TUESDAY 14 MARCH 2017

ZSL SCIENCE AND CONSERVATION EVENT

The Meeting Rooms, Zoological Society of London,
Regent's Park, London NW1 4RY

AGENDA

Immigrants to the rescue! How can immigration help save threatened wildlife populations?

Chair: Dr Patricia Brekke, Research Fellow, Institute of Zoology, ZSL

Receive the following communications:

Emeritus Professor Richard Frankham, Macquarie University and Australian Museum
What is genetic rescue and what is its role in conservation?

Professor Michael W Bruford, University of Cardiff
Accelerating genetic rescue using genomic data

Professor Jane Reid, University of Aberdeen
Using evolutionary ecology to inform genetic rescue

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ABSTRACTS

Immigrants to the rescue! How can immigration help save threatened wildlife populations?

Tuesday 14 March 2017
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What is genetic rescue and what is its role in conservation?
Emeritus Professor Richard Frankham, Macquarie University and Australian Museum

Many species have fragmented distribution with small isolated populations suffering inbreeding depression and/or reduced ability to evolve. Without gene flow from another population within the species (genetic rescue), these populations are likely to be extirpated. However, there have been only ~ 30 published cases of such outcrossing for conservation purposes, likely a very low proportion of populations that would potentially benefit. Two of the major impediments to genetic rescues are (a) fear that outcrossing will be harmful (an issue that has previously been addressed by my group), and (b) the lack of an overview of the magnitude, consistency and persistence of genetic rescue effects across generations in wild species. I carried out a meta-analysis to address the second of these concerns.

Outcrossing of inbred populations resulted in beneficial effects in 92.9% of 156 cases screened as having a low risk of outbreeding depression. The median increase in composite fitness (combined fecundity and survival) following outcrossing was 151% in stressful/wild environments and 51% in benign/captive ones. Fitness benefits also increased significantly with maternal and zygotic ΔF (reduction in inbreeding coefficient due to gene flow), and for naturally outbreeding versus inbreeding species, and for outbred versus inbred immigrants. However, benefits did not differ significantly among invertebrates, vertebrates and plants. Fitness benefits persisted across generations in outbreeding species, but are expected to eventually be lost in highly selfing species. The ability to evolve in inbred populations also benefited from gene flow. There are no scientific impediments to the widespread use of outcrossing to genetically rescue inbred populations of naturally outbreeding species, provided potential crosses have a low risk of outbreeding depression.

Emeritus Professor Richard Frankham is one of the leading international figures in conservation genetics, having been a pioneer in the field and senior author on the first textbooks in the field (3 textbooks that have been subject to 6 translations). In 2005 he was awarded a DSc by Macquarie University, based upon his published work (now ~ 170 publications). His background is in agriculture, having received BScAgr [Hons 1] and PhD from the University of Sydney. He worked for Agriculture

Canada, followed by a postdoctoral fellowship at the University of Chicago, before spending 31 years at Macquarie University, beginning as a lecturer and ending as a Professor. He officially retired in 2002, but continues to work full-time, sharing his time between Macquarie University and the Australian Museum. In 2004, he was Hrdy Visiting Professor in conservation biology at Harvard University, USA

Accelerating genetic rescue using genomic data
Professor Michael W Bruford, University of Cardiff

Genetic rescue is generally regarded as a valuable tool to improve the viability of small populations and endangered species. However, its uptake has been limited to date and negative perceptions persist around the risks posed by its application both at a scientific and ethical level. Scientifically, some of the risks perceived by the conservation community (which include the possibility of inducing outbreeding depression, negative demographic effects and genetic 'swamping') could be mitigated by a 'genome-informed' rescue strategy. Here, breeding programmes could target the introgression of regions of annotated genomes predicted to confer the highest fitness benefit, accelerating genetic rescue while minimising genetic swamping. Alternatively, *post hoc* management could be used to select individuals carrying introgressed genomic segments predicted to be the most desirable. In this context, the phenomenon of adaptive introgression is increasing being studied using genomic tools to provide evidence to enhance genetic rescue programmes.

Professor Bruford will highlight one example of adaptive introgression from his work, which focuses on feral mouflon and domestic sheep living in the mountains of Sardinia, where he has searched for unmanaged introgression between the two gene-pools, focusing on its magnitude and directionality. He will also examine the management implications of a recent genomic study of genomic purity, diversity and inbreeding in Przewalski's horse, where genome resequencing data potentially enables a new paradigm for future breeding strategies for this species and those encountering similar problems. While genomic data will undoubtedly provide additional valuable information to guide management of imperiled genetic resources, its usefulness will depend on a better understanding of the genomic basis of fitness in non-model species and will necessitate more sophisticated breeding solutions to balance the benefits of genetic rescue against notions of genomic integrity.

Mike Bruford is Professor of Biodiversity at the School of Biosciences, Cardiff University. After gaining his PhD in DNA profiling in animals from the University of Leicester in 1990, Mike worked for ZSL as a conservation biologist for nine years, before moving in Cardiff in 1999. Mike's research focuses on the population biology of endangered species, with a special focus on those found in fragmented habitat. He uses DNA profiling to gain information about elusive animal species, which helps to build a picture about their population size and distribution, often in inhospitable habitats where direct observation is impossible.

Using evolutionary ecology to inform genetic rescue
Professor Jane Reid, University of Aberdeen

Numerous wild populations of conservation or economic value are facing combinations of ecological and genetic threats to their persistence. Quantifying such ecological and genetic threats, and hence determining the most effective management intervention, can be extremely challenging. This situation is illustrated by the remaining Scottish population of red-billed choughs. This population is thought to be declining due to ecological constraints stemming from food availability and land management, but the population's isolation and small effective size implies that inbreeding and loss of genetic diversity might also constrain population persistence. However the relative balance between such ecological and genetic constraints, and hence the case for translocations to aid 'genetic rescue', cannot be directly evaluated because the short-term and longer-term effects of inbreeding and immigration on individual survival and reproduction cannot be quantified. Such effects consequently need to be estimated in tractable model systems. Accordingly, Jane used long-term pedigree and life-history data from a natural song sparrow meta-population to quantify direct and cross-generational effects of inbreeding on survival and reproduction, and to quantify the long-term genetic contributions of immigrants. These analyses showed that maternal inbreeding constrained offspring condition, but such effects were transient and only detected early in offsprings' lives. Subsequently, there was weak inbreeding depression in female survival and lifetime reproductive success and strong inbreeding depression in male survival and lifetime reproductive success. However, such strong inbreeding depression resulted primarily from inbreeding depression in male mating success, implying that inbreeding might not substantially constrain population growth rate. Immigrants caused outbreeding, but made only moderate long-term genetic contributions to the population. Overall, these analyses demonstrate the complexity of inbreeding effects on fitness that can arise in wild populations, and that might need to be incorporated into population viability analyses to fully assess the merits of translocations for genetic rescue.

Jane Reid's research spans the fields of population, evolutionary and conservation ecology. Specifically, she uses long-term field studies of marked individuals (birds) to understand the genetic and environmental causes of individual variation in life-history, and to understand the consequences of emerging demographic variation for population dynamics and evolution. She is also a diehard field ecologist. Jane completed her Undergraduate degree in Natural Sciences at the University of Cambridge, followed by a PhD in behavioural ecology at Glasgow University and Killam Postdoctoral Fellowship at the University of British Columbia, and a Junior Research Fellowship at Jesus College, University of Cambridge. She was appointed Royal Society University Research Fellowship at University of Aberdeen starting 2006 and since 2014 works on an ERC-funded research programme in population & evolutionary ecology. In 2013 Jane was awarded the ZSL Scientific Medal for her work.

Chair: Dr Patricia Brekke, Research Fellow, Institute of Zoology, ZSL

Patricia Brekke is a Research Fellow at ZSL, with research interests in ecology, evolution and conservation of small and fragmented populations. She applies molecular genetics and genomics to understand the role that changes in genetic diversity and inbreeding have on a species' risk of extinction. She is particularly interested in understanding how small populations cope and adapt to conservation management interventions to predict their long-term effects.

FORTHCOMING SCIENCE AND CONSERVATION EVENTS
www.zsl.org/science/whats-on

Conserving the mountain chicken frog: the impact of chytridiomycosis under scrutiny
Tuesday 11 April 2017, 6pm - 7.45pm
ZSL Science and Conservation Event

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The mountain chicken frog became critically endangered following the incursion of the amphibian disease chytridiomycosis, which caused an 85% decline on its endemic island of Dominica and near extinction on neighbouring Montserrat. ZSL scientists are working within a world-leading consortium devoted to understanding how to mitigate the disease's impacts and prevent further extinctions.

FIND OUT MORE
www.zsl.org/science/whats-on/conserving-the-mountain-chicken-frog-the-impact-of-chytridiomycosis-under-scrutiny

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Wildlife of the West African Savannah: unfamiliar and under threat
Tuesday 9 May 2017, 6pm - 7.45pm

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The savannah of West Africa once hosted large populations of African elephant, West African giraffe, lion, cheetah and wild dog, but these are now restricted to isolated pockets. This meeting will celebrate the amazing diversity of savannah systems, the ecological history of West Africa, the threats it's currently facing and the work under way to conserve it.

FIND OUT MORE
www.zsl.org/science/whats-on/wildlife-of-the-west-african-savannah-unfamiliar-and-under-threat

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Stamford Raffles Lecture 2017: How animals shape habitats, ecosystems and the global biosphere
by Professor Yadvinder Malhi, University of Oxford
Tuesday 20 June 2017, 6.30pm – 9.30pm

Yadvinder Malhi will explore a variety of ways in which animals can influence ecosystem structure, biomass, fire regimes and even climate, drawing on evidence from the Pleistocene to modern times, looking at scales from termites to mammoths, and drawing on ongoing experiments and "rewilding" projects.

FIND OUT MORE
www.zsl.org/science/whats-on/how-animals-shape-habitats-ecosystems-and-the-global-biosphere