

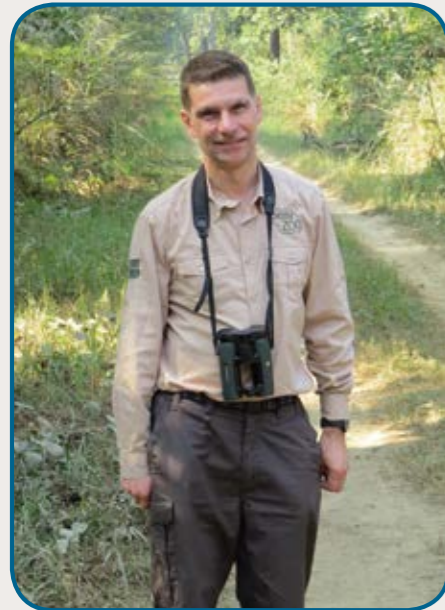
2017 SCIENCE REVIEW

Reporting period January to December 2017

African painted dog (*Lycaon pictus*)

CONTENTS

Foreword	4
Supported conservation and science projects	5
Our year in highlights	6
Conservation & science news	8
Biodiversity surveys and ecological monitoring	12
Conservation breeding and management	16
Human-wildlife conflict/livelihoods and sustainable developments	22
Visitor and community engagement	26
Wildlife health and wellbeing	32
Science communication	36
One-year industrial placement students	38
Chester Zoo conservation fellows	40
Chester Zoo conservation scholars	40
Collaborating institutions	42
Publications & conference presentations	44



Welcome to our Science Review for 2017. Our scientific programme is central to our conservation and education work which is directed at preventing extinction of species around the world. This task is more pressing than ever as we face what has been described as 'the sixth mass extinction' which is the first one due to anthropogenic causes. Our scientific activities are designed to maximise our conservation impact through providing the evidence base for effective action.

Our scientific work is organised around our six specialisms which are stated on the following page and in the pages of this report you will find articles written by a wide variety of people involved in developing these specialisms and delivering scientific projects at Chester Zoo. They include our Applied and Conservation Science staff, members of our Curatorial, Veterinary, Field Programmes and Discovery and Learning teams and our Conservation Scholars and Fellows. We believe that for science to be relevant and effective in informing conservation management it has to be fully integrated into our work and our holistic approach to this is reflected in this review.

Communication of our scientific activities to all areas of society is an important priority and in 2017 we appointed a Science and Conservation Communications Officer to strengthen our team. Our participation in an increasing number of science outreach events, together with our Wildlife Connections festival and our symposia, reported on in the events section of this report on page 36 and 37, have served to raise awareness of our work and inspire the next generation of conservation scientists.

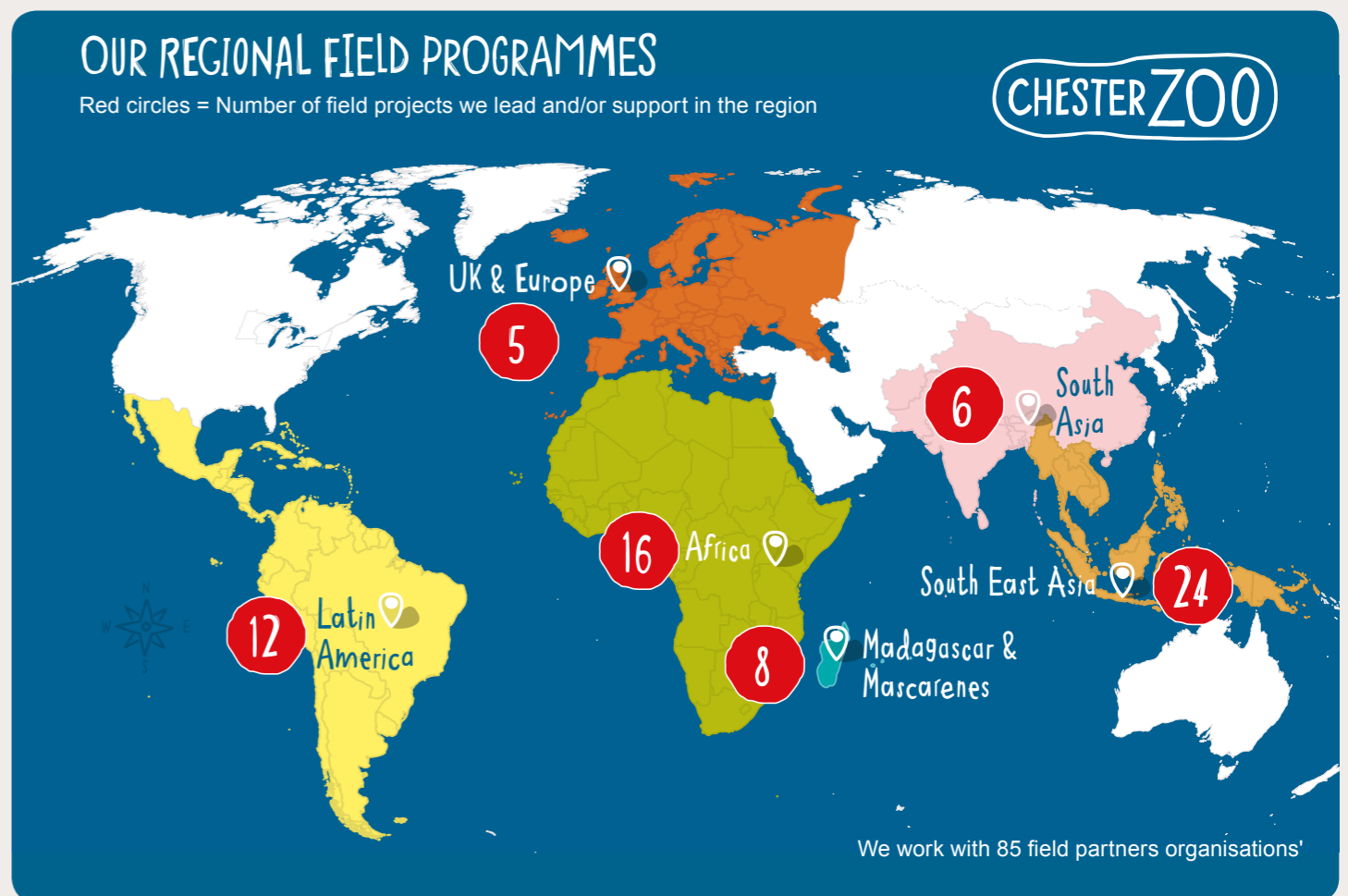
A particular highlight of the year was the conference we co-hosted with the Natural Environment Research Council in April on the Future Direction of Conservation Science. The conference was aimed at PhD students from two of the NERC Doctoral Training Partnerships and

enabled us to bring together our growing band of Conservation Scholars and Fellows to showcase their work and debate the future priorities for conservation with a number of eminent speakers from international conservation organisations. This was an important element of our scholarship programme which aims to train the conservation practitioners of the future and prepare them for the challenges ahead. Further details can be found on page 36.

A vital part of our efforts towards preventing extinction involves working with people to inform, empower and inspire positive behaviour change for a healthy environment. We draw on the social sciences to underpin this work both in the zoo through research to inform our public engagement activities and in the field through our carefully planned interventions in communities living with wildlife.

Our scientific activity continues to expand across all areas. In 2017 we led or facilitated 71 projects by providing financial and/or technical support to our partners. We also supported 49 research projects and provided biological samples to a further 22. A total of 70 projects were conducted through our undergraduate training scheme by students from 19 universities. Our staff, scholars and fellows were authors or co-authors of 37 peer reviewed papers during 2017 and gave 78 presentations at national and international conferences and symposia. Further details can be found towards the end of this review and on our website chesterzoo.org/conservation. To keep up to date with our scientific activities you can also follow us on twitter @ScienceatCZ.

Dr Simon Dowell
Science Director

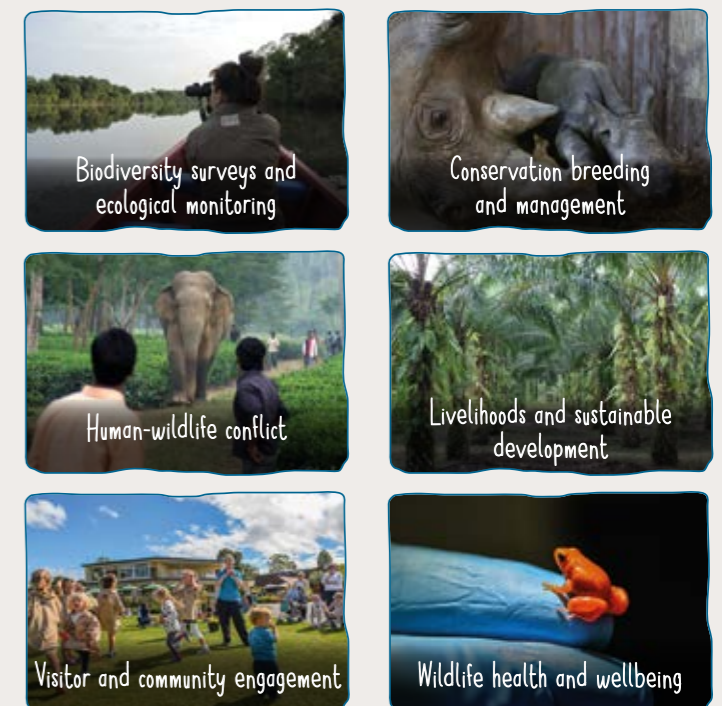


RESEARCH WE SUPPORTED

- 70** Undergraduate Students
- 23** Chester Zoo Conservation Scholars (PhDs)
- 48** External PhD Students and research professionals
- 7** One-year industrial placement students
- 3** Chester Zoo Conservation Fellows (Postdocs)

From **30** universities and colleges

OUR SIX SPECIALISMS



OUR YEAR IN HIGHLIGHTS



JANUARY

Our expedition team headed to Ecuador to collect crucial data on the endangered Ecuador Amazon parrot. The expedition's objectives were to search for the elusive parrot's nests, to collect data on their habitat, to conduct roost counts but also to launch the pilot of our first community survey in the region.

FEBRUARY

A High-Performance Liquid Chromatography machine was installed in our science laboratory allowing us to develop a method to monitor the reproductive health of our animals from faeces.



MARCH

- Phase 2 developments of our Nature Reserve progressed quickly with several south-facing banks, two ponds and a viewing platform created and a total of 450 native tree saplings planted.
- In Nepal, as part of our Living with Tigers project, the first season of camera trapping in Bardia National Park resulted in the detection of tigers in over half of the 97 grid cells being studied and in addition, leopards were recorded in 22 grids.



APRIL

- Chester Zoo Conservation Fellow, Dr Tanja Maehr, began vital research into EEHV through a post-doctoral position that has been funded by our Never Forget campaign.
- The 'Future Directions in Conservation Science' symposium brought together professionals and students to discuss current issues, explore new opportunities and identify the priorities for the next generation of conservation research.



MAY

Conservation Fellow, Dr Ximena Velez-Liendo, was a winner of a prestigious Whitley Award for her work protecting threatened Andean bears in Bolivia. Our partner Indira Lacerna-Widmann was also a winner at the ceremony for her work on the rare Philippine cockatoos.



JUNE

- Our scientists published a new study that reveals the positive impact that education campaigns in zoos and aquariums can have on members of the public.
- We provided financial support for and attended a workshop run by our partners the Giraffe Conservation Foundation and the Ugandan Wildlife Authority to develop the first ever national strategy for giraffe conservation in Uganda.



JULY

Our conservationists presented their research at the International Congress for Conservation Biology 2017 in Colombia and our one-year industrial placement students all presented their research projects at the BIAZA Research Conference in Edinburgh.

AUGUST

- Conservationists from Chester Zoo gathered together fruit growers, netting experts and government officials in Mauritius for the first time in a joint effort to develop new solutions to resolve conflict between farmers and crop raiding bats.
- New research, published by our Conservation Scholar, Luiza Passos, assessed the differences in anti-predator behaviour between golden mantella frogs from the zoo and from the wild.



SEPTEMBER

- We grew Llangollen whitebeam trees, one of the rarest trees in the world, using seeds obtained from the Millennium Seedbank at Kew and we conducted a comprehensive survey of the cliffs where the trees grow in the wild.
- We published a report highlighting the impact of volunteering in zoos. 19 BIAZA collections took part in the research which revealed significant positive self-reported impacts.



OCTOBER

- Members of our Discovery and Learning team went to Indonesia to deliver a two-day education and engagement workshop prior to the Indonesian Zoo Association Conference.
- A documentary about the work we are conducting in Indonesia on songbirds aired on BBC News Our World.



NOVEMBER

- Conservation Scholar and Manchester University PhD student, Nick Harvey was among the winners of The British Ecological Society's annual photography competition in the category Ecology in Action with his photo of a white rhino being translocated from a small reserve in South Africa.
- Our Wildlife Champions project reached a significant milestone with a total of 100 champions trained over the past two years.



DECEMBER

- Our South East Asia Field Programme Coordinator appeared on live TV to talk about her re-discovery of the rare Javan warty pig with BBC Breakfast.
- The Living with Tigers project recently commissioned an external expert to conduct a livelihood and market analysis study within our project study sites.



Chester Zoo Conservation Scholar and Fellow Programme

Over the past year Chester Zoo's Conservation Scholar & Fellow Programme has continued to develop and we are now proud to be supporting 23 postgraduate research students from eight different institutions. We welcomed nine new Conservation Scholars and Fellows to our programme in 2017. These PhD students and postdoctoral researchers are working on a diverse range of topics across a variety of species from the ecology of Indonesian songbirds to the population performance of Grevy's zebra (*Equus grevyi*). Four of our Conservation Scholars completed their studies this year: Luiza Passos who studied the fitness of golden mantella frogs (*Mantella aurantiaca*) (see pages 18-19), Oliver Hughes who conducted his PhD on orchid-mycorrhizal fungi interaction (see pages 20-21), Jessica Lea who studied the ecology and physiology of Cape mountain zebras (*Equus zebra zebra*) (see below) and Becky Titchard who studied scent communication in eastern black rhino (*Diceros bicornis michaeli*) for her master's degree.

Award Winning Science

The Andean bear project, a collaboration between Chester Zoo, WildCRU and the Bolivian NGO PROMETA, was among the winners of the prestigious Whitley Awards, often referred to as the Green

Oscars. Awarded by the Whitley Fund for Nature, the international prize honours exceptional conservationists working in grassroots conservation projects in developing countries. Conservation Fellow Dr Ximena Velez-Liendo, who is working towards understanding the level of human-bear conflicts while also monitoring the presence and distribution of Andean bears in the Inter-Andean dry forests in Bolivia received £35,000 in funding.

Indira Lacerna-Widmann, COO of the Katala Foundation, a Philippines-based organisation which successfully implemented the Philippine Cockatoo Conservation Program, was also among the winners. Supported by Chester Zoo since 2003, her project is employing former poachers as wardens and is playing a key role in conserving and restoring the most viable subpopulations of the critically endangered species and its habitat.

We were also awarded, for the fifth consecutive year, a Gold Research Award at the BIAZA Annual Conference for the work of our Conservation Scholar Jessica Lea. The PhD student from the University of Manchester uncovered the physiological and environmental drivers behind poor population performance in Cape mountain zebra by analysing key measures of population

performance: population growth rate, zebra density, and the number of foals per mare.

Our conservation work was rewarded by a Gold Conservation Award celebrating the work accomplished by the Orangutan Veterinary Advisory Group. Initiated by Orangutan Conservancy and led by Chester Zoo, the Orangutan Veterinary Advisory Group is striving to create a sustainable regional network of professionals able to provide capacity building, advice, guidance and management of One Health matters with wildlife in Indonesia and Malaysia (see pages 32-33 for more details).

Finally, we also received a Gold Education Award for our Protect Our Wildlife programme which was developed in conjunction with Chester Zoo's native species project, Wildlife Connections. Students who participated in the programme revealed positive changes associated with their knowledge of conservation and native species, pro-conservation behaviours, and attitudes towards zoos and conservation.



Searching for okapis in Uganda

In 2017, we conducted a pilot study to investigate the presence of okapis (*Okapia johnstoni*) in the Semuliki National Park in Uganda. Magloire Vyalengerera, a field researcher from the Democratic Republic of Congo helped our Field Programmes Coordinator for Africa to implement the fieldwork by sharing his

expertise in okapi surveys and monitoring but also by leading one of three teams tasked with the placement of camera traps.

The team installed 40 cameras in the forest and trained 15 Uganda Wildlife Authority rangers to recognise okapi signs. The camera traps will stay in place until next year when the team will collect them.

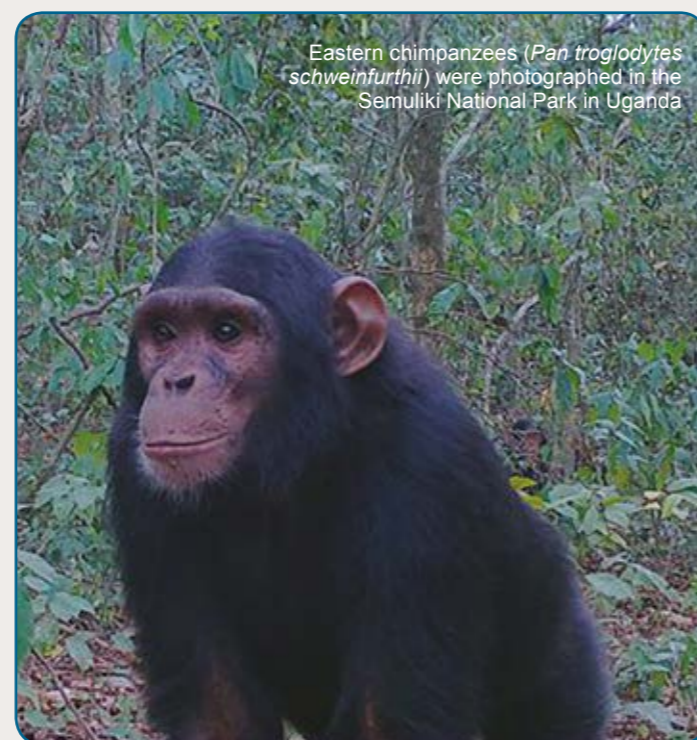
Even though no okapis were detected, the survey revealed that the forest harbours other interesting species and sub-species



such as the endangered eastern chimpanzee (*Pan troglodytes schweinfurthii*) and the African forest elephant (*Loxodonta cyclotis*). The team also confirmed the presence of leopards (*Panthera pardus*) in the park, a species that had not been reported there for several years.

Nature Reserve

We secured a grant from the WREN Landfill Communities Fund to realise our ambition to significantly expand the zoo Nature Reserve during 2017. The Phase-2 plans included converting an area of 'improved' pasture-grassland that had limited opportunities for wildlife into a species-rich wildflower meadow, with surrounding native shrubs, new ponds, a hide and a number of mounds which will provide south facing slopes for sun-loving flora and invertebrates. To do this we stripped off over 10cm of top soil on an area roughly the size of three football pitches in order to reduce the fertility and to allow space for the wildflowers to grow. We used the excess topsoil to create mounds, and harrowed and scattered locally sourced wildflower seed on most of the stripped area. Other new features include a wooden hide, an invertebrate/amphibian refuge, and meandering pathways. We excavated two large ponds that are already being used by numerous dragonflies, and kingfishers (*Alcedo atthis*) have recently been seen from our new hide.



Eastern chimpanzees (*Pan troglodytes schweinfurthii*) were photographed in the Semuliki National Park in Uganda

CONSERVATION & SCIENCE NEWS

We have instigated a new monitoring and management scheme for the reserve that we will constantly refine as we gather data on the species moving into to the restored habitats on the site. New surveys have been designed for everything from butterflies to large mammals, and we will produce an annual wildlife 'audit' as well as submitting all observations to our local records centre. The flora will be closely monitored along with the structure and composition of the new meadow using quadrat surveys. Additionally we have set up some test plots to compare how different ground preparation techniques affect the plant communities. The reserve will act as a place where the public can engage with nature, relax and enjoy the fantastic views, as well as being a place where we can run educational activities and training sessions. The new interpretation scheme will be in place for the opening ceremony after which the reserve will be free to enter for members of the public during zoo opening hours.

Elephant Endotheliotropic Herpesvirus (EEHV)

As part of a post-doctoral research study, Chester Zoo Conservation Fellow, Dr Tanja Maehr, is carrying out vital research into EEHV. The research is carried out in collaboration with the University of Surrey and the Animal and Plant Health Agency and has been funded through our Never Forget campaign.

We're also working closely with Akbar Dastjerdi, a virologist at the Animal and Plant Health Agency, who was instrumental in developing the method to detect EEHV using PCR technology. We now have the capacity and equipment to perform the tests ourselves.

This means that samples no longer have to be sent away for testing and results are known almost immediately. This will give us up to date information and help to improve the treatment of individuals that reveal positive infections.

BBC documentary about the songbird crisis produced in partnership with Chester Zoo

BBC Science reporter Victoria Gill travelled to Indonesia with a team of Chester Zoo experts in July to film a documentary about the songbird crisis.

The 20 minute-long documentary was aired on BBC News Our World programme in October. An interactive news feature, Sold for a Song, was also released on BBC News website along with some exclusive videos and pictures of Pramuka Market in Jakarta, which is known to be the largest wildlife market in the world.

Two Conservation Scholars from Manchester Metropolitan University have also started their PhD in 2017 studying the songbird crisis. Harry Marshall is researching the supply and demand within Java's huge captive bird market and Tom Squires is improving the evidence-base for the conservation management of three Critically Endangered species of 'black-winged starling'.

www.bbc.co.uk/news/resources/idt-sh/sold_for_a_song



BBC Science Reporter Victoria Gill with Andrew Owen, Curator of Birds



Chester Zoo Conservation Fellow, Dr Tanja Maehr, is carrying out vital research into EEHV.

BIODIVERSITY SURVEYS AND ECOLOGICAL MONITORING

Understanding basic ecological parameters is essential in order to implement effective conservation. Robust and accurate surveys are key research tools required to implement carefully designed monitoring initiatives. Our staff and partners are experts at surveying a wide variety of biodiversity in all of our regional programmes.

Losing lizards in the Bermuda Triangle: Assessing the status of the Critically Endangered Bermuda skink

By Heléna Turner, Conservation Scholar



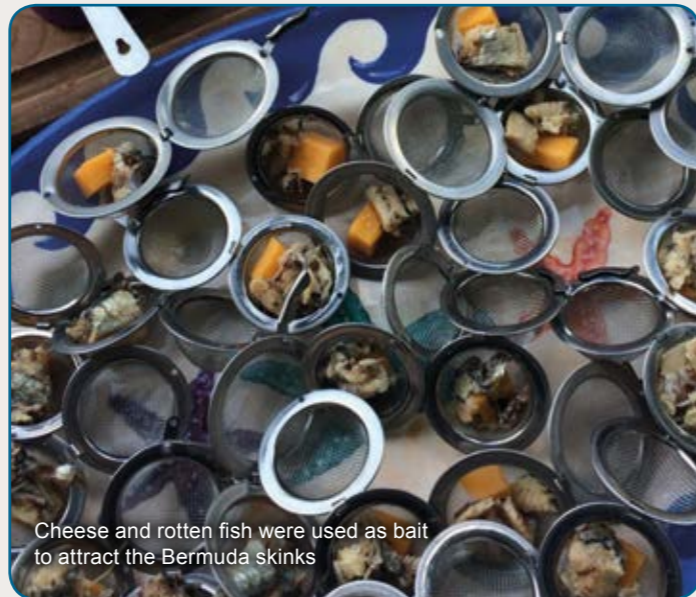
Heléna Turner, Conservation Scholar and PhD student from the University of Kent, tells us more about her research on the population and conservation of the critically endangered Bermuda skinks.

A wide variety of sampling methods have been used in monitoring studies such as capture mark-recapture techniques to estimate abundance, capture probability and survival probability of wildlife populations (Krebs 1999). Abundance and survival are critical determinants of a population's viability (White & Burnham 1999) and important for implementing effective conservation strategies. However, the choice of sampling methods can influence the reliability of reptile surveys, which is an important consideration when unbiased estimates for secretive, nocturnal or infrequently active species are required (Beebee 2013).

Although some trapping and monitoring techniques can have relatively high capture rates, they may be seasonally biased or influenced by dietary and habitat preferences, behavioural attributes and body size of the target species (Crosswhite et al.



Bermuda Skink (*Plestiodon longirostris*)



Cheese and rotten fish were used as bait to attract the Bermuda skinks

1999). During my PhD I have been assessing the distribution, abundance and status of the critically endangered Bermuda skink (*Plestiodon longirostris*). This study represents the most comprehensive review and long-term survey of this species to date. Once common throughout Bermuda, skink populations have been declining since 1965 due to several factors including habitat loss and fragmentation, anthropogenic activities and the introduction of multiple invasive species (Glasspool and Outerbridge 2005).

Using one-gallon glass jars as traps and a small amount of cheese or rotten fish as bait, the research team undertook island-wide surveys between 2015 and 2017 across a grid of traps shown in figures 1 and 2. We found skinks in 12 sites which represents 31.6% of all sites surveyed. A total of 253 individual skinks were marked with PIT (Passive Integrated Transponder) tags and were captured and subsequently recaptured 1,078 times.

By evaluating the efficiency of a capture-mark-recapture population estimation method and robust-design model, we were able to monitor trends in abundance, density, survival and capture probabilities, of the two largest Bermuda skink sub-populations in Bermuda, Castle Island and Southampton Island. We found that the robust-design model provided precise estimates of abundance where we estimated an abundance of 258 skinks (\pm SE 4.5, CI 255–275) on Southampton Island and an estimated abundance of 157 skinks (\pm SE 4.4, CI 153–172) on Castle Island. We estimated the density to be of 318 skinks/Ha on Southampton Island and 111 skinks/Ha on Castle Island. We also showed that capture probabilities were highest on Southampton Island (mean

$\hat{P} = 0.50 \pm 0.09$) compared to Castle Island (mean, $\hat{P} = 0.42 \pm 0.07$).

Although the two islands are roughly 400 metres apart and are similar in abiotic environmental conditions the main differences between the two are largely due to two main factors. 1) Castle Island is located on the cusp of the mainland and continues to be a popular location for locals and tourists to anchor boats and to swim and jump off the island, disturbing coastal habitat and leaving litter. In comparison, Southampton Island is much more difficult to access and is not affected by anthropogenic disturbances, 2) In order to try and prevent people from landing on Castle Island the vegetation is minimally managed. This in turn creates dense coastal forest habitat that is perfect for invasive anoles, kiskadees, herons and rats, all of the skinks main predators so although Castle Island is much larger the population is substantially lower due to these continued threats.

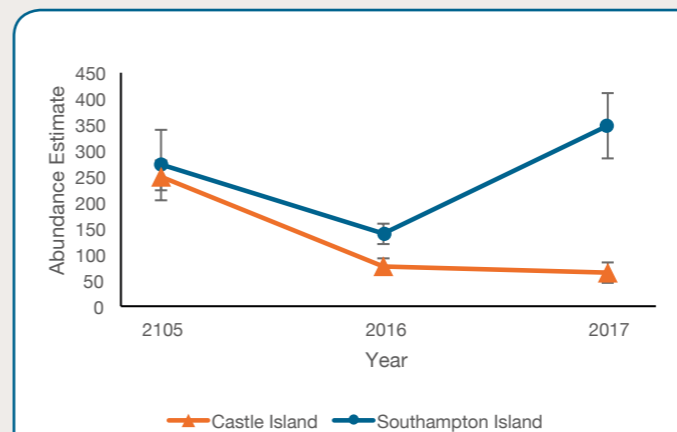
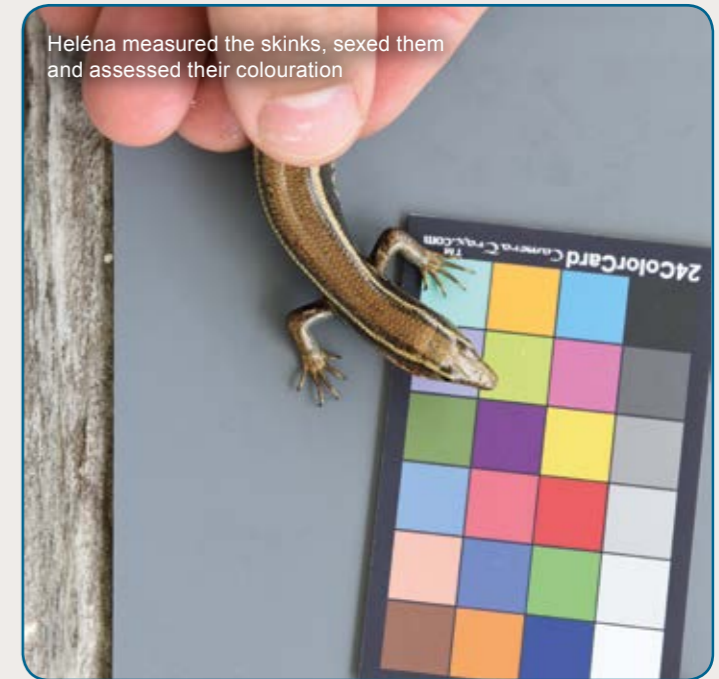


Figure 1. Comparison of robust design model abundance estimates with standard error ($N_i \pm SE$) of Bermuda skinks *Plestiodon longirostris* on Southampton Island and Castle Island, Bermuda.

Overall, we found that the populations did not appear to be stable and fluctuated at both sites over the three-year period (see figure 1). As a result, we found that reliable trapping estimates can provide accurate early-warning signals of the decline in the breeding population so action can be taken in time to ensure populations remain stable.

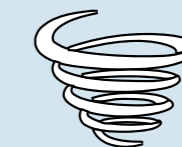
Further analysis is currently being conducted to see if sub-populations are morphologically or genetically distinct. The data collected from this study will be vital to assess the current size and status of the population that will then be used to inform conservation management and used in the implementation of future monitoring programmes.



References

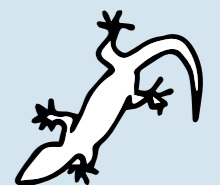
Beebee, T. J. *Amphibians and reptiles* (Pelagic Publishing, 2013).
 Crosswhite, D. L., Fox, S. F., Thill, R. E. *Oklahoma Academy of Science Proceedings* **79**, 45–50 (1999).
 Glasspool, A., Outerbridge, M. *A population re-survey of the Bermuda skink, Eumeces longirostris cope* (1861), on Southampton Island (Bermuda Zoological Society, 2005).
 Krebs, C. J. *Ecological Methodology*, 2nd ed. (Addison-Wesley Educational Publishers, Inc, 1999).
 White, G. C., Burnham, K. P. *Bird Study* **46**, 120-139 (1999).

Key findings



96% of skinks were found in the east of the island within Castle Harbour confirming that in the event of a hurricane the population is extremely vulnerable.

258 Bermuda skinks were estimated to be on Southampton Island and 157 on Castle Island.



Estimating reliable population parameters can provide timely insights into population trends and the mechanisms driving them and has important implications for the future conservation and research effort to help prevent extinction.

BIODIVERSITY SURVEYS AND ECOLOGICAL MONITORING

Tracing the elusive Ecuador Amazon parrot: Assessing its distribution and threats

By Rebecca Biddle, Technical Assistant to the CEO and Conservation Scholar



Conservation Scholar and Technical Assistant to the CEO, Rebecca Biddle, has been studying the Ecuador Amazon parrot for five years. She tells us more about her PhD at Manchester Metropolitan University and how she is studying the distribution and threats affecting this endangered parrot species.

The Ecuador Amazon parrot, *Amazona lilacina*, is a dry forest specialist and endemic to Ecuador (Pilgrim 2010). It feeds throughout a fragmented landscape of protected forest, agricultural land, villages and gardens. At night individuals come together to form large communal roosts, often in mangroves (Berg & Angel 2006).

Major threats to this species include habitat destruction, persecution and the illegal pet trade (Berkunsky et al 2017). Its range in south west Ecuador has been heavily impacted historically by the shrimp farming industry, which has resulted in the loss of almost all the remaining mangrove forest (Clirsen 1984). Additionally, the majority of lowland dry forest has been converted to agricultural land and human settlement (Dodson & Gentry 1991). In the 1980s many birds were exported via the pet



Ivette Solis carrying out community conservation education

trade to Europe and today local trade in the species for household pets still occurs.

As with many bird species, *A. lilacina* is particularly shy and thus difficult to observe in forests during the day. For this reason, the full extent of its range is unknown and a topic of debate in the literature. There is agreement however, that the species is in decline and in need of conservation effort (Juniper et al 2008; Ridgley & Greenfield, 2001). In 2014, Chester Zoo's research fed into the IUCN Red List classification for this species, leading to its endangered status (BirdLife International 2017).

Ecuador is listed as a priority for parrot conservation due to a number of factors (Olah et al 2016), however in order to implement successful conservation action a full understanding of where the species occurs, its preferred habitats, and a grasp of the level of threat it faces is needed.

Between 2013 and 2017, in partnership with local NGO Fundación Pro-Bosque, we have gathered over 100 observations of the

species which have been used to create statistical models which relate the species distribution to various environmental variables such as temperature, rainfall, and a measure of land cover. From this we can make predictions about additional areas they may be using and why, and guide further investigations to confirm their presence or absence.

To strengthen these models we have also undertaken, in partnership with local conservationist Ivette Solis, a community survey within the species' range with over 90 communities and over 400 households (see Figure 1). Observation and behaviour records from survey participants will be used to strengthen the species distribution models and to assess the reliability of this method in determining the species' range.

Additionally, information about local communities' perceptions of population trends and believed threats, such as land use change and trade, were recorded. This has allowed us to select communities to participate in a conservation education initiative which will highlight the importance and rarity of *A. lilacina*.

Finer habitat characteristics (forest structure, tree species presences and density, evidence of human activity etc.) are also being documented to help with the investigation. Data have been

gathered from over 70,000 m² in both presence and absence areas, which will be used to assess the suitability on the ground of new areas predicted by species distribution models.

The next phase of the project will focus on roost sites and roosting strategy, aiming to understand the reliance on communal roosting sites, and to assess how best to safe guard those areas. Additionally, a further community survey is underway, aiming to quantify threat levels to the species in order to further develop our community conservation initiative.

References:

Berg, K. S., & Angel, R. R. *Journal of Field Ornithology* **77**(2), 95–103 (2006).

Berkunsky, I. *et al. Biological Conservation* **214**, 278–287 (2017).

BirdLife International. *Amazona lilacina* (IUCN, 2017).

Clirsen, 1984. *Aplicacion de sensores remotos en el estudio del levantamientos integrados de recursos naturales por sensores remotos* (Center for Remote Sensing, 1984).

Dodson, C.H. & Gentry, A.H. *Annals of the Missouri Botanical Garden* **78**(2), 273-295 (1991).

Juniper, T. *et al. Parrots: A Guide to the Parrots of the World* (Helm, 2008).

Olah, G. *et al. Biodiversity and Conservation* **25**(2), 205–223 (2016).

Pilgrim, M. *An investigation into the Taxonomic status of Amazona autumnalis lilacina using a multidisciplinary approach* (Liverpool John Moores University, 2010)

Ridgley, R. & Greenfield, P. *The birds of Ecuador* (Cornell University Press, 2001).

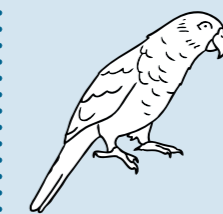


Figure 1: Location of all households participating in the survey (c) World Boundaries and Places - Esri, HERE, DeLorme, MapmyIndia, © OpenStreetMap contributors, and the GIS user community. World Imagery - Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



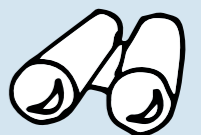
Amazona lilacina

Key findings



Over 100 observations of the Ecuador Amazon parrot were gathered between 2013 and 2017.

70,000 m² were assessed to gather presence and absence data.



≥ 400 households took part in our community surveys in over 90 communities.

CONSERVATION BREEDING AND MANAGEMENT

Chester Zoo is a centre of excellence for conservation breeding and management. By identifying the drivers of reproductive viability, we can make informed management decisions to boost the reproductive success of threatened species. By managing zoo populations effectively we're also maximising the survival chances of *ex situ* bred individuals that are reintroduced to the wild. In some cases, conservation breeding centres need to be established in the field and the knowledge and skills of zoo staff are critical in ensuring the success of these centres for re-establishing populations in the wild.

Saving Bermuda snails from extinction: A joint effort between British zoos and the Bermudian Government

By Gerardo Garcia, Curator of Lower Vertebrates and Invertebrates



Land snails of the genus *Poecilozonites* are endemic to Bermuda, where they have a long and illustrious fossil record (Pilsbry 1924; Gould 1969; Hearty and Olson 2010). Two species of this genus, *P. circumfirmatus* and *P. bermudensis*, still remain, although both were

thought to be extinct in the wild and are listed as critically endangered under the 2003 Bermuda Protected Species Act.

A remnant population of *P. bermudensis* was rediscovered in 2014 during some construction work in the city of Hamilton. A rapid rescue operation was launched following the discovery and more than 200 snails were translocated to Nonsuch Island. The island was selected as the best available introduction site because of the absence of predators, particularly the Pondoland cannibal snail (*Euglandina rosea*) and *Gonatoides* species, which appear to have contributed to the recent demise of *Poecilozonites* in their natural habitats.

The rest of the population was divided to create a network of *ex situ* safety populations between the Department of Environment and Natural Resources of Bermuda, Chester Zoo and ZSL with the aim to release them back to Bermuda once a secure breeding group was created.

As very little is known regarding the husbandry requirements for Bermuda's endemic snail species, it became vital to connect the field and *ex situ* components to maximise the success of this programme. Identifying the appropriate environmental and habitat preference parameters was vital to create successful breeding

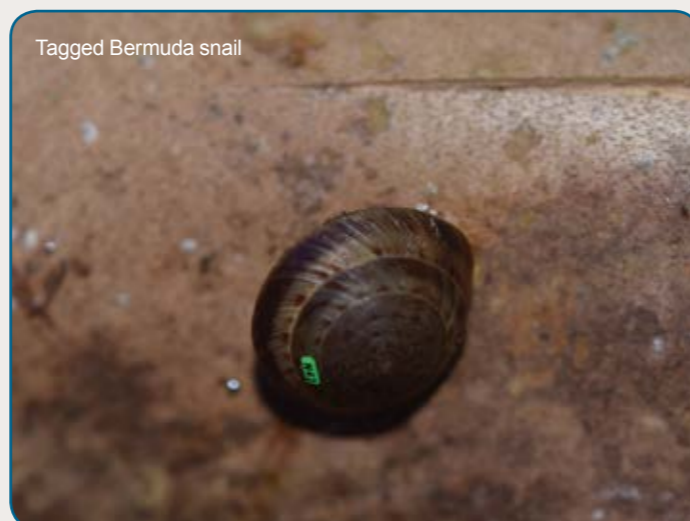


Bermuda snail (*P. bermudensis*)

colonies in our zoo. The populations have since done incredibly well and we are confident that we have secured breeding groups to support future translocations.

My team is now directly involved in various areas of the project and staff members are working on developing the best practice guidelines for the species to secure the long-term management of the *ex situ* colonies and to develop health-screening protocols. We are also assisting the Bermudian Government with the translocation and post-release monitoring while supplying future colonies for re-establishment.

However, a few parameters need to be assessed before reintroducing any *ex situ* bred snails. We are conducting a comprehensive comparative study of endo-parasitofauna between the wild and *ex situ* populations. Baseline surveys were simultaneously performed for existing gastropod faunas and snail predators at potential reintroduction sites on Nonsuch Island in order to obtain a clearer picture of the risks and threats that could impact on the success of the reintroduction programme.



Tagged Bermuda snail



Release sites on Nonsuch Island. Credit: Dr Mark Outerbridge, Government of Bermuda | Department of Environment and Natural Resources.

The individuals will then be released in selected release sites that will provide moist refuges and will facilitate the monitoring of the translocated snails. Supplementary feeding will be provided after the release in rat-proof tubes set underneath the cover boards near the release site. All Bermuda snails of sufficient size, identified during the baseline surveys or selected to be released, will be marked for individual identification. A small fluorescent tag with an alphanumeric code, designed to identify individual snails at night, will be glued to their carapace to facilitate monitoring through mark-recapture methods.

A Chester Zoo team will be joining the future survey of the released populations to collect data on habitat and to conduct health screening of the wild populations. Periodic monitoring over the long term will be crucial to document whether the introductions have been successful and to determine whether further augmentation of the population from *ex situ* snails is desirable.

References:

- Gould, S.J. *Bulletin of the Museum of Comparative Zoology* **138**(7), 407-531 (1969).
- Hearty, P.J. & Olson, S. L. *Palaeogeography, Palaeoclimatology, Palaeoecology* **293**, 9-29 (2010).
- Pilsbry, H.A. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 1-9 (1924).

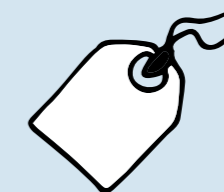
Sarkis, S. 2009. *Recovery Plan for the Bermuda land snail, Poecilozonites circumfirmatus* (Department of Conservation Services, Government of Bermuda, 2009).

Key findings



≥ 2,500 snails were raised at Chester Zoo within a few months of intensive breeding from 60 founders.

Only 200 *P. bermudensis* snails were left in the city of Hamilton in 2014.



≥ 5mm fluorescent coded tags are placed on the released snails to facilitate monitoring.

CONSERVATION BREEDING AND MANAGEMENT

Fitness for the ark: Are ex-situ bred amphibians ready to be wild?

By Luiza Passos, Conservation Scholar



Luiza Passos, Conservation Scholar and PhD student from the University of Salford, tells us more about how she investigated behavioural attributes of golden mantella frogs at Chester Zoo in order to understand their suitability in the event of their reintroduction to the wild.

The behavioural integrity of wildlife is one of the most important aspects to conserve in an *ex situ* population, especially if animals are part of a conservation programme that will include reintroduction. Therefore, it is important to investigate whether conservation breeding centres are providing the appropriate environmental resources and stimuli to allow species to satisfy their biological or behavioural needs; thereby, also improving their welfare.

The aim of my PhD research project was to test this hypothesis using the golden mantella frog (*Mantella aurantiaca*), which has been identified as requiring reintroductions from *ex situ* populations to ensure the continued survival of wild populations. The golden mantella frog is a species classified as Critically Endangered on the IUCN Red List of Threatened Species and is endemic to the Moramanga district of Madagascar. It is well known due to its aposematic orange-red colouration and presence in the international pet trade. During this project, I

looked at three different populations of golden mantellas: Chester Zoo, Mitsinjo Breeding Centre (Madagascar) and wild individuals in Madagascar.

My PhD project has implemented an innovative multidisciplinary approach to explore and understand the effects that *ex situ* conditions have on different aspects of the golden mantella frog's ecology and behaviour. During this study a combination of different methodologies were used such as: behavioural experiments, microbiology, bioacoustics, and spectroscopy analysis of zoo populations and wild frogs to understand the consequences of being born and reared in an *ex situ* environment. I specifically examined which aspects of the species' biology could affect an individual's survival skills and the consequences of this in the long-term for *ex situ* populations due for future reintroduction.

The results obtained during this study shown that *ex situ* conditions do have a significant impact on the behaviour and ecology of this species. However, animal husbandry has been shown to attenuate or increase these negative consequences. Even though the Chester Zoo colony has been housed at the zoo for a long time (over seven generations), frogs still have a similar skin colouration, body condition and anti-predator response to their wild counterparts. However, the Mitsinjo's colony, composed of wild caught individuals and their first offspring, already presented greater differences, although the vocalisations of these individuals had a greater similarity with wild ones than those of the Chester Zoo animals.

Species recognition was tested using a playback and a phonotaxis experiment and both tests showed that *ex situ* animals were more attracted to their own calls and neglected wild calls while wild individuals responded equally to all calls. Species recognition is



an essential trait that predicts survival of released animals and so animals bred *ex situ* if released, should be able to recognise and appropriately respond to their wild conspecifics. This inability to communicate with wild individuals could lead to *ex situ* animals being more likely to mate with other zoo-born animals, compromising the effectiveness of a reintroduction attempt.

Ex situ conditions also affected skin associated microbiota, which is a vital part of the amphibian immune system, having a great impact on host susceptibility to a range of infectious diseases, including the deadly chytrid fungus.

After exploring different aspects of *ex situ* and wild golden mantella frogs it is possible to conclude that the *ex situ* conditions do affect animals but results cannot be generalised as the husbandry regimes in each conservation breeding centre tend to vary. Nonetheless, with special attention to the choice of husbandry regime to fulfil all the environmental and behavioural needs of each species, conservation breeding can be an important and viable option for the conservation of threatened amphibians. More research is still needed to fully understand the consequences of keeping species *ex situ* for many generations without contact with wild individuals. The next stage for this research would be to test how permanent these changes are and the effectiveness of soft-release as a mitigating measure.

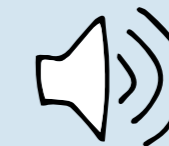
References:

- Passos, L.F., Garcia, G., Young, R.J. *PLOS ONE* 12(7) (2017) e0181972.
- Passos, L.F., Garcia, G., Young, R.J. *PLOS ONE*, 12(7) (2017) e0181931.



Golden mantella frog (*Mantella aurantiaca*)

Key findings



4,875 Hz was the recorded dominant frequency in wild frogs versus 5,198 Hz in Chester Zoo.

No significant difference was recorded in anti-predator responses between the wild and *ex situ* populations.



114 genus of bacteria were found on the skin of wild golden mantella versus 10 on the zoo's population.



Luiza and her field team in Madagascar

CONSERVATION BREEDING AND MANAGEMENT

Matchmaking orchids and fungi: Propagation of terrestrial and epiphytic orchids from seeds

By Oliver Hughes, Conservation Scholar



Conservation Scholar, Oliver Hughes has spent five years working on orchids for his MPhil and PhD at Manchester Metropolitan University. He tells us more about the fascinating interaction between orchids and fungi and how he has been working on improving the propagation of different orchid species.

Renowned for their flamboyant, highly variable flower forms and unique pollination methods, orchids are often described as the pinnacle of flower evolution. Orchids have evolved differently to other plants by developing symbiotic relationships with mycorrhizal fungi. Indeed, orchid reproduction, germination and establishment requires highly specific interactions with pollinators and mycorrhizal fungi often resulting in species with narrow geographic ranges. As a result, orchid populations are easily impacted by human activities and many species are also highly threatened due to the illegal collection of the plants for the horticulture trade. To preserve orchid species and their diversity, active *in situ* conservation and *ex situ* conservation efforts are required and improving propagation techniques is important to help relieve the pressure threatening the wild orchids.

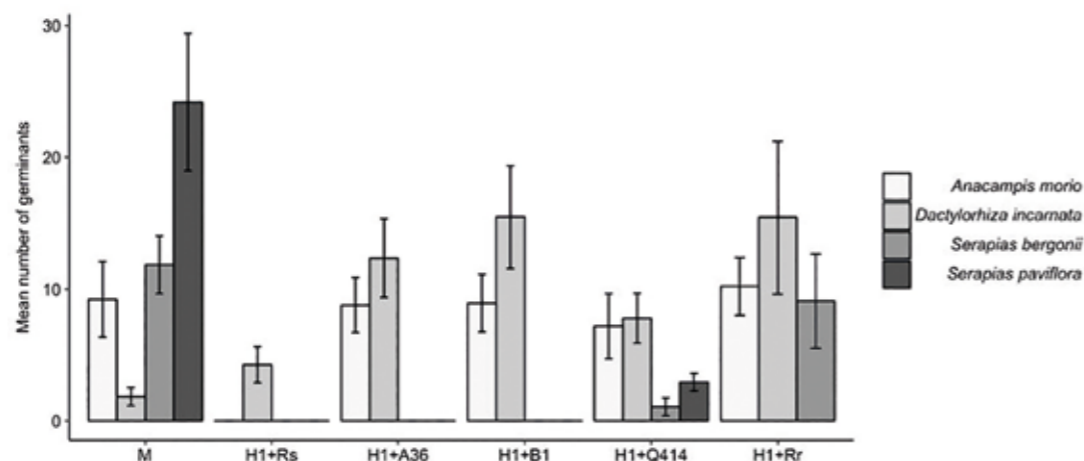
Mycorrhizae are the symbiotic association between plant roots and fungi. 95 percent of all plant species examined to date have been found to have active mycorrhizal relationships, demonstrating the broad scale of mycorrhizal activity that is present in nature.



The mycorrhizal association is beneficial to both partners as it increases the overall root surface area, resulting in greater water and nutrient absorption.

Research into *ex situ* propagation must involve study of the orchid-mycorrhiza relationship, as it plays a significant part in orchid reproduction. Although orchid seeds are capable of germinating in water, they are highly reliant on being infected by an appropriate fungus for further development to occur. This infection induces a symbiotic response from the orchid embryo enabling the formation of a tuber-shaped body with rhizoids called a protocorm. This allows for further plant development, resulting in the formation of roots and leaves. Once leaves are formed, the orchid starts to photosynthesize and its dependence on mycorrhizal fungi is reduced.

Figure 1. Germination of *Anacamptis morio* (white), *Dactylorhiza incarnata* (light grey), *Serapias bergonii* (grey) and *Serapias parviflora* (dark grey) on asymbiotic Malmgren (M) media, and symbiotic H1 media with the fungi: A36, B1, Q414, *Rhizoctonia repens* (Rr), *Rhizoctonia solani* (Rs) and asymbiotic Malmgren (M) media at 8 weeks from sowing. Values represent mean number of germinants per plate for each treatment. Error bars represent the standard error.



Many orchids are rare and endangered due to habitat loss, degradation and human interference. My studies aimed to improve our understanding of orchid-mycorrhiza relationships and optimise methods for successful *in vitro* germination and development of terrestrial and epiphytic orchids.

I investigated fungal specificity in the Australian terrestrial mignonette orchid, *Microtis media*, as it plays a key role in orchid distribution. Experiments demonstrated low fungal specificity in germination, although later development was more specific, with one fungus allowing the orchid to develop into flowering adult plants.

I also tested fungal compatibility in several Eurasian terrestrial orchids. Varying degrees of specificity were observed, with the UK native green-winged orchid, *Anacamptis morio*, and early Marsh orchid, *Dactylorhiza incarnata*, displaying low fungal specificity, germinating with numerous fungi. Tongue orchids (*Serapias* species), however, were more specific, germinating with one or two fungal strains only (see Figure 1).

Orchids are commonly propagated from seeds using agar-based nutrient media, which can be symbiotic (inoculated with a symbiotic fungus) or asymbiotic (without fungi). I conducted an experiment to compare the effectiveness of asymbiotic and symbiotic propagation methods in two Eurasian terrestrial orchids: the Jersey orchid and the bee orchid. In both cases, symbiotic methods resulted in higher germination and development. In the Jersey orchid, successful seedling establishment *ex vitro* was only achieved with symbiotic seedlings which flowered after three years of culture.

The neotropical and largely epiphytic orchid subtribe Pleurothallidinae is one of the largest in the family Orchidaceae and little is known about their propagation requirements. To investigate this, seeds of a number of species as well as root samples were collected from plants in the collection held by Chester Zoo. These and were sown on different asymbiotic media, and on a symbiotic media with different potential symbiotic fungi which were isolated from the orchid roots. Germination was highest with two fungal strains but development of viable plantlets only occurred on certain asymbiotic media (see Figure 2). This suggests that suitable fungi that could induce further plant development were not present in those tested from the collection. Future studies isolating fungi from a wider range of orchids *in situ* and in the collection may lead to the discovery of useful fungal symbionts for these orchids. Thousands of seedlings have been produced using asymbiotic methods, with the first flowers recorded after three and a half years culture. This research has helped to improve our understanding of orchid biology and has applications for conservation and horticulture. It is hoped that many of the plants produced can be used for reintroduction projects, particularly in the case of species such as the Bolivian

Masdevallia menatoi which are highly endangered if not extinct in the wild.

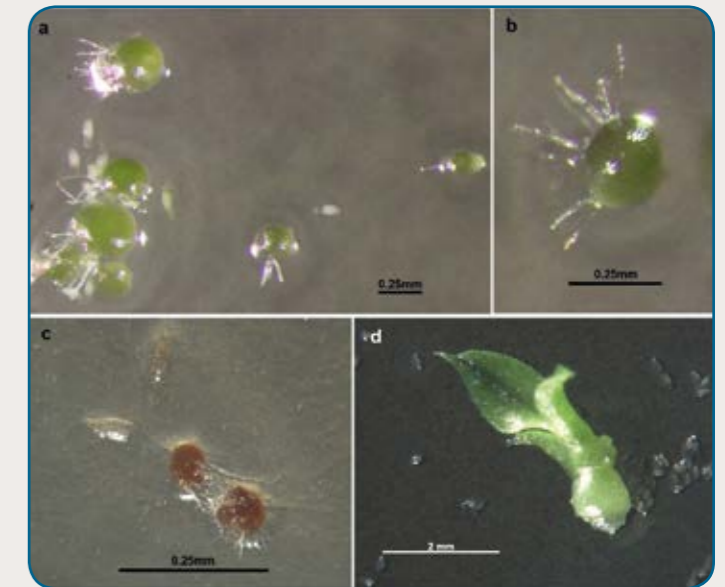
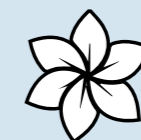


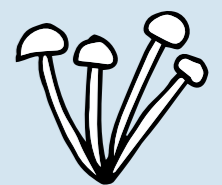
Figure 2. a) Ungerminated seed and stage 2 protocorms of *Masdevallia menatoi* displaying rhizoids on half strength P6668 asymbiotic media at 10 weeks from sowing. b) Protocorm of *Stelis* sp. Peru at stage 2, displaying rhizoids on half strength P6668 asymbiotic media at 10 weeks from sowing. c) Brown coloured protocorms of *Restrepia contorta* at stage 1 with *Dracula felix* fungal isolate at 20 weeks from sowing. d) *Pleurothallopsis microptera* germinant at stage 5 with first leaves and formation of root initials, amongst ungerminated seed on half strength P6668 asymbiotic media at 20 weeks from sowing

Key findings



1000 seedlings have been produced, with the first flowers recorded after three and a half years.

Suitable symbiotic fungi improve germination and development in terrestrial orchids.



Effective methods for the germination and development of a range of orchids have been ascertained and can aid the production and conservation of orchids both *in situ* and *ex situ*.

HUMAN-WILDLIFE CONFLICT/LIVELIHOODS AND SUSTAINABLE DEVELOPMENTS

Human-wildlife conflict mitigation requires a variety of disciplines and knowledge, including behavioural ecology, social psychology, economics, development and anthropology. In many cases sustainable livelihoods and development initiatives are essential and must be integrated into conservation strategies if they are to succeed. Many of our field projects are built around this concept, working to find culturally acceptable, equitable and economically viable solutions for communities to benefit from conservation efforts around the world.

Bridging the gap with the fruit-growing industry: Mitigating human-bat conflict in Mauritius

By Dr Simon Tollington, Conservation Scientist



The Mauritius fruit bat is endemic to the Mascarene Islands and is known to cause damage to fruit crops triggering conflicts with the fruit-growing industry. Conservation Scientist, Dr Simon Tollington, tells us more about the issue and the positive development that has recently been happening on the island.

The Mascarene greater flying fox or Mauritius fruit bat (*Pteropus niger*) is endemic to the Mascarene Islands and now restricted to Mauritius after disappearing from nearby Réunion more than 100 years ago. These megabats are known to cause damage to fruit crops in orchards as well as to private household trees and they are sometimes perceived as a messy, noisy menace by many members of the public. Although the species is considered Vulnerable by the IUCN, recent pressure from fruit-growers concerned at the loss of revenue, led to culls in 2015 and 2016. Official government figures reveal that approximately 38,000 bats were killed as part of this process and although population size estimates vary (e.g. 50,000-90,000 pre-cull), this number is likely to represent a considerable proportion of the total population.

The government of Mauritius is trying to find alternative solutions and since 2009 has invested millions of rupees in a netting subsidy scheme. Under the scheme, growers can apply to purchase a certain number of protective nets at 25% of the original cost and in 2015 more than 4,500 people benefitted from government subsidies totalling nearly USD\$1m. However, once purchased, the nets must be erected in a specific manner in order to exclude bats which can be difficult on tall, sprawling trees and therefore many trees are left unprotected.



Damaged lychee fruits

I travelled to Mauritius during the fruiting season of 2016/2017 and with the help of biologists from the Mauritian Wildlife Foundation, initiated an experiment designed to precisely quantify the damage caused by bats to privately owned 'backyard' trees. Alongside this, a questionnaire survey designed by our Head of Conservation Science, Dr Alexandra Zimmermann, was carried out across the island and aimed to capture the attitudes and perceptions of approximately 360 members of the public and the fruit growing industry.

The results of the damage assessment indicated that, on average, bats were responsible for damaging up to 21% of fruit from lychee trees but could sometimes destroy the crop of a whole tree in a single evening. Correctly installed netting however, eliminated the damage completely. The questionnaire survey confirmed that many people associated bats with being noisy and messy but also revealed an unexpected result. When asked 'which outcome would you prefer?' more than 30% of respondents claimed that they would like to see this species extinct. Perhaps surprisingly, this attitude was significantly more common among the general public than among fruit growers. I presented the results of this research to the international conservation community at the 28th International Congress for Conservation Biology in Cartagena, Colombia in July 2017 and I am currently preparing a manuscript for publication.

Meanwhile a workshop designed to discuss issues associated with netting and managing fruit trees and to identify future priorities and solutions was jointly organised by Chester Zoo, the IUCN, the Government of Mauritius and the Mauritius Wildlife Foundation. The workshop, which took place in August, brought together orchard owners, fruit sellers, scientists, government agencies and international experts who all contributed to a very successful event. Participants collectively identified a list of recommendations towards a long-term and sustainable strategy



Fruit grower netting fruit trees to protect them from the bats

for reducing fruit bat damage which were consolidated into a final workshop report that was then disseminated to all involved including senior government officials.

The workshop and report were mentioned in recent parliamentary discussions in Mauritius and no cull occurred during the 2017 fruiting season. A strategy workshop, aimed at identifying research priorities that will continue this work is planned for 2018.



Mauritius fruit bat (*Pteropus niger*)

IUCN Human-Wildlife Conflict Taskforce

The IUCN SSC Human-Wildlife Conflict Task Force is a global advisory group of experts from a range of subjects working on interdisciplinary approaches to wildlife conservation.

Chaired by Dr Alexandra Zimmermann, Head of Conservation Science at Chester Zoo, its main goal is to support the IUCN SSC network in addressing human-wildlife conflict by providing interdisciplinary guidance and expert support, through an integration of ecological and social sciences.

For more information: <http://www.hwctf.org/>



Key findings

35 participants representing researchers and stakeholders from all areas of the fruit industry attended a two-day workshop on netting and tree management.

26% of fruit growers responded that they would like to see bats go extinct whilst 36% of people who do not grow fruit answered in this way.

0 bats were culled during the 2017 fruiting season and the final recommendations report was mentioned in the Parliament of Mauritius.

HUMAN-WILDLIFE CONFLICT/LIVELIHOODS AND SUSTAINABLE DEVELOPMENTS

Reducing human-bear conflict in Bolivia: Working hand in hand with the government and the local communities

By Dr Ximena Velez-Liendo, Conservation Fellow



Our Conservation Fellow Dr Ximena Velez-Liendo won a prestigious Whitley Award in 2017 which is helping fund the Andean Bear Project for a year. From working with the government to delivering a TEDx talk, Ximena had a busy year in Bolivia!

The Andean Bear Project was developed by Chester Zoo in partnership with The University of Oxford's Wildlife Conservation Research Unit (WildCRU) and Bolivian NGO PROMETA. This conservation initiative is the first of its kind in Bolivia and aims to study the population dynamics of bears and the drivers of human-bear conflict in the Andean dry forests of Bolivia.

With severe droughts affecting Bolivia's agriculture production, communities are shifting from agriculture to livestock, which has led to an increase in encounters between local people and bears.

Applying an interdisciplinary approach of both ecology and social sciences, the project aims to develop practical interventions for immediate reduction in Andean bear (*Tremarctos ornatus*) conflict, developing alternate livelihoods to local communities, bringing positive change and monitoring the Andean bear



Ximena has been working with MPs to pass a law to protect the Andean bear

populations. So far, the team has deployed 70 camera traps in 35 stations and has collected signs of bear presence such as tree marks, food remains and scats.

We have also been working with local people, government authorities and the scientific community to raise awareness of the important role bears play in the Andean dry forests of Bolivia. To raise the profile of the species, I worked with various MPs and other politicians to pass a law, called the Ajayu's law, to protect the Andean bear and its ecosystem by declaring the emblematic species part of Bolivia's National Natural Heritage.

In parallel, I have also been working with other Bolivian conservationists and the government to develop the first Conservation Action Plan for the Andean bear in Bolivia. Presented at the International Bear Association Conference in Ecuador in November 2017, the Plan was then refined during a two-day national workshop attended by 46 participants including scientists, government officials from both national and local levels, park rangers and *in situ* and *ex situ* specialists. The final draft of the document is currently being reviewed by the authorities.



Bolivian conservationists working with the government to develop the first Conservation Action Plan for the Andean bear in Bolivia



Ximena gave a TEDx talk about her research in Tarija, Bolivia in September 2017

Working with local communities, I am also developing conflict hotspot maps to get a better understanding of the situation on the ground. Knowing which areas are particularly impacted by human-bear conflict will allow us to put relevant mitigation techniques in place such as improving livestock enclosures.

The Andean Bear Project also aims to identify alternative livelihoods to reduce human-bear conflict and provide local communities with a variety of economic opportunities. So far, the communities have identified beekeeping as a suitable option and a pilot project with ten beehives will be initiated in 2018. Four workshops will be provided to those interested and appropriate further training will be made available.

For more information about the Andean Bear Project: www.chesterzoo.org/conservation-and-science/where-we-work/latin-america



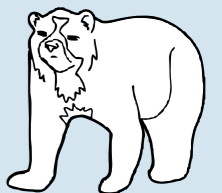
Ximena with Princess Anne

Key findings



70 camera traps were deployed by the team in 35 stations.

1st Conservation Action Plan for the Andean bear in Bolivia was developed in collaboration with Bolivian conservationists and the government.



Conservation Fellow Dr Ximena Velez-Liendo was among the winners of the prestigious Whitley Award.

VISITOR AND COMMUNITY ENGAGEMENT

With over 1.8 million visits a year, Chester Zoo has a great chance to engage visitors and communities on the conservation of wildlife around the world. Through our many varied learning programmes, a large part of our role as a zoo is to raise awareness and educate the public on ways they can maximise their contribution to conservation. In order to assess the effectiveness of these programmes, we conduct research that allows us to understand the impact of our work, provide evidence-based recommendations for improvements, as well as gaining insight into the value of zoos in connecting people with wildlife.

Insights into the impacts of volunteering in UK zoos and aquariums

By Charlotte Smith, Head of Discovery & Learning
Dr Andrew Moss, Conservation Social Scientist



Our visitor engagement volunteer scheme has proven hugely popular since its launch and now gathers a total of around 200 volunteers. Charlotte Smith, Head of Discovery & Learning, Nicola Buckley,



Volunteer Manager and Dr Andrew Moss, Conservation Social Scientist, joined forces to quantify the impacts that the scheme is having on our volunteers' wellbeing and personal development.

The majority of Chester Zoo's volunteers work in public facing roles supporting visitors to make the most of their visit; helping with orientation, imparting species information and engaging them to get involved with conservation. Chester Zoo's visitor engagement volunteer scheme, which launched in 2015, was designed with not only these visitor outcomes in mind but also with an explicit aim to support the wellbeing and personal development of the volunteers involved, based on evidence of similar impacts from other sectors. However, little has been done in the UK to quantify the impacts of zoo-based volunteering on the volunteers themselves. This research aimed to redress that balance and, in collaboration with BIAZA, volunteers from several additional zoological collections were also asked to participate.

Using a framework developed by the National Council for Voluntary Organisations, we developed an online survey design with questions on four different areas of impact; human capital, social capital, economic capital and cultural capital (see Table 1

Table 1. Breakdown of capital content and measures operationalised within the overall survey design

Capital measure	Capital summary
Human Capital	People's knowledge, skills and health
Economic Capital	Benefits or costs with financial value
Social Capital	More cooperative relationships between people
Cultural Capital	A sense of own identity and understanding of other's identity

for a summary). The majority of the questions used a 5-point Likert-type scale for participants to self-report increases or decreases against a set of attribute statements, reflecting changes they experienced during their time volunteering. Questions enabling us to describe our sample were also included and the research explored relationships between factors such as age or length of time volunteering and the impacts reported by participants.

522 individuals volunteering in 19 zoological collections took part in the research. Due to the fluctuating nature of the volunteer populations at the collections it is hard to gauge the exact population surveyed, however a conservative estimate would approximate the response rate at 35%. The sample included collections from across the UK, and included collections with varying visitor numbers (from those with just tens of thousands of each year to over 1.5 million) and a range of traditional zoos, aquariums, wildlife parks and sanctuaries.



The analysis revealed that volunteers report moderate positive impacts across all four capital areas (see Figure 1). In particular it showed benefits in the areas of human and social capital. Within human capital, some of the most positive impacts reported were in areas relating to self-esteem, confidence and motivation. 88% of volunteers reported that their sense of making a useful contribution had increased during their time volunteering. This was also echoed with increases in their willingness to try new things (76%) and having something to look forward to in life (73%). Within social capital, volunteers reported higher impacts in relation to increased friendships, networks and contact with others – potentially highlighting the role that volunteering can play in combatting loneliness.

When looking for relationships between participant characteristics and the degree of reported impacts, we found that younger participants (18-25 year olds) were more likely to report greater benefits than older participants (55 – 70 year olds). Additionally, an increased period of initial training statistically predicted greater positive reported impacts. However, the length of time having been a volunteer, the frequency of volunteering and gender did not relate to the variation in impacts reported by volunteers. These findings, about who may benefit most from in-zoo volunteering and what activities can enhance those benefits, will be used to inform the future direction of the volunteer programme at Chester Zoo. Our findings were also shared with volunteer managers from other BIAZA collections via a report and at their annual meeting as part of a discussion about the design of future volunteer programmes, so it is hoped they will support the development of volunteering programmes across the sector.

References:

Smith, C. *et al. Cultural Trends* 27(1), 19-33 (2018).

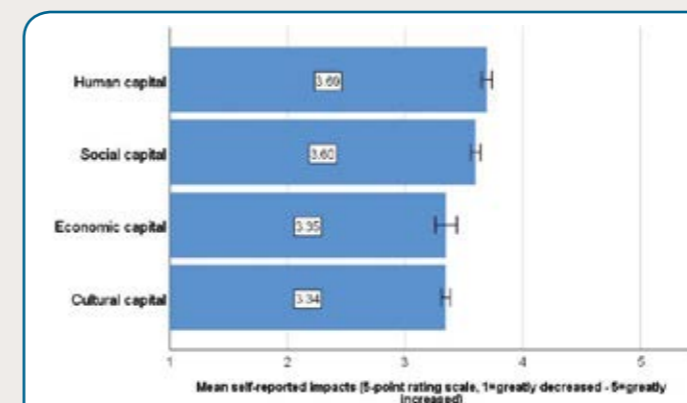


Figure 1. Mean self-reported impact measures across the four capital measures. Error bars depict 95% confidence intervals



Key findings



522 individuals volunteering in 19 zoological collections took part in the research.

88% of volunteers reported that their sense of making a useful contribution had increased during their time volunteering.



Within social capital, volunteers reported higher impacts in relation to increased friendships, networks and contact with others.

VISITOR AND COMMUNITY ENGAGEMENT

Pine martens and Welsh communities: Investigating the local community's views towards pine martens and their translocation

By David Bavin, Conservation Scholar



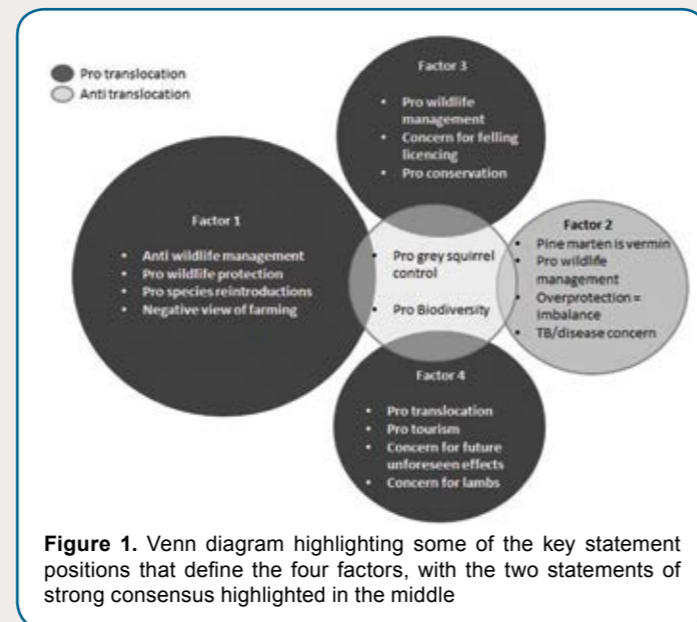
David Bavin, Chester Zoo Conservation Scholar from the University of Exeter and Pine Marten Project Officer for the Vincent Wildlife Trust (VWT), is assessing the impact of the recent Pine Marten Recovery Project in Wales. He tells us more about the perception that local communities have towards the project.

People underpin conservation and can determine whether conservation initiatives ultimately succeed or fail. It is therefore of central importance to fully understand how people feel towards conservation work, and to identify knowledge gaps and areas of concern (as well as people's aspirations), in order to incorporate people into the process in a meaningful way.

The Vincent Wildlife Trust's Pine Marten Recovery Project aims to restore the European pine marten (*Martes martes*) throughout its former range in Wales via translocations from a healthy Scottish population. Assessing social feasibility was a key component of the overall planning and was particularly important at the early stages when local people could have valuable input into the process. The VWT had previously conducted a large scale public opinion survey. The conclusions were useful but generalised in their breadth and we felt they lacked the relevant

local nuance and complexity that we knew existed within the selected release region.

We therefore decided to use a novel technique called Q method (Watts & Stenner 2012; Rust 2016), a tool for discourse analysis, to investigate the local community's views towards the pine marten and the proposed translocation. The process essentially involves taking a representative sample of the existing spectrum of opinion on a subject within the target community and distilling the information down via a factor analysis. This process revealed four dominant narratives within the community, three of which were broadly in support of the translocation whilst one was unequivocally opposed to it (see Figure 1).



Inviting community input at an open session in Llangurig, a local community. Credit Henry Schofield.

The methodology enabled a rich interpretation and understanding of these distinct viewpoints, highlighting the relative importance of a number of issues and elements of our work. One useful outcome from the results was the identification of two unifying points of consensus across all four narratives:

- 1) If pine martens had a negative impact on grey squirrels, that was a good thing
- 2) A biodiverse local environment is desirable

These provided the building blocks for an engagement strategy that enthused and brought people together, though the purported relationship between pine martens and grey squirrels was treated cautiously and objectively. Rather, we focussed on the overall environmental benefits of restoring biodiversity to the wider environment, including the regulatory roll of top predators such as the pine marten on other smaller predators, such as jays and crows.

The work also highlighted some key concerns, such as potential livestock predation, impact on other wildlife and the risk of future unforeseen effects of an expanding pine marten population (cited as being analogous to government afforestation, which though well intentioned, is perceived as having damaging side effects). With this knowledge, we were able to effectively target our information at public meetings and during our face to face farm visits.

Accurate identification and incorporation of views prevents people feeling marginalised and fosters trust. I interviewed two sheep farmers in the initial stage of this study, both of whom disagreed that the pine marten translocation was a good idea. However, they respected that the 'proper' approach had been taken which has stimulated continued dialogue, resulting in trust and mutual respect. One of those farmers now regularly updates the VWT on activities that might potentially disturb the settlement of the pine

martens. For us as conservationists, this is the ultimate goal: to inform and include local people to the point where they feel both invested in and part of our work; not just a statistic in a box ticking exercise.

References:

Rust, N.A. *Oryx*, 1-8 (2016).
Watts, S. & Stenner, P. *Doing Q Methodological Research* (SAGE, 2012).



Pine marten (*Martes martes*). Photo Credit: Edward Delaney.



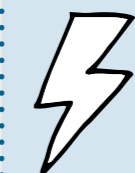
Discussing mitigation for potential game bird predation at an open community meeting. Credit Henry Schofield

Key findings



Q method is an effective tool for disclosing people's viewpoints at the community level, identifying key areas of consensus and divergence.

30 statements were isolated by David and presented to a wider sampling group.



The Q method facilitates the resolution of potential conflicts by identifying them at an early stage.

VISITOR AND COMMUNITY ENGAGEMENT

Wildlife Connections: Training Wildlife Champions to create a network of safe spaces for local wildlife

By Hannah Brooks, Community Engagement Manager



For the past two years, Chester Zoo has developed a campaign called Wildlife Connections to boost the knowledge and appreciation of the native species that surround us here in the UK. Hannah Brooks, Community Engagement Manager, tells us more about the project and reflects on what has been achieved so far.

Species in the UK are under threat. Increasing pressure on the natural world from primarily man-made sources such as infrastructure developments and pollution is pushing the wildlife that lives in our communities to the brink of extinction. In urban environments, parks and road verges are often managed purely for their aesthetics and the pathways available for wildlife to move around the landscape to find all that they need to thrive are becoming increasingly fragmented and disconnected. As a result of this, along with many other causes, people of all ages are becoming more and more disconnected with the wildlife that lives around them. Knowledge and appreciation of the species that share our communities is decreasing rapidly, which puts the future of wildlife in these areas at ever greater jeopardy.

To combat this challenge, Wildlife Connections aims to develop better connections between people, and between people and wildlife across the landscape.

A significant element of this campaign is a training course for community group leaders to provide them with the knowledge, skills and inspiration required to improve their area of green space for native species through local community involvement. Those involved in the training also have the option of having two follow up visits from our Wildlife Connections Project Officer to provide ongoing advice and support.

Over the last two years the Wildlife Champion training course has trained 100 individuals. The study we conducted to assess what people gained out of the course shed light on the impact that participation has had on the individuals and on their community.

The data were recorded through a series of surveys, in-depth interviews, enabling and creative methods, before, during and after participation and were primarily analysed using a structured thematic approach.

The study found that over 70% of the participants attending the course were employed by the group/organisation that they were representing and over 60% of the groups represented met once a month or more regularly. While the highest proportion of groups had 50 members or less, 18 groups that responded to the survey had groups ranging between 50 and 500+ participants. This demonstrates the potential reach and impact of training community group leaders as these 100 individuals had a potential audience of over 8,000.

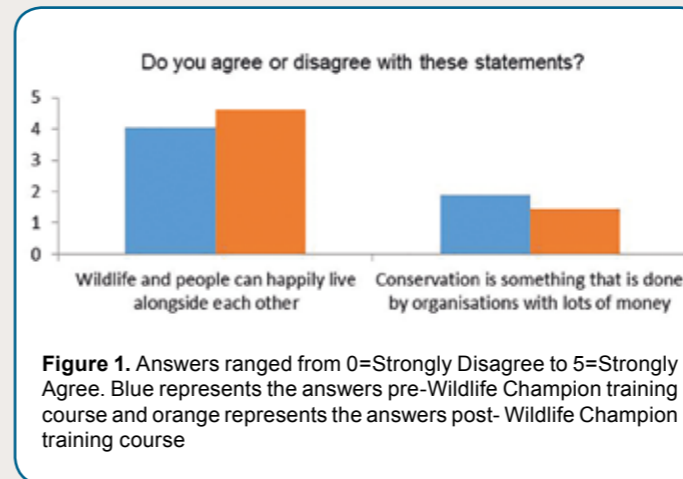


Figure 1. Answers ranged from 0=Strongly Disagree to 5=Strongly Agree. Blue represents the answers pre-Wildlife Champion training course and orange represents the answers post-Wildlife Champion training course

Champions were asked to complete a follow up questionnaire between six months and one year after taking part in the training. All of the individuals who responded confirmed that they had taken action for UK wildlife since the training with a wide range of activities, the most popular were building a bug hotel, creating a log pile, and putting up bird feeders. There was a significant increase in the attitude statement 'wildlife and people can happily live alongside each other' and a significant decrease in the statements 'conservation is something that is done by organisations with lots of money' and 'economic growth is a higher priority than saving animal species' (see figure1).

Participants attending the course also reported an increase in all of the following statements after taking part in the training course: 'my knowledge about how to protect UK wildlife', 'my knowledge of UK wildlife in general', 'the sense that the actions I take to help UK wildlife are meaningful', 'the feeling that I am making a positive difference for UK wildlife', 'the feeling that my personal relationship with nature is positive'.


These results indicate that the participants expressed a greater sense of responsibility for conservation, and an increase in knowledge and proactivity. The study also showed an increase in community involvement and sustainable ways of working by collaborating with others working towards local conservation initiatives. Approximately 2,000 community members were directly engaged in conservation action by Wildlife Champions following their training. The study also revealed an increase in the number of Champions engaging with other conservation charities.


Overall we have found that upskilling people who have a role within their community to share information and to facilitate the creation of new networks is an effective way of bringing positive behavioural and attitudinal change to combat loss of connection with the natural world and loss of habitat for urban/suburban wildlife.


There are loads of ways that you can get involved and do your bit for UK wildlife too. To find out more about how you can get involved and to explore all our resources visit chesterzoo.org/connections.



Key findings

 **100** Wildlife Champions have been trained over the last two years.

 **≥ 8,000** people can be reached through the 100 Wildlife Champions we trained proving the reach and impact of training community group leaders.

 All of the individuals who responded confirmed that they had taken action for UK wildlife since the training.

WILDLIFE HEALTH AND WELLBEING

The many research projects we conduct at the zoo are designed to address and inform on matters that may impact on the health and wellbeing of the species in the collection at the zoo. We regularly evaluate our husbandry techniques, the habitat spaces and environmental enrichment using a range of methods to provide evidence-based recommendations for the care of the species. We also investigate potential causes and treatments for diseases to benefit both the animals at the zoo and their counterparts in the wild.

The Orangutan Veterinary Advisory Group (OVAG): Linking One Plan thinking to the One Health Paradigm to improve conservation impact

By Steve Unwin, Veterinary Officer and Co-Founder of OVAG and Andy Moss, Conservation Social Scientist



Initiated by the Orangutan Conservancy and supported by Chester Zoo, the Orangutan Veterinary Advisory Group aims to bring together those working with orangutans



in order to share expertise, knowledge and ideas to move forward with effective orangutan conservation. Steve Unwin, Veterinary Officer and Co-Founder of the group reflects on almost 10 years working on the project.

The Global Health Security Agenda envisions “a world safe and secure from infectious disease threats”. However, weaknesses in the public and veterinary health workforces in many countries and mismatches between available training programmes and modern needs have been exposed.

Integrative approaches, such as One Health, unite different fields and require the development of mutual understanding and cooperation across disciplines. By taking a One Plan approach, Chester Zoo is linking One Health expertise from within zoological institutions to those in wildlife range countries in which we work.

The Orangutan Veterinary Advisory Group (OVAG) is a capacity building and expertise network that consolidates experts from a wide variety of organisations and aims to improve their individual and collective impact towards wildlife conservation. OVAG’s programmes are based heavily on the One Health concept and practiced using the orangutan as a species model to provide

participants with skills in wildlife clinical needs, public health and ecosystem health.

Participants range from veterinarians, academics, researchers, project managers, and government authorities from Indonesia, Malaysia, and around the globe. As a group, we provide direct input into conservation management at the NGO level individually and the government level collectively.

OVAG provides a forum, empowering Indonesian and Malaysian wildlife health practitioners and academics to formulate plans relevant to all wildlife health management needs that are respected and utilised by decision makers. This consolidation of experts from a wide variety of organisations improves their individual impact.

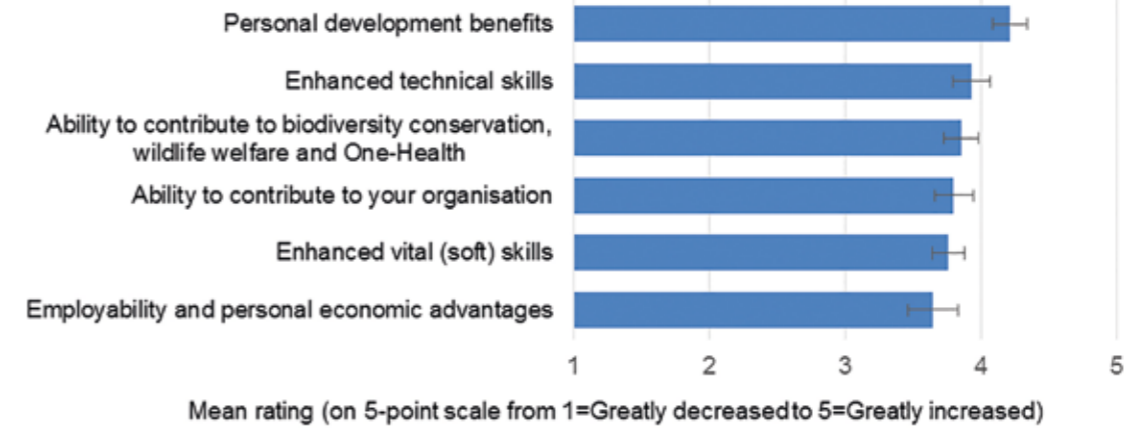


Figure 1. Self-reported impacts of OVAG programme on survey participants across a range of six key criteria

Each year, we link practitioner participants to INDOHUN, the Indonesia One Health University Network, during OVAG’s annual workshops. INDOHUN leverages the capacity building of the university network with training and education to build the skills, knowledge and attitude based on One Health concept for One Health leaders. We are also integrated as a disease risk communicator in the regional Orangutan Action Plan and provide workshop training in wildlife disease risk analysis and outbreak response, which are in turn put into practice by participants from the Sumatran Orangutan Conservation Programme in Sumatra and Sabah Wildlife Department in Malaysian Borneo.

OVAG also plays a crucial role as the only consistent wildlife medicine and One Health programme for post graduates endorsed by the Indonesian Veterinary Medical Association. It provides official, professional development for the veterinarians to be able to be recognised as leading wildlife health professionals nationally and internationally. Moreover, OVAG participants in Chester Zoo based learning opportunities have confirmed improved skills in emergency response, have been provided with a project donor perspective, and have learned multiple aspects of conservation management, which are extremely useful for field work (see figure 1).

The advisory group has gone further this year in its effort by joining forces with Universitas Gadjah Mada to run undergraduate summer schools in Wildlife Health. This course will be university accredited and incorporated into the core curriculum for veterinary undergraduates across Indonesia.

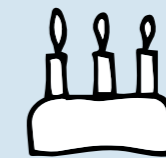
OVAG’s key objective is the creation of a sustainable regional network of professionals able to provide capacity building, advice, guidance and management of One Health matters with a wildlife focus in Indonesia and Malaysia by 2022. This successful integration of One Health programmes into conservation efforts

will lead to successful disease mitigation in wild populations. It will also provide a model for other regions by demonstrating that combining public health and environmental disease issues can contribute to the protection of South East Asian wildlife, habitat and human health.

For more information:

- <https://www.ghsagenda.org/>
- <http://www.onehealthinitiative.com/about.php>
- <https://www.cbd.int/health/SOK-biodiversity-en.pdf>
- <http://www.chesterzoo.org/conservation-and-science/where-we-work/south-east-asia/orangutan-veterinary-advisory-group>

Key findings



10 The Orangutan Veterinary Advisory Group will celebrate its 10th anniversary next year.

7% knowledge increase was recorded after participants followed the OVAG course.



Participants self-reported that OVAG allowed them to increase their ability to contribute to biodiversity conservation, wildlife welfare and One Health.

First report of successful long-term management of Alopecia Syndrome in Andean bears

By Gabby Drake, Veterinary Officer



Andean Bear Alopecia Syndrome (ABAS) is a condition characterised by symmetrical hair loss on the flank of the bears sometimes accompanied by profound itching and secondary bacterial infections. Veterinary Officer, Gabby Drake, tell us more about the way a team of biologists and veterinarians have succeeded for the first time to manage the syndrome successfully.

Andean bear (*Tremarctos ornatus*) Alopecia Syndrome (ABAS) commonly affects bears in *ex situ* environment, particularly sexually mature females. The syndrome is characterised by a loss of hair on the flank and face of affected individuals. Prior to this study bears received palliative care only, as there was no known effective treatment.

Also known as spectacled bears, the Andean bear is the only bear species endemic to South America and is classified as Vulnerable by the IUCN Red List. The first case of Alopecia Syndrome in that species was recorded in 1968 in Europe. At the

time of publication, seven cases of ABAS were recorded within the European Endangered Species Programme. A prevalence of 35% has also been reported within the females older than three years old in the United States, making ABAS one of the most significant medical issues seen in Andean bears.

Looking at three female Andean bears afflicted by ABAS, the team of researchers tried different methods such as novel diet trials, antifungals, antihistamines, allergen specific immunotherapy, and topical antimicrobials to treat the syndrome but without any success.

The Veterinary Officers then decided to try a novel treatment marketed towards atopic dermatitis in domestic dogs. The treatment with a new drug called oclacitinib maleate (Apoquel, Zoetis; 0.46–0.5 mg/kg po, bid) resulted in rapid and complete resolution of the itchiness with subsequent improvement in demeanour and fur regrowth.

One of the major advantages of using this new treatment is that the potential side effects seen with other immunosuppressive drugs are minimised. After five months under this treatment, the bears were almost fully furred and off all other medication without any adverse effects being noted. Usually considered as an intractable condition, this is a major breakthrough and represents the first treatment shown to result in sustained clinical improvement. Since publication of this study a further three bears have begun treatment based on our findings and have shown similar dramatic improvements.



Andean bear affected by Alopecia Syndrome in 2013

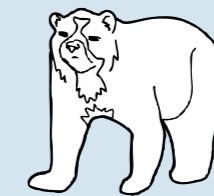


Same bear after treatment in 2015

References:

Drake, G. J. *et al.* *Journal of Zoo and Wildlife Medicine* **48**(3), 818-828 (2017).

Key findings



100 active cases of ABAS have been recorded within the European Endangered species Programme (EEP) population.

0 side effects or relapses have been noted with oclacitinib maleate treatment.



6 bears have been successfully treated with oclacitinib maleate to date.

SCIENCE COMMUNICATION

A large part of our scientific work includes disseminating our findings both nationally and internationally to our peers and also to the wider public. We achieve this through various ways such as publishing our findings in scientific papers, presenting our work at scientific conferences, providing seminars, lectures, and technical training and participating in a number of scientific events across the country.

Symposia

Conservation Symposium 2017: Trade Off

Chester Zoo hosted its Annual Conservation Symposium in October which was focused this year around the topic of illegal wildlife trade. The sold-out event proved extremely popular and attracted a total of 155 attendees. The event was chaired by Act for Wildlife patron, TV vet and wildlife presenter, Steve Leonard. Speakers from research and conservation organisations included staff members from the IUCN SSC Pangolin Specialist Group, the University of Oxford, the Environmental Investigation Agency, Oxford Brookes University, Manchester Metropolitan University and the National Wildlife Crime Unit. A diversity of topics was covered during the event from online orchid fever to the Asian songbird crisis.



leading conservation scientists delivered presentations at the event including academics from the University of Manchester, University of York, University of Kent, University of Glasgow and Nelson Mandela Metropolitan University (South Africa) as well as representatives from conservation institutions such as IUCN, IUCN Conservation Breeding Specialist Group, RSPB and Foundations of Success.



Science Symposium 2017: Future Directions in Conservation Science

In April 2017, along with the University of Manchester, we hosted the Future Directions in Conservation Science Symposium at the zoo and the Queen Hotel in Chester. This event attracted attendees from the UK and from abroad and was part funded by two of the National Environment Research Council Doctoral Training Programmes through the University of Manchester.



During four days, the symposium showcased some of the great conservation science work we do at Chester Zoo. A number of

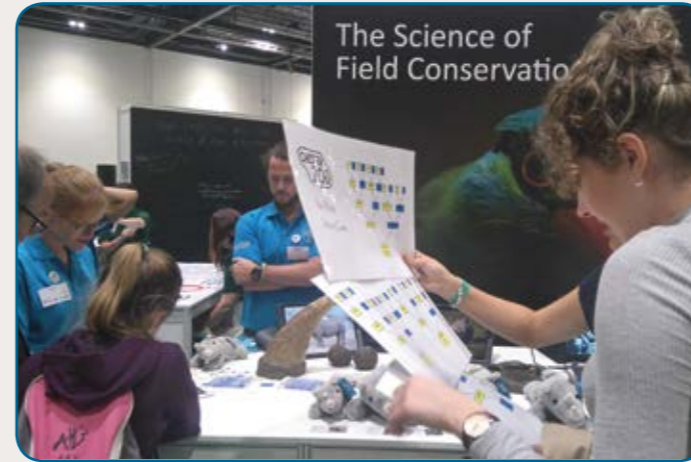
Wildlife Connections Festival

We invited everyone to join us to celebrate our British native wildlife in style with our second Wildlife Connections Festival extended from two to three days this year which attracted over 1,500 visitors!

We invited for the first time local businesses and practitioners to join us in our Sustainability Centre to promote their products and share how we can all make eco-friendly choices every day. Our first ever Sleepover was a great success on the Saturday night, with over 150 people enjoying a night getting closer to nature.



During the weekend, we offered some of our ever popular activities like bug hunts, storytelling and drone demos in the Nature Reserve. We had six great local musicians playing on our stage and had lovely fluttering giant butterflies brightening up the field throughout. We were joined by two theatre companies, Yan Tan Tethera and Peoplescapes Theatre who entertained the festival goers with their performances in our amphitheatre.



New Scientist Live

Chester Zoo staff members and Conservation Scholars were in London in September to participate in the New Scientist Live event in London. Rooted in the biggest, best and most provocative science, New Scientist Live touched on all areas of human life and featured five immersive zones covering Humans, Engineering, Technology, Earth and Cosmos.

Sharing a BIAZA stand with other organisations including the Whitley Wildlife Conservation Trust, The Deep and ZSL, we covered a range of topics and shared our expertise with an incredibly diverse audience ranging from young children to experienced scientists.



We engaged with a total of 1,200 people during the four-day long event through various activities such as radio tracking, songbird origamis, a rhino dating game, and thermal imaging infrared cameras. Topics covered by the different organisations on the BIAZA stand included the Science of Field Conservation, the Science of Animal Care and the Science of Conservation Breeding.

Science Education, Training and Conference Participation

Chester Zoo staff members regularly participate in international and national conferences to share ideas and scientific achievements with both the academic and zoo community. In 2017, we delivered in over 78 presentations at conferences and symposia such as the BIAZA Research Conference in Edinburgh and the International Congress for Conservation Biology in Cartagena, Colombia.

In addition, Chester Zoo staff members delivered 61 lectures and technical training sessions. Last year, we hosted seven 2016-2017 students participating in industrial placements as part of their undergraduate qualifications (see page 38-39) and one PhD student as part of her doctoral training.

Within the zoo, staff members led programmes such as the Junior Members summer school and the Zoo Intern Workshops, providing the opportunity for future conservation scientists to learn more about the work of Chester Zoo. We also provide opportunities for our staff to learn more about conservation projects by hosting a number of successful internal seminars and regularly inviting leading experts and academics to give talks and discuss potential collaborations.



ONE-YEAR INDUSTRIAL PLACEMENT STUDENTS

Every year we offer a limited number of work placements throughout the zoo to enable the next generation of keepers, conservationists and scientists to develop their skills, knowledge and experience. Meet our 2016-2017 cohort of One-Year Industrial Placement Students!

Behaviour and Welfare Intern: Lydia Underwood University of Manchester



Lydia's research project focused on the two sun bears at the zoo. The two bears could be found in the Spirit of the Jaguar area, before they were recently moved

to their new habitat in Islands. Lydia's project titled 'Bear behaviour: A behavioural study of a breeding pair of Malayan sun bears (*Helarctos malayanus*)' assessed the way the move affected the two bears' behaviour. She found that both of the bears slept more when they were together compared to when they were separate which leads to the conclusion that they are more relaxed when they are together. They also moved more when they were outside compared to when inside.

"Being able to be part of a science team and to feel like you're contributing to something, learning so much from being around all those really good scientists has definitely helped me gain so many skills."

More here: www.chesterzoo.org/conservation-and-science/news-and-events/2017/08/lydia-underwood-intern

Bird Intern: Abbie Buxton Nottingham Trent University



Abbie carried out a research study investigating the husbandry techniques and the breeding behaviour of the Javan green magpie (*Cissa thalassina*),

developing the first behavioural dataset of its kind for the Critically Endangered bird.

"We found out that there was no sex difference in pre-breeding season behaviours between males and females. I didn't know whether the males might be a bit more alert or aggressive but

they weren't. During the breeding season, we also found out that it's the female who incubates the eggs and the male brings food to the nest."

More here: www.chesterzoo.org/conservation-and-science/news-and-events/2017/08/abbie-buxton-intern

Conservation Social Science Intern: Elinor Bridges University of Manchester



Elinor's project looked at Islands which highlights endangered species through theming. Her goal was to assess visitor engagement levels at different

areas in Islands, including the gharials, the cassowaries, the hornbills, the tigers and the Sulawesi macaques allowing her to investigate different forms of engagement and to explore the relationship between dwell times and visitors' conversations. Her results revealed that visitors spent the longest time and talked more within the gharial area. At this area, the water line comes up to about eye height so if the gharials are underwater, visitors have to crouch down to be able to see them. Elinor's results are suggesting that once people have made the effort to sit down on the floor they don't want to get up and leave straight away, they want to take their time to have a look at it.

"One of the main things that we try to bring across to people is that you can make small changes in your life that can help the environment, but that is applicable to every aspect of your life. You can make small changes that can make everything in your life better and it doesn't really take long to make an actual difference!"

More here: www.chesterzoo.org/conservation-and-science/news-and-events/2017/09/elinor-bridges

Endocrinology Intern: Alice Clark University of Glasgow



Alice's project titled 'Non-Invasive Pregnancy Detection in Captive Equids' looked at the differences between progesterone and oestrogen during pregnancy

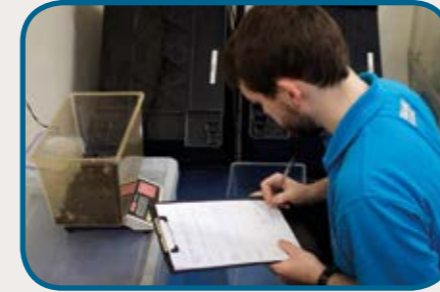
of four different equid species: Przewalski's horse (*Equus ferus przewalskii*), onager (*Equus hemionus*), Grevy's zebra (*Equus grevyi*) and domestic horse (*Equus caballus*).

She found that from the second trimester onwards, which is month five, in every single species, progesterone in pregnant individuals rose higher than in non-pregnant individuals. This showed that progesterone is a very reliable indicator of pregnancy which can be used to non-invasively diagnose pregnancy from faecal samples and without having to draw blood.

"The protocol I conducted could potentially be used in the field as well, you can just follow a herd of animals from a distance and then after they moved on, collect the faecal samples and take them back to the laboratory to assess how many individuals in your population are pregnant."

More here: www.chesterzoo.org/conservation-and-science/news-and-events/2017/09/alice-clark

Nutrition Intern: Jasper Hughes University of Manchester



Jasper compared crickets' gut-loading diets to determine the best method to produce highly nutritious crickets to feed the small reptiles and amphibians. More

precisely he compared two different diets: a commercially available gut-loading diet, which we regularly give to our reptiles and amphibians, and an alternative recipe for a gut-loading diet successfully used by other institutions.

"I found out that the commercially available gut-loading diet, which is more convenient to use than the homemade diet, does meet the target we wanted to reach for calcium levels."

More here: www.chesterzoo.org/conservation-and-science/news-and-events/2017/09/jasper-hughes

Curatorial Intern: Jill Vevers Liverpool John Moores University



Jill carried out a research project looking at the nesting behaviour of the Endangered Sumatran laughingthrush (*Garrulax bicolor*). Her

aim was to investigate natural behaviours and husbandry techniques to look for implications on breeding success. She found that the adult males incubate the eggs longer than the females but that both the males and females spent equal times on nest-building activities.

"This placement year made me realise that I might want to go to a different career path than the one I thought before. Previously I wanted to do husbandry but doing the curatorial internship helped me realise that I really enjoy doing research so maybe I would like to do that instead and do a masters."

More here: www.chesterzoo.org/conservation-and-science/news-and-events/2017/09/jill-vevers

Reptile Intern: Jonathan Holman Manchester Metropolitan University



Jonathan's study assessed the optimal method for recording temperatures within our different reptile's species. He compared three tools

used to measure temperatures: thermal imaging cameras, infrared laser thermometers, and data loggers which are harmlessly fed-to and swallowed by the animal and will record the information as it passes through the digestive tract, after which it is retrieved from the animal's poo.

"FLIR ONE, a phone mounted thermal imaging camera working in conjunction with a free app, worked best to measure temperatures and to give thermal visuals of the heat which is really helpful!"

More info: www.chesterzoo.org/conservation-and-science/news-and-events/2017/09/jonathan-holman

CHESTER ZOO CONSERVATION FELLOWS & SCHOLARS

Chester Zoo Conservation Fellows



Andean Bear Project, Dr Ximena Velez-Liendo, WildCRU, University of Oxford, in collaboration with Dr Alexandra Zimmermann and Prof David Macdonald



Harnessing the adaptive immunity of Asian elephants for generating a vaccine against EEHV, Dr Tanja Maehr, University of Surrey, in collaboration with Prof Falko Steinbach and Dr Javier Lopez



Grevys' zebra (*Equus grevyi*): Unravelling causes of population decline and improving population performance, Dr Danielle Gilroy, University of Manchester, in collaboration with Dr Susanne Shultz and Dr Sue Walker

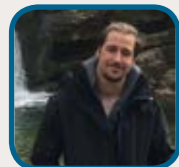
Chester Zoo Conservation Scholars



Assessing practical interventions for reducing human-large felid conflict in Nepal, Amy Fitzmaurice, University of Oxford, supervised by Prof David Macdonald and Dr Alex Zimmermann



Can conservation physiology improve the population management of eastern black rhinos? Nicholas Harvey, University of Manchester, supervised by Dr Susanne Shultz and Dr Sue Walker



Developing physiological and behavioural markers to identify health and responses to environmental change in Cape mountain zebra, Jake Britnell, University of Manchester, supervised by Dr Susanne Shultz and Dr Sue Walker



Exploring the innate and adaptive immunity of Asian elephants that may confer protection from elephant endotheliotropic herpesviruses haemorrhagic disease (EEHV-HD), Johnathan Haycock, University of Surrey & Animal and Plant Health Agency, supervised by Prof Falko Steinbach and Dr Javier Lopez



Factors underlying reproductive success in black rhinoceros (*Diceros bicornis michaeli*) in Kenya, Antony Wandera, Manchester Metropolitan University, supervised by Dr Bradley Cain and Dr Sue Walker



Fencing African elephants in Kenya: landscape and welfare impacts, Jacqui Morrison, Manchester Metropolitan University, supervised by Dr Bradley Cain and Dr Sue Walker



From Kukila to the Asian songbird crisis: supply and demand within Java's huge captive bird market, Harry Marshall, Manchester Metropolitan University, supervised by Prof Stuart Marsden, Andrew Owen and Dr Andrew Moss



Genetics and conservation in the mountain bongo, Tommy Sandri, Manchester Metropolitan University, supervised by Dr Edwin Harris and Dr Nick Davies



How does sound produced by the zoo-going public affect zoo mammals? Marina Bonde de Queiroz, University of Salford, supervised by Prof Robert Young and Dr Leah Williams



Improving the evidence base for the conservation management of three Critically Endangered species of 'black-winged starling', Tom Squires, Manchester Metropolitan University, supervised by Prof Stuart Marsden and Andrew Owen



Incorporating the genetic structure of captive and introduced populations into population management plans, Franziska Elsner Gearing, University of Manchester, supervised by Dr Cathy Walton and Dr Jon Bielby



Investigating scent communication in the eastern black rhino (*Diceros bicornis michaeli*), Rebekah Titchard, University of Liverpool, supervised by Prof Jane Hurst and Dr Lisa Holmes



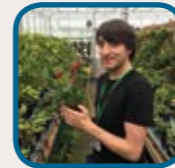
Keeping fit for the ark: Are zoo-bred reptiles and amphibians ready to go back to the wild? Luiza Passos, University of Salford, supervised by Prof Robert Young and Dr Gerardo Garcia



Linking ecology and physiology to aid conservation of wild equids, Jessica Lea, University of Manchester, supervised by Dr Susanne Shultz and Dr Sue Walker



Managing aggression in captive primates, Veronica Cowl, University of Manchester, and supervised by Dr Susanne Shultz and Dr Sue Walker



Orchid - Mycorrhizal fungal interactions; improving propagation methods for chlorophyllous and mycoheterotrophic orchids, Oliver Hughes, Manchester Metropolitan University, supervised by Prof Richard Preziosi and Phillip Esseen



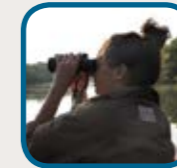
Population status and conservation of the critically endangered Bermuda skink *Plestiodon longirostris*, Helena Turner, University of Kent, supervised by Prof Richard Griffiths and Dr Gerardo Garcia



Proximate mediators of competitive behaviour in cooperatively breeding mammals, Rhiannon Bolton, University of Liverpool, supervised by Dr Paula Stockley and Dr Lisa Holmes



Retrospective analysis of morbidity and mortality in the European mountain chicken frog (*Leptodactylus fallax*) population, 2000-2017, Ian Ashpole, University of Liverpool, supervised by Dr Julian Chantrey and Dr Javier Lopez



Conservation planning for a newly described Amazon parrot, *Amazona lilacina*: distribution, habitat preference, roosting dynamics, local attitudes and threats, Rebecca Biddle, Manchester Metropolitan University, supervised by Dr Martin Jones and Dr Mark Pilgrim



The significance of the social welfare of captive Asian elephants (*Elephas maximus*), Rutendo Wazara, University of Liverpool, Dr Paula Stockley and Dr Lisa Holmes

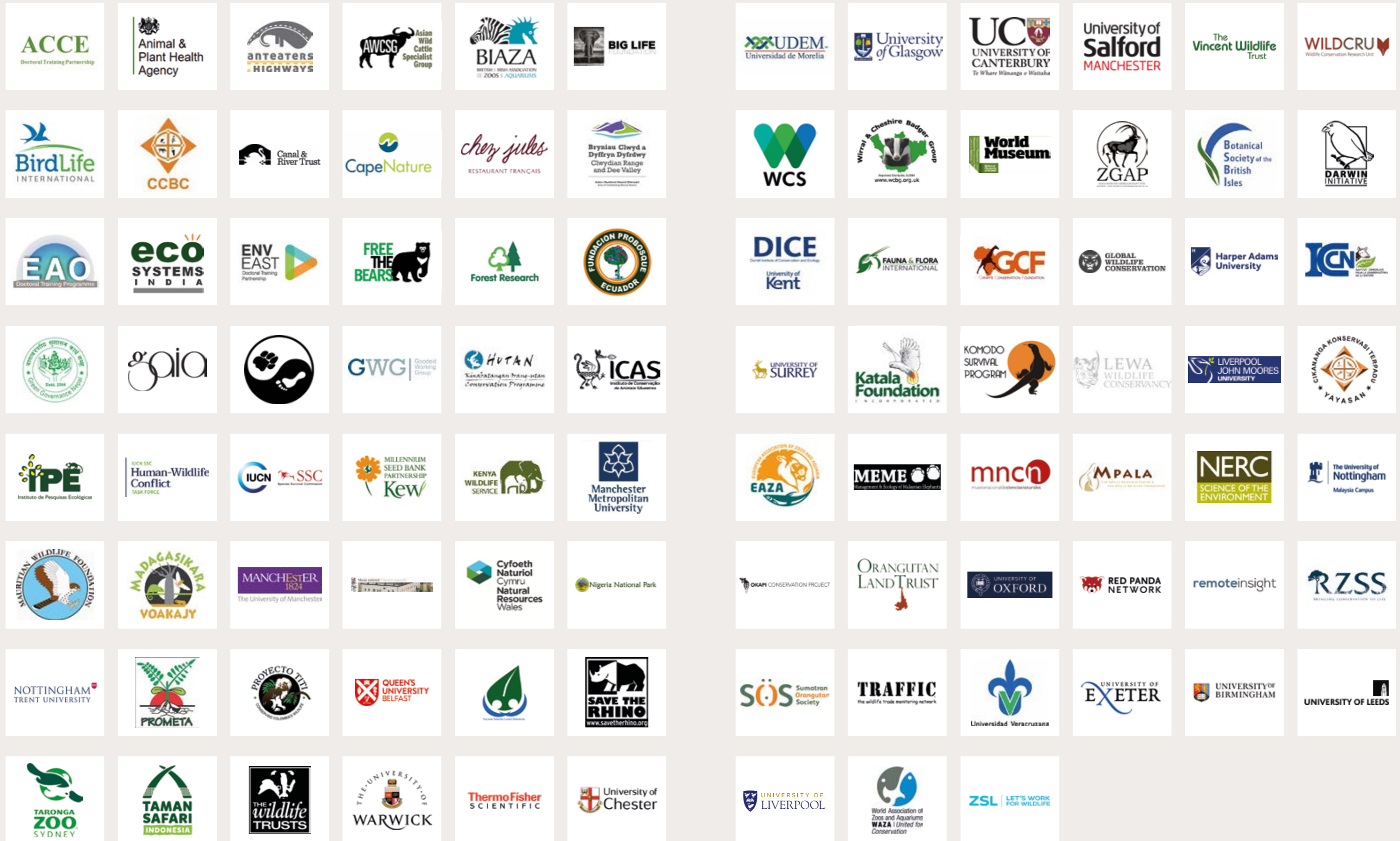


UK pine marten recovery programme: Impact of translocation strategies, David Bavin, Vincent Wildlife Trust and University of Exeter, supervised by Prof Robbie McDonald and Sarah Bird



Understanding the impact song-divergence in spatially isolated populations (*in* and *ex situ*) on meta-population management, Rebecca Lewis, University of Manchester, supervised by Dr Tucker Gilman and Dr Leah Williams

COLLABORATING INSTITUTIONS



Peer-reviewed publications

Ashpole, I. & Murray, M. 2017. What Is Your Diagnosis? Diagnosis and medical management of extensor process fracture of carpometacarpus in a barred owl (*Strix varia*). *Journal of Avian Medicine and Surgery*, 31(1), 75-78.

Atencia, R., Stohr, E.J., Drane, A.L., Stembridge, M., Howatson, G., del Rio, P.R.L., Feltre, Y., Tafon, B., Redrobe, S., Peck, B., Eng, J., **Unwin, S.**, Sanchez, C.R., Shave, R.E. 2017. Heart rate and indirect blood pressure responses to four different field anesthetic protocols in wild-born captive chimpanzees (*Pan troglodytes*). *Journal of Zoo and Wildlife Medicine*, 48(3):636-644.

Aziz, M. A., **Tollington, S.**, Barlow, A., Goodrich, J., Shamsuddoha, M., Islam, M. A. & Groombridge, J. J. 2017. Investigating patterns of tiger and prey poaching in the Bangladesh Sundarbans: Implications for improved management. *Global Ecology and Conservation*, 9, 70-81.

Aziz, M.A., **Tollington, S.**, Barlow, A., Greenwood, C., Goodrich, J.M., Smith, O., Shamsuddoha, M., Islam, M.A. and Groombridge, J.J. 2017. Using non-invasively collected genetic data to estimate density and population size of tigers in the Bangladesh Sundarbans. *Global Ecology and Conservation*, 12, 272-282.

Barbon, A., Goetz, M., **Lopez, J.** & Routh, A. 2017. Uterine rupture and cesarean surgery in three rio cauca caecilians (*Thyplonectes natans*). *Journal of Zoo and Wildlife Medicine*, 48(1), 164-170.

Bertelsen, M.F., Grøndahl, C., Stegmann, G.F., **Sauer, C.**, Secher, N.H., Hasenkam, J.M., Damkjær, M., Aalkjær, C., Wang, T. 2017. Accuracy of noninvasive anesthetic monitoring in the anesthetized giraffe (*Giraffa camelopardalis*). *Journal of Zoo and Wildlife Medicine*, 48(3), 609-615.

Bird, S. A., Esseen, P. J. & Hewitt, R. 2017. Reintroductions of native plant species to the United Kingdom. *International Zoo Yearbook*, 51, 32-49.

Bortolami, A., Verin, R., Chantrey, J., Corró, M., **Ashpole, I., Lopez, J.**, Timofte, D. 2017. Characterization of Livestock-Associated Methicillin-Resistant *Staphylococcus aureus* CC398 and mecC -positive CC130 from Zoo Animals in the United Kingdom. *Microbial Drug Resistance*, 23 (7), 908 - 914.

Chatterton, J., **Unwin, S., Lopez, J.**, Chantrey, J. 2017. Urolithiasis in a group of Visayan warty pigs (*Sus cebifrons negrinus*). *Journal of Zoo and Wildlife Medicine*, 48(3), 842-850.

Cowl, V. & Shultz, S. 2017. Large brains and groups associated with high rates of agonism in primates. *Behavioral Ecology*, 28, 803-810.

Drake, G., Nuttall, T., **López, J.**, Magnone, W., Leclerc, A., Potier, R., Lécuyer, A., Guézéne, M., Kolter, L., Nicolau, A., Lemberger, K., Cosgrove, S.B. Treatment success in three Andean bears (*Tremarctos ornatus*) with alopecia syndrome using oclacitinib maleate (Apoquel®). *Journal of Zoo and Wildlife Medicine*, 48(3), 818-828.

Flacke, G.L., Schwarzenberger, F., Penfold, L. M., **Walker, S. L.**, Martin, G.B., Millar, R.P., Paris, M.C.J. 2017. Characterizing the reproductive biology of the female pygmy hippopotamus (*Choeropsis liberiensis*) through non-invasive endocrine monitoring. *Theriogenology*, 102, 126-138.

Fu, Y., Dai, B., Wen, L., Chen, B., **Dowell, S.** 2017. Unusual incubation behavior and embryonic tolerance of hypothermia in the Sichuan Partridge (*Arborophila rufipectus*). *Journal of Ornithology*, 158(3), 707-715.

Jensen, E., **Moss, A.** & Gusset, M. 2017. Quantifying long-term impact of zoo and aquarium visits on biodiversity-related learning outcomes. *Zoo Biology*, 36(4), 294-297.

Jones, K. A. B., Nicoll, M. A.C., **Raisin, C.**, Dawson, D.A., Hipperson, H., Horsburgh, G.J., Groombridge, J.J., Ismar, S.M.H., Sweet, P., Jones, C.G., Tatayah, V., Ruhomaun, K., Norris, K. 2017. Widespread gene flow between oceans in a pelagic seabird species complex. *Molecular Ecology*, 26(20), 5716-5728.

Lea, J. M., Walker, S. L., Kerley, G. I., Jackson, J., Matevich, S. C. & Shultz, S. 2017. Noninvasive physiological markers demonstrate link between habitat quality, adult sex ratio and poor population growth rate in a vulnerable species, the Cape mountain zebra. *Functional Ecology*.

Lopez, J., Dukes-McEwan, J., **Drake, G.**, Chantrey, J. 2017. Preliminary characterization of dilated cardiomyopathy in a captive population of banded mongooses (*Mungos mungo*). *Journal of Zoo and Wildlife Medicine*, 48(3), 829-841.

Lopez, J., Haycock, J., Mackenzie, A., Dasterdji, A. 2017. Assessment of a lancet-and-swab blood sampling technique for surveillance of elephant endotheliotropic herpesvirus infection. *Journal of Zoo and Wildlife Medicine*, 48(3), 659-667.

Lopez, J., Waters, M., Routh, A., Rakotonanahary, T. F., Woolaver, L., Thomasson, A., Holmes, E. & Steinmetz, H. W. 2017. Hematology and plasma chemistry of the ploughshare tortoise (*Astrochelys yniphor*) in a captive breeding program. *Journal of Zoo and Wildlife Medicine*, 48(1), 102-115.

Maclachlan, N., Hunt, G., Frost, M., Miller, J., Purcell-Jones, G., Sullivan, P., Barbon, A., Routh, A., **Lopez, J.** & Price, E. C. 2017. Successful treatment of infertility in a female Sumatran Orangutan (*Pongo abelli*). *Zoo Biology*, 36, 132-135.

Monné Rodríguez, J.M., Chantrey, J., **Unwin, S.**, Verin, R. 2017. Cardiac Truncus Arteriosis In An Eastern Black Rhinoceros (*Diceros bicornis michaeli*). *Journal of Comparative Pathology*, 157, 276-279.

Moss, A., Jensen, E. & Gusset, M. 2017. Probing the Link between Biodiversity-related Knowledge and Self-reported Pro-conservation Behaviour in a Global Survey of Zoo Visitors. *Conservation Letters*, 10(1), 33-40.

Moss, A., Jensen, E. & Gusset, M. 2017. Impact of a global biodiversity education campaign on zoo and aquarium visitors. *Frontiers in Ecology and the Environment*, 15(5), 243-247.

Moss, A., Littlehales, C., **Moon, A., Smith, C.** & Sainsbury, C. 2017. Measuring the impact of an in-school zoo education programme. *Journal of Zoo and Aquarium Research*, 5, 33-37.

Passos, L.F., Garcia, G., Young, R.J. (2017). Neglecting the call of the wild: Captive frogs like the sound of their own voice. *PLOS ONE*, 12(7).

Passos, L.F., Garcia, G., Young, R.J. (2017). The tonic immobility test: Do wild and captive golden mantella frogs (*Mantella aurantiaca*) have the same response? *PLOS ONE*, 12(7).

Pooley, S., Barua, M., Beinart, W., Dickman, A., Holmes, G., Lorimer, J., Loveridge, A.J., Macdonald, D.W., Marvin, G., Redpath, S., Sillero-Zubiri, C., **Zimmermann, A.**, Milner-Gulland, E.J. 2017. An interdisciplinary review of current and future approaches to improving human–predator relations. *Conservation Biology*, 31(3), 513-523.

Rademaker, M., **Rode-Margono, E. J.** & Weterings, M. J. A. 2017. Estimation of species area abundance from point abundance data, using effective detection areas from camera traps. *Journal of Biodiversity & Endangered Species*, 5(4), 200.

Rodríguez, J. M. M., Chantrey, J., **Unwin, S.**, Verin, R. 2017. Cardiac Truncus Arteriosus in an Eastern Black Rhinoceros (*Diceros bicornis michaeli*). *Journal of Comparative Pathology*, 157(4), 276-279.

Sauer, C., Clauss, M., Bertelsen, M.F., Weisbjerg, M.R., Lund, P. 2017. Rumen content stratification in the giraffe (*Giraffa camelopardalis*). *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology*, 203, 69-76.

Strike, T.B., **Bielby, J.**, Feltre, Y., Alibhai, H.I.K., Rendle, M., Neilson, D.M. 2017. Comparison of Isoflurane and Sevoflurane for short-term anesthesia in meerkats (*Suricata suricatta*) – Are there benefits that outweigh costs? *Journal of Zoo and Wildlife Medicine*, 48(2), 371-379.

Sukumal, N., **Dowell, S.**, & Savini, T. (2017). Micro-habitat selection and population recovery of the Endangered Green

Peafowl *Pavo muticus* in western Thailand: Implications for conservation guidance. *Bird Conservation International*, 27(3), 414-430.

Turbé, A., Strubbe, D., Mori, E., Carrete, M., Chiron, F., Clergeau, P., González-Moreno, P., Le Louarn, M., Luna, A., Menchetti, M., Nentwig, W., Parau, L. G., Postigo, J., Rabitsch, W., Senar, J. S., **Tollington, S.**, Vanderhoeven, S., Weiserbs, A., Schwartz, A. 2017. Assessing the assessments: evaluation of four impact assessment protocols for invasive alien species. *Diversity and Distributions*, 23(3), 297-307.

Turner, H., Griffiths, A. R., **Garcia, G.**, Outerbridge, E. M. 2017. Pleistodon longirostris (*bermuda skink*) Tail bifurcation. *Herpetological Review*, 48(1).

Turvey S., T., Crees, J., J., Li, Z., **Bielby, J.**, Yuan, J. 2017. Long-term archives reveal shifting extinction selectivity in China's postglacial mammal fauna. *Proceedings of the Royal Society B*, 284 (1867).

Yarnell, K. & **Walker, S. L.** 2017. Environmental conditions impact upon faecal glucocorticoid metabolite concentrations; a case study in Grevy's Zebra (*Equus grevyi*). *Journal of African Wildlife Research*, 47(2):138-143.

Yarnell, K. & **Walker, S. L.** 2017. Glucocorticoid assessment in the domestic horse: the impacts of time and climatic variables on sample integrity. *Equine Veterinary Journal*, Early Views.

Reports and non peer-reviewed publications

Bazley, S., Garcia, G. 2017. The main attraction (a creative approach to making tarantulas and leeches more attractive to visitors). *ZooQuaria*, 33.

Biddle, R. 2017. Studbook Annual Report - Blue-throated macaw, *Ara glaucogularis*. *EAZA Website TAG Space*.

Biddle, R. 2017. Studbook Annual Report - Jaguar, *Panthera onca*. *EAZA Website TAG Space*.

Biddle, R. & Pilgrim, M. 2017. Studbook Annual Report - Ecuadorian Amazon, *Amazona lilacina*. *EAZA Website TAG Space*.

Biddle, R. & Pilgrim, M. 2017. Studbook Annual Report - Black rhino, *Diceros bicornis michaeli*. *EAZA Website TAG Space*.

Buckley, N., Smith, C. & Moss, A. 2017. Volunteering impacts. *Chester Zoo Act for Wildlife publication*.

Fitzmaurice, A. 2017. Living with Tigers. *Mammal News / The Mammal Society*, 179, 14-15.

Rode-Margono, E.J. 2017. Saving the banteng - Action Indonesia makes a plea for more members to join the Banteng EEP. *ZooQuaria*, 19.

Rode-Margono, E.J., Rademaker, M., Semiadi, G., Bulk, S. 2017. Javan Warty Pig *Sus verrucosus* (Boie, 1832) and Bawean Warty Pig *Sus blouchi* (Groves and Grubb, 2011) Mario Meletti & Erik Meijaard (eds.), *Ecology, Conservation and Management of Wild Pigs and Peccaries*. Cambridge, UK: Cambridge University Press, 193-201.

Rode-Margono, E.J., Rademaker, M. 2017. Populationsgröße, Verhalten und Arterhaltung des Bawean-Hirsches – Eine Studie des Projekts BEKI (Bawean Endemics Conservation Initiative). *ZGAP Mitteilungen*, 28-30.

Rode-Margono, E.J., Treanor, A., Rowlands, T. 2017. Teaching pigs to fly: Integrative conservation breeding of babirusa – an example by Chester Zoo. *Suiform Soundings*, 16(1), 19-28.

Conference presentations and posters

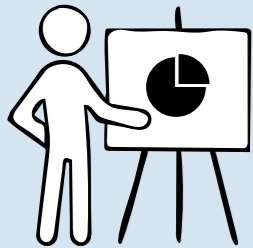
In 2017, Chester Zoo delivered

63 talks and presented

13 posters at

30 conferences and symposia in

10 different countries around the world





Male big-belly seahorse (*Hippocampus abdominalis*) giving birth at Chester Zoo.

For more information on our conservation and science work visit:

www.chesterzoo.org/conservation

Follow us on Twitter [@ScienceatCZ](https://twitter.com/ScienceatCZ)



www.chesterzoo.org

Registered Charity Number 306077
Registered Company Number 287902

North of England Zoological Society
Caughall Road
Upton by Chester
Chester CH2 1LH
Tel: 01244 380280
Fax: 01244 371273
Email: info@chesterzoo.org

Chester Zoo is licensed under the Zoo Licensing Act, 1981. In the interests of conservation and educational study, this report may be freely copied without alteration or amendment and stored by electronic means without formal permission. It is also available to download from our website. The NEZS is happy to assist anyone with special needs obtain a copy in the appropriate format. Published May 2018 by the North of England Zoological Society.