



**INSTITUTE OF ZOOLOGY
REVIEW 2014/2015**
SCIENCE FOR CONSERVATION

ZSL
LET'S WORK
FOR WILDLIFE

A close-up photograph of a wolf's face, focusing on its intense yellow eyes. The wolf has thick, dark fur. The background is blurred, making the eyes stand out.

ZSL

OUR VISION:

A world where animals
are valued, and their
conservation assured

OUR MISSION:

To promote and achieve the
worldwide conservation
of animals and
their habitats

Welcome

The President and Director General of the Zoological Society of London introduce the Institute of Zoology Review 2014/2015.



As President of the Zoological Society of London, it gives me great pleasure to welcome you to the Institute of Zoology (IoZ) annual review.

Global trends continue to pose formidable problems. Population growth, increasing urbanisation and an increasing middle class in the developing world combine to raise issues of food, water and energy security, complicated by the changing climate and the need to reduce greenhouse gas emissions. All this increases pressure on scarce habitats and species. Indeed, the 2014 Living Planet Index, which measured more than 10,000 populations of mammals, birds, reptiles, amphibians and fish, revealed a global decline in vertebrate population abundance of 52% since 1970. If humans are to coexist with wildlife, we will need to address fundamental questions about nature and the effects we have on it, and determine what measures can be taken to reverse such declines.

This review illustrates the breadth of the science undertaken at IoZ, as we work to understand the causes of species declines, and to use this knowledge to inform policy and practical conservation action.

Six 'Impact Area' case studies show how our science has made a difference to conservation, including three that we submitted to the recent Research Excellence Framework. Two of these were rated by experts in environmental science as demonstrating 'outstanding impact' and the third as having 'very considerable impact'. I am proud to introduce this review of the impressive and influential body of work carried out by IoZ.



The Zoological Society of London is extremely fortunate to have an institute dedicated to conservation science. This review illustrates the scope of research carried out by scientists at IoZ: from saving individual species right through to the development of new technologies to measure global trends in biodiversity loss. This work is made possible with the support of our many external collaborators, most notably through our partnership with University College London, and the wide range of organisations that fund our research. I would like to thank them all for their continued generosity.

In addition to our world-leading conservation science, IoZ is committed to educating the next generation of scientists, with its participation in MSc courses on Wild Animal Health, Wild Animal Biology and Conservation Science. IoZ scientists also co-supervise around 50 PhD students at any time. These students make an enormous contribution to IoZ, as they develop new ideas and techniques that advance conservation science, as well as create a dynamic environment in which to carry out research.

Alongside our formal education programme, we host an annual series of public lectures and international symposia, which provide opportunities for researchers to share their concepts and develop new collaborations. The focus on 'Impact Areas' in this review both highlights the science we do and shows why it is so important. I hope you enjoy reading about our work in the pages that follow.

Professor Sir John Beddington
President, Zoological Society of London

Ralph Armond
Director General, Zoological Society of London

IoZ's global reach

Research carried out at the IoZ is truly international in scope. Each dot on the map represents at least one project, and examples of our research are given below.



Protecting the mountain chicken frog **DOMINICA/MONTSERRAT**

The mountain chicken frog (*Leptodactylus fallax*) is threatened by the fungal disease chytridiomycosis and human consumption. The remaining wild population consists of fewer than 100 known individuals. IoZ, in partnership with the Forestry Department of the Dominican government, continues to research the epidemiology and impact of chytridiomycosis in mountain chickens and assists in the running of a captive facility in Dominica. ZSL maintains a biosecure facility at ZSL London Zoo, where the frogs have been bred and then released in Montserrat.



Benthic habitats of west Greenland **GREENLAND**

IoZ researchers are examining the impact of shrimp trawl fisheries on the diversity of the seabed. This year, new images were taken at sites originally photographed in the 1970s in order to assess changes to the biodiversity over the past 40 years. Despite unusually extensive sea ice, more than 450 images and 3.5 hours of video footage were taken from 50 sites, covering 700km of the continental shelf. This research is funded by Sustainable Fisheries Greenland, which has entered its shrimp fishery into the sustainability certification process run by the Marine Stewardship Council. IoZ is supporting this process by conducting independent research into the influence of the fishery on the seabed. Our research is informing management of the fishery and leading to more sustainable fishing practices.



Cetacean Strandings Investigation Programme UK

The CSIP has been funded by the UK government since 1990 and is tasked with providing a systematic and coordinated approach to the surveillance of cetacean strandings nationwide and to the investigation of causes of death, so that more can be learnt about the threats cetaceans face in UK waters.



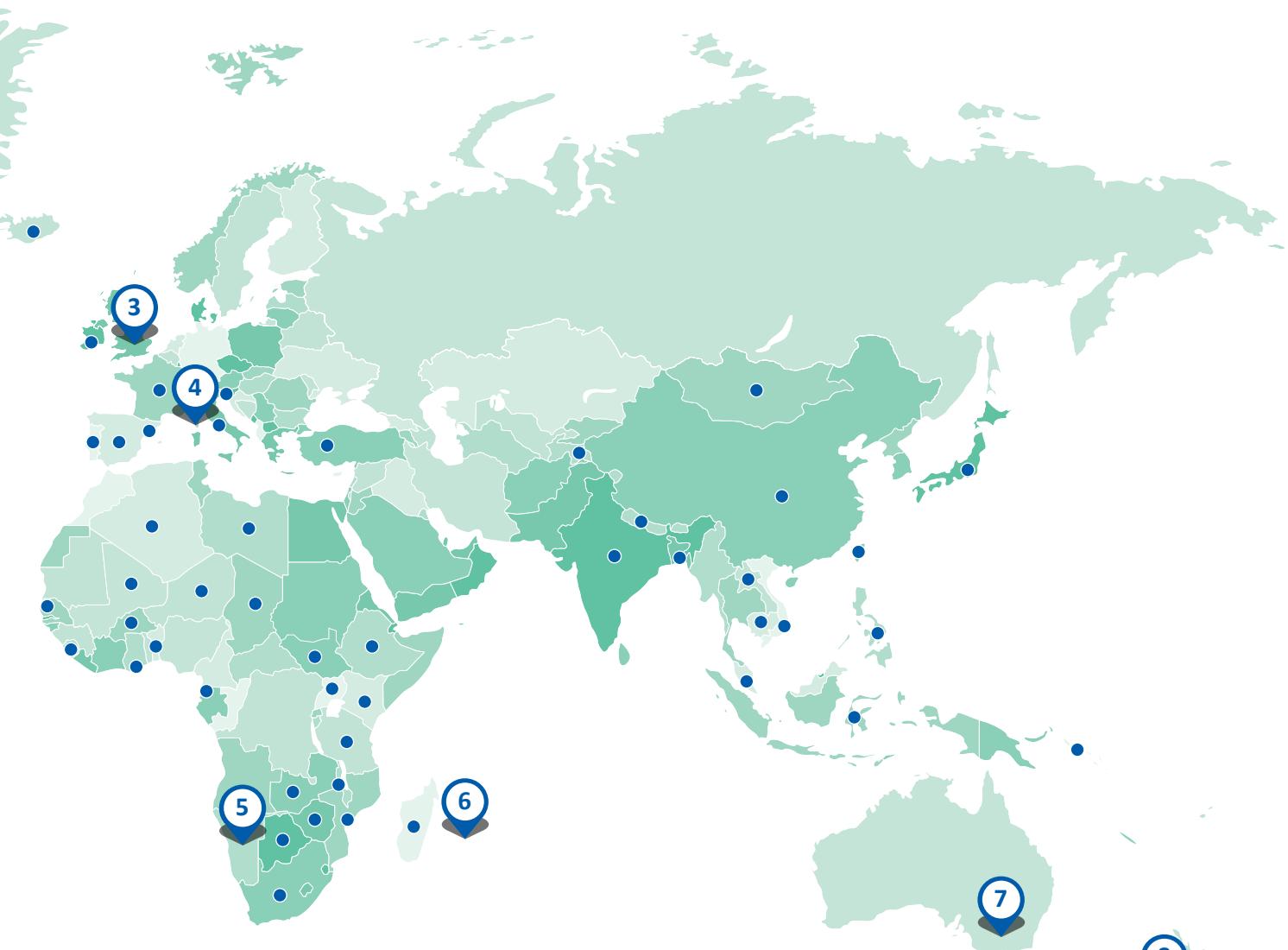
Conserving amphibians in Sardinia ITALY

Sardinia is home to about 10% of Europe's amphibian biodiversity. Since 2007, IoZ scientists have worked with local government agencies and the NGO Zirichiltaggi to determine if the fungus *Batrachochytrium dendrobatidis* is a threat to this unique European amphibian community.



Tsaobis Baboon Project NAMIBIA

This project is a long-term study of a wild baboon (*Papio ursinus*) population on the edge of the Namib Desert. Our research integrates behaviour, ecology, genetics and health, with a particular focus on social dynamics in animal groups and the conservation of social species. Research began in 1990, and has continued annually since 2000.



Conserving the echo parakeet **MAURITIUS**

Only 25 years ago, fewer than 20 echo parakeets

(*Psittacula eques*) remained in the wild following widespread habitat loss and increasing competition with introduced exotic species. Fortunately, a recovery programme implemented in 1993 has restored the population to almost 600 wild birds. IoZ research will improve our understanding of echo parakeet demographics, identify factors that continue to limit their population growth, and question how management activities should continue to ensure a long-term viable population.



Conserving the regent honeyeater **AUSTRALIA**

IoZ is working closely with Australian partners to monitor the release of captive-bred regent honeyeaters (*Anthochaera phrygia*) in northern Victoria. The research we are undertaking will help to develop the best possible conservation management plan for this Critically Endangered species in the future.



Reintroduction of hihi **NEW ZEALAND**

IoZ scientists have invested more than

11 years in conservation work with the hihi (*Notiomystis cincta*), a bird that, until only a few decades ago, was restricted to one single, small offshore island. Now, thanks to the work of many in-country partners and ZSL, and a highly successful and continuing reintroduction programme, hihi are spread across six populations.



To find out more about IoZ's current research projects, visit zsl.org/science/research

IoZ news

Over the past year, IoZ's research has continued to improve our understanding of the natural world and advance a huge range of conservation issues.



Scientists' advice prevents irreversible loss of UK native species

The UK government's Infrastructure Act for England and Wales gives new powers to control or eradicate invasive, non-native species. However, in its original draft form, this legislation also posed a threat to native species, including those listed in Schedule 9 of the Wildlife and Countryside Act, such as the barn owl (*Tyto alba* – pictured above), capercaillie (*Tetrao urogallus*), chough (*Pyrrhocorax pyrrhocorax*) and red kite (*Milvus milvus*), as well as future reintroductions. These problems arose because the legislation was expanded in scope to include problematical releases of native species, as well as invasive non-native species. A small team at ZSL worked with other NGOs to address these problems. A letter to the journal *Nature* titled 'UK bill will prompt biodiversity loss', written by IoZ researcher Sarah Durant and co-signed by 23 other experts, was published in August 2014. This led to a constructive dialogue with the government, resulting in significant improvements to the original draft.

The problematical definition of non-native species was removed; all native species listed on Schedule 9 (except wild boar) were put outside scope of the Act; any animals that were in a location as a result of a licensed reintroduction were also put outside scope; and native species subject to the legislation were dealt with separately to invasive non-native species. In addition, native species are now subject to a stronger test prior to the granting of a species control order or agreement compared with invasive non-native species. The legislation is now no longer a threat to existing native species, or an impediment to future reintroductions.

Inset, above right: IoZ Research Fellow Nathalie Pettorelli (left) with her Soapbox Science co-founder Seirian Sumner of the University of Bristol. Their initiative aims to encourage women to pursue a career in science



IoZ researcher included on BBC Wildlife power list

In May, popular wildlife magazine *BBC Wildlife* produced a power list of the top 50 people who have contributed to the protection of the environment and conservation of species.

Rosie Woodroffe (pictured), Senior Research Fellow at IoZ, was ranked at number eight in the list. Rosie shares the list with other well-known conservationists and researchers including former IoZ Director Georgina Mace and Sir David Attenborough.

Points of Light award for IoZ researcher

IoZ Research Fellow Nathalie Pettorelli and Seirian Sumner from the University of Bristol received a prestigious Points of Light award this year. This government award recognises outstanding individual volunteers – people who are making a change in their community and inspiring others. Passionate believers in the need for more positive and inspirational female role models in science, Nathalie and Seirian founded Soapbox Science, an initiative which brings top female academics to the streets to meet the public, making science accessible to everyone.

Prime Minister David Cameron said: 'Through Soapbox Science, Seirian and Nathalie have inspired scores of leading female scientists from around the country to get out onto the streets and encourage girls to learn more about the opportunities open to them through science. It's so important that girls feel as able as boys to pursue a career in science. And it's great that thousands of people can look to Seirian and Nathalie as role models. I am delighted to recognise them both by making them Points of Light.'



IoZ researchers find new family of Critically Endangered Hainan gibbons

In July, IoZ postdoctoral researcher Jessica Bryant visited Bawangling National Nature Reserve (BNNR) on Hainan Island, China, in order to trial new technologies to improve monitoring for the sole remaining population of the Hainan gibbon (*Nomascus nasutus*). This Critically Endangered species is restricted to one population of just 25 individuals, found only within BNNR. Jessica led a small team, including collaborator Chanee Brule from Project Kalawit Indonesia and BNNR staff, which set out to use new bioacoustic techniques to try to detect any solitary individuals of the species that may exist outside the known range of the three existing family groups. Using call playback, the team successfully



located gibbons that were previously undetected in the landscape. However, rather than simply detecting a solitary individual, an entirely new Hainan gibbon family group, consisting of a male, female and young infant, was found. This discovery of a fourth social group increases the overall population size by about 12%, as well as its reproductive potential, with six breeding females now in the population. This boost could be vital for the long-term survival of the species and demonstrates that the current habitat within BNNR can support additional gibbons and groups. It also shows that this novel methodological approach can be used to successfully locate gibbons that have previously gone undetected.



New endangered rodent discovered

A team of scientists, led by IoZ, have named a newly discovered rodent after renowned Caribbean ornithologist James Bond, who was also the inspiration for Ian Fleming's famous fictional spy. James Bond's hutia (*Plagiodontia aedium bondi*) is found on Hispaniola, the Caribbean island shared by the Dominican Republic and Haiti.

There may be as few as eight native Caribbean rodent species remaining, and almost all are thought to be threatened with extinction

This highly secretive and poorly known mammal (pictured above) is part of a unique Caribbean mammal family that once numbered more than 30 species. Colonisation of the Caribbean, first by Amerindian settlers from South America and later by Europeans in the 1500s, led to most of these rodents becoming extinct. Scientists believe there may be as few as eight native Caribbean rodent species remaining, and almost all are thought to be threatened with extinction. The new subspecies is highly threatened due to uncontrolled deforestation, even in protected areas.



Keep up to date with all the latest IoZ news and breakthroughs at zsl.org/science/news



World-leading conservation science

IoZ's work is changing the world of conservation – and you needn't just take our word for it. Science Director Professor Ken Norris reveals how highly our science has been rated by the experts, and looks at the many ways it is making an impact.

Science should be provocative and challenge existing thinking and ideas. In conservation, this helps us better understand threats to animals and their habitats, and design effective action to address these threats. Science can only play this role if it is conducted to the highest possible standards. Phrases such as 'world-leading' and 'internationally excellent' are often used to define such standards. How does IoZ compare with these standards?

The quality of science is usually assessed by looking at its outputs, such as published papers and books. Papers that reshape the way we think about or approach conservation tend to be widely cited by others. We can, therefore, look at citation statistics to give us an idea of how our science is influencing other people compared with similar organisations. The table [below right] shows that IoZ is right up there with the very best conservation science organisations in the world.

Rating our outputs

An even better assessment would be for other scientists to read and rate our outputs. This happened during the recent Research Excellence Framework (REF) that reported at the end of 2014. The REF is a periodic assessment of the quality of scientific work done by universities and similar research organisations in the UK. To take part, we submitted details of the best science papers we published over the past five years, three impact case studies that described how our science has made a difference to conservation (more about this in the following pages), and details of our research environment – our strategy, organisation, funding and facilities. Our submission was then assessed by an independent panel of experts in environmental science. What did the panel say about our outputs? The majority (85%) of the 65 outputs (mostly papers) we submitted were judged to be



internationally excellent or world-leading. In other words, IoZ is producing science of the very highest quality. Of course, there is always room for improvement, but our science is in really good shape.

Outstanding conservation impact

The strapline of this review is *Science for Conservation*. Science for conservation is about much more than publishing papers in academic science journals. While this is a critically important step, conservation knowledge generated by science needs to be accessible to people who can use it, and use of this knowledge needs to make a difference. In other words, the science we do needs to have significant conservation impact. Does it?

The REF in 2014 looked at more than just the science. It also assessed the impact of that science. Part of our submission, therefore, also involved what were called 'Impact Case Studies'. Each presented an area of our science and explained how the science has had conservation impact. We submitted three case studies on different topics and these were then assessed by the REF panel. Two were rated as demonstrating 'outstanding' impact – global biodiversity indicators for the Convention on Biological Diversity (see page 10) and amphibian chytridiomycosis (page 20) – while the third, the UK Cetacean Strandings Investigation Programme (page 14), was rated as having 'very considerable' impact. We were assessed in a group of 45 universities and research institutes working in environmental science, and placed fourth in this group for the impact of our science: ahead of Oxford, Cambridge and University College London. This shows that not only are we undertaking top-quality science, but also that this science is having very significant conservation impacts.

Our strapline, *Science for Conservation*, is very important to us. We are doing our best to live up to the very highest standards it demands.

IoZ research compares to the very best science organisations in the world

| Organisation | Papers published | Total citations | Citations per paper | h-index |
|-------------------------------|------------------|-----------------|---------------------|---------|
| ZSL (all papers) | 1,373 | 27,279 | 19.87 | 72 |
| ZSL (IoZ only) | 1,093 | 25,164 | 23.02 | 69 |
| Wildlife Conservation Society | 2,101 | 32,590 | 15.5 | 68 |
| Conservation International | 844 | 19,932 | 23.62 | 67 |
| The Nature Conservancy | 1,477 | 26,824 | 18.16 | 67 |
| RSPB | 906 | 16,030 | 17.69 | 57 |

Citation reports produced from *Web of Science* in March 2015 based on papers published since 2005. The h-index is a measure of how citations are distributed across all the papers published – a high index means a relatively large number of highly cited papers.

Making an impact

In the pages that follow, we present a range of ‘Impact Area’ case studies that show how our science is changing the world of conservation. These include the case studies we submitted to REF, as well as a range of others illustrating the breadth of the science for conservation work we do.



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Global biodiversity indicators

IoZ is at the forefront of monitoring global biodiversity, developing key indicators to help us understand and measure our impact on the planet and leading the way on assessing species extinction risks.

Global environmental agreements, such as the Convention on Biological Diversity (CBD), have set stringent goals for the conservation of biodiversity. Scientifically robust biodiversity indicators are required to track progress towards these goals, to define the status and trends of biodiversity, and to measure human impact on the planet. Over the past year, scientists at IoZ have continued to develop leading indicators of the status of global biodiversity (the Living Planet Index and the Red List Index). These indicators have been developed by, or in collaboration with, researchers at IoZ, and underpin both the analysis featured in *Global Biodiversity Outlook 4* and an accompanying *Science* paper.

Our researchers have also continued to lead on new IUCN Red List assessments of under-represented taxonomic groups, and continue to contribute assessments to the IUCN Red List, the foremost tool for assessing species extinction risk, and collate and maintain a unique, growing database of national assessments for more than 76 nations across the globe. In addition to their use in monitoring progress towards CBD targets in 2020, these indicators and assessments also inform policy, and engender public interest and engagement through our collaborations with non-governmental organisations, government, and inter-governmental panels and processes.



Assessing extinction risk

Over the past year, IoZ researchers have led on the first assessments of extinction risk in freshwater crayfish. An assessment of more than 590 species using the IUCN Categories and Criteria revealed that 32% of all species were threatened with extinction (Richman et al. 2015). We continue to collate and manage national extinction assessments (through the National Red List, hosted at IoZ). This database, established in 2010, now contains more than 109,000 assessments of over 74,000 species across 76 countries. We also play a significant role in the development and training of Red List assessors globally. Researchers ran Red

List training courses in Bangladesh (November 2014 and June 2015) and one workshop in Russia in September 2014.

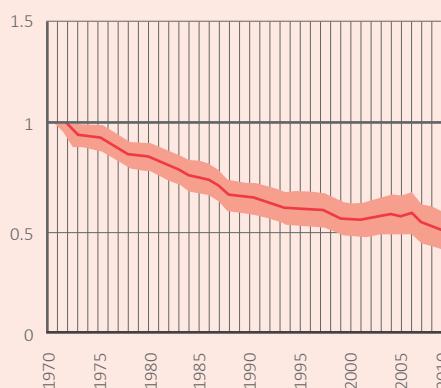
The institute's partnership with the IUCN was further highlighted in an event in 2015 – '50 years of the Red List: past, present and future' – which included a celebration of the long and ongoing relationship between ZSL and the IUCN Red List.



Learn more about the Red List at nationalredlist.org

The Living Planet Report

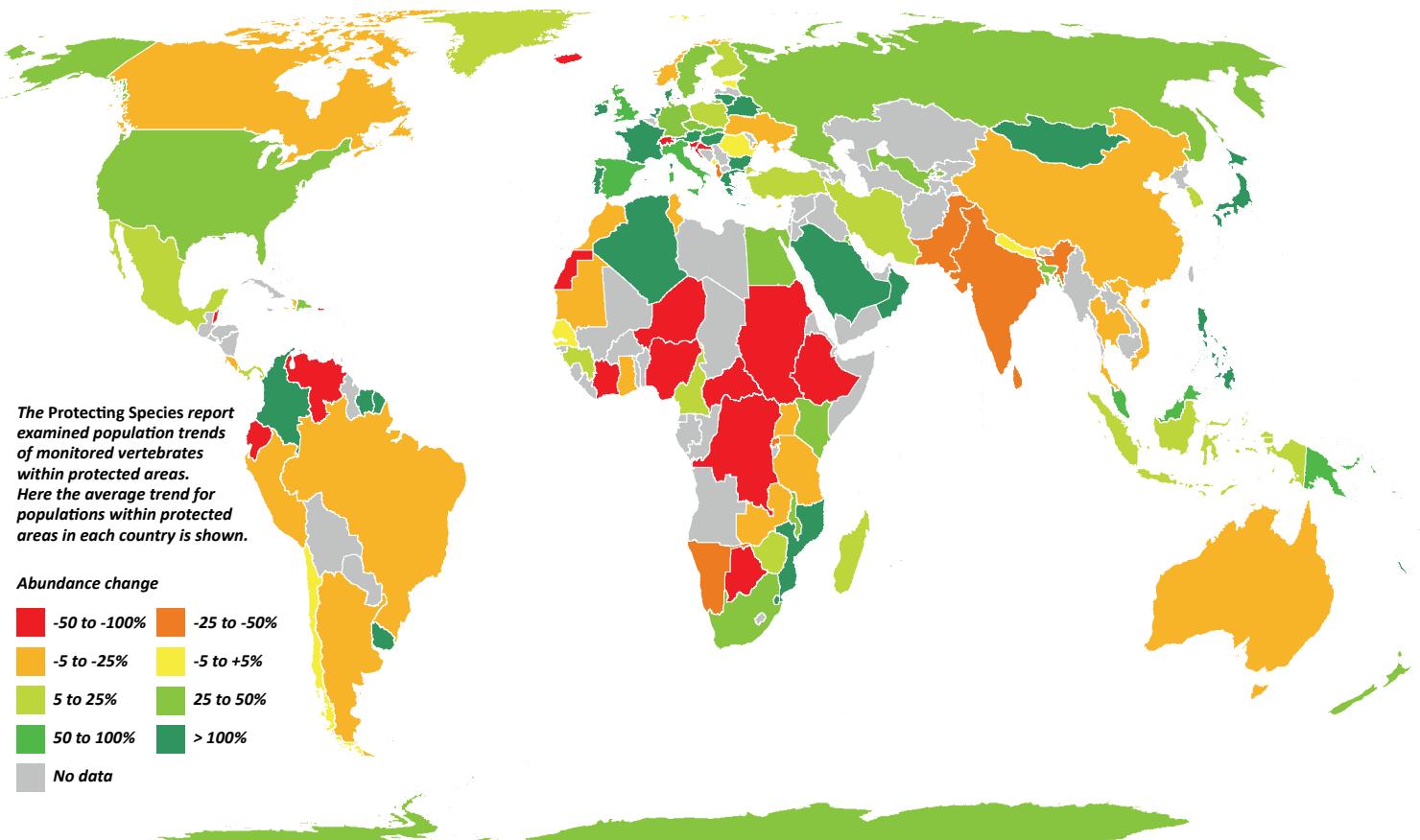
In September 2014, ZSL and WWF published the *Living Planet Report* (McRae et al. 2014), a biennial assessment of the state of the world's biodiversity. This most recent report revealed that global wildlife populations have reduced in size by more than half in just 40 years, with vertebrate populations overall (mammals, birds, reptiles, amphibians and fish) declining by an average of 52%, and freshwater species populations suffering a 76% decline – an average loss almost double



The global LPI shows a 52% decline in the size of vertebrate populations between 1970 and 2010. The dark line shows the index values and the shaded areas represent 95% confidence intervals surrounding the trend. WWF/ZSL (2014)

that of land and marine species. The most significant threat to wildlife populations monitored was the combined impact of habitat loss and degradation, with climate change noted as a growing issue.

While the trends reported show that the situation is critical, the report also highlights that, with focused conservation action,



Protecting species

In November 2014, researchers from IoZ presented the inaugural *Protecting Species* report at the World Parks Congress in Australia (Milligan et al. 2014).

The report detailed the status and trends of wildlife populations within protected areas globally, assembling population trends for 4,326 populations of 1,654 species, and showed that of 130 monitored countries, 39% have declining populations within protected areas.

It highlighted that there is no clear overall pattern of increases or decreases within protected areas, and that the drivers of

any declines are unclear. Much more work is needed to understand the effectiveness of protected areas globally and the trends of species, both protected and unprotected.

The role of management within protected areas has also been explored in collaboration with IoZ researchers. The ability of indicators such as the Living Planet Index and Red List Index to reflect modelled changes in protected area populations was examined.

Management changes were determined to be more effective than expansion of protected area coverage alone (Costelloe et al. 2015).

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political will and support from businesses globally, it is not yet too late. There is still hope for a healthy future, for both people and wild nature. The Living Planet Index (LPI), curated and maintained at IoZ, is the world's leading database on the status and trends of wildlife populations. The index is used to monitor global biodiversity and is one of the global biodiversity indicators used to measure progress towards the Aichi Biodiversity Targets. Analysis of the LPI was incorporated into *Global Biodiversity*



Different taxonomic groups show differing trends. Freshwater species in particular show a dramatic decline of 76% in the size of monitored populations

Outlook 4 (Secretariat of the Convention on Biological Diversity, 2014), which was presented to the Convention on Biological Diversity at the Conference of the Parties in

2014 to inform future biodiversity policy. IoZ researchers also co-authored a *Science* paper reporting on progress towards these targets (Tittensor, et al. 2014).

Wildlife zoonoses

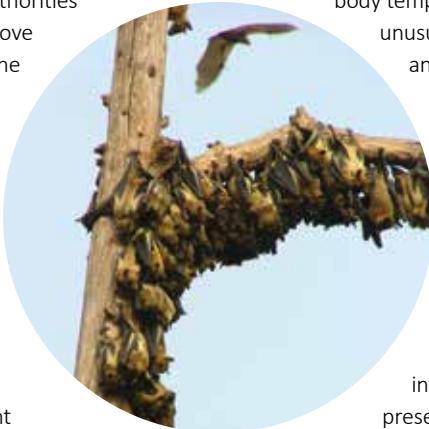


Zoonotic diseases that can cross between species are a threat to both wildlife and human health – and IoZ is finding solutions.

The emergence of infectious diseases from wildlife is a growing threat to human health, but, as IoZ scientists have shown, this is largely driven by human activities (eg Daszak et al. 2000). This zoonotic threat impacts wildlife conservation as authorities and the public look to remove the threat by eliminating the wildlife host. IoZ scientists seek alternative methods that allow the coexistence of people and wildlife. This involves understanding the human-wildlife interface and pathogen dynamics in the wildlife host and developing mitigation strategies in light of this knowledge. To complicate matters, anthropogenic influences on ecosystems, such as land-use change and climate change, alter interactions between people, wildlife and pathogens. We have shown that a multidisciplinary, integrated approach involving researchers from both the natural and social sciences is required in order to adequately address the issue (Wood et al. 2012). Our work in this area informs policy and practice for disease control.

Understanding infection dynamics of pathogens in wildlife hosts

Knowledge of infection dynamics is a prerequisite for identifying risk factors for, and mechanisms of, zoonotic spillover. Bats are particularly important in this respect, hosting more zoonotic viruses per species than any other taxon (Luis et al. 2013). Flight singles bats out from all other mammals and we have shown that flight, and adaptations to it, appears to be what makes bats so special when it comes to harbouring zoonotic viruses. The mobility of bats allows for a high degree of contact and mixing within and between species and



locations, and this correlates with the number of known viruses carried by any particular species (Luis et al. 2015). Physiological adaptations to flight, such as periods of extremely high metabolic rate and body temperature, might allow for unusually high viral diversity and the selection of viruses tolerant of innate immune responses, such as fever (O'Shea et al. 2014). Our work with henipaviruses in bats showed how determining host population dynamics allows geographic inference of pathogen presence (Peel et al. 2013).

While using a powerful, novel antibody quantitation method to follow henipavirus antibody levels in individual bats, we developed a better understanding of population-level persistence of viral infection (Baker et al. 2014).

Understanding the risk factors for zoonotic disease emergence and spread

We have used pathogens from bats (Peel et al. 2013; Baker et al. 2014) and rodents (Lo Iacono et al. 2015) as models to understand the risk factors for zoonotic disease emergence and disease spread. Data from cases of Lassa fever, a disease caused by a virus harboured by the multimammate rat (*Mastomys natalensis*), allowed us to demonstrate that 20% of human cases arose from human-to-human transmission when it had been thought that almost all human cases arose directly from rats (Lo Iacono et al. 2015). We were also able to show that human-to-human transmission was propagated by a small proportion (~5%) of humans with Lassa fever: so-called 'super-spreaders'. People's behaviours and perceptions are important



Main image: IoZ is exploring the role of badger vaccination in controlling bTB
Left: Ghana's bats are widely hunted for bushmeat, increasing the risk of zoonotic spillover

when it comes to human-to-human disease spread, but also for initial spillover risk. We showed that bats are widely hunted in Ghana, West Africa (Kamins et al. 2011) and, by conducting interviews across southern Ghana, we identified the characteristics of people involved in the bat bushmeat trade (Kamins et al. 2015). We found that bat butchering is predominantly done by women, and only by men who actively hunt. Although bat consumption was perceived to be associated with certain tribes, it is in fact widely distributed across regional and ethnic lines. These data inform both disease and conservation management plans, drawing on social contexts and ensuring that local voices are heard within the larger global effort to study and mitigate zoonotic disease outbreaks (Kamins et al. 2015).

Identifying zoonotic agents that come into contact with people

Although much of this work is focused in West Africa (eg Baker et al. 2013), which we identified as one of the world's hotspots for zoonotic disease emergence (Jones et al. 2008), we also investigate the potential for zoonoses from wildlife in the UK (eg Lawson et al. 2014). Occasionally, disease appears to jump from humans to wildlife (Franklin et al. 2015), and we might expect this to occur more frequently as the human-wildlife interface grows.



Control of bovine tuberculosis

In the maelstrom of controversy over badger culling, it can be hard to remember that this debate ultimately concerns how to control a zoonotic disease. Bovine tuberculosis (bTB) is mainly a cattle disease, but it can also infect many other mammalian species, including people. Indeed, in 1930s Britain some 50,000 people caught the disease each year, mostly by drinking unpasteurised milk from a national cattle herd with a 40% prevalence. Today, pasteurisation has virtually eliminated the risk of bTB to the general public. Nevertheless, bTB does remain an occupational risk for farm and abattoir workers. Because of this human health risk, the EU requires all member states to work towards eradicating this disease. Unfortunately, bTB is now well established in Britain's badger population, and probably cannot be eradicated from cattle unless it is also eradicated from badgers.

For the past 40 years, managing bTB in badgers has been synonymous with culling. But culling badgers is risky, because it can increase cattle disease as well as reducing it. While public and political debate rages about whether to extend badger culling across England, farmers in bTB-affected areas are left with no legal methods to tackle the problem. Meanwhile, relations between wildlife groups and farmers have soured, potentially threatening conservation activities for other farmland species.

ZSL scientists are working with farmers to develop alternative approaches. The way that bTB is transmitted between badgers and cattle has long remained a mystery, making it difficult to avoid infectious contact. Using modern tracking technology, we have explored where, when and how badgers and cattle come into contact. Do they come into contact at all, or might disease be transmitted through a contaminated environment?

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Do cattle encounter badgers outdoors, at pasture, or indoors when badgers enter farm buildings? Working in Cornwall, one of Britain's worst-affected bTB hotspots, ZSL scientists have fitted lightweight satellite tracking devices to more than 60 badgers and nearly 500 cattle, and adorned farm buildings with remote cameras, to create a seamless picture of how badgers and cattle interact throughout the farm environment.

We have also explored the potential role of badger vaccination in bTB control. Vaccination has been largely dismissed by ministers because it is perceived to be expensive and ineffective where badger populations are already infected. Yet in other species (including people), vaccination has successfully reduced disease prevalence in infected populations. Working with local volunteers to reduce the costs, ZSL is gradually rolling out badger vaccination across the Penwith peninsula in west Cornwall, testing whether badgers in the not-yet-vaccinated areas suffer higher bTB rates than those in the vaccinated areas. In future years, we hope to quantify how cattle and badgers contribute to a pool of bTB bacteria in the environment, potentially explaining not just transmission between badgers and cattle, but also components of transmission among cattle. This whole body of work promises to influence bTB policy and practice – though public debate is likely to continue for years to come.

Cetacean strandings research



The Cetacean Strandings Investigation Programme (CSIP), led by IoZ, coordinates the investigation of all cetaceans, marine turtles and basking sharks that strand around the UK coastline.

The causes of cetacean stranding events are not always clear, and the role that human activity may play in either directly or indirectly causing strandings has often been called into question. Since 1990, data on more than 12,000 stranded cetaceans have been recorded and nearly 3,500 post-mortem examinations have been carried out by the CSIP, producing one of the world's largest research datasets on strandings, causes of mortality, disease and many other aspects of the health of cetacean populations in UK waters. Our systematic and long-term monitoring programme of stranded animals facilitates the investigation of spatio-temporal trends in disease, causes of mortality and exposure to environmental pollutants.

It also enables both ongoing assessment of the dynamics of particular threats and their response to specific conservation measures. The national cetacean tissue archive, with more than 80,000 samples held at IoZ alone, provides an internationally important resource for collaborative scientific research.

The role of acoustic disturbance in cetacean strandings

In 2014–2015, we continued to research cetacean mass stranding events linked to exposure to high-intensity, man-made acoustic sources, such as mid-frequency active naval sonars used by warships and helicopters to detect submarines.

On 22 July 2011, a mass stranding of long-finned pilot whales (*Globicephala melas*) occurred in the Kyle of Durness, near Cape Wrath in north-west Scotland. Approximately 40 pilot whales live-stranded, and the efforts of volunteer rescue groups, including British Divers Marine Life Rescue, led to the refloat and rescue of a large proportion of them. However, 19 whales died or were euthanised during the course of the stranding. A CSIP team, led by staff from the Scottish Marine Animal Stranding Scheme (SMASS), conducted field necropsies on 16 whales that were available for post-mortem. An extensive investigation, undertaken by SMASS and funded by Defra and Marine Scotland, concluded that an underwater munitions disposal conducted around Garvie Island by a Royal Navy bomb disposal team the day before and during the mass stranding, was 'the only external event with the potential to cause the mass stranding'. The report also concluded that navigational error, and/or



a sick pilot whale (found with an infected pectoral joint) could not be eliminated as contributory factors to the stranding (Brownlow et al. 2015).

This builds on a previous CSIP/IoZ-led investigation into a large common dolphin (*Delphinus delphis*) mass stranding event in Falmouth Bay in 2008 that was caused by acoustic disturbance from an international naval exercise

(Jepson et al. 2013). Earlier research by CSIP and University of Las Palmas (Gran Canaria) discovered a form of cetacean decompression sickness ('whale bends') in deep-diving beaked whales that mass stranded after being exposed to high-intensity mid-frequency naval sonars (Jepson et al. 2003).

The report on the long-finned pilot whale stranding (Brownlow et al. 2015) received significant press coverage, including *The Guardian* and *The Times* newspapers. The Royal Navy and Ministry of Defence 'accepted the findings of the CSIP report in full' and committed to modify their activities to limit the environmental risk to cetaceans in UK waters in future. Our investigation into the stranding event in Falmouth Bay led to the establishment of the Marine Underwater Sound Stakeholders Forum (later the Underwater Sound Forum), convened by the UK government with additional input from the oil and gas industry.



Marine chemical pollution

The link between PCBs and reproductive failure in harbour porpoises

Until banned in many countries in the late 1970s, polychlorinated biphenyls (PCBs) were widely used in industrial processes. These chemical pollutants are extremely stable and slow to biodegrade, which causes them to bioaccumulate in humans and animals. Research published this year investigated reproductive failure in UK harbour porpoises (*Phocoena phocoena*)



linked to PCBs. The study used samples collected over a 22-year period, and is the largest on PCB burdens in female harbour porpoises. Almost 20% of sexually mature females examined showed direct evidence of reproductive failure such as stillbirth or foetal death, while a further 16.5% had infections or tumours of the reproductive tract that could contribute to reproductive failure. The results suggest that reproductive dysfunction in porpoises may be related to PCB exposure occurring either through endocrine disrupting effects or via immunosuppression and increased disease risk (Murphy et al. 2015).

Other pollutants

Research carried out with the Centre for Environment, Fisheries and Aquaculture Science in the late 1990s found accumulating levels of new chemical pollutants (brominated flame retardants) in the blubber of UK-stranded harbour porpoises. This study contributed directly to the EU-wide ban of these chemicals in 2004. A new study, published this year (Papachlimitzou et al. 2015), analysed organophosphorus flame retardants and plasticisers in blubber and liver tissue of harbour porpoises stranded in 2012. Fourteen of the 20 compounds were below the limits of quantification in all samples, indicating a very low risk of health impacts from these new and emerging chemicals in porpoises.

Our research on new and existing chemical contaminants in UK harbour porpoises and other cetacean species continues to feed into UK and EU risk assessments, and inform policy to reduce their concentrations on a national and international basis.

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Conservation technology

Technological innovations are changing the way we monitor, assess and protect wildlife and habitats – and IoZ is at the forefront of these developments.

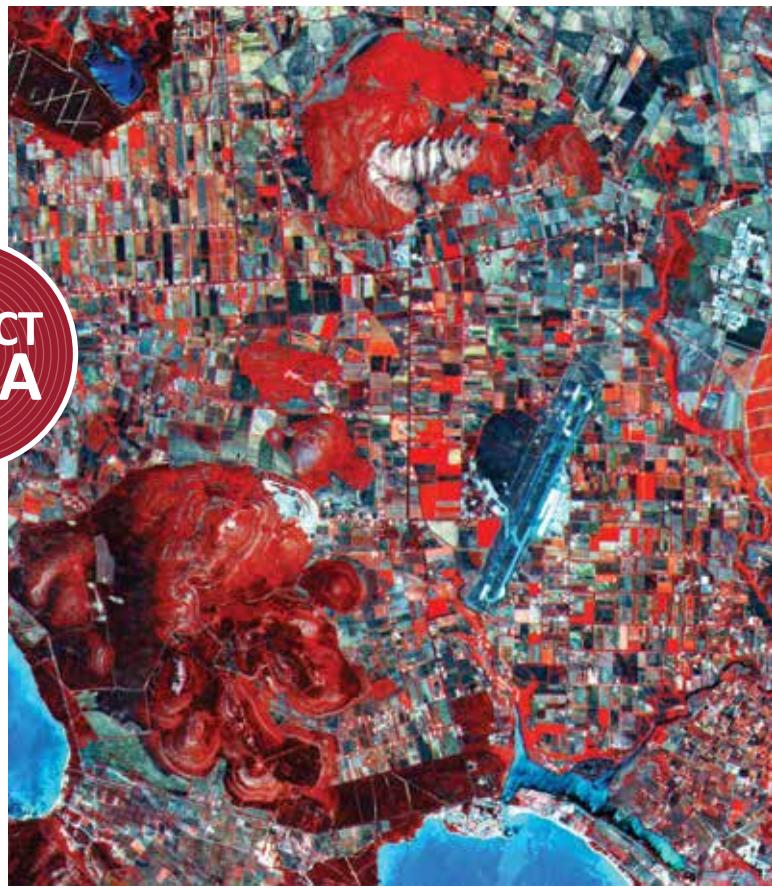
Rapid advances in technology are providing conservation biologists with unprecedented opportunities to obtain and process information on biodiversity and the state of the planet. We can now gather information at fine scales at the level of individual field sites using camera traps and acoustic sensors; at global scales using satellite remote sensing and large networks of local sensors; and through animal-borne sensors (telemetry). Importantly, the use of technology in conservation encompasses both the acquisition of new data and the development of new methods to analyse and process these data. Researchers at IoZ have been at the forefront of developments in using conservation technology for ecological analysis and biodiversity monitoring across spatial scales and have made major inroads at integrating approaches to provide new insights into the status of biodiversity and the causes and consequences of future change.

Remote Sensing in Ecology and Conservation

This engagement and high level of expertise is reflected in the Society's decision to develop a new open-access journal, *Remote Sensing in Ecology and Conservation*. This new platform for the publication of novel work at the interface between remote sensing and ecology and conservation will fill a gap in the publication landscape, and foster interdisciplinary collaborations (Pettorelli et al. 2014a). Our impact in remote-sensing science is demonstrated by the publication of one review and two policy papers this year on the importance of satellite data for ecology and conservation. The first, a review in *Journal of Applied Ecology*, identifies the opportunities and challenges associated with the use of satellite data in applied ecology (Pettorelli et al. 2014b). The second paper, published in *Biological Conservation*, calls for satellite data to be free and open-access, so that their utility and use can be optimised (Turner et al. 2015).

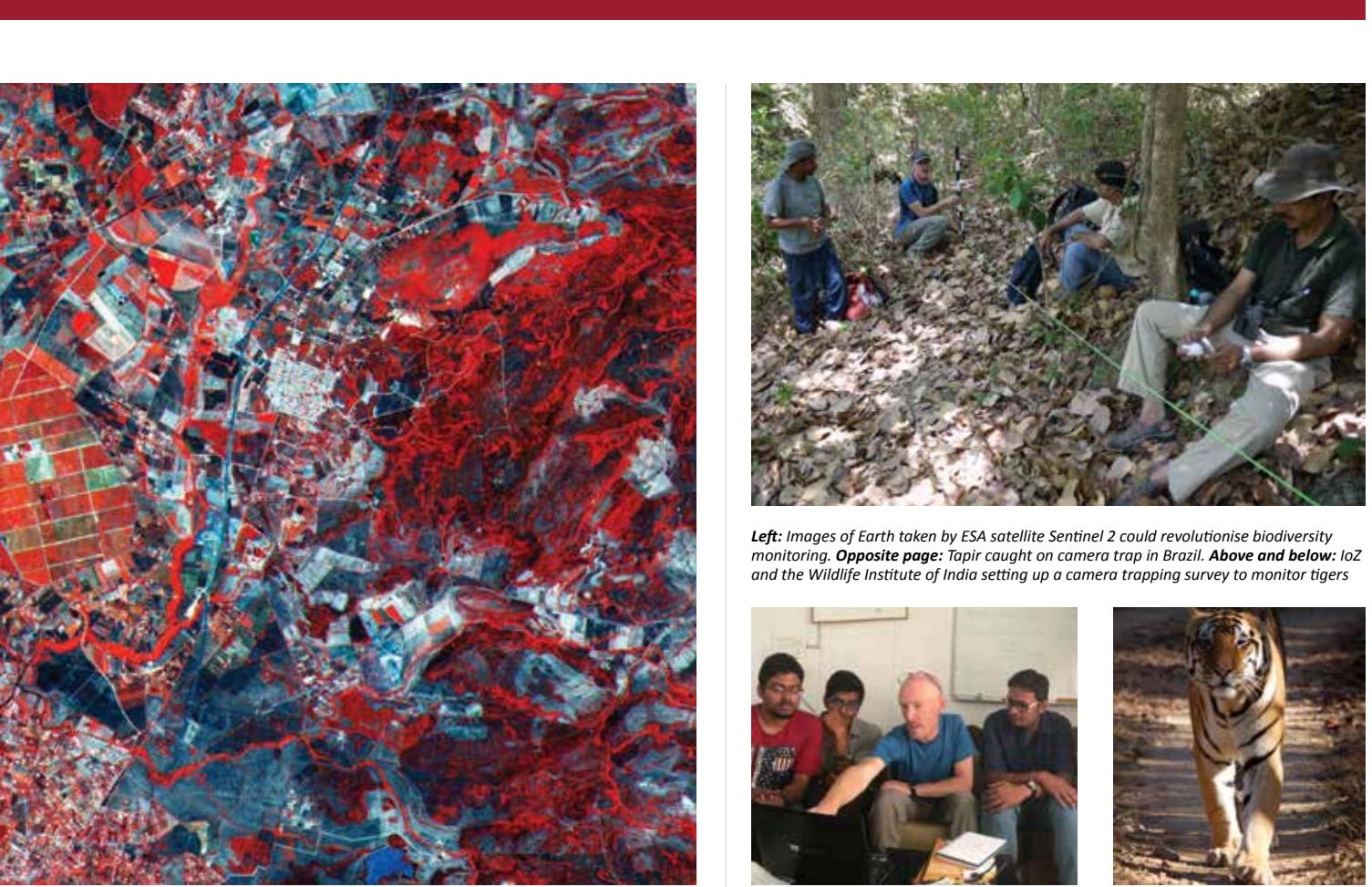
Monitoring biodiversity from space

A comment published in *Nature* in July 2015 highlighted the importance of satellite data to inform progress towards the Aichi targets as defined by the Convention on Biological Diversity. The team of authors, led by scientists at IoZ and University of Twente, Netherlands, call for conservation scientists to collaborate with space agencies, such as the National Aeronautics and Space Administration (NASA) and the European Space Agency (ESA), to identify measures and agree on metrics to help track global declines in biodiversity (Skidmore et al. 2015). In a move that previously proved successful in helping to monitor climate change on a global scale, the authors argue that space technology could help track biodiversity across the planet. Interestingly, publicly funded space agencies, including NASA and ESA, already collect



IoZ researchers are using local sensors, such as camera traps, to develop a framework for estimating mammal abundance

and regularly provide open-access to satellite data. However, a lack of agreement between conservation biologists and space agencies on a definitive set of variables to track and translate this information into data useful for conservation has meant that this game-changing resource remains untapped. With wildlife populations halved in just 40 years, there is a real urgency to identify variables that both capture key aspects of global biodiversity change and can be monitored consistently. Global biodiversity monitoring from space could be a reality in a decade, but only if ecologists and space agencies agree on a priority list of satellite-based data that is essential for tracking changes in biodiversity.



Left: Images of Earth taken by ESA satellite Sentinel 2 could revolutionise biodiversity monitoring. **Opposite page:** Tapir caught on camera trap in Brazil. **Above and below:** IoZ and the Wildlife Institute of India setting up a camera trapping survey to monitor tigers



Camera trap studies

IoZ has been at the forefront of developing new techniques for using camera traps to monitor mammal diversity in remote areas. Camera trap studies led by IoZ PhD students have been used to monitor the Critically Endangered Saharan cheetah (*Acinonyx jubatus hecki*) (Belbachir et al. 2015), or the poorly known bay cat (*Pardofelis badia*) (Wearn et al. 2013) or to estimate lion (*Panthera leo*) density in the Serengeti national park, Tanzania (Cusack et al. 2015). IoZ researchers have also been developing a framework for estimating animal abundance across community assemblages using local sensors, such as bat detectors, acoustic sensors and camera traps (Lucas et al. 2015) and to monitor activity patterns from photo records (Rowcliffe et al. 2015).

We also have been developing cutting-edge methods for monitoring and evaluating animal behaviour in the wild, including new open-source tracking devices (mataki.org) and novel analytical methods for the analysis and prediction of behaviour. Such methods allow for understanding fine-scale associations between animals and environmental features (Freeman et al. 2013; Dean et al. 2013) that ultimately may improve our understanding of species habitat requirements, the impacts of habitat change on these species, and for understanding the impact of social relationships in group decision-making (Flack et al. 2015).

Conservation Hackathon

In collaboration with UCL, IoZ has also established the Conservation Hackathon programme to run a series of events that bring together technology developers and analysts with ecologists and conservation researchers. These cross-disciplinary events are aimed at maximising the potential impact of our research, and identifying novel techniques and collaborations with industry that may otherwise be hard to initiate.



Learn more about the Conservation Hackathon, and how to get involved, at conservationhackathon.org

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Threatened island biodiversity

IoZ's work with island species is safeguarding some of the world's most vulnerable and threatened wildlife.

How do we go about recovering a threatened species? How do we identify key threats? What is the best management action to take, and how do we know if it is working? These are the types of questions we address in our applied conservation research. Our staff work at all steps along a problem-solving pathway, and do so in close collaboration with our international conservation partners. Our work often focuses on island species, because island ecosystems have experienced high levels of recent extinction and today contain a disproportionately large number of threatened species. Island species are often particularly threatened because they comprise isolated populations with typically small geographical ranges, making it more difficult for them to escape or respond to persistent and emerging threats such as invasive species, human-caused habitat loss and climate change. In some cases our options are restricted to managing populations *in situ*, although in other cases more intensive and potentially controversial measures may be the only effective conservation solution.

Over the past year our research on threatened island species in eastern Asia, the Caribbean, and the Pacific and Indian oceans has made a direct contribution both to their conservation and to the wider fields of conservation biology, population ecology and wildlife management. Our research impacts at multiple levels, including: policy, through the production of species action plans and the prioritisation of conservation actions; the identification of current threats to species persistence; and the assessment of applied conservation management actions in species recovery programmes.



The following three case studies highlight how our science impacts at each of these levels.

Identifying science-based conservation solutions for the world's rarest mammal

There is increasing recognition that conservation management decisions for threatened species should be based upon rigorous, objective research into relevant aspects of their ecology, population dynamics and threats, and this is especially important for populations that require urgent or intensive conservation intervention.

The Hainan gibbon (*Nomascus hainanus*), an ape species endemic to the island of Hainan off southern China, is the rarest primate and probably the world's rarest mammal species, with a known global population of only about 26 to 28 individuals as a result of historical habitat loss and hunting. A long-term field research programme by ZSL has generated new baseline data into both the spatial requirements and social group structure of the species, and the genetic status of the final surviving population.

These data have formed the basis for population modelling to predict the viability of the species under different anticipated future conditions and proposed management approaches. The improved understanding of Hainan gibbon population parameters and status generated through this research programme was used to inform a recent multi-stakeholder planning workshop held in Hainan, which identified a new series of key conservation goals and priority activities required to protect the final surviving Hainan gibbon population

IMPACT AREA



and promote population growth of the species into areas of its former historical range.

As part of a wider ongoing Hainan gibbon conservation programme, our work aims to maximise the likelihood that the final surviving gibbon population will form new social groups and expand into new good-quality habitat. This involves a strong research component, including both trialling of new monitoring techniques and technologies to better understand on-the-ground gibbon population dynamics, and exploration of the effectiveness of approaches such as construction of 'canopy bridges' to encourage gibbons to colonise currently unoccupied forest patches.

Reference

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Supplementary feeding and making the best management decisions

Remnant populations of threatened species often require supportive management. A common type of support is supplementary feeding, which is often used in the belief that lack of natural foods inhibits a species' recovery. There are some problems with this, however, in that supplementary feeding can sometimes hinder the population it is



intended to help or make no difference to its recovery. Another important consideration is that, even if it is successful, how can an increasing demand be supplied and maintained? Choosing to supplementary feed should therefore be based on sound ecological theory, and its expected benefits carefully evaluated. This has been a focus for our work with New Zealand's endemic hihi (*Notiomystis cincta*). Recently, we used hihi to show how to evaluate management options and make better conservation choices (Ewen et al. 2015). The decision-analytic approach links explicitly stated management objectives to clearly defined alternative management strategies, which are evaluated in terms of their expected outcomes. This provides a framework to making good, transparent and defendable decisions, and is well suited for multi-objective and group decision problems that are common in conservation biology. Conservation of threatened species at a global scale requires making important choices, often in the face of substantial uncertainty. Our work shows how to make these choices, and how this has led to direct changes in management of hihi by the New Zealand government.

We continue to explore the role that supplementary feeding plays in recovery of threatened bird species, both in New Zealand and Mauritius. An important consideration is how feeding may offset

declines in habitat suitability predicted to occur under climate change. In addition, we are working to understand and then design management to reduce potential health problems linked to use of supplementary feeding stations.

Reference

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Invasive species and endemic island passerines

On the Indian Ocean island of Mauritius, rats are thought to have contributed to the extinction of 50% of the island's avifauna and currently pose a threat to four endemic passerines, including the Critically Endangered olive white-eye (*Zosterops chloronothos*). Rats are thought to be a nest predator, taking both eggs and chicks of this species, and a driver of the documented circa 60% decline in the white-eye population over the past 40 years. Currently, the white-eye population on mainland Mauritius is estimated at about 120 pairs and restricted to a 25km² area. However, the true impact of rats on breeding success, and how this contributes to the observed population decline, has not been quantified. In conjunction with the Mauritian Wildlife Foundation, National Parks and Conservation Service



Left: Supplementary feeding of the New Zealand hihi.
Above: The Critically Endangered olive white-eye in Mauritius. **Below:** Predation by rats is an ongoing threat to the olive white-eye



(Government of Mauritius) and Chester Zoo, we examined the impact of reducing rat abundance on white-eye breeding success and the population-level consequences of any observed benefits (Maggs et al. 2015). Our work showed that reducing rat abundance during the breeding season led to a significant improvement in breeding success, which at a population level was sufficient to reverse the current observed population decline. This work suggests that in order to safeguard the white-eye on mainland Mauritius, long-term rat management needs to be implemented. The challenge now is to identify an optimal rat management solution.

Over the next two years we will work with our *in situ* partners to: (1) establish on-the-ground actions to reduce rat abundance in priority areas for white-eyes, thereby arresting the ongoing population decline in the short term; and (2) in conjunction with advice from leading invasive species managers in New Zealand, identify the optimal long-term solution for controlling rat abundance within the white-eye's range on mainland Mauritius, thereby securing its future in the long term.

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Amphibian disease

The world's amphibian population is at grave risk from two deadly groups of pathogens – chytrid fungi and ranaviruses – and IoZ scientists are at the forefront of the fightback.

Amphibians are recognised as the most highly threatened vertebrate class, in no small part due to the impacts of two groups of pathogens – chytridiomycete fungi and ranaviruses. In the 1990s, research at IoZ was key to the identification of these pathogen groups as causes of amphibian mass mortality and significant population declines. IoZ continues to lead the world in understanding the impacts these pathogens have on wild and captive amphibians and identifying factors that increase the probability of infection, disease and host population decline. Last year, we played a significant role in identifying new genetic variants of these pathogens that may pose a greater threat to amphibians than previously thought. In response to the ever-increasing and global risk infectious diseases pose to amphibians, our researchers are at the forefront of efforts to control the spread, and mitigate the impacts, of chytrid fungi and ranaviruses in both wild and captive populations.

Newly described ranavirus decimates amphibian communities

Ranaviruses have long been recognised as lethal pathogens of amphibians, reptiles and fish. For amphibians, only one case of emergent ranavirosis, first described in the early 1990s by IoZ scientists, has been shown to cause amphibian declines. In the UK, infection with, and disease caused by, FV3-like variants of ranaviruses commonly result in mass death and persistent population declines of common frogs (*Rana temporaria*). Other UK native amphibians are rarely affected, even at locations where infected common frogs share ponds with them (Duffus et al. 2014a,b). In contrast, last year we showed how CMTV-like variants of the virus, first discovered by a team including IoZ staff (Balseiro et al. 2009), are decimating entire Iberian amphibian communities. Unlike the FV3-like variants causing common frog mass mortalities in the UK, CMTV-like ranaviruses emerging in amphibian communities in Spain and Portugal have the ability to infect and cause disease in all eight host amphibian species at the study sites (Price et al. 2014). Even more worryingly, the extraordinary number of host species exploited by CMTV-like ranaviruses does not stop at amphibians. A snake that ingested a diseased frog died with signs of disease consistent with ranavirosis and from which virus DNA could be isolated. The genetic code of this DNA was identical to that infecting



Main image: Amphibians worldwide are under threat from lethal pathogens. Below, inset: Midwife toad tadpole infected with a ranavirus. Opposite: European salamanders have proved vulnerable to novel infections



the frogs (Price et al. 2014). Additional research has shown CMTV-like viruses are not uncommon across Europe and are already being detected in traded and transported hosts (Stöhr et al. 2015).

As part of the Global Ranavirus Consortium, our staff work with researchers across the globe to understand why CMTV-like viruses affect so many species to such a terrifying degree. Funded by the Natural Environment Research Council, we are exploring the genetic make-up of ranaviruses to determine if CMTV-like ranaviruses contain specific genetic elements associated with broad host range and severe disease. To do this, researchers at IoZ, our partner institution UCL and long-term collaborators at Queen Mary University of London are comparing the genomes of ranaviruses isolated from amphibians, reptiles and fish to identify genes or gene variants that are unique to Iberian CMTV-like viruses. Once these have been described, we will use state-of-the-art molecular manipulation techniques to 'knock out' these novel genetic elements to see if loss of gene function leads to decreased infectivity and virulence.



Find out more about the Global Ranavirus Consortium at ranavirus.org

We continue to investigate where, how and why the fungus Batrachochytrium dendrobatidis causes amphibian population and species declines.



Ancient chytrid fungus poses a severe threat to Europe's amphibians

At the end of the last century, IoZ researchers were part of an international consortium that first described how a fungal infectious disease was responsible for amphibian declines in the New World, Australia and beyond. We continue to investigate where, how and why the fungus *Batrachochytrium dendrobatidis* causes amphibian population and species declines.

Last year, we showed how, unlike in the Americas and Australia, infection is relatively rare in Europe (Baláž et al. 2014). In some cases this could be attributed to resistance to infection (Bielby et al. 2015). However, even highly susceptible European species can avoid lethal infections through the efforts of the aquatic microorganisms that inhabit amphibian breeding ponds. If the population densities of these microorganisms are high enough, they can reduce the amount of fungus and reduce the risk of infection and disease by eating the



aquatic zoospores that lead to infection (Schmeller et al. 2014).

At the same time, colleagues in Belgium were describing a newly discovered species of *Batrachochytrium*, *B. salamandivorans*. Unlike the genetic lineages that have been identified as variants of *B. dendrobatidis*, a recently evolved species (Farrer et al. 2011), *B. salamandivorans* appears to be a distinct and ancient species.

We collaborated with this group and others to show that this novel chytrid fungus has newly emerged in Europe, infects and kills

salamanders and newts, but not frogs and toads, and likely evolved as a parasite of Asian newts millions of years ago (Martel et al. 2014).

So why the sudden and devastating emergence of lethal chytridiomycosis in wild European

salamanders caused by an ancient Asian fungus? We hypothesised that emergence in Europe was the result of movement of infected, but tolerant Asian newt species to Europe via the amphibian pet trade (Martel et al. 2014).

Less than a year later, our researchers described new cases of this disease caused by the Asian fungus in animals involved in the amphibian trade, showing conclusively how infected animals in the trade may be moved among facilities and transmit chytrid infections on arrival (Cunningham et al. 2015).



IoZ research is conserving species threatened by disease

The combined evidence of ongoing emergence of novel and highly lethal viruses and fungi presents a compelling case arguing for immediate effort to control dangerous pathogens in the amphibian trade. Again, IoZ researchers lead in this, developing strategies for chemical disinfection, application of antifungals and strategies for biosecurity to control pathogen transmission in nature and captivity. We seek to understand how amphibians respond immunologically to exposure and infection (Price et al. 2015) and how microbial communities that inhabit the skin of amphibians may afford resistance to infection (Antwis et al. 2015). We work at various locations across the globe – Chile, Dominica,Montserrat, Mallorca, the French Pyrenees, Sardinia, Madagascar (Bletz et al. 2015) and wherever novel and threatened amphibian populations, species and communities may be threatened by these and other parasites – to develop local capacity to conserve amphibian biodiversity in captivity and return species threatened by disease safely to the wild. This is an enormous and daunting task, requiring international efforts to coordinate research and implement conservation strategies guided by the evidence we produce.



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Highlights

In this section, we focus on other areas of IoZ's work and the breadth of our research outputs, including some of the highlights from our groundbreaking published studies. Plus, we look at our vital work to communicate science, our annual awards, and key education and funding successes.



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Student research projects included work on North Atlantic right whales (see page 34)

Publications highlights

Published research by IoZ staff and students continues to advance our understanding of the natural world. Here, we look at just some of the papers that have been making an impact over the past year.



Enhancer evolution across 20 mammalian species

Samples collected by the Cetacean Strandings Investigation Programme proved integral in the publication of a paper in the journal *Cell*. Mammals share a common ancestor and also many common genes. The study examined the evolution of gene enhancers and promoters in liver samples of 20 diverse mammalian species, including the sei whale (*Balaenoptera borealis*), common dolphin (*Delphinus delphis*) and Sowerby's beaked whale (*Mesoplodon bidens*), to gain an understanding of how and when genes are regulated in each species. We found that rapid evolution of gene enhancers was a universal feature of mammalian genomes, but that gene promoters were relatively conserved across the study species. The results provided a unique insight into the functional genetics underpinning mammalian regulatory evolution following the 'mammalian radiation', a time of rapid morphological evolution that occurred shortly after the extinction of the dinosaurs.

Reference

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For the latest updates on IoZ's groundbreaking scientific research, visit zsl.org/science/news



Male-biased dispersal in a cooperative breeding bird

Sex-biased dispersal (SBD), where one sex disperses further or at a higher rate from its natal territory than the other, is a common phenomenon in wild animal populations. Understanding SBD is important because it can have numerous implications for the genetic structure of populations, the local availability of mating opportunities with unrelated individuals and the strength of competition for resources between relatives. Despite the high frequency of SBD in the wild, and its strong influence on demographic parameters at all levels of organisation from individuals to populations, the drivers of SBD remain poorly understood. IoZ research presented evidence from both observational and genetic data of a rare reversal of the typical female-biased pattern of avian dispersal in the cooperatively breeding white-browed sparrow-weaver (*Plocepasser mahali*), where males disperse further than females. Existing hypotheses regarding the drivers of SBD cannot readily explain the direction of SBD in white-browed sparrow-weavers, suggesting that it occurs for reasons more complex than simply inbreeding avoidance or as a by-product of the species' mating system alone. Instead, male sparrow-weavers may disperse greater distances than females because they are able to detect vacant breeding positions over a larger spatial scale. This could occur because: (1) males undertake extraterritorial forays for extragroup mating opportunities; and (2) dominant males sing a conspicuous dawn song throughout the breeding season, the absence of which may readily advertise unoccupied dominance positions in novel territories. Our results provide a model system for understanding both the evolutionary



Chacma baboons
grooming at Tsaobis



Above: Our study on cooperatively breeding white-browed sparrow-weavers has added to our understanding of sex-biased dispersal

drivers of SBD and its effect on demographic processes occurring in wild populations, which in turn can inform management decisions for threatened species in the wild.

Reference

Harrison, XA, York, JE and Young, AJ (2014) Population genetic structure and direct observations reveal sex-reversed patterns of dispersal in a cooperative bird. *Molecular Ecology* 23: 5740–5755

Social strategies and market forces in animal groups

In many animal groups, social interactions between individuals are influenced by market forces. Changes in supply or demand for a given service, such as tolerance at shared feeding sites, leads to changing preferences for those social partners who can provide that service. Previous research has shown that such changes can occur over relatively short periods of weeks or months. IoZ researchers investigated whether such market forces might lead to an even more rapid response, with individuals optimising their social strategies over the course of a single day. We studied social interactions in Tsaobis baboons, a wild population of chacma baboons (*Papio ursinus*) living on the edge of the Namib Desert, in order to assess whether subordinate animals might trade one service, grooming, for another service, tolerance at shared feeding sites, with dominant animals. Because the 'purchase' of tolerance from dominant animals should be most valuable earlier in the day, when most of the day's foraging activities still lie ahead, the researchers predicted that subordinates should prefer to groom more dominant animals earlier in the day. A total of 1,674 grooming bouts involving 60 individuals in two different troops were analysed. Our findings confirm that subordinate animals have a stronger preference for grooming more dominant animals earlier in the day. This is the first report of diurnal social strategies in any animal, and suggests that social strategies may be a good deal more flexible, and involve elements that are optimised over shorter periods, than previously appreciated.

Reference

Sick, C, Carter, AJ, Marshall, HH, Knapp, LA, Dabelsteen, T and Cowlishaw, G (2014) Evidence for varying social strategies across the day in chacma baboons. *Biology Letters* 10: 2014.0249. DOI: 10.1098/rsbl.2014.0249

Does G_{ST} underestimate genetic differentiation from marker data?

Measuring the uniqueness of and differentiation between populations is important in many fields, such as evolution, conservation, medicine and forensics. However, the widely used genetic differentiation statistics F_{ST} and G_{ST} have been criticised for underestimating differentiation when applied to highly polymorphic markers such as microsatellites. A recent study has shown that G_{ST} gives accurate estimates and underestimates of differentiation when demographic factors are more and less important than mutations, respectively. In the former case, all markers, regardless of diversity (H_s), have the same G_{ST} value in expectation and give replicated estimates of differentiation. In the latter case, markers of higher H_s have lower G_{ST} values, resulting in a negative, roughly linear correlation between G_{ST} and H_s across loci. The results suggest that the correlation coefficient between G_{ST} and H_s across loci, r_{GH} , can be used to distinguish the two cases and to detect mutational effects on G_{ST} . A highly negative and significant r_{GH} , when coupled with highly variable G_{ST} values among loci, would reveal that marker G_{ST} values are affected substantially by mutations and marker diversity, underestimate population differentiation, and are not comparable among studies, species and markers. The proposed correlation analysis is applied to simulated datasets to check its power and statistical behaviour, and to empirical datasets to demonstrate its usefulness.

Reference

Wang, J (2015) Does G_{ST} underestimate genetic differentiation from marker data? *Molecular Ecology* 24: 3546–3558



The Saharan cheetah as a flagship species for a threatened ecosystem

Deserts are particularly vulnerable to human impacts and have already suffered a substantial loss of biodiversity. In harsh and variable desert environments, large herbivores typically occur at low densities, and their large carnivore predators occur at even lower densities. The continued survival of large carnivores is key to healthy, functioning desert ecosystems, and the ability to gather reliable information on rare, low-density species is critical to their monitoring and management.



The continued survival of large carnivores is key to healthy, functioning desert ecosystems

We tested camera trap methodologies as a monitoring tool for the Critically Endangered Saharan cheetah (*Acinonyx jubatus hecki*). Two camera trapping surveys were carried out over two to three months across a 2,551km² grid in the Ti-n-hağgen region in the Ahaggar Cultural Park, south central Algeria. A total of 32 records of Saharan cheetah were obtained. The results show that the behaviour and ecology of the Saharan cheetah is severely constrained by the harsh desert environment, leading them to be more nocturnal, be more wide-ranging, and to occur at lower densities relative to cheetah in savannah environments. Density estimates ranged from 0.21-0.55/1,000km², some of the lowest large carnivore densities ever recorded in Africa, and average home-range size over two to three months was estimated at 1,583km². The study identifies the Ahaggar Cultural Park as a key area for the conservation of the Saharan cheetah. The Saharan cheetah meets the requirements for a charismatic flagship species that can be used to ‘market’ the Saharan landscape at a sufficiently large scale, to help reverse the historical neglect of threatened Saharan ecosystems.

Reference

Belbachir, F, Pettorelli, N, Wacher, T, Belbachir-Bazi, A and Durant, SM (2015) Monitoring rarity: the Critically Endangered Saharan cheetah as a flagship species for a threatened ecosystem. *PLOS ONE* 10.1371/journal.pone.0115136



Developing fencing policies for dryland ecosystems

In dryland ecosystems, mobility is essential for both wildlife and people to access unpredictable and spatially heterogeneous resources, particularly in the face of climate change. Fencing has been used worldwide to protect remnant wildlife populations from overhunting, poaching or invasive species, and to reduce human-wildlife conflict and human encroachment. However, fences can prevent connectivity vital for the mobility of wildlife and people. There are recent calls for large-scale barrier fencing interventions to address human-wildlife conflict and illegal resource extraction; however, the evidence available for facilitating sound decision-making for fencing initiatives is limited, particularly for drylands.

An IoZ-driven recent study has identified six research areas that are key to informing evaluations of fencing initiatives: economics, edge permeability, reserve design, connectivity, ecosystem services and communities. Implementing this research agenda to evaluate fencing interventions in dryland ecosystems will enable better management and policy decisions. If future fencing strategies lack local community support and a financing plan to meet the long-term costs of fence maintenance, there is a danger that they may generate more problems than they solve. The United Nations Convention on Migratory Species and the United Nations Convention to Combat Desertification are appropriate international agreements for moving this agenda forward and leading the development of policies and guidelines on fencing in drylands.



Fencing in Africa (this image) can impede the movements of migratory wildlife (above)



Fences can prevent connectivity vital for the mobility of wildlife and people

Ultimately, there is a need for funding agencies to increase support for these areas and their marginalised peoples and develop better management strategies to sustain dryland ecosystems.

Reference

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A generalised random encounter model for estimating animal density using remote sensor data

Wildlife monitoring technology is advancing rapidly and the use of remote sensors, such as camera traps and acoustic detectors, is becoming common in both the terrestrial and marine environments. Current methods to estimate abundance or density require individual recognition of animals or knowing the distance of the animal from the sensor, which is often difficult. A method without these requirements, the random encounter model (REM), can be used to estimate animal densities from count data generated from camera traps. However, count data from acoustic detectors do not fit the assumptions of the REM due to the directionality of animal signals. To tackle this problem, a generalised REM (gREM), was developed to estimate absolute animal density from count data from both camera traps and acoustic detectors. Different combinations of sensor detection widths and animal signal widths were derived to test accuracy and precision of the model. The results showed that the gREM produces accurate estimates of absolute animal density for all combinations of sensor detection widths and animal signal widths. However, larger sensor detection and animal signal widths were found to be more precise. While the model is accurate for all capture efforts tested, the precision of the estimate increases with the number of captures. The gREM is applicable for count data obtained in both marine and terrestrial environments, visually or acoustically (eg big cats, sharks, birds, echolocating bats and cetaceans). As sensors, such as camera traps and acoustic detectors, become more ubiquitous the gREM will be increasingly useful for monitoring unmarked animal populations across broad spatial, temporal and taxonomic scales.

Reference

Lucas, TCD, Moorcroft, EA, Freeman, R, Rowcliffe, JM and Jones, KE (2015) A generalised random encounter model for estimating animal density with remote sensor data. *Methods in Ecology and Evolution* 6: 500-509



Communicating science

An important part of IoZ's work is facilitating the communication of science among professional zoologists and researchers, and to the public. We achieve this through a varied programme of events and the publication of scientific journals and books.



Science and conservation events

ZSL's popular series of science and conservation events is free and open to the public. Held on the second Tuesday of each month throughout the academic year, each meeting provides an overview of the latest developments in conservation and zoological research. This year's programme included lectures on '50 years of Red List: past, present and future', 'Global land-use change: causes and consequences for biodiversity', 'Flagship species for freshwater conservation' and 'The devourer of newts: a novel chytrid fungus on Britain's doorstep'.

Main image, top: Mangrove forests were the focus of a major symposium at ZSL.
Above: Ceri Margerison of BES and Nathalie Petrelli of ZSL, co-organisers of the science policy conference. **Right:** Jeremy Farrar delivering the Stamford Raffles Lecture. **Opposite page:** Organisers of the mangrove symposium (left to right) Joe SY Lee of Griffith University and Jurgenne Primavera and Heather Koldewey, both of ZSL

Stamford Raffles Lecture

The Stamford Raffles Lecture is the foremost event in ZSL's programme of science and conservation events. Established in 1995, lectures have been given by eminent speakers on a wide range of topics. The 2015 lecture 'Health research in the context of rapidly emerging public-health threats' was given by Professor Jeremy Farrar OBE, Director of the Wellcome Trust. The recent Ebola outbreak highlights the serious threat that emerging infectious diseases can pose to global public health. Despite years of apparent preparations for a devastating pandemic, responses to outbreaks are cumbersome and

delayed, and opportunities to save lives are missed. Understanding the interrelationships between human behaviour, animal health and the environment is essential for mobilising successful responses to future events. Drawing on his experience as Director of the Oxford University Clinical Research Unit in Vietnam, Professor Farrar discussed the need for a new paradigm for health governance and health research to bring epidemics to a faster conclusion.





Symposia

ZSL symposia bring together teams of international experts to discuss important topics in conservation science, providing an opportunity for leaders to exchange ideas and communicate their research. 'Turning the tide on mangrove loss: the status of mangroves and their associated fauna', held in November, brought together stakeholders from the mangrove community, including researchers, conservation NGOs and policymakers, to focus on improving conservation success. The event showcased initiatives that are being developed around the world to conserve mangrove forests, including the use of blue carbon and climate-change mitigation.

Outcomes from the symposium included several new sources of funding for mangrove conservation and an IUCN Mangrove Specialist Group statement, prepared for the 2014 World Parks Congress.

A one-day conference, 'The conservation science/policy interface: challenges and



opportunities', was held in collaboration with the British Ecological Society (BES) in April. This event brought together ecologists, conservation practitioners and policymakers to discuss a range of case studies showing how science-policy interactions work in practice. Experts working at the interface between science and policy illustrated how good communication and excellent working relationships are crucial to successfully influencing or initiating change.

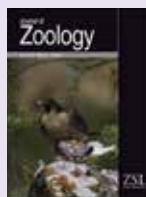
The symposium 'Health and disease in translocated wild animals', held in May, focused on the impact of disease on species restoration through translocation.

Special consideration was given to disease surveillance, health management, the use of molecular tools to unravel disease risk, and methods of post-release monitoring. The event marked the 25th anniversary of the ZSL/Natural England partnership in health surveillance for the Species Recovery Programme.

From public lectures to scientific symposia, visit zsl.org/science/whats-on to discover our current programme of events

Scientific publications

ZSL publishes a range of scientific journals and books that feature the latest international research in zoology and conservation science.



Journal of Zoology

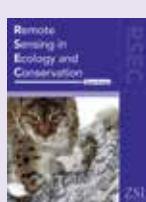
Our monthly journal includes hypothesis-driven studies that advance our understanding of animals and their systems. In 2015, virtual issues on women in

zoology and sound production in animals were published. The series of Huxley review papers is now available on the journal home page at onlinelibrary.wiley.com.



Animal Conservation

Animal Conservation provides a forum for the publication of quantitative research on the conservation of species and habitats. Highlights this year include a special issue on reptile and amphibian translocations, and 'Letters from the Conservation Front Line', which highlights questions for scientists from the conservation practitioner community.



Remote Sensing in Ecology and Conservation

Remote sensing has the potential to significantly advance ecology and conservation. ZSL's new open access journal, *Remote Sensing in Ecology and Conservation*, aims to provide an outlet for innovative thinking and promote the collaborative development of new sensors, methods and tools.



International Zoo Yearbook

An invaluable resource for researchers, animal managers and anyone interested in wildlife conservation, the latest *Yearbook* (volume 49) focuses on the evolution of herpetology programmes in zoological institutions, with the movement away from large collections of reptiles towards linked partnerships for the conservation of species in their natural habitats worldwide.

ZSL Scientific Awards

ZSL recognises outstanding achievements in conservation and zoological research through its annual presentation of awards and prizes. The following awards were presented at our most recent scientific awards ceremony in June 2015.



ZSL Frink Medal

Presented to a professional scientist for substantial and original contributions to zoology. Awarded to **Sir Patrick Bateson** FRS Emeritus Professor of Ethology, University of Cambridge, for significant research on animal behaviour as an evolutionarily adaptive trait,

the role of play in development, the role of genetic and environmental influences on behaviour, and animal ethics and welfare.



ZSL Scientific Medal

Presented to research scientists with up to 15 years' postdoctoral experience for distinguished work in zoology. Awarded to **Andy Gardner** (pictured), University of St Andrews, for outstanding contributions to our understanding of adaptation, social evolution, fitness and multilevel selection and evolution of mating systems; **Patrik Nosil**, University of Sheffield, for important research on evolutionary genetics and speciation; and **Tommaso Pizzari**, University of Oxford, for influential contributions to the evolutionary ecology of sexual behaviour, sexual selection and intersexual coevolution.



ZSL Silver Medal

Awarded for outstanding contributions to the understanding and appreciation of zoology. Presented to **Darren Mann**, Head of Life Collections at Oxford University Museum of Natural History, for major contributions to the public understanding of entomology and extensive outreach activities.



ZSL Stamford Raffles Award

For distinguished contributions to zoology, open to amateur zoologists or to professional zoologists in recognition of activities that are outside the scope of their profession. Awarded to **Elise Andrew**, founder of IFLScience, for exceptional contributions to science communication.



Left to right: Elise Andrew, Andy Gardner, Tommaso Pizzari, Benjamin Hopkins, Patrik Nosil, Darren Mann, Ben Ashby, Sir John Beddington, Brian Marsh, Robin Fitzgerald, Heather Koldewey, Ben Collen, Ulrich Schüre, Johanne Matheson, Jamie Weir



Marsh Award for Conservation Biology

For contributions to fundamental science and its application to the conservation of animal species and habitats. Awarded to **Ben Collen**, University College London, for high-impact research on biodiversity monitoring, conservation science and informing policy.



ZSL Marsh Award for Marine and Freshwater Conservation

For contributions to fundamental science and its application to conservation in marine and/or freshwater ecosystems. Awarded to **Heather Koldewey**, ZSL, for important work on marine protected areas, Project Seahorse, reef and mangrove conservation, and marine science.



ZSL Prince Philip Award and Marsh Prize

Awarded to an A-level or Higher student for the best project on some aspect of animal biology. Awarded to **Jamie Weir**, Larbert High School, for his project 'The ground beetle fauna of Glen Finglas, Stirlingshire, and factors affecting species distribution and abundance'.



ZSL Charles Darwin Award and Marsh Prize

Presented for the best zoological project by an undergraduate student attending university in the UK. Awarded to **Benjamin Hopkins**, University of Oxford, for his project 'The role of the accessory

gland secondary cells in mediating sperm competition in *Drosophila*'.



ZSL Thomas Henry Huxley Award and Marsh Prize

Presented for the best zoological doctoral thesis produced in the UK. Awarded to **Ben Ashby**, University of Oxford, for his thesis 'The effects of contact patterns and genetic specificity on host and parasite evolution'.



ZSL Award for Outstanding Contributions to the Zoo Community

Awarded to **Ulrich Schürer**, Wuppertal Zoo, for important contributions to the development of the European Zoo Directive, EAZA legislative committee and for his work to develop and promote the highest standards of husbandry, animal welfare and exhibit design.



ZSL Thomson Reuters Award for Communicating Zoology

Presented for the public communication of zoology. Awarded to **Brett Westwood** and **Stephen Moss** for the BBC Radio 4 programme and book *Tweet of the Day*.



ZSL Staff Medal

Presented for outstanding contributions and service to ZSL. Awarded to **Robin Fitzgerald**, Senior Project Manager, for important contributions to major construction projects across ZSL Whipsnade Zoo and ZSL London Zoo, including *Butterfly Paradise*, *Gorilla Kingdom*, *Penguin Beach* and *Tiger Territory*.



ZSL would like to take this opportunity to thank the Marsh Christian Trust and Thomson Reuters for their generous support of our scientific awards programme

ZSL Library

The ZSL Library plays an active role in the activities of the learned society and manages, develops and facilitates access to a relevant and useful body of zoological/conversation knowledge.

During 2014, 1,700 titles were added to the ZSL Library and all books in the Reading Room have now been added to the online catalogue at library.zsl.org. Thumbnail images of artworks and historic books have also been added to aid retrieval of our resources.

Our events

Our public engagement activities increased this year. We hosted a range of visitors, including the Association of Librarians and Information Professionals in the Social Sciences (ALISS), wiki editors during a world 'Wikimania' event, archivists from AIM25, Library and Information MA students from UCL, members of the Bartlett Society and Victoria and Albert Museum, staff of the London Library, and groups of A-level Biology students. In October, poetry readings were held in the Library, as part of ZSL's Poetry Weekend.

In July, we were pleased to speak to the public about our services at ZSL London Zoo's Sunset Safari event. ZSL welcomes members of the public to the Library. Visitors can enjoy a display of our books and archives, and use our resources to develop their interest in animals and conservation.

With the approaching bicentenary of the UK's involvement with Nepal, there continues to be great interest in Brian Houghton Hodgson manuscripts on birds and



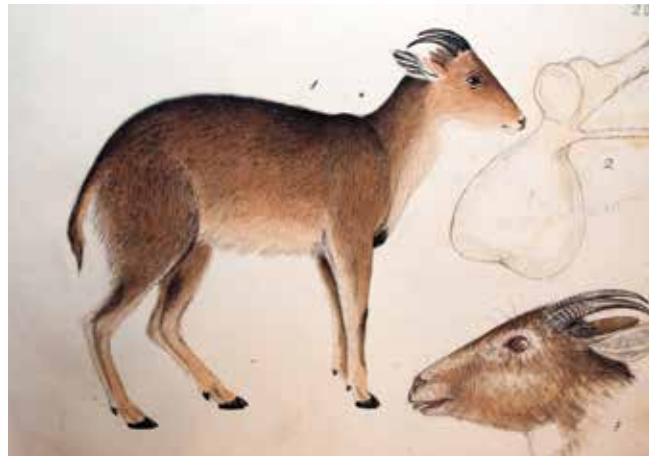
mammals of Nepal. These works date from 1820-1843 and include detailed descriptions of many species that were new to science at that time. With funding from the National Manuscripts Conservation Trust, Volume 1 of Hodgson's mammals has been repaired, conserved and digitised. This primary research material is now accessible worldwide via the ZSL website and Library catalogue, providing an important digital resource for people who may not otherwise be able to study the manuscripts. David Lowther, PhD student at the University of Newcastle, has continued his role as ZSL Library's visiting scholar. David has given talks about Hodgson at ZSL, increasing the profile of our collections and awareness of these beautiful manuscripts.

A rare book about Mauritius has also been digitised and made available via the online catalogue: *Notice historique sur Charles Telfair...lue à la 4me séance annuelle de la Société d'Histoire Naturelle de l'Île Maurice, le samedi, 24 août 1833 / par Julien Desjardins. Port-Louis: Soc. Hist. nat. Maurice, 1836.*

Our artefacts

Artefacts on the ZSL website is now a monthly blog featuring items of general interest. Recent examples include: a celebration of 150 years of *Zoological Record*; the extinction of the passenger pigeon 100 years ago; and an unpublished painting of

Main image: The Library team has been conserving Brian Houghton Hodgson's works on mammals (shown below and right)



a giant Chinese salamander, which may have accompanied the 1924 paper 'On a new giant salamander, living in the Society's Gardens', published in *Proceedings of the Zoological Society of London*, that was read by EG Boulenger at a meeting at ZSL.

Items consulted from the archives include material on: Darwin's apes, ZSL London Zoo history, the Granada TV programme *Zoo Time*, Chi-Chi the giant panda, a snow leopard donated in 1905, Clarissa the carp, Jackson the rhino, the Snowdon Aviary and Monkey Hill,

among other topics. As usual, the 'Daily Occurrences', Council minutes and press cuttings were frequently used. We do not normally require visitors to make appointments, but it is helpful if they intend to view any of our special collections.

We are, of course, extremely grateful for the continued help of our dedicated team of volunteers and the many Fellows and Members of ZSL who continue to support the Library with their time, and by donating books, archives, zoo ephemera and funds for the conservation of items in our collections.



Available 24/7, the catalogue lists 40,555 books, serial holdings, archives and artworks, and was accessed over 18,700 times in 2014

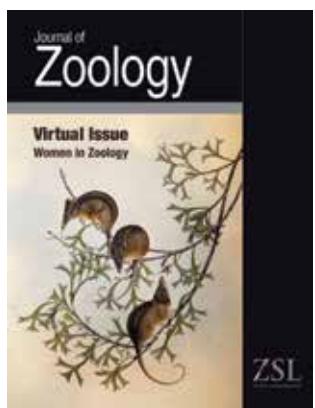
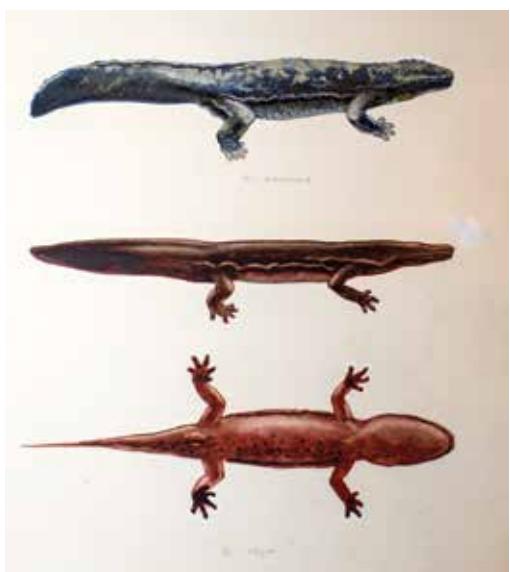


Women and zoology

Special tours and displays were held in December and March to celebrate the historic contribution that women have made to the development of zoology. Publications, illustrations and items from the ZSL Archives were used to unveil this little-known story. The March events coincided with International Women's Day.

ZSL had a key part to play in encouraging the contribution of women to the development of zoology. From 1827 – almost from the very beginning of the Society – women could become Fellows. This was unusual for the time, as many learned societies did not allow women to join until the 20th century. Our talks describe the 17th-century contributions of Hannah and Susana Lister to the work of Martin Lister, and the pioneering work of Marie Sibille Merian on the life cycles of insects in Europe and Suriname during the 18th century.

Special mention was also made of entomologist Emily Bowdler Sharpe, who was the first woman to author a paper in the *Proceedings of the Zoological Society* in 1891: ‘Descriptions of New Butterflies collected by Mr FJ Jackson, FZS, in British East Africa, during his recent Expedition – Part I’. We also highlighted the work of the first two women appointed as curatorial staff at ZSL, Evelyn Cheesman (Entomology) and Joan Proctor (Herpetology). ZSL continues to encourage women in zoology and conservation science as staff, students, volunteers and members of ZSL.



Centre: The ZSL Library. **Above:** The virtual issue of 'Women in Zoology'. **Left:** Artefacts showcased on our monthly blog included this unpublished 1924 painting of a giant Chinese salamander. **Top right:** An illustration by pioneering female naturalist Marie Sibille Merian



A virtual issue of *Journal of Zoology*, on women in zoology, features on the journal's home page

Education and training

Educating the next generation of conservation scientists is at the heart of ZSL's work. Here, we look at some of the research highlights over the past academic year.

MSc course in Conservation Science

The MSc course in Conservation Science, run in partnership with Imperial College, the Royal Botanic Gardens Kew and Durrell Wildlife Conservation Trust, remains popular with students focused on starting or enhancing their careers in conservation research or action. The 2014 cohort included students from China, Kenya, Sudan, Canada, Mexico, the Bahamas and the USA, as well as the UK and EU. In all, 36 students graduated, with the award of 13 Distinctions and 21 Merits. Pria Ghosh was awarded the TH Huxley prize for the best student overall, and Lucy Dablin was awarded the prize for the best coursework performance. Elizabeth Duthie and Sarah Walker were jointly awarded the prize for the best project. Elizabeth analysed the power of celebrity endorsement in conveying conservation messages, while Sarah developed machine-learning algorithms to identify priorities for the conservation of bulbous monocot plants.



Access the full Conservation Science thesis archive at iccs.org.uk/publications/thesis-archive-msc-con-sci

MSc courses in Wild Animal Health and Wild Animal Biology

The graduates of our MSc courses in Wild Animal Health (WAH) and Wild Animal Biology (WAB) have a good record of publishing the results of their scientific research projects: 131 articles have been published since the course commenced in 1994, in a period when 387 students have graduated. In the past year, a paper by Ashley Barratclough, an MSc WAH graduate, and her collaborators, entitled 'How much does a swimming, underweight, entangled right whale (*Eubalaena glacialis*) weigh? Calculating the weight at sea, to facilitate accurate dosing of sedatives to enable disentanglement,' was published in *Marine Mammal Science*. The authors used body weight, length and circumference data gathered from post-mortem examinations of North Atlantic right whales to develop an equation to calculate the body weight of living right whales from photogrammetry images. This important work allows dose rate of sedatives to be more accurately calculated in order to remove nets and other fishing gear in which North Atlantic right whales become entangled. Entanglement compromises the health of right whales, one of the most highly endangered whale species. Ashley gave a presentation on her work at the International Association for Aquatic Animal Medicine conference in Chicago in 2015, and won the first prize for student talks.



Top: Ashley Barratclough's paper on right whale measurement appeared in *Marine Mammal Science*. **Above:** Justine Shotton's work on cheetahs won both MSc Wild Animal Health prizes. **Right:** MSc Wild Animal Biology student Eloise Stephenson in the field



Learn more about the postgraduate opportunities at IoZ at zsl.org/science/postgraduate-study

Of the 2013-2014 cohort of 29 graduates, Lucy Sangster received the award for the MSc WAB student with the highest aggregate marks, and the best MSc WAB research project prize was shared between Lucy and Eloise Stephenson. Eloise's research was on 'Developing and assigning age classes to field specimens of Asian elephants (*Elephas maximus*) using dentition, cranial sutures and morphology' while Lucy's was 'Detection and molecular characterisation of *Cryptosporidium* species in British European hedgehogs (*Erinaceus europaeus*)'. Justine Shotton received both MSc Wild Animal Health prizes: for the student with the highest aggregate marks, and for the best research project for her work on 'Determining habitat utilisation, and locomotor and hunting activity of wild cheetahs (*Acinonyx jubatus*) in Botswana'.



Our PhD students



One of the perks of trawling through the endless emails, forms and spreadsheets that accompany the role of postgraduate tutor is becoming aware of the staggering scope of what our PhD students work on, and their importance to IoZ and ZSL as a whole. I find myself amazed by the range of projects, the spread of study sites, and the scope of skills and techniques encompassed by our postgraduates. And there's more: the role of students in engaging the public with our work via events like Sunset Safari, blogs and the Twittersphere cannot be overstated. Our PhD students set the tone for the mood and culture of IoZ as an organisation; if we have a vibrant, dynamic student body, we tend to have a happier, more dynamic organisation.

We presently have more than 60 PhD students and, in any given year, a number receive their PhDs in a great variety of subjects. In 2014-2015 students graduated addressing questions such as: 'How are high-altitude amphibians affected by infectious disease?' (Frances Clare); 'How do South American bird and mammal populations respond to agricultural habitat changes?' (Julietta Decarre); 'What defines the distribution of riparian tree species along ephemeral riverbeds in desert landscapes?' (Caitlin Douglas); 'How, why and when do social traits evolve in ants?' (Henry Ferguson-Gow); 'Can we use boat-based surveys and local knowledge to improve our knowledge of the Ganges River dolphin?' (Nadia Richman); 'Does the global trade in amphibian species play a role in the spread of infectious disease?' (Emma Wombwell); 'How is one of the most cryptic mammal species in the world, the *Hispaniolan solenodon*, affected by habitat modification?' (Rosalind Kennerley); and 'Can bats be used as reliable indicators of environmental change?' (Charlotte Walters).

By addressing these questions, our students make tremendous strides in advancing science, as well as in providing essential information upon which IoZ bases science-informed conservation and policy briefs, and engages with the broader conservation community and the general public. More than that, they help IoZ function and develop, and contribute immensely to making IoZ what it is.

Jon Bielby, postgraduate tutor

Funding

The IoZ depends upon funding from a wide range of sources, including the Higher Education Funding Council for England, to carry out its research. Here, we look at some funding highlights.



Benthic habitats in Iceland's shrimp trawl grounds

IoZ scientists Kirsty Kemp, Chris Yesson and Chris Turner received funding from the European consortium Eurofleets to undertake a research cruise aboard the vessel *Magnus Heinason* to the Icelandic Arctic. Knowledge of the distribution, abundance and biodiversity of seabed communities in the Arctic is sparse and fragmented. This information is vital if we are to assess the impact of activities such as trawl fishing on marine ecosystems. The shrimp trawl fishery of northern Iceland has been in operation since the 1970s, but there is increasing pressure to demonstrate its sustainability, and, to date, no images have been taken to allow evaluation of these areas. Using a deep-water camera, our team took hundreds of photographs of the seabed. Identifying the organisms in the images will enable us to evaluate the relationships between benthic community structure, diversity and fishing pressure. This project, a collaborative effort between IoZ and the Marine Research Institute (Iceland), builds on IoZ research conducted in other Arctic regions.



Garden Wildlife Health

Garden Wildlife Health (GWH) is a collaborative project that investigates causes of mortality in British garden wildlife, in order to identify emerging health conditions that may pose significant threats to wildlife biodiversity and conservation. IoZ coordinates the research in collaboration with our partner organisations, the British Trust for Ornithology, Froglife and the Royal Society for the Protection of Birds. IoZ received funding from Defra (through the GB Wildlife Disease Surveillance Partnership and projects WC 1027, SV3040 and SV3032), the Esmée Fairbairn Foundation and the Universities Federation for Animal Welfare to support this research. GWH is a citizen-science project which relies on reports of sick or dead wildlife submitted to our website by members



of the public. This year we have received disease incident reports from almost 800 sites, and performed post-mortem examinations on approximately 350 wild animals that have enabled us to identify diseases that affect amphibians, garden birds, hedgehogs and reptiles across Great Britain. Our work spans the range of focus from individual to local and national populations. This year we've identified the first case of a novel disease caused by avian reovirus in a British wild bird, investigated the causes of mortality in the local hedgehog population in collaboration with the Regent's Park Hedgehog Survey, and established an early-warning surveillance system for salamander chytrid *Batrachochytrium salamandivorans*, a new disease threat to British amphibian species.



Find out more about the GWH project and how we can all support local wildlife at gardenwildlifehealth.org



Our Garden Wildlife Health project is monitoring birds and animals such as the hedgehog (main image) and blue tit (below left)

Identifying viral genetic mechanisms behind catastrophic amphibian declines

Trent Garner has been awarded £280,000 by NERC (the Natural Environment Research Council), as part of a £730,000 award to ZSL, UCL and Queen Mary University of London, to research how the genetic composition of some ranaviruses allows them to cause lethal disease in a wide range of amphibian hosts. The project builds on the outputs of several PhD projects co-supervised by Trent with Richard Nichols of Queen Mary, and the historical studies of ranavirus emergence in the UK, initiated by Andrew Cunningham at ZSL almost 25 years ago. Lethal disease caused by UK ranaviruses predominates in UK common frogs, while the recent emergence of ranavirosis in northern Spain and Portugal has been causing mass mortality and declines of entire amphibian communities. These two events are associated with different ranavirus strains, and, by using a combination of viral genome sequencing, experimentation and viral gene manipulation, Trent and colleagues hope to determine what genes are responsible



We are studying ranaviruses in amphibians such as the marbled newt (above) and common midwife toad (below)



for wide host range in Iberian viruses and narrow host range in UK viruses. The project funds positions for Stephen Price as a postdoc (paid by the UCL component of the grant) and William Leung, a new technician based at ZSL.

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- Natural England
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- Tellus Mater
- Universities Federation for Animal Welfare (UFAW)
- University of Cambridge
- Wildlife Conservation Society
- WWF Netherlands
- WWF UK



If you would be interested in helping to fund ZSL's vital work, call **0344 225 1826** or find out more at zsl.org/support-us

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ZSL would like to thank its students, interns, volunteers and collaborators, as well as its staff.

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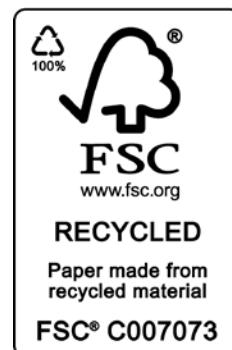
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ZSL The Year in Review 2014
Our annual overview of the year,
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ZSL Conservation Review 2014
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