**IoZ RESEARCH STRATEGY**

**OUR AIM**
To undertake and promote relevant high-quality zoological and conservation research, to help ZSL achieve its conservation objectives, and to inform and influence conservation policy.

**OUR OBJECTIVES**
1. Encouraging and rewarding excellence in the performance and communication of science, conservation and animal husbandry
2. Attracting and engaging a diverse range of people and organisations in the science of zoology and conservation – from students to leaders in their field
3. Using our unique convening role as a leading learned society to foster and achieve international excellence in science relevant to our core conservation priorities
4. Managing and developing a relevant and useful body of zoological knowledge
5. Providing policy makers, conservationists and the general public with the information needed to make informed decisions on conservation issues
6. Raising the profile of conservation issues and priorities, and ensuring they are well represented at policy level and in the media

**OUR ACTIVITIES**

**HEFCE-funded programme**
We undertake research and research training in the following themes:
- Biodiversity and Macroecology
- Behavioural and Population Ecology
- Evolution and Molecular Ecology
- Wildlife Epidemiology

We provide education through MSc and PhD programmes

**Science Plan**
The major topics:
- **Biodiversity patterns and processes**
  How can we explain and model biological diversity at a range of spatial, temporal and biological scales?
- **People and the environment in a changing world**
  How can we manage wild species and habitats sustainably alongside human population growth and development?

With the rest of the Zoological Society of London
We respond to research questions and contribute to ZSL’s Conservation Programmes:
- Conservation Breeding and Reintroduction; EDGE; Indicators and Assessments; Marine and Freshwater; Wildlife Health
- Africa; South and Central Asia; Southeast Asia; Mongolia; UK and Europe

We respond to research questions and contribute to ZSL’s living animal collection:
- Animal health and welfare research
- Reproductive monitoring

We run a programme of meetings and publications:
- *Journal of Zoology and Animal Conservation*
- Annual programme of evening science and conservation events
- Biannual international symposia on topical themes in conservation biology
- Technical publications to support best practice in zoos (*International Zoo Yearbook*) and in field conservation (*Conservation Reports*)

**With University College London**
We maintain and develop research links with genetics, evolution and environment, and other relevant departments, notably the Centre for Biodiversity and Environmental Research.
We aim to maximise the opportunities for shared graduate training at masters and doctoral level.

We contribute to London-wide activities in ecology and evolution through membership of the Centre for Ecology and Evolution.

**With institutions in London**
We maintain and develop research links with academic bodies, especially the Centre for Ecology and Evolution. We run MSc courses in wild animal health and wild animal biology with the Royal Veterinary College and an MSc in conservation science.

Our research is influenced by London-based conservation issues.

**With other organisations**
We collaborate with most relevant outside bodies for our core research interests.

Our programme of talks communicate science and conservation.
The President and Director General of the Zoological Society of London introduce the Institute of Zoology Review 2012/2013.

The Zoological Society of London (ZSL) was founded in 1826, with one of its core aims being to promote the science of zoology. The kind of questions that this discipline addresses has changed out of all recognition in the intervening 187 years. What the founding fathers would have made of conservation genomics, macroecology or wildlife epidemiology is anyone’s guess, but I am sure they would be happy to see that ZSL continues to be at the forefront of zoological research thanks to the scientists at its Institute of Zoology (IoZ).

It is worth taking a moment to consider just how unusual a creature is IoZ. A world-class independent scientific research institute, part of a conservation charity but supported by funds from the UK government, affiliated with one of the world’s top universities, based at a zoo in the centre of one of the world’s major cities, but with researchers away studying animals from the tropics to the poles. It is truly a unique institution, and one of which ZSL is justly proud.

In the pages that follow, you can read about some of the ongoing research projects being carried out by IoZ scientists. These span a wide range of topics, from the reasons for the extreme sexual size dimorphism shown by the giant moa of New Zealand to the identification of zoonotic viruses in African fruit bats. They illustrate why IoZ has the reputation it does within the scientific community, and why it continues to attract so many high-quality students and collaborators from around the world to work with its scientists.

The IoZ could not achieve so much without the support of its many partners, and most notably University College London, with which we continue to develop our research interests.

I am proud to welcome you to IoZ’s annual review, in which you can read about some of our scientific highlights from the past year.

It is probably fair to say that most people who know of ZSL know of it because of its world-famous zoos in London and Whipsnade. These attractions are fantastic shop windows for the work of the organisation, and many of the visitors to them leave knowing (and hopefully also caring) more about the animals they share the planet with.

What many people don’t know is the incredible breadth of ways in which ZSL educates people about the natural world. A significant proportion of that comes from the work of the Institute. IoZ participates in three MSc courses in conservation-related subjects in collaboration with the Royal Veterinary College and Imperial College London, and in this past year has started up an MRes course jointly with University College London and the Natural History Museum. Around 60 students take these courses each year. IoZ scientists currently co-supervise almost 50 PhD students, while a further 10 PhD students are affiliated with IoZ, to the benefit of their research and ours. Many of these masters and doctoral students are from overseas, helping to give ZSL a strong international profile.

IoZ also has four staff dedicated to producing ZSL’s scientific journals and to running ZSL’s programme of free scientific meetings for the general public, as well as our annual programme of international scientific symposia. All this means that ZSL is educating people from their earliest visits as children through to their senior years. I hope that you enjoy this review, and that in reading it you learn something new.

Professor Sir Patrick Bateson FRS
President, Zoological Society of London

Ralph Armond
Director General, Zoological Society of London
Over the past year, IoZ’s research has continued to improve our understanding of the natural world and address a wide range of conservation issues, while new staff, a new research theme and new laboratories will further advance our work.

**PEOPLE, WILDLIFE AND ECOSYSTEMS**

This year, IoZ saw the introduction of a new research theme. The People, Wildlife and Ecosystems theme, headed by Sarah Durant (seated, right), will contribute to our understanding of humans as a component of ecosystems to develop solutions to ensure sustainable coexistence in the face of environmental change.

Research in the theme will explore the processes that promote and impede human-wildlife coexistence, evaluate the contribution of ecosystem services to sustainable livelihoods, economies and society, and study the effects of policy and management interventions on conservation outcomes. Research under this theme will appear for the first time in next year’s *Science for Conservation*.

**NEW PUBLICATIONS**


October saw the publication of a themed issue of *Philosophical Transactions of the Royal Society B* titled ‘Disease invasion: impacts on biodiversity and human health’. Articles in this issue, co-edited by Andrew Cunningham, focus on the extent to which wildlife pathogens threaten biodiversity and human health, the processes driving these disease threats, where future threats will arise, and how these might be mitigated.

**ROBIN FREEMAN JOINS THE IAU**

In July, Robin Freeman (above) joined IoZ as head of the Indicators and Assessments Unit (IAU). Previously a Research Fellow at UCL’s Centre for Mathematics and Physics in the Life Sciences and Experimental Biology (CoMPLEX), Robin has a background in software engineering, pattern recognition, machine learning, hardware development and web technology. He will combine ecological and behavioural research with computational techniques to further the research and delivery of population monitoring within the IAU.
A major refurbishment of the second-floor laboratories in the Nuffield Building is under way. Once completed, these new laboratories will place IoZ at the cutting edge of DNA- and RNA-based research in advanced genetics and genomics.

NEW IoZ RESEARCH FELLOWS
Four IoZ Research Fellows were appointed during the year: Xavier Harrison (top left, above) joined us from Exeter University, where his research focused on the genetic traits and ecological processes that drive asymmetries in reproductive success among individuals in wild populations. His current work at IoZ will investigate the effect of variation in vertebrate immunity genes – toll-like receptors (TLRs) and the major histocompatibility complex (MHC) – on key fitness traits such as survival and reproduction in a co-operatively breeding bird, the white-browed sparrow weaver (Plocepasser mahali).

Patricia Brekke (top right, above) will continue her studies on the ecology, evolution and conservation of reintroduced species, particularly the evolutionary and genetic consequences of reintroduction of wild bird populations. This research uses pedigrees (quantitative genetics) and molecular tools to understand the role of inbreeding, genetic diversity loss and a species’ life-history traits on vulnerability to extinction.

Becki Lawson (bottom left, above) will research the effects of disease on free-ranging wildlife populations, particularly where pathogens have significant welfare or conservation implications, and wildlife population health. Becki also focuses on the epidemiology of disease transmission between free-ranging wildlife, domestic animals and humans, and the role that anthropogenic activity may have in influencing these processes.

Jon Bielby (bottom right, above) will research how extrinsic factors – such as temperature, resource availability and the intensity of threatening processes – interact with intrinsic factors – such as species ecology, life-history and behaviour – to produce the patterns of species mortality, decline and extinction that we observe in the natural world. To address these issues, Jon will use data collected from scientific literature, field systems, palaeontological records, and laboratory work, in several systems including amphibians, fungi and badgers. Jon will continue to work on projects that are relevant to science policy, such as plans to cull badgers to address the spread of bovine tuberculosis, and that help inform and implement ZSL’s applied conservation – for example, with his work on the Sardinian brook salamander (Euproctus platycephalus).

A NEW MRes
This year we introduced a joint MRes in Biodiversity, Evolution and Conservation in collaboration with University College London’s (UCL) Department of Genetics, Evolution and Environment and the Natural History Museum. The programme provides training in scientific approaches to studying and preserving biodiversity, and covers both basic research on the evolutionary and ecological processes that produced our present biodiversity, and applied research on how to preserve biodiversity in the future.

STAFF MOVES
We have had to say goodbye to several key members of staff. In April, Ben Collen joined the Centre for Biodiversity and Environmental Research at UCL. Since he was appointed head of ZSL’s Indicators and Assessments Unit in 2007, Ben contributed widely to our understanding of status and trends in biodiversity with the development of the Living Planet Index with WWF, the IUCN-sampled approach to Red Listing and biodiversity indicators for the Convention on Biological Diversity. Seirian Sumner has joined the School of Biological Sciences at the University of Bristol, where she will continue her research on social evolution and behaviour of insects.
Introduction

IoZ Director Professor Tim Blackburn reflects on how the scientific work of the Institute is advancing conservation and finding ways for humanity and wildlife to coexist.

I had wanted to visit South Africa’s Kruger National Park for as long as I could remember, so my first visit there in 2006 was the subject of huge anticipation. The drive from Johannesburg took several hours, most of it through a countryside dominated by agriculture, until we finally arrived at the park border. A collection of small buildings and a barrier across the road breached a tall, heavy fence that ran as far as the eye could see in both directions. On one side, the landscape was low-cropped grassland and fields with a few goats and dogs. On the other, low thorny woodland and, within a few hundred metres, zebra, impalas and baboons. In terms of wildlife, Kruger certainly did not disappoint. It is a wonderful park, with a glorious diversity and abundance of birds and mammals (and I’m sure of plants, insects and herptiles as well). It has comfortable and scenic lodges, the road is as smooth as any urban street, and there’s that big, heavy fence to protect the animals. Or is it to protect the people from the animals? Either way, that big, heavy fence.

I have many memories of that visit to Kruger, but one of the most abiding is the sharp delineation of the countryside marked by the fence. Driving through it was like entering the world’s largest safari park – and in some ways, that is exactly what Kruger is. For me, that fence brought into sharp focus how the relationship between humans and the (rest of the) natural world has changed in the past century. We have gone from a situation in which humans exist in a natural landscape, to one in which nature exists in a human landscape. Nature has always been precious, but as truly wild areas shrink in the face of the expansion of human populations and human endeavours, what is left is becoming ever more so. In most parts of the world, we can no longer simply fence off areas ‘for wildlife’ and expect nature to continue to function, especially as so many other features of the environment change around us. Increasingly, we have to find ways for humans and wildlife to coexist within landscapes. As science is the best tool yet invented for solving problems and answering questions, increasingly these are the kinds of issues that the science of conservation is having to address.

IoZ has a long history of high-impact research on questions of human-wildlife coexistence, and of how human societies can live sustainably with nature. This year, we have formally recognised this area of expertise with the introduction of our new research theme on People, Wildlife and Ecosystems. However, conservation science relevant to human wellbeing is not limited to this theme. Our research on wildlife epidemiology includes studies of some of the wildlife reservoirs of potentially serious new diseases for humans. Our research on the status and trends in biodiversity helps to identify areas where humans are causing particular environmental damage, with implications for the sustainability of livelihoods and economies. Indeed, since people cannot live without the goods and services that nature provides – clean air, fresh water, fertile soils, medicinal compounds, climate regulation – and since the ultimate aim of our research is to provide knowledge to help to conserve nature, it is fair to say that all of our work benefits humanity just as much as it does nature. I would like to think that our research is helping us to move towards a world where humans and wildlife can live sustainably together without the need for fences. If that is indeed the outcome then I, for one, will believe that we have done our work well.
Research themes

Research at IoZ is organised into themes, and the following pages outline some of the recent work in each theme:

8 BIODIVERSITY AND MACROECOLOGY
10 BEHAVIOURAL AND POPULATION ECOLOGY
12 EVOLUTION AND MOLECULAR ECOLOGY
14 WILDLIFE EPIDEMIOLOGY

Our work also includes the development of indicators for biodiversity monitoring and provides the scientific basis for ZSL’s conservation programmes:

16 INDICATORS AND ASSESSMENTS UNIT
18 CONSERVATION PROGRAMMES

Further key objectives are to communicate our research outcomes to our collaborators, policy makers, conservationists and the public, and to train future scientists and conservation practitioners:

20 COMMUNICATING SCIENCE
22 ZSL SCIENTIFIC AWARDS
23 THE ZSL LIBRARY
24 EDUCATION AND TRAINING

IoZ’s research is advancing our understanding of wildlife populations, including chacma baboons in Namibia
The Biodiversity and Macroecology research theme aims to describe patterns of diversity in the biology, ecology and distribution of animal species and their habitats at regional and global scales, and to test hypotheses about the evolutionary and ecological processes that may explain the origin and maintenance of this diversity. We also aim to work with practitioners to apply this knowledge in setting priorities for conservation action.

Body size differences are often shown between male and female birds. Males are typically larger, although some birds, notably ratites – the largest modern birds, including ostriches, emus and cassowaries – show female-biased size differences. This type of sexual size dimorphism, also called reversed sexual size dimorphism (RSD), was taken to the extreme by New Zealand’s recently extinct giant moa (Dinornis), where males weighed less than 100kg but females could weigh up to 240kg.

There has been little consideration of the evolutionary mechanism that produced this massive level of dimorphism: was it the result of evolutionary adaptation, or just what might be expected for such a large bird that has smaller relatives also displaying RSD? Using male and female body mass data for extant ratites and the related tinamous, together with four extinct moa genera, we investigated whether giant moa were truly unusual with respect to RSD relative to other species using tests of phylogenetic dependence of body size evolution, and examined which sex was under greater pressure to change in size over evolutionary time.

This research demonstrated that the extreme level of RSD exhibited by giant moa represents a straightforward consequence of positive scaling of overall body size, such that the level of sexual dimorphism seen in giant moa is no different from what we might expect based on wider evolutionary patterns across ratites. However, giant moa females have undergone more evolutionary change than males, and they also vary in body size in different environments: larger females in high-productivity environments are associated with greater differentiation, possibly driven by intraspecific competition and female-biased selection for increased offspring investment in a pre-human landscape that lacked mammalian predators.

MAGNITUDE AND VARIATION OF PREHISTORIC BIRD EXTINCTIONS IN THE PACIFIC

The largest extinction event in the Holocene occurred on Pacific islands, where Late Quaternary fossils reveal the loss of thousands of bird populations following the first human colonisation of the region. However, the fossil record is incomplete, and its gaps mean that considerable uncertainty surrounds the magnitude and pattern of these extinctions.

We can estimate the number of missing species in the fossil record by seeing how well fossils preserve bird species that survived the arrival of people. If many extant species are missing from the fossil record, then many extinct species are likely to be missing, too. We can use the mismatch to estimate how many. This is equivalent to the ‘mark-recapture’ method for estimating animal population sizes. Nevertheless, further complications are added to the analysis because features of islands and species that affect the quality of the fossil record are also likely to have affected how many species became extinct, and this may bias our estimates of extinction rate. We dealt with these uncertainties by exploiting recent advances in the Bayesian analysis of mark-recapture data to model gaps in the fossil record and to quantify losses of non-passerine land birds on a sample of 41 Pacific islands. These models suggest that around two-thirds of Pacific bird species became extinct soon after the first humans arrived, and that two-thirds of these extinct species are missing from the fossil record. More species were lost from smaller, drier islands, probably because these suffered more habitat destruction and had fewer refuges from hunters. Flightless and large-bodied species are the preferred targets of these hunters, and were more likely to have become extinct.

Our results imply that around 1,300 bird species were lost from all tropical Pacific islands following the arrival of the first humans. This equates to the loss of around one in every 10 bird species that existed at the time.


PREHISTORIC BIRD EXTINCTIONS

The probability that a species of non-passerine land bird became extinct on each of 41 Pacific islands grouped by biogeographic region, with regions differentiated by colour. The median predicted extinction rate for each island is shown as a filled square, along with the 50% (thick horizontal lines) and 95% (thin horizontal lines) credible intervals.

Island

Lifou

Toga

Efaté

Erromango

Malakula

Grande Terre

Teuia (Waga)

Tirian

Rota

Saipan

Agujian

Guam

‘Ulu

Håna

Huléwa

‘Eua

Liluka

Tongatapu

Foa

Tutuila

Niue

Lakeba

Aiwa Lai’ai

Aiwa Levu

Nayau

Viti Levu

Usa Huka

Hiva Oa

Mangaia

Tahitua

Huahine

Atiu

Nuku Hiva

Aituataki

Henderson

Molokai

Lahain

Kauai

Maui

Oahu

Hawaii

Biogeographic region

Melanesia

Micronesia

West Polynesia

East Polynesia

Hawaii

Extinction probability
Our research in Behavioural and Population Ecology has two major interlinked aims: to test fundamental hypotheses in behavioural and population ecology, and to use our knowledge of the behavioural and population ecology of wild species, and the human populations that interact with them, to inform conservation policy and management.

Flexible Foraging Behaviour in Chacma Baboons

In a changing environment, increases in the amount of time an animal has to devote to foraging will restrict the amount of time it has left to devote to other important activities, such as looking for predators and resting. Predicting these changes in foraging time, and so the effects of environmental change, requires an understanding of how the factors influencing individual foraging decisions vary in different environments. This is especially true in social animals, which are more time constrained due to their need to maintain social bonds with conspecifics, and whose decisions are influenced by the behaviour of other members.

We studied the factors influencing foraging decisions in wild chacma baboons (Papio ursinus) at LoZ’s Tsaobis Baboon Project. We focused on how baboons make decisions about entering and leaving food patches. In the first case, we employed a technique originating from the study of human consumer choices known as discrete-choice modelling. Our analysis showed that the criteria baboons use to choose foraging patches were surprisingly flexible. They adjusted the factors influencing their decisions to reflect the level of competition in different environments. They also adjusted their decisions to reflect their social position in the group. Low-ranked individuals are more likely to receive aggression from higher-ranked group members during foraging. Individual baboons compensated for this when choosing a patch by placing more importance on their social bonds with other patch members, which are likely to moderate the aggression they receive. In the second case, we found that baboons made ‘Bayesian-like’ decisions about when to leave a patch, by using their experiences in previous patches as indicators of how profitable the next patch was likely to be in comparison to their current patch. This suggests that baboons are able to incorporate previous experiences in their decision-making and adjust the number of experiences in light of how reliably these experiences predicted future foraging.

These findings add to mounting evidence that animal decision-making may be more flexible than traditionally thought, and indicate that animals may be able to cope with a degree of change in their physical and social environment. But once the limits of this individual flexibility are reached, and critical foraging time limits are exceeded for the group as a whole, the detrimental effects of environmental change may appear rapidly.


**EARLY-LIFE ENVIRONMENTAL CONDITIONS AND FITNESS IN AN ENDANGERED NEW ZEALAND PASSERINE**

Environmental conditions faced during development are important for an individual’s subsequent quality and fitness. A range of environmental factors experienced during prenatal and early postnatal development, from temperature and stress exposure to immunological and nutritional conditions, can have long-term consequences for a diverse range of phenotypic traits.

This phenomenon can provide important information. For example, the potential for a bird to signal information about its developmental past, via colourful plumage, may provide potential mates with information about the direct or indirect benefits they stand to gain. Likewise, a better understanding of how nestling nutrition influences the subsequent growth and survival of endangered species will inform decisions about what, if any, supplementary food should be provided by conservation managers.

We used a nestling feeding experiment to explore these issues in the hihi (*Notiomystis cincta*), an endangered New Zealand passerine. We found that nutritional conditions during development have an effect on the colourful plumage that males subsequently express as adults. Nestling access to dietary carotenoid pigments enhanced the subsequent quality of yellow breeding plumage, while nestling protein access reduced the subsequent quality of white breeding plumage. These same dietary manipulations also reveal that male and female nestlings have different nutritional requirements. Female fledging success was improved when a high-protein supplement was provided, while male success was reduced. Our results provide the first evidence that colourful displays are accurate indicators of developmental nutrition and provide important lessons for the implementation of supplemental feeding.


Evolution and Molecular Ecology

The Evolution and Molecular Ecology research theme aims to deepen our knowledge of the evolutionary processes that shape biodiversity across systems and on all scales. Although the tools of molecular genetics are commonly employed by theme members, projects also involve experimental ecology, modelling and long-term population studies, among other methods and approaches, to inform conservation practice and policy, and add to our basic understanding of evolution.

The Ethiopian wolf (*Canis simensis*) is not only the rarest canid in the world, but also the most endangered carnivore in Africa. Three populations have become extinct over the past century and there are now fewer than 500 adults living in six isolated habitat fragments in the Ethiopian highlands. The wolves have become victims of their own specialisation, relying heavily on undisturbed Afroalpine habitat that supports large populations of rodents, which are their main prey. The most persistent threat to the species is the human-induced degradation of the Ethiopian highlands, and this is likely to accelerate if climate change allows agriculture to flourish at higher elevations. Human expansion into wolf habitat also brings the threat of diseases carried by domestic dogs, as well as persecution. In the past, rabies has reduced local densities by up to 75% in just a few months. From a genetic perspective, the current isolation and small size of the extant populations could result in further disruption to gene flow, genetic isolation and drift, and eventually loss of the adaptive potential.

If these trends persist it may be necessary in the future to manage wolf populations by artificially increasing population size and genetic diversity. However, management of the species to restore gene flow could have detrimental effects for populations where local adaptation is strong. Therefore, a balanced *in situ* meta-population management approach, aimed at maintaining historic levels of variation within, and dispersal among, Ethiopian wolf populations, would require identifying population genetic boundaries and patterns of gene flow.

The result of our genetic survey will provide vital information to assist the Ethiopian Wolf Conservation Programme in the successful management of the species.

Computationally Efficient Sibship and Parentage Assignment from Multilocus Marker Data

Knowledge of the genealogical relationships among individuals in a population (sample) is important in many research areas in behavioural, ecological and evolutionary genetics, and in conservation biology. It is crucial in studying the social behaviours, mating systems, and sex and reproductive allocations of wild populations, in managing the conservation of populations of endangered species, and in assessing the genetic variation and inheritance of quantitative traits.

In practice, relationships can be estimated easily from pedigree records. Unfortunately, however, detailed pedigree information is rarely available for most natural populations. Genetic markers can be employed instead to infer the relationships, parentage and sibship in particular, among individuals using several statistical methods based on population genetics theory. The full likelihood method, which assigns sibship and parentage relationships among all sampled individuals jointly, is by far the most accurate method, but it is computationally prohibitive for large data sets with many individuals and many loci.

The current study proposes a new likelihood-based method that is computationally efficient enough to handle large data sets. The method uses the sum of the log likelihoods of pairwise relationships in a relationship configuration as the score to measure its plausibility, where log likelihoods of pairwise relationships are calculated only once and stored for repeated use. By analysing several empirical and many simulated data sets, we can show that the new method is more accurate than pairwise likelihood and exclusion-based methods, but is slightly less accurate than the full likelihood method. However, it is computationally much more efficient than the latter, and for the cases of both sexes polygamous and markers with genotyping errors, it can be several orders of magnitude faster. The new method can handle a large sample with thousands of individuals and with the number of markers limited only by computer memory.

Effects of Oil-Palm Plantations on Diversity of Tropical Anurans

Agriculturally altered landscapes, especially oil-palm plantations, are rapidly increasing in Southeast Asia. Decreased diversity of several taxonomic groups is commonly associated with conversion to oil palm, but data on anuran diversity in plantations are lacking.

We investigated how anuran biological diversity differed between forests and oil-palm plantations on Peninsular Malaysia. We compared species richness, abundance, and community composition between plantation and forest areas, and between site types within plantation and forest (forest stream vs plantation stream, forest riparian vs plantation riparian and forest terrestrial vs plantation terrestrial). Frogs were almost equally abundant in both plantations and forests, but frog community composition differed greatly between forest and plantation.

Although plantations supported large numbers of breeding anurans, our study concluded that these were common, disturbance-tolerant species that were of little conservation concern. Current oil-palm plantation practices are unlikely to encourage forest-dependent species into plantation landscapes. Nevertheless, we believe that with several management interventions, oil-palm plantations can provide habitat for some of the frog species that dwell in secondary forests.


Wildlife Epidemiology

The Wildlife Epidemiology research theme aims to identify where disease is a threat to wildlife conservation, either as a primary cause of species declines or as a threat to remnant wildlife populations. It also aims to investigate the emergence of disease as a conservation threat and develop an understanding of the consequences of changes in wildlife disease epidemiology, both to wildlife conservation and welfare, and to human health and welfare, particularly where these changes are driven by anthropogenic forces.

EMERGENCE OF A NOVEL AVIAN POX DISEASE IN BRITISH TIT SPECIES

While emerging infectious diseases are often caused by novel agents, known pathogens in new host species or new locations may also have a dramatic effect. Reports of garden bird morbidity and mortality have been collected by the Garden Bird Health initiative, a research programme co-ordinated by IoZ to investigate causes of mortality in British garden birds since 2005.

Avian pox is a viral disease of birds with a wide host range and is considered endemic in a range of non-Paridae hosts in Britain. Avian pox in Paridae species (birds of the tit family) was first diagnosed in a great tit (Parus major) from south-east England with severe skin lesions in 2006, further to which the spatial and temporal patterns of avian pox in all species were analysed between 2006-2011. Results showed several Paridae species to be susceptible to Paridae pox. However, the majority of incidents involved great tits, with multiple individuals affected. There was an annual seasonal peak of reports in late summer, likely driven by environmental and demographic factors. Virus sequencing produced a single sequence from each of the 30 great tits tested from reports in late summer, likely driven by environmental and demographic factors.

In contrast, sequence variation was evident among virus samples tested from multiple non-Paridae hosts. Our findings show Paridae pox to be an emerging infectious disease in wild birds in Britain, possibly originating from viral incursion from Central Europe or Fennoscandia. Ring recovery data does not support great tit migration as a likely route of viral spread; instead vector movement, perhaps via a wind-borne spread of mosquitoes, offers a more likely explanation for the method of incursion. Spatial spread of Paridae pox from its origin in the south-east was observed, and in 2009 the disease was first observed at a site in Oxfordshire where wild tit populations have been studied for several decades. Monitoring the disease in this study showed that, while Paridae pox is not invariably fatal, it can cause a significant reduction in host survival. Particularly large effects were observed for juvenile survival. These results also showed that significant population decline due to the emergence of Paridae pox in Britain is likely. Indeed, national monitoring of the great tit has revealed no evidence of population decline to date.

WHAT CAUSED THE UK’S LARGEST COMMON DOLPHIN MASS STRANDING EVENT?

On 9 June 2008, the UK’s largest mass stranding event of short-beaked common dolphins (Delphinus delphis) occurred in Falmouth Bay, Cornwall. At least 26 dolphins died and a similar number were refloated or herded back to sea. IoZ scientists led by Paul Jepson and Rob Deaville of the UK cetacean strandings investigation programme (CSIP) led the subsequent Defra-funded investigation. All dolphins examined were in good nutritive status and had no evidence of infectious or non-infectious disease, physical injury or exposure to chemical or biological toxins. A range of potential causes were therefore systematically excluded.

The investigation concluded that international naval exercises in very close proximity were the most probable cause of the mass stranding event via a mechanism involving profound behavioural disturbance to the dolphin group. This was the first dolphin mass stranding event globally to be causally linked to naval activities. The investigation led to revisions to environmental mitigation of Royal Navy activities, including a direct role for CSIP scientists in the early reporting of near-shore groups of pelagic cetaceans directly to Royal Naval Command. The UK government (Defra, Ministry of Defence) also established the Marine underwater sound stakeholders Forum to discuss the environmental mitigation of naval activities, which was later subsumed into the underwater sound stakeholders forum with input from the oil and gas industry.

The increasing emergence from wildlife of new infectious diseases that are zoonotic (ie infect people) is a recognised phenomenon. Often, the reaction of public health or other governmental authorities to such zoonotic outbreaks is to kill, or otherwise remove, the wildlife source. However, a better understanding of the mechanisms leading to such disease spill-over events might lead to improved methods of control that protect both public health and wildlife. Several zoonotic diseases, including Ebola, Marburg, SARS, Hendra, Nipah and several rabies-like diseases, have arisen from bats over recent years, and we have used the African straw-coloured fruit bat (Eidolon helvum) in Ghana as a model to investigate disease spill-over from bats to people. *E. helvum* is widely distributed throughout Africa, lives in close proximity to humans and is commonly eaten as bush meat.

We used next-generation sequencing to characterise the viruses carried by *E. helvum*, and identified a previously unknown adenovirus, as well as an abundance of novel herpes viruses and papillomaviruses. We also detected, for the first time, sequences of a chiropteran poxvirus, which is closely related to the virus that causes the human disease molluscum contagiosum. The presence of bat viruses genetically similar to known human pathogens highlights the possibility of zoonotic transmission.

Previously, *E. helvum* has been shown to harbour a great diversity of paramyxoviruses. This is of particular interest because several bat paramyxoviruses are known to cause often-lethal disease in people. Our continued investigations into the paramyxoviruses of *E. helvum* led to the isolation and characterisation of two novel paramyxoviruses within the *Rubulavirus* genus, which we named Achimota virus 1 (AchPV1) and Achimota virus 2 (AchPV2). We developed specific assays for the detection of antibodies to these viruses, and found evidence that both viruses infect *E. helvum* throughout its range across sub-Saharan Africa. We also detected serological evidence of apparent human infection with AchPV2. Although no reports of associated disease were obtained, it is likely that clinically significant infection with bat paramyxoviruses could be missed throughout much of Africa, where health surveillance and diagnostics are poor.

It has been hypothesised that healthy, intact ecosystems protect against zoonotic disease emergence from wildlife, but interactions between ecosystem and human health in this context are poorly understood, partly because they encompass a wide range of social, economic and ecological factors. We therefore developed a novel framework incorporating both the natural and social sciences for the holistic investigation of zoonotic disease emergence from wildlife, using the spill-over of bat pathogens as a case study. This framework will enable a detailed interdisciplinary understanding of the mechanisms underlying disease emergence, thus informing policy for the improvement of both public health and wildlife conservation.

Opposite: a great tit with avian pox. Below left: some of the 26 dolphins that died in a mass stranding event in 2008. Below right: the African straw-coloured fruit bat has been used as a model to investigate zoonotic diseases.

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Indicators and Assessments Unit

The Indicators and Assessments Unit is a joint IoZ and Conservation Programmes initiative to monitor global biodiversity, and comprises around 20 staff and students.

Global environmental agreements such as the Convention on Biological Diversity (CBD) have set stringent goals for biodiversity conservation. Scientifically robust biodiversity indicators are required to track progress towards these goals and define the status and trends of biodiversity; the Indicators and Assessments Unit (IAU) was formed in 2006 for this purpose. This year, work has expanded to build an understanding of wildlife population dynamics in the Arctic, develop new methods for forecasting the effect of changes in environmental policy on wildlife, and understand how robust our comprehension of invertebrate biodiversity patterns is in the context of data uncertainty. Many of the projects are providing science to inform global biodiversity policy for the CBD 2020 strategic plan.

The importance and conservation status of some of the world’s most fascinating, and often overlooked, species groups were the focus of two studies led by the IAU this year. The IUCN’s Red List of Threatened Species is a tool for assessing the extinction risk of a species, but there has naturally been a predisposition towards well-studied, large-bodied and commercially important taxa for the selection of species groups to be assessed.

To gain a greater understanding of the status of global biodiversity, the conservation status of a sample of 1,500 reptile species and more than 12,000 species of invertebrates was reviewed. Surprisingly, these groups are under similar levels of extinction risk to other vertebrates and plants, where one fifth of species were assessed as threatened. However, the principal threats vary according to habitat and species.

The study on reptiles used research and knowledge from more than 200 experts around the world to make the assessments. We found that increasing rates of habitat loss are the primary threat to terrestrial reptile species, and that freshwater turtles have a particularly high risk of extinction, suffering from over-harvesting, illegal trade and pollution. Future research aims to establish trends in reptile extinction, pinpointing threats to these species, which, as both predator and prey, play a vital role in the functioning of the world’s ecosystems and are sensitive indicators of ecosystem health.

The results of our second study were published in Spineless, the most comprehensive assessment of the world’s invertebrates to date. While reacquainting the conservation community with the staggering diversity of invertebrates, from microscopic zooplankton to giant squid, we were also able to highlight some of the major threats to these species. The prevailing threat to freshwater invertebrates is pollution, whereas for terrestrial species it is habitat loss. These studies establish a baseline conservation assessment against which future changes in the status of these species groups can be tracked, and measures to tackle the major threats addressed.
NEW FRAMEWORKS FOR DETECTING POPULATION DECLINES AND SPECIES RECOVERY

One of the major challenges in conservation biology is to tackle biodiversity loss in time to reverse the downward trend before species extinction becomes inevitable. Abundance trends in wildlife populations can be a sensitive measure for gauging biodiversity change; population responses to anthropogenic pressure can be noticed relatively quickly in comparison to other metrics such as geographic range change. One of the greatest barriers to deciding whether and when to intervene with conservation measures is distinguishing real declines from natural population fluctuations. As part of her PhD thesis, Martina Di Fonzo developed a method to detect threat types according to the shape of the decline curve of 124 population time series and the algebraic function used to model the data. The results revealed that broad threat types could be attributed according to the decline curve, and also that any increase in pressure over time could be identified – a finding that could be used to prioritise conservation action for populations most under pressure.

Detecting the potential of species recovery is just as important as identifying populations in decline in informing appropriate conservation measures. To date, most studies of recovery have been species, population or site-specific, and a broad-scale analysis of this process has been lacking. Using a multi-species meta-analysis, a research framework was developed by a collaboration including Ben Collen from the IAU to identify ‘red flags’ that warn of impairment to the recovery of a species. If recovery potential can be predicted at an early stage, this can influence the decisions taken to initiate conservation efforts.

VULNERABLE ECOSYSTEMS

In the context of limited resources, prioritisation is essential to ensure that conservation efforts are allocated wisely. One important consideration is to establish what the main threats to biodiversity are, where they occur and whether certain species or ecosystems are particularly under pressure. The Living Planet Report 2012 revealed that freshwater vertebrates showed the greatest decline in population sizes compared to their terrestrial and marine counterparts, and most critically in tropical regions. In a new study, which used the extinction risk from the IUCN Red List of Threatened Species as the monitoring tool, six groups of freshwater species (both vertebrates and invertebrates) were found to be at a consistently higher risk of extinction than their terrestrial counterparts. In addition, using geographical range data, we were able to look at the congruence of species richness, the richness of threatened species and endemism between these freshwater groups. A lack of congruence between these diversity measures was found, which suggests that when conservation decisions are being made, both the metric of biodiversity and the taxa in question are important considerations.

Climate change is one of the threats to biodiversity that is currently of great concern, largely because the effects are as yet unknown but also because the visible signs, such as a reduction in sea ice extent in the Arctic, are happening at an increasingly rapid rate. The IAU has been collaborating with the Conservation of Arctic Flora and Fauna since 2009 to monitor biodiversity change in the Arctic, a region particularly vulnerable to predicted changes in climate. A culmination of this research yielded almost 900 population time series for more than a third of all known Arctic vertebrate species. Using trends in population size can provide a sensitive indicator of how species are faring in the face of environmental change. The results revealed a mixed picture of trends, with population declines observed among High Arctic species and particularly in some populations dependent on sea ice. The next steps are to target the taxonomic and regional data gaps that were identified in the current monitoring network to gain a more thorough understanding of how biodiversity is changing in the Arctic.
Conservation Programmes

Research carried out at IoZ focuses on scientific issues relevant to the conservation of species and their habitats. This work directly supports ZSL’s field conservation programmes in more than 50 countries. The combination of applied and pure research means that we are engaged in and can inform conservation policy and practice at all levels.

CONSERVATION TECHNOLOGY

Advances in technology are transforming the field of wildlife conservation, changing the ways we monitor species, manage protected areas and involve the public in our work. ZSL is developing creative technological tools, ranging from advanced camera traps to law-enforcement software. Innovative tracking devices relay data on species in remote habitats, which can now be monitored via satellites.

ZSL’s potential was recognised in 2013 with a Google Global Impact Award. This award – voted for by the public – will enable us to develop new tools, including Instant Wild 2.0, a second-generation camera that will relay images via satellite, enabling use even in remote, forested areas.

Our first success in using technology to stop the poaching of endangered species came in the Russian Far East in late 2012. Special camera traps in our ‘Forest Eyes’ Amur tiger project relayed pictures of poachers entering Lazovsky Nature Reserve directly to the smartphones of park staff, enabling an instant response and the arrest of four intruders. Meanwhile, our camera traps in Sembilan National Park on the Indonesian island of Sumatra captured pictures of tiger cubs: evidence of tiger breeding in the area.

The successful implementation of any new tool hinges on effective monitoring and evaluation of management practices. SMART – the Spatial Monitoring and Reporting Tool – is a free computer programme that helps protected-area managers improve their practices and assists them in tackling poaching and other illegal activities. ZSL is a founding member of the SMART partnership and we are committed to training our staff, and those in partner organisations, in its use. To date we have carried out SMART training in Cameroon, Kenya and Indonesia.

STATE OF THE PLANET

The Indicators and Assessments Unit (see page 16) has built up a global reputation as a leader in monitoring species and ecosystems throughout the world. By 2026 we aim to have defined and monitored the status of at least 20,000 species. In the past year we have made significant progress towards this goal, with scientists from across ZSL and partner organisations coming together to publish several groundbreaking reports.

The book Priceless or Worthless identified the 100 most threatened species in the world and Spineless reported on the most comprehensive assessment to date of the status of the world’s invertebrates (see page 16 for more details). Both were launched at the International Union for Conservation of Nature (IUCN) World Conservation Congress and garnered impressive global media coverage, both for ZSL and to publicise the need for more species-focused conservation.

In early 2013, ZSL continued to study underrepresented species by publishing an assessment of the global extinction risk for reptiles. We also published the first global assessment of centres of Evolutionary Distinctiveness and Globally Endangered species – EDGE zones. The resulting maps will be used to inform the spatial prioritisation of our conservation work. Finally, publication of the IUCN Red List of mammals in Nepal and the Red List of birds of Mongolia will be invaluable in informing conservation action plans for the most threatened species in these countries.

VISIT THE SITE

Learn more about our work at www.zsl.org/conservation
**NATURE’S SECURITY SYSTEMS**

Made from material also used in carpet tiles, discarded nylon fishing nets can persist for centuries, wreaking havoc in the marine environment. In Danajon Bank in the Philippines, for example, nets totalling around 400 times the length of the coral reef are discarded annually, covering beaches and coral reefs, continually trapping and killing marine life.

Net-Works – an innovative collaboration between ZSL and the carpet manufacturer Interface – is successfully tackling this issue by establishing community-based collections of discarded fishing nets that are then converted into recycled nylon yarn for use in carpets. Since August 2012, the programme has collected 12,000kg of discarded fishing nets, transforming the beaches and ocean floor of the Danajon Bank. The sale of these nets provides a sustainable source of revenue for residents in the area while also cleaning up the marine ecosystem that provides their main income. This successful pilot will be replicated in other countries and a scoping visit to Mozambique has already taken place.

**TOP PREDATORS AND MEGAPARKS**

Following a highly successful launch in 2011, 2013 saw the return of Project Ocean to Selfridges. This year’s event focused on sharks, with the department store undertaking an extensive audit to remove all products containing shark oil from its beauty and health lines. Selfridges worked with ZSL and the Marine Reserves Coalition to highlight the diversity and plight of these much-maligned species with unique art installations, imagery and a pop-up shark exhibition in its London store.

The event also kick-started a brand new Project Ocean initiative, ‘Shark Parks’, which will use the amazing diversity and charismatic nature of sharks to advance ocean conservation through the establishment of new marine protected areas.

To date, six candidate shark parks have been identified, including the Galapagos Islands in the Pacific, Sudan in the Red Sea and the Sahara Seamounts in the Atlantic, and ZSL is now working with partners around the world to take the initiative forward.

Next generation conservation leaders

ZSL is committed to developing and supporting the next generation of conservation leaders – wherever they may be found. Since 2007, 35 young conservationists have passed through our flagship EDGE Fellows programme, receiving training in technical scientific methods, as well as instruction on approaches to project management and fundraising. In 2012, we brought 13 early-career conservationists working on mammal, amphibian and coral EDGE species, including five Kenyan participants, to the Coast Province of Kenya for four weeks of training in the design, execution and management of conservation projects. This included carrying out locally relevant fieldwork, for example, surveying the waters of Kisite Mpunguti Marine Park for EDGE corals. Eight participants were awarded EDGE Fellowships and ZSL will continue to support them over the next two years while they spearhead action for some of the most neglected EDGE species.

2012 also saw 12 Chagossian trainees graduate from our first Chagos Environment Training Course – an intensive nine-weekend course through which the group explored elements of marine and terrestrial ecology and conservation communication. One trainee was also awarded a place on our scientific expedition to Chagos in early 2013. Finally, through our annual field course in Mongolia we provided 20 students (both international and Mongolian) with training in conservation biology and ecological census techniques.
Communicating Science

A major part of IoZ’s work is facilitating the communication of science among researchers and professional zoologists, and to the public. We achieve this through a varied programme of meetings and the publication of scientific journals and books.

SCIENCE AND CONSERVATION EVENTS

SYMPOSIA

ZSL’s symposia bring together teams of international experts to discuss important topics in conservation science, providing an opportunity for leaders to exchange ideas on best practice and communicate their research. The November symposium ‘Protected Areas: are they safeguarding biodiversity?’ reviewed the extent to which the world’s protected areas are effectively conserving species, ecosystems and ecosystem services, and identified new tools and technologies that are necessary to ensure effective biodiversity preservation within the global protected-area network.

Our May symposium, ‘New technologies for monitoring biodiversity’, described the ways in which advances in technology are contributing to the surveillance of wildlife – for example, by using autonomous sensors to gather information at larger scales, over longer periods and in more inaccessible places. An international team of experts discussed the application of satellite, aerial, ground-based and underwater technologies, and considered the challenges of designing smaller, stronger, cheaper, more sensitive and more flexible sensors for biodiversity monitoring.

SCIENCE AND CONSERVATION EVENTS

ZSL’s popular Science and Conservation Events lecture series 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: ‘The small things that rule the world: conserving the world’s invertebrates’; ‘Saving the tiger: innovation, tradition or both?’; ‘Can the food security agenda and the conservation agenda be reconciled?’; ‘Deserts: a neglected ecosystem’; and ‘Invasive species: one of the four horsemen of our apocalypse’.

A collaborative event with the Wellcome Collection, ‘Surviving the century: a key species debate’, was held in November.

SCIENCE FOR CONSERVATION SEMINAR SERIES

This series provides the IoZ’s staff and students with the opportunity to learn more about the work of visiting researchers, collaborators and invited speakers. A range of subjects was covered during the year, including: ‘Biodiversity research in Indonesia: marrying science with practical conservation’; ‘Monkey see, which monkey do? Personality and social learning in wild baboons’; ‘Pathways to fitness: what is the link between signal expression and quality in sexually selected animals?’; and ‘Islands, conservation and research: lessons from 40 years of species translocations in New Zealand’.

OUR EVENTS PROGRAMME

Please see www.zsl.org/science/events for our current programme of events.
The 2013 Stamford Raffles Lecture was given by Sir Brian Hoskins FRS, Director of the Grantham Institute for Climate Change, at Imperial College London. ‘A very dangerous experiment with our planet’ described the scientific basis for the concern over climate change and reviewed observational evidence for the changes currently taking place. The likely implications of climate change, for both the natural world and the human species, were also explored. Visit www.zslsites.org/lectures/stamfordraffles2013 to view the lecture online.

Opposite: ZSL’s symposia reviewed the potential of protected areas to conserve biodiversity. Above: ‘Deserts: a neglected ecosystem’ was a recent lecture topic. Left: the 2013 Stamford Raffles Lecture was given by Sir Brian Hoskins FRS

Conservation Science and Practice book series
Books in the Wiley-Blackwell/ZSL Conservation Science and Practice series aim to address the multidisciplinary aspects of conservation by looking at how biological scientists and ecologists are interacting with social scientists to effect long-term, sustainable conservation measures. Titles published this year include: Biodiversity Monitoring and Conservation: Bridging the Gap Between Global Commitment and Local Action, edited by Ben Collier, Nathalie Pettorelli, Jonathan Baille and Sarah Durant; and Biodiversity Conservation and Poverty Alleviation: Exploring the Evidence for a Link, edited by Dilyes Roe, Joanna Elliott, Chris Sandbrook and Matt Walpole.

PUBLICATIONS

Journal of Zoology
Published monthly, the Journal includes hypothesis-driven studies that advance our knowledge of animals and their systems. The 2013 Thomas Henry Huxley Review, ‘Social competition and its consequences in female mammals’ by Tim Clutton-Brock and Elise Huchard, was published in March. A virtual issue to celebrate Alfred Russel Wallace, including contributions from proceedings of ZSL, is available via the Journal homepage. Three further episodes of the popular Journal of Zoology podcast can also be downloaded from the homepage – visit www.zsl.org/science/publications.

Animal Conservation
Animal Conservation provides a forum for rapid publication of novel research into the conservation of animal species and their habitats. Feature papers and commentaries, published in each issue, continue to be well received. A themed virtual issue on protected areas is available via the Journal homepage.

International Zoo Yearbook
Volume 47 of the International Zoo Yearbook adds to its reputation as an invaluable resource for researchers, students and animal managers. The focus of the current volume is freshwater fishes and their conservation, guest-edited by Gordon McGregor Reid, director emeritus, North of England Zoological Society (Chester Zoo). The biodiversity of freshwater fish and the valuable ecosystem services they provide are reported on, and descriptions are given of the co-ordinated action being undertaken to conserve freshwater-fish species from habitat modification, overfishing, pollution, the introduction of alien species and climate change.

Animal Conservation sponsored the student poster competition at the International Congress for Conservation Biology conference in Maryland, USA. First prize was awarded to Hilton Oyamaguchi for his poster ‘Importance of the Amazon-Cerrado gradient in preserving adaptive variation in a changing world’.

International Zoo Yearbook
Volume 47 of the International Zoo Yearbook adds to its reputation as an invaluable resource for researchers, students and animal managers. The focus of the current volume is freshwater fishes and their conservation, guest-edited by Gordon McGregor Reid, director emeritus, North of England Zoological Society (Chester Zoo). The biodiversity of freshwater fish and the valuable ecosystem services they provide are reported on, and descriptions are given of the co-ordinated action being undertaken to conserve freshwater-fish species from habitat modification, overfishing, pollution, the introduction of alien species and climate change.
ZSL Scientific Awards 2012

ZSL recognises outstanding achievements in conservation and zoological research through its annual presentation of awards and prizes. In 2012, the following awards were presented:

**ZSL Frink Award**
Presented to a professional scientist for substantial and original contributions to zoology. Awarded to: Georgina Mace FRS, University College London, for the development of pioneering approaches to advance research in population biology and biodiversity conservation.

**ZSL Scientific Medal**
Presented to research scientists with no more than 15 years postdoctoral experience for distinguished work in zoology. Awarded to: Jane Reid, University of Aberdeen, for significant contributions to our understanding of evolutionary ecology and conservation biology, and Jason Wolf, University of Bath, for influential research on evolutionary genetics.

**ZSL Silver Medal**
For contributions to the understanding and appreciation of zoology, including such activities as higher and public education in natural history and wildlife conservation. Awarded to: Helen Roy, Centre for Ecology and Hydrology, for significant contributions to the scientific understanding and appreciation of ladybird ecology and conservation.

**ZSL Stamford Raffles Award**
Presented for distinguished contributions by amateur zoologists. Awarded to: Stephen Petty, for significant long-term monitoring and data collection that has contributed to our understanding of the ecology of tawny owl populations, their vole prey and other raptors.

**Marsh Award for Conservation Biology**
For contributions to fundamental science and its application to the conservation of animal species and habitats. Awarded to: Dave Goulson, University of Sussex, for significant contributions to our understanding of bumblebee biology, ecology and conservation.

**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: Alex Rogers, University of Oxford, for outstanding contributions to deep-sea ecology, biology and conservation.

**Thomson Reuters Zoological Record Award**
Presented for the communication of zoology. Awarded to: David Littschwager for his book *A World In One Cubic Foot*.

**ZSL Thomas Henry Huxley Award and Marsh Prize**
Presented for the best zoological doctoral thesis produced in the UK. Awarded to: Mary Caswell Stoddard, University of Cambridge, for her thesis ‘The evolution of colour, pattern and structure in avian eggs’.

**ZSL Charles Darwin Award and Marsh Prize**
Presented for the best zoological project by an undergraduate student attending a university in the UK. Awarded to: Katrina Spensley, University of Oxford, for her project ‘Population structure of the malarial protein Plasmodium falciparum Apical Membrane Antigen 1’.

**ZSL Prince Philip Award and Marsh Prize**
Awarded to an A-level (or Higher) student for the best zoological project involving some aspect of animal biology. Awarded to: Emily Seccombe, Brighton College, for her project ‘An investigation into the accuracy of the Habitat Suitability Index as an indicator of great crested newt (Triturus cristatus) populations’.

**ZSL Award for Outstanding Contributions to the Zoo Community**
Awarded to: Gordon McGregor Reid, former director general and chief executive of Chester Zoo, who stepped down in 2010 after 18 years at the zoo and 15 years at the helm.

**ZSL Honorary Fellowship**
Awarded to persons who, by their association with ZSL, have promoted the objectives of ZSL. Awarded to: Desmond Morris, world-renowned zoologist, author and artist.

**ZSL Staff Medal**
Presented for outstanding service and contributions to ZSL over an extended period of time. Awarded to: Ian Meyrick, Director of Human Resources.

ZSL thanks the Marsh Christian Trust and Thomson Reuters for their generous support of the awards programme.
The ZSL Library

During 2012 more than 3,100 book titles were added to our online catalogue, 2,363 journal issues accessioned and 2,124 loans were made to ZSL staff and Fellows, while the ZSL Library online catalogue at library.zsl.org was used 11,300 times.

The ZSL Library manages, develops and facilitates access to a relevant and useful body of zoological and conservation knowledge, and inspires interest in animals, habitats and conservation to a wide audience. A key element of this is the development of the ZSL online catalogue (http://library.zsl.org), which acts as a portal to aid access and discovery of a range of resources. The new-look online catalogue was launched in April and includes details of more than 37,000 books, serial holdings, ZSL's Archives, artworks and links to relevant online resources. Over the past year, Alfred Russel Wallace books have been added to the online catalogue in preparation of our Wallace centenary celebrations, while a special collection of books on climate change is being added to the Library and the catalogue.

IN THE PUBLIC EYE

The Public Catalogue Foundation has catalogued and photographed oil paintings in our collection. These appear on the Your Paintings website www.bbc.co.uk/arts/yourpaintings.

Major donations included copies of zoo-related magazines and newsletters presented by International Zoo News. The family of the late Bernard Owens kindly donated a ZSL Silver Medal and a Queen Victoria Golden Jubilee Medal. The ZSL Silver Medal had been presented to His Highness Nripendra Narayan Bhup, in Acknowledgement of Valuable Donations to the Society in 1887. The medals were purchased in 1989 by Bernard Owens, a ZSL Fellow and former ZSL Council member.

There has been continued interest in the manuscripts of Brian Houghton Hodgson. The mammal drawings were used in The status of Nepal’s mammals: the national Red List series, compiled by SR Jnawali et al and published by WWF. The bird paintings have been photographed for The status of Nepal’s birds, which will be published in 2013.

The Royal Society borrowed three items illustrated by Edward Lear for their exhibition Edward Lear and the Scientists, held to celebrate the bicentenary of his birth. The BBC also made a slideshow of the exhibition featuring an original painting from our collection at www.bbc.co.uk/news/science-environment-19409112.

Above: the family of the late Bernard Owens donated this ZSL Silver Medal, previously owned by an Indian Maharajah. Top of page: the ZSL Library. Right: recent acquisitions include wildlife watercolours by artist and naturalist Charles Hamilton Smith, among them this painting of two South American cats.

AT THE LIBRARY

Displays in the Reception and Reading Room included a historic collection of materials to show how ZSL’s housing for big cats has developed since the Zoo’s inception. This feature was chosen to celebrate the imminent opening of Tiger Territory at ZSL London Zoo. The display in the Reading Room Gallery also featured the Fish House, the first public aquarium, celebrating 160 years since it first opened its doors in May 1863.

A special Library tour for Fellows was held during March to celebrate the contribution of women to the history and development of zoology. Tours for external groups have included the Bartlett Zoo History Society, the London Appreciation Society, Sparsholt College, artists from the Zoo-topia project, which is a collaboration between ZSL, the Royal College of Art, The Hungarian Cultural Centre and the British Council.

Numerous items from the Archives and Special Collections were consulted, including the letters of Dr John Anderson of the Indian Museum, drawings by PJ Smit, manuscripts of Brian Houghton Hodgson, the history of Zoological Record, historic images of dolphins and sea monsters dating back to the 16th century, 19th-century letters of the Rothschild family and information on Kenneth Martin, creator of the mobile suspended in the ZSL Meeting Rooms.

During May our team of Wednesday Library volunteers completed the rehousing of the negatives in our historic photograph collections; an estimated 20,000 images! The negatives are now in conservation-quality storage.

Our Artefact of the Month series is available on the ZSL website (www.zsl.org/about-us/library and click on Artefact of the Month). In August we featured The Coulton Portfolio, which consists of 55 mainly watercolour drawings of vertebrate animals from the collection of Charles Hamilton Smith (1776-1859). The portfolio was presented by ZSL’s former secretary, Professor R McNeill Alexander, in 2012.

We are 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.
Education and training are central to IoZ’s activities and we have a strong commitment to hosting research projects, particularly those leading to a PhD degree.

CONSERVATION SCIENCE MSc COURSE

The MSc course in conservation science, run in partnership with Imperial College London, the Royal Botanic Gardens Kew and Durrell Wildlife Conservation Trust, is becoming increasingly popular with those strongly focused on starting or enhancing their career in conservation research or action. As such, it continues to attract good numbers of high-quality applicants from the UK, Europe and further afield. In 2012, 35 students graduated. Heather Gurd received the Thomas Henry Huxley award for best overall grade, Katherine Sainsbury received the Joseph Hooker Award for best coursework grade, and Lia Vieira da Silva received the Gerald Durrell Award for the best project, with her study evaluating the ecosystem services of the Steart Peninsula in Somerset. The project carried out by students on the course is a substantial piece of research, and a critical element of their studies. Three-quarters of the projects involved an element of fieldwork in 2012, mostly overseas, and were carried out in 17 different countries across Europe, Asia, Africa and Latin America. Several of these projects are now in the process of being published.

WILD ANIMAL HEALTH AND WILD ANIMAL BIOLOGY MSc COURSES

In 2012, 22 students graduated from the MSc courses in wild animal health and wild animal biology. Victoria Franks received the award for the MScWAB student with the highest aggregate marks and Natalie Reinhart received the prize for the best MScWAB research project for her work on ‘An assessment of killer whale (Orcinus orca) rake mark occurrence in the Eastern Canada-West Greenland bowhead whale (Balaena mysticetus) population’.

Toni Dalziel was a double prize-winner for the MScWAH, as the student with the highest aggregate marks and the best MScWAH research project for her work on ‘Relocation, Relocation – DRAs to DRA-ts: disease risk analysis for selected parasites in hihi (Notiomystis cincta) translocations.’ The 329 graduates of these two courses (from 54 countries, 25 of which are developing) working in wild animal health and conservation are in contact with ZSL through our alumni association, Wild Animal Alumni. Our graduates continue to take up important positions in conservation medicine and wildlife health; for example, Rodrigo Cunha Serra is now director of the Centro Nacional de Reprodução de Lince Ibérico and Jörg Mayer is associate professor of Zoological Medicine at the University of Georgia College of Veterinary Medicine.

The curriculum structure of both MSc courses has been amended so that a certificate, a diploma or a full MSc degree can be awarded in line with the European Credit Transfer and Accumulation System.

PhD STUDENTS

Our PhD students are co-registered at a university department, but most spend the majority of their time at the IoZ. In the 2012-2013 academic year, PhDs were awarded to Alénor Chauvenet (Imperial College London) for her research on the dynamics of translocated populations; Johanna Nielsen (University of Edinburgh) for her study on the evolutionary genetics of meerkats (Suricata suricatta); Kate Baker (University of Cambridge) for her investigation into the African straw-coloured fruit bat (Eidolon helvum) as a reservoir host for viral zoonoses; Harry Marshall (Imperial College London) for his study of social foraging behaviour in a varying environment; Paddy Brock (University of Leeds) for his research on immunity, life history and conservation in Galápagos sea lions (Zalophus wollebaeki); Martina Di Fonzo (Imperial College London) for her examination of extinction risk and causation from population trends in vertebrates; Aisyah Faruk (Queen Mary University of London) for her evaluation of the effect of oil-palm plantations on tropical amphibians; Eric Islai Ameca y Juárez (Imperial College London) for his research into natural population die-offs as lessons for conservation; and Fay Clark (Royal Veterinary College) for her study on cognitive challenge as a means to enhance the psychological wellbeing of large-brained mammals in zoos.
People and projects

Find funding information and full details of our collaborations, publications and staff positions in this section.

26 FUNDING
27 COLLABORATIONS
32 STAFF REPRESENTATION
33 PUBLICATIONS
38 GOVERNANCE AND STAFF

Our scientific research is directly influencing conservation teamwork on the ground.
In 2012 we received our annual core income from the Higher Education Funding Council for England via University College London, while 55% of our income came from other sources. In total, 27 new grants were received during the year.

**AMPHIBIAN CHYTRIDIOMYCOSIS**

Trenton Garner has received funding from the National Environment Research Council for the project ‘The spatial epidemiology and molecular evolution of panzootic amphibian chytridiomycosis’. Currently, several lines of argument suggest the pandemic form of *Batrachochytrium dendrobatidis* (Bd) evolved in Africa. The IoZ and Imperial College London, in collaboration with Consejo Superior de Investigaciones Científicas (Spain), University of Zurich (Switzerland), North-West University (South Africa), the Natural History Museum, University College London and the Natural History Museum (all UK) and the University of Copenhagen (Denmark), will investigate this ‘Bd out-of-Africa’ hypothesis by sequencing the genomes of Bd isolates from across Africa and Europe, and undertaking fine-scale studies of pathogen impact where it has been introduced into new environments. The researchers will twin these genomic approaches with experimental approaches to determine whether invasive ‘outbreak’ lineages have altered their virulence and infectivity owing to accelerated evolution by the action of natural selection. The expectation is that outbreak lineages that are adapting to new environments and hosts will have increased virulence and transmission rates when compared with the ancestral lineage in its original geographic background.

**GARDEN WILDLIFE HEALTH**

Andrew Cunningham and Becki Lawson have received funding from the Esmée Fairbairn Foundation and the Department for Environment, Food & Rural Affairs for the project Garden Wildlife Health. As landscape change continues in Great Britain, gardens are becoming an increasingly important refuge for many wildlife species. Launched in 2013, Garden Wildlife Health is a collaborative project between IoZ, the British Trust for Ornithology, Froglife and the Royal Society for the Protection of Birds. The project aims to monitor the health of, and identify infectious and non-infectious disease threats to, British garden wildlife, with particular focus on garden birds, amphibians, reptiles and hedgehogs. This research builds on the success of the long-running Frog Mortality Project and Garden Bird Health initiative, which IoZ has helped co-ordinate for many years. Garden Wildlife Health relies on the help of the public to submit reports of sick or dead garden wildlife at www.gardenwildlifehealth.org and to submit samples for analysis. Disease surveillance will be integrated with population monitoring, so that we can determine whether diseases are having an effect at the population level and are therefore of potential conservation concern. Findings will be used to offer best-practice advice to optimise garden management and safeguard wildlife health.
Collaborations

IoZ’s work is carried out in conjunction with a host of international collaborators and partners to whom we extend our thanks.

Adelphi University (USA) IUCN Sampled Red List Index
Adrian Menderes University (Turkey) IUCN Sampled Red List Index
African Technology Policy Stu...
Staff representation

IoZ staff play a significant role within a wide range of professional organisations and are involved in some leading scientific and conservation publications.

PROFESSIONAL AFFILIATIONS

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Trent Garner (Member)

Animal Health Information
Specialists Association (Meland)
Ann Slyth (Member)

Ape Alliance
Juliet Wright (Chair, Bushmeat Working Group)

Bat Conservation Trust, UK
Kate Jones (Trustee)

Biodiversity Indicators
Partnership
Louise McRae (Partner)

Board of Studies (Wildlife)
of Kerala Veterinary Animal Science
Anthony Sainsbury (Honorary Senior Lecturer)

British Ecological Society
Jon Belby (Member; Tim Blackburn (Council Member),
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David Curnick (Member), Tammy Davies (Member),
Ellie Dyer (Member), Member, Macroecology Special Interest Group), Trent Garner (Member),
Kirsty Kemp (Member), Nathalie Pettorelli (Member)

British Herpetological Society
Frances Clare (Member)

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Kate Beckett (Member; Andrew Cunningham (Member)
Bushmeat Working Group
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Kate Jones (Member, Steering Committee)

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Department for Environment, Food and Rural Affairs

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Paul Jepson (Member, CSP Project Steering Group)

European College of Zoological Medicine
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Paul Jepson (Diplomat, Wildlife Population Health),
Anthony Sainsbury (Member)

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Trent Garner (Member)

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Trent Garner (Member)

Hhi Recovery Group
Patricia Brekke (Member)

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Trent Garner (Honorary Research Fellow)

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Andrew Cunningham (Committee Member)

International Council for the Exploration of the Sea
Paul Jepson (Member, Working Group on Marine Mammal Ecology)

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Paul Jepson (Member, Wildlife Health Specialist Group; Member, Cetacea Specialist Group),
Kate Jones (Member, Chiroptera Specialist Group),
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Anthony Sainsbury (Member, Wildlife Health Specialist Group),
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Rose Woodroffe (Member, Core Member, Co-ordinator, African Wild Dog Working Group, Member, Canid Specialist Group, Member, Wildlife Health Specialist Group)

Keny Wildlife Service
Rose Woodroffe (Member),
Steering Group on Conservation and Management of Large Carnivores)

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Tim Blackburn (Member, Distinguished Scientist Fellowship Scheme)

Laurentian University
Trent Garner (Adjunct Professor)

London Biology Librarians Group
Anny Slyth (Member)

London Invasive Species Initiative
Ellie Dyer (Committee Member)

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and Professional Societies
Librarians’ Group
Michael Palmer (Member)

Nature Conservation Trust, South Africa
Sarah Duzant (Trustee)

New Zealand Department of Conservation
John Ewen (Co-chair, Hhi Recovery Group)

Office International des Epizooties
Andrew Cunningham (Member, Ad hoc Group on Amphibian Diseases)

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Juliet Wright (Member)

Rainforest Life
Ben Collen (Member, Environmental Advisory Committee)

Student Conference on Conservation Science
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Ben Collen (Honorary Fellow, Lead Author, Global Environmental Outlook)

University College London
Tim Blackburn (Honorary Professor),
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Veterinary Research Club
Becki Lawson (Council Member, Wildlife and Wetlands Trust)

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Working Dogs for Conservation
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World Congress of Herpetology

Trent Garner (Member, Environmental Advisory Committee)

Zebra Foundation for Veterinary Zoological Education
Becki Lawson (Council Member)

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Jon Belby (Member),

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EDITORIAL POSITIONS

Animal Conservation
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Trent Garner (Editor), Nathalie Pettorelli (Editor)

Computational and Mathematical Methods in Medicine
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Diseases of Aquatic Organisms
Andrew Cunningham (Editor)

Ecology
Andrew Cunningham (Member, Editorial Board)

Ecological Applications
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Emu: Austral Ornithology
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Endangered Species Research
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European Journal of Wildlife Research
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Neobiota
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Scientific Reports
Andrew Cunningham (Editor)

Tropical Conservation Science
Ben Collen (Associate Editor)

Wildlife Research
Andrew Cunningham (Associate Editor)
Publications

IoZ staff and students have contributed to a huge range of publications over the 2012–2013 academic year.

Clements, CF (2013) Public interest in the extinction of a species may lead to an increase in donations to a large conservation charity. Biodiversity and Conservation, DOI: 10.1007/11031-013-0355-z.


Duncan, RN, Boyer, AG and Blackburn, TM (2013) Magnitude and variation of prehistoric bird extinctions in the Pacific.


populations. Imperial College London, UK.
Di Fonzo, M (2012) Inferring extinction risk and causation from population trends: case studies in the vertebrates. Imperial College London, UK.
Nielsen, J (2012) The evolutionary genetics of meerkats (Suricata suricatta) genotype and management of the Caribbean pine finch (Carpodacus brunnicephalus) in the Turks and Caicos: treating scale and burning broadleaf.

Fouda, L (2012) Noisy neighbours: using Automatic Identification System (AIS) and passive acoustic monitoring data to measure individual vessel source levels in critical whale habitat.
Griffin, D (2012) Modelling the severity of deforestation in coastal Tanzania and comparison of data sources.
Greene, M (2012) Matrix-mitigated edge and area effects on neotropical bats in a fragmented landscape.
Preston, A (2012) Small scale alternatives to bushmeat: success or failure?
Pinon, V (2012) Is pasture structure and plant-competition the key to explaining the mass die-off of the Saiga antelope, Saiga tatarica tatarica, in the Borsy region of Kazakhstan?
Vanlerberghe, S (2012) Developing a standardised system for the objective measurement of pathological lesions of feet in captive elephants in the UK and Ireland.

Williams, D (2012) Which environmental factors influence mammalian species richness and occurrence along the Swakop River, western Namibia?
Youl, L (2012) Optimising the qPCR assay for the detection of Batrachochytrium dendrobatidis infection in archived specimens: comparison of current methods with the inclusion of a commercial DNA clean-up step and with the inclusion of bovine serum albumin.

Dewar, E (2012) Enhancing the automatic identification system (AIS) through binomial n-mixture models of individual vessel source levels in critical whale habitat.


Griffin, D (2012) Modelling the severity of deforestation in coastal Tanzania and comparison of data sources.

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

Staff at the IoZ

Senior Research Staff
Andrew Cunningham, Deputy Director of the Institute of Zoology, Theme Leader, Wildlife Epidemiology
Chris Carbone, Theme Leader, Biodiversity and Macroecology
Guy Cowlishaw, Theme Leader, Behavioural and Population Ecology
Sarah Durant, Theme Leader, People, Wildlife and Ecosystems
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Anthony Saunders
Samuel Turvey
Anjuang Wang
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Louise McRae
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Postgraduate Research Students
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Contact Us

IoZ enquiries 020 7449 6610
The Zoological Society of London
Regent’s Park
London NW1 4RY
zsl.org/science
Registered charity in England and Wales: no 208728

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Regent’s Park
London NW1 4RY
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Our overview of the year, featuring our zoos, fieldwork, science, engagement activities and ways to get involved.

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