Cryptosporidium* sp., herpesviruses, *Salmonella* Enteritidis, *Listeria monocytogenes* and *Streptococcus pyogenes*. Whilst there is currently no evidence that disease is a cause of the hedgehog population decline in Great Britain, the importance of infectious and non-infectious disease remains unknown and there is a need to investigate the range of conditions affecting wild hedgehog health and their impacts.

Abstract 19.

Regeneration of pulmonary tissue during hibernation: a pilot study.

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One female, and two male, wild, mature hedgehogs were brought in to a hedgehog rehabilitation facility in Lincolnshire, England, during October and early November 2017 from three separate locations. Each hedgehog had acute respiratory problems which didn't respond to the centre's standard treatment protocol (designed by their vet). The hedgehogs were x-rayed in two different positions in December 2017 and all medication stopped. They were kept in captivity, separately, outside in large rabbit hutches and allowed to hibernate over the winter.

In April 2018 x-rays were repeated to assess bronchial patterns and the possible regeneration of pulmonary tissue and estimated values of 35% to 90% regeneration were observed. The animals' fitness for release was assessed by the centre's vet; although they were still audibly wheezing when very active, it was considered that they had a good chance of successfully resuming life in the wild. The hedgehogs were released back to the locations in the area found- and monitored by the finders using night cameras.

The female, who achieved 90% regeneration of pulmonary tissue, was recorded during courtship and was seen in late June with a litter of young. A male who achieved approximately 45% regeneration of pulmonary tissue was recorded visiting supplementary food for nine days (and he was observed by a neighbour beyond that) while the other male who achieved approximately 35% regeneration of pulmonary tissue was observed engaged in courtship and mating for several months.

Further work with a larger numbers of casualties may help to establish parameters for the prognosis and period of captivity required to achieve recovery from pulmonary disease, and the level of recovery that should be achieved for hedgehogs to be considered fit for release.

Abstract 20.

Erasure and abstraction of hedgehog extinction: Applying ecolinguistic analysis to Bayer's 2016 Integrated Report.

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How is Bayer, a multinational corporation producing biocides, currently accounting for biodiversity and extinction? How can extinction accounting and an extinction accounting framework (Atkins and Maroun, 2018) help mitigate the current 6th mass extinction, and the rapid decline of hedgehogs in the UK?

Taking the European hedgehog as a case study, this paper applies an ecolinguistic analysis of textual and visual semiosis (images, charts, graphs) that elicit profound ethical and political questions about animal representations, social perceptions and destruction in the form of extinction. The emerging ecolinguistic approach aims to expose, critique and raise awareness of forms of domination and hegemonic discourses that prevent constructing a positive relationship between human and nonhuman animals (Hughes, 2018). Ecolinguistics holds that emancipation of both human and nonhuman animals can be realised not only through the deconstruction of a critique of the representation of entities in texts, but also through resistance to these negative discourses and searching for a way to reshape or reconstruct discourses that can be a useful approach in imagining social change where nonhuman animals are placed at the centre.

Specifically, this paper examines erasure, a concept following Stibbe's (2012) three level abstraction for erasure to analyse which actors or goals are excluded from texts and other semiosis: (1) the void, where a complete exclusion occurs; (2) the mask, where erasure occurs through a distorted version of the entity excluded; and (3) the trace, where someone or something is partially erased, but elements of them are still present. The exclusion could be manifest through linguistic devices such as passives (a grammatical form such as 'Y' is destroyed by 'X' as opposed to the active voice 'X' destroys 'Y'), metonymy (calling something not by its name but by something associated with it, e.g., a chicken can be called a *broiler*, or *roaster*), hyponymy (a relationship of equivalence e.g., in the phrase *fish, grains and timber*, *fish* is a hyponym of grain and timber, represented as a resource), and nominalisation (a noun that derives from a verb e.g., *destruction*).

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Abstract 21.

Hedgehog rehabilitation in the West Midlands and surrounding counties.

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We currently have no understanding of how hedgehog rehabilitation is impacting on hedgehog populations. Consideration of these impacts is stipulated as an area of principal importance in the 10 year conservation strategy put forward by the conservation partnership between the People's Trust for Endangered Species (PTES) and the British Hedgehog Preservation Society (BHPS).

Grassroots conservation should always be informed by an evidence base. Datasets held by hedgehog welfare organisations could, and should, contribute towards this evidence base. Information pertaining to reasons for admission, locations of admission and release could all contribute significantly to our understanding of problems hedgehogs are facing at a local level.

With funding from the BHPS, the Warwickshire Wildlife Trust has collected and collated data from several hedgehog rehabilitators in the West Midlands and surrounding counties. It is intended that analysis of this preliminary data will provide insight into a widespread and understudied practice in the region. Combining findings from untapped data sources has the potential to benefit hedgehog populations in the long-term by revealing unknown trends and potential contributing factors to hedgehog decline. Moreover, this partnership work fosters a greater connection and crossover between the work of hedgehog welfare organisations and the work of conservationists.

Abstract 22.

The Danish hedgehog project, results status and future perspectives.

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In a Danish countrywide survey based on citizen's science, 697 dead European hedgehogs (*Erinaceus europaeus*) were collected by volunteers between May and December 2016. The overall purpose of the survey was to study the dead hedgehogs in order to understand the living. The volunteers were instructed to collect dead hedgehogs, record the date and location of the find, and deliver the hedgehog to the nearest of 26 collection stations, distributed all over the country. The dead hedgehogs were kept in freezers at -20°C until they were thawed and autopsied. The autopsies took place from August 2016 to May 2018. The massive data set is representing all areas of Denmark.

The entire data set of 697 dead hedgehogs consists of 505 road-killed individuals, 93 individuals dying in care, 71 that died naturally in people's gardens, and 28 with an unknown cause of death (either naturally in the wild or due to traffic).

The gender distribution is: 133 females, 216 males and 348 individuals of unknown sex.

Current status: A study on MRSA in Danish hedgehogs will soon be published. Research into the genetics of the Danish hedgehogs is well underway (samples from all 697 individuals), detecting inbreeding and genetic diversity between hedgehogs residing on the Danish islands. Parasitology has been performed on livers, hearts, lungs and intestines of 297 individuals. Furthermore, the following samples have been extracted and prepared for future research:

- Fecal samples from 195 individuals for diet analyses (DNA)
- 145 samples from 106 different individuals fixed in formalin for histological examinations, out of which 47 samples *may* be cancerous.
- Toxicology samples (liver and fat tissue) from 275 individuals
- 245 samples (stomachs) for microbiome analyses
- 402 skulls in varying conditions, for age determinations and dental examinations
- Kidneys and spleens from 219 individuals

A demographic modelling approach will eventually be performed based on past, current and future research on the Danish hedgehogs in order to describe and attempt to predict the conservation status of the Danish hedgehogs.

Abstract 23.

How a dedicated team of volunteers is annually monitoring the last population of hedgehogs in Central London.

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The hedgehog population in The Regent's Park (The Royal Parks, London, UK) is isolated, vulnerable and in need of active conservation. In this paper, we describe how in 2014 we initiated and managed a continuing programme of research and population monitoring with the help of partner organisations and hundreds of dedicated volunteers recruited from a wide range of backgrounds. These volunteers, trained and supervised by our project scientists, have carried out systematic nocturnal surveys of hedgehogs involving four field sessions per year; two in early May and two in early September. As the number of experienced volunteers has grown, these individuals have also taken on supervisory roles – leading field survey groups. The design of data collection protocols has been critical in ensuring efficient data recording and storage, and maximising the quality of data gathered on, for example, population size, distribution, habitat preferences and movement patterns of hedgehogs. Such data have helped to inform the park management team's actions to improve conditions for hedgehogs in the park. The on-going recruitment of volunteers, ensuring a high quality of experience for those involved and the loyalty of experienced long-term participants have all been crucial to the success of the project. There is no doubt that the nocturnal fieldwork experience captured the volunteers' hearts and minds. These interested amateurs have now become strong advocates of hedgehog conservation, an important and valuable legacy of the continuing programme.

Poster papers presented 22-23 February 2019

Poster abstract 1.

Nesting behavior of the European hedgehog (*Erinaceus europaeus*, Linnaeus, 1758) under direct anthropogenic influences.

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Keywords: *Erinaceus europaeus*, urban wildlife, nesting behaviour, anthropogenic disturbance

Urbanization is a global process of Anthropocene that also affects wildlife. In an urban environment, animals have to cope with increased direct and indirect human influences on their habitat. Beside indirect and mostly slow changes like light pollution or climate change, there are also a lot of direct and mostly fast changes which occur within days or weeks and, thus, affect the animals daily life. The reaction to those changes of habitat is important for survival of the individual or species. Related to this framework, we investigated the effect of a festival on the nesting behavior of European hedgehogs in an urban park. As a nocturnal insectivores species, hedgehogs rely on nest during day to sleep and rest. The festival took place on two days (plus 18 days of construction and deconstruction work) having about 140,000 festival visitors. During the research period from August until September 2016, 17 hedgehogs (9 male, 8 female) were captured within the festival area and fitted with a VHF radio-transmitter. Daily controls of the nest use of every tracked hedgehog were carried out. Data was analysed with respect on the effect of the festival on the nesting behaviour comparing periods before and during the festival respectively construction work.

Survival analyses of the nest use show a different result for male and female. During the festival, male hedgehogs significantly decreased their time using the same nest, while, females did not change the nests more than before the festival. Taking into account that some of the tracked female hedgehogs did care for hoglets during that time could be an explanation why they were not able to change the nest.

In summary, male hedgehogs changed their nests more frequent during the whole festival (including periods of construction and deconstruction), while, females showed no significant difference.

It is not clear how the hedgehog population is or is not affected in the long-term or energy metabolism by those big events but further analyses in the project "hedgehogs in Berlin" will investigate also the influence on the movement and the rhythmic behaviour using data from GPS and accelerometer devices to get more information about the short term reactions.

Poster abstract 2.

How to be sure of hedgehog absence before building projects, bush pruning or clearing events?

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European hedgehogs (*Erinaceus europaeus*) are nocturnal, solitary, hibernating, ground-dwelling insectivores. Particularly in Great Britain, there is a threatening decline in the hedgehog abundance of which the causes are being speculated. In Germany, hedgehogs are strictly protected but population development is not known as monitoring would be very complex due to the hedgehogs' way of life.

According to the German federal law on nature protection (BNatSchG §42), it is not allowed to remove, damage or destroy the daytime or the winter nests of hedgehogs. These nests are mostly hidden in bushes close to meadows but they cannot be discovered by simple visual inspections of the bushes. Hence, nightly spotlighting was described as the most effective method to detect hedgehogs. However, nocturnal spotlighting is highly time-consuming and unreliable for consultancy or planning offices. Thus, hedgehogs are mostly not considered during local building or planning work. Moreover, out of respect for breeding birds and by law, most pruning or wood clearing work is done during the hibernation period of the hedgehog (November until April) in which these animals are unable to escape or move.

Wildlife detection dogs (trained on hedgehog odour) can be used to detect and indicate the hidden hedgehog nests. The dogs can work during the day in both summer and winter. As the hedgehogs stay in their nests at these times, a systematic search is possible. When indicating the nests, the dogs should not touch it in order to not disturb the animals in the nest. Hedgehog detecting dogs are now used in Zurich, the Lucerne region (Switzerland) and in Berlin (Germany). Considering the decline in the hedgehog abundance, hedgehog detecting dogs are recommended to be used as a standard method in consultancy or planning offices during local planning and building processes. Using detection dogs will greatly improve the feasibility of removing the hedgehogs temporarily from the danger zone to protect the animals.

Poster abstract 3.

An evaluation of thermal infrared cameras for surveying hedgehogs in parkland habitats.

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Direct observation is frequently used to monitor animal populations and infrared thermography, or thermal imaging, offers a non-invasive method to assist the detection of animals when carrying out such surveys. So far, infrared thermography has been evaluated in respect to several animal and bird species including antelopes, giraffes, big cats, deer, wild boar, foxes, rabbits, hares, bats and marshland birds. Spotlighting is a widely used direct observation method to survey hedgehogs using torchlight, but in Ireland Haigh et al. 2012 reported that thermal imaging was not very effective at detecting hedgehogs. Here we report on the effectiveness of using hand-held thermal infrared cameras (model FLIR E-60) during volunteer, spotlighting surveys of hedgehogs in The Regent's Park, London between 2015 and 2018. We found that infrared cameras were helpful at detecting hedgehogs at greater distances than torchlight in the open habitats within the park. We evaluate this finding and note the limitations to their general application. However, as thermal imaging cameras are now becoming increasingly available and cheaper to buy, we believe they offer a very useful tool to assist the more traditional use of torches during spotlighting surveys.

Poster abstract 4.

Admission and survival trends in animals admitted to RSPCA Wildlife Rehabilitation Centres.

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We examined admission and survival trends in 19577 hedgehogs admitted to 4 RSPCA centres over a 13 year period (2005, 2017). 3065 animals died or were euthanased before admission was complete. 2605 additional animals admitted outside the breeding season were excluded. The remaining 13907 animals, made up of 6848 adults, 4001 first litter, and 3058 2nd litter juveniles, underwent further analysis. Admissions increased by 60 animals a year, more than doubling over the study period, by the same approximate proportion in each age category. 53% of animals had a specific admission diagnosis, grouped as trauma, malnutrition, and orphan. Proportions of trauma and orphan admissions were unchanged over the study period, but malnutrition admissions increased 17%. Trauma admissions decreased over the breeding season; malnutrition admissions increased. Admission weights were greater in 2nd than first litter juveniles. Survival improved 26% overall in the study period, 33% in juveniles. 3007 (22%) animals died or were euthanased within 48 hours of admission. Including these, Kaplan-Meier analysis gave survivor functions of 0.78 at 2 days, 0.66 at 10 days, 0.62 at 20 days, and 0.53 at 80 days. Survival was independent of admission weight in each age category. It was greater in first litter juveniles than in adults or 2nd litter juveniles; and across the breeding season diminished in juveniles and increased in adults. These data are of value in assessing the contribution of wildlife rehabilitation centres, providing insight into events in the wild, and directing future conservation efforts.

Poster abstract 5.

The Hedgehog Housing Census: What makes a house a home?

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Hedgehog houses are artificial nest boxes designed to be suitable for use by hedgehogs (*Erinaceus europaeus*) for resting, hibernating and raising hoglets. They are a familiar feature found in residential gardens across the UK, and in recent years, an increasing number of designs have been made available in supermarkets, garden centres and online retailers. In addition, many internet and printed tutorials – including those produced by conservation campaigns such as Hedgehog Street – provide guidance on how to make homemade houses.

In recent years, it has become evident that urban areas serve as important strongholds for the declining UK hedgehog population. Incorporating hedgehog-friendly features into residential gardens such as nest boxes could therefore be an effective management tool for conserving this species. However, little is known about the effectiveness of hedgehog houses and what constitutes a good design. As such, Hedgehog Street launched the Hedgehog Housing Census (HHC) – an online questionnaire survey – during August–October 2017. The survey sought to measure how hedgehog houses are used (e.g. extent of use and nest type) and what affects this (e.g. house features, house positioning, garden features). Overall, 5,273 respondents completed the questionnaire, with 62% reporting on commercially available houses and 38% reporting on homemade houses.

Preliminary analysis suggests that providing food and bedding in the garden increases the likelihood of a house being used for all nest types. In addition, it is suggested that homemade houses are more likely to be used than commercially available houses – this could be due to the reported homemade houses having more favourable features, materials or dimensions, and analysis is underway to investigate this further. Finally, the results indicate that the positioning of the house may affect how it is used during different seasons.

The information gathered from this study can inform householders on the preferred hedgehog house design, and highlights the value of using artificial nest boxes to increase nest site availability for hedgehogs in urban areas.

Poster abstract 6.

A curious distributional shift of hedgehogs in a London Park.

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Between 2014 and 2018, nocturnal spotlighting surveys of the small resident population of hedgehogs in The Regent's Park, London were carried out by volunteers each spring and autumn. To standardise survey effort, the 166ha park was divided into seven approximately equal zones. During each survey, groups of 4-6 volunteers searched for hedgehogs following predetermined routes for a set amount of time in each zone using torches and thermal imaging cameras. The position of each hedgehog found was determined using a hand-held GPS tracker and marked on a map. Although the number of individuals found in each zone varied from one survey to the next, over the five-year period of study, there has been a noticeable distribution shift within the park with animals largely disappearing from the western and southern zones and occurring most often in central and north eastern zones. This apparent shift in the distribution seemed to occur after population numbers hit a low in spring 2016. We speculate on the reasons for this shift and what it might mean for the future of this vulnerable population.

Poster abstract 7.

Going the whole hog – a community approach to hedgehog conservation.

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In response to declines of the Western European Hedgehog *Erinaceus europaeus* in the UK and the increasing importance of urban areas for the species, a two-year community engagement project was launched by Suffolk Wildlife Trust with efforts focussed within the town of Ipswich, Suffolk. The project had a multi-faceted remit with a major focus on awareness raising and delivering conservation action as well as an involvement in a wider research project. A variety of different approaches have been taken with positive outcomes for both hedgehogs and people; this poster briefly outlines some of the activities and lessons learnt in the hope that our actions and successes can be useful for similar community projects elsewhere

Poster abstract 8.

An improved identification marking method for hedgehogs.

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As part of a long-term study of hedgehogs in The Regent's Park (London, U.K.) begun in May 2014, we developed and tested an improved identification marking method using 10 mm lengths of yellow plastic sleeving (heat-shrink polyolefin) bearing pre-printed animal identification numbers. During twice-yearly study periods, six spines on each hedgehog were marked with duplicate numbers in a single central patch just behind the crown of the head; easily visible in both active and rolled-up hedgehogs. From May 2016 (animals marked in September 2015) to May 2018, the mean number of tags remaining in the pelage after eight months (September to May) was 3.78 (SE = 0.24, n = 45) and 4.16 (SE = 0.31, n = 25) after four months (May to September). In five additional cases, individuals were easily identified after periods of one year or more. The tags have minimal welfare implications, do not interfere with the function of the spines and can be easily read by anyone finding the animal. We conclude that this method is very effective, requires minimal handling and is suitable for use by volunteer field workers. Only one marked spine allows correct identification, making it especially suitable for identifying road-killed, partially eaten or decomposed hedgehogs.

Poster abstract 9.

A critical look at the use of GPS tags to study the movements of hedgehogs in a London park.

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Based on studies reported in 2013, Glasby and Yarnell recommended that Global Positioning System tags should be considered for studying the spatial dynamics of hedgehogs and other small mammal species, despite fix location errors that occur particularly in certain types of habitat such as woodland. Work on the small population of hedgehogs living in The Regent's Park, London, has been ongoing since 2014 and during spring and autumn surveys in 2014 and 2015, we investigated radio- and GPS tracking of individual animals. First, we carried out static tests on the accuracy of fix locations of GPS tags placed in different types of habitat. We then fitted radio- and GPS tags to selected animals (N = 6 to 9) and followed them for 7 days and nights. Here we present examples of how the tracking techniques have been used to estimate distances moved, home range size, nest placement and use of habitat, taking into account fix location errors where possible. Based on these findings, we believe GPS are useful, but there are benefits to using combined radio- and GPS tags rather than just GPS tags for studying hedgehog spatial behaviour.

Copies of this book of abstracts may be downloaded from
The Royal Parks website: www.royalparks.org.uk/hedgehog



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