Institution:
Cardiff University

Unit of Assessment:
UoA5_Casestudy1

Title of case study:
Genetic data optimises conservation of endangered species

1. Summary of the impact (indicative maximum 100 words)

During the last 10 years Cardiff University researchers have developed and applied a range of genetic and molecular analysis techniques to inform conservation and biodiversity policy and practice in regions around the world where specific species and biodiversity are under threat. Genetic research on orang-utans and elephants in the Kinabatangan Wildlife Sanctuary in Borneo has guided strategic action plans for these species. Cardiff's molecular censusing and genetic analysis of giant panda populations in China have directly informed the strategic relocation of individual animals into isolated populations in the wild to preserve the genetic diversity of the species.

2. Underpinning research (indicative maximum 500 words)

Interventions to manage endangered species often lack a scientific basis, especially when it comes to preserving the genetic diversity of species. Although the 2020 Convention on Biological Diversity (CBD) explicitly calls for action to assess genetic diversity for the first time, there is still little guidance on evidence-based approaches to achieve this aim.

A team of researchers from Cardiff University, led by Professor Mike Bruford (Professorial appointment, 1999-present), worked with conservation partners in Malaysia and China over a period of a decade from 2000 to collect and analyse genetic and demographic data on several 'flagship' endangered species: orang-utans, elephants and the giant panda.

Orang-utans and elephants in Borneo

For orang-utans, between 2000 and 2003 the Cardiff researchers provided genetic analysis and modelling as part of a collaborative Darwin Initiative project. The other project partners were Malaysia's Sabah Wildlife Department (SWD), the management authority for Lower Kinabatangan Wildlife Sanctuary; the University Malaysia Sabah, which contributed an MSc student for research activities; and the Non-Governmental Organisation (NGO) Kinabatangan Orang-Utan Conservation Project, which orchestrated the collection of faecal samples and produced demographic data and habitat assessments for the sanctuary's orang-utan population.

PCR genetic profiling, including mitochondrial DNA analysis, was carried out for over 200 individual orang-utans. Bruford combined the genetic data with demographic information (e.g. the ranges and territories of individuals, offspring, breeding rates etc.) to create a predictive model that suggested the Kinabatangan sub-population would be extinct within 50 years without action to reconnect the Kinabatangan riparian forest (now largely disconnected due to palm oil related land conversion). The model also showed that the relocation of individuals would add diversity to the isolated gene pools[3.1-3.3].

The Cardiff team provided similar research expertise between 2005 and 2008 to build a predictive model for the elephant populations in Borneo as part of a second Darwin Initiative project in collaboration with SWD, University Malaysia Sabah and World Wildlife Fund (WWF) Malaysia (which provided satellite tracking data). Simulations revealed that habitat fragmentation increases the size of an elephant's home range because they are forced to move further afield to find food. These 'vagrant' elephants would be more likely to encounter and enter into conflict with humans[3.4-3.5].

Giant pandas in China

In China, Bruford and Dr Benoit Goossens (Senior Research Associate, 2005-present) from Cardiff worked with Fuwen Wei, Department Director of the Institute of Zoology of the Chinese Academy of Sciences. The Cardiff team carried out molecular censusing, developed through the Darwin Initiative projects, on 250 samples of giant panda faeces taken from the Wangland reserve to produce a DNA profile and generate a more accurate estimate of panda populations. Previous

sampling methods suggested there were only 27 individuals, but Cardiff's research provided robust evidence of at least 66 individuals. The work revealed the dispersal patterns of the giant pandas during 2006 and 2007[3.6].

The study also showed that females disperse over larger distances than males, perhaps because the number of birthing sites has fallen due to the degradation of old-growth forest and the lack of tree cavities at a suitable temperature[3.6].

The two Cardiff researchers also worked with the Beijing Genomics Institute (2008-2010) to analyse the genetic structure of giant panda populations in China to determine the interconnectivity between sub-populations. Cardiff's role in the project was to assess the genetic diversity of giant panda populations. This work showed for the first time that the species possesses substantial genetic variation and they are not at an evolutionary 'dead end'. However, the profiling highlighted the genetic differences between isolated mountain populations[3.7].

Giant panda genome project

Cardiff's substantial involvement in the genetic analysis of giant pandas led to an expanded sequencing effort and the publication of the giant panda genome in the journal Nature[3.8]. The giant panda is the first endangered species to have had its genome sequenced.

3. References to the research (indicative maximum of six references)

3.1 Darwin Initiative project. Conservation of the orang-utan in Kinbatangan Wildlife Sanctuary, Sabah, Malaysia, Final report. http://darwin.defra.gov.uk/documents/9016/21258/09-016%20FR%20-%20edited.pdf

3.2 **Goossens B**, Chikhi L, Ancrenaz M, Lackman-Ancrenaz I, Andau P, **Bruford MW**, 2006. Genetic signature of anthropogenic population collapse in orang-utans. *PLoS Biology* 4: 285-291,e25. http://dx.doi.org/10.1371/journal.pbio.0040025

3.3 **Bruford MW**, Ancrenaz M, Chikhi L, Lackman-Ancrenaz I, Andau M, Ambu L, **Goossens B**, 2010. Projecting genetic diversity and population viability for the fragmented orang-utan population in the Kinabatangan floodplain, Sabah, Malaysia. *Endangered Species Research* 12: 249-261. http://dx.doi.org/10.3354/esr00295

3.4 Darwin Initiative project. Conservation of the Bornean Elephant. Final report. http://darwin.defra.gov.uk/documents/14014/5464/14-014%20FR%20-%20edited.pdf

3.5 Alfred R, Ahmad AH, Payne J, Williams C, Ambu LN, How PM, **Goossens B** (2012) Home range and ranging behaviour of Bornean elephant (*Elaphas maximus borneensis*) females. *PLoS ONE* 7: e31400. http://dx.doi.org/10.1371/journal.pone.0031400

3.6 **Zhan XJ**, Li M, Zhang Z, **Goossens B**, Chen Y, Wang H, **Bruford MW**, Wei F. (2006) Molecular censusing doubles giant panda population estimate in a key nature reserve. *Current Biol.* Vol.16, No.12, R451-R452 http://dx.doi.org/10.1016/j.cub.2006.05.042

3.7 Zhu L, **Zhan X**, Wu H, Zhang S, Meng T, **Bruford MW**, Wei F (2010) Conservation implications of drastic reductions in the smallest and most isolated populations of giant pandas. *Cons. Biol.* 24: 1299-1306 http://dx.doi.org/10.1111/j.1523-1739.2010.01499.x

3.8 Li RQ, **Bruford MW,** Fan W *et al*. (2010). The sequence and de novo assembly of the giant panda genome. *Nature* 463: 311-317. http://dx.doi.org/10.1038/nature08696

Funding and grants

- DEFRA: Darwin Project 09/016 - Conservation of the Orang-Utan in Kinbatangan Wildlife sanctuary, Sabah, Malaysia. Cardiff University, Professor Mike Bruford, 1 December 2000 – 30 November 2003, £147,268
- DEFRA: Darwin Project DI 14/014 – Conservation of Bornean Elephant, Cardiff University, Professor Mike Bruford, 1July 2005 – 30 June 2008, £239,997

4. Details of the impact (indicative maximum 750 words)

Shaping conservation action in Borneo

Cardiff's genetic analysis forms a central part of the Orang-utan State Action Plan that was written by Bruford and Goossens in collaboration with Sabah Wildlife Department. The plan was presented on 10-11 June 2010 for endorsement by the Sabah State Cabinet and formally published and launched in January 2012[5.1].

Following the similar project focusing on the Bornean elephant, Goossens was charged, together with a member of the Sabah Wildlife Department, with producing the Elephant State Action Plan which has now also been endorsed and published by the Sabah State Cabinet [5.2]. By identifying the link between fragmentation and home-range, a key element of this Action Plan is to reconnect the forests of the Kinabatangan to form a 'corridor of life' along the river.

The species Action Plans have helped Malaysia (and especially the Sabah Wildlife Department) to meet its obligations under the Convention on Biological Diversity.

The Action Plans were launched at a workshop in 2012, attended by conservationists and representatives from the palm oil sector to discuss the implementation of the plan and suitable solutions to the shrinking orang-utan and elephant habitats. Goossens presented an overview of the scientific evidence and forecasts produced by the Cardiff team; Bruford facilitated a plenary discussion on strategies to harmonise wildlife conservation and the development needs of the region [5.3].

The Action Plans are now being implemented in Sabah. A key element of the Orang-utan Action Plan has been the extension of the rope bridge programme to facilitate interactions between previously isolated populations. Photographic evidence in 2010 has shown that the primates use bridges installed above Kinabatangan tributaries in a pilot scheme to cross these natural barriers allowing them to roam further afield [5.4].

International training for evidenced-based conservation

During the elephant project, Cardiff University also developed a plan to establish a field centre in partnership with the Sabah Wildlife Department in the Lower Kinabatangan Wildlife Sanctuary. Following substantial investment from Cardiff, the Danau Girang Field Centre (DGFC) opened in July 2008. During its first five years the centre has hosted 24 training courses for international and Malaysian scientists and students; it has a high local media profile.

Supporting livelihoods and sustainability in Borneo

DGFC contributes to the local economy as it employs twelve local people, including a centre manager. The centre also promotes sustainability in the area through active engagement with the oil palm sector. It helped to organise the Sabah Conservation Colloquium 2012 and collaborates with Yayasan Sime Darby, a palm oil funded conservation charity, to study and conserve the proboscis monkey in Sabah [5.5].

The creation of DGFC has helped to precipitate the closure of an unlicensed tourist site called Uncle Tans, which was having a significant negative effect on the environment.

Improving Chinese conservation practices

In China, Cardiff's collaboration with the Institute of Zoology, Chinese Academy of Sciences has built the Institute's capacity in non-invasive genetic analysis. Since the initial studies of the genetic structure of the giant panda, Chinese scientists have now developed a full assessment of the greater Shangri-La ecosystem [5.6-5.7].

The genetic census of giant pandas in 2006 spurred a revision of the sampling strategy for China's fourth national giant panda survey; molecular censusing will be carried out across the entire geographic range of the survey. The authorities will use the more accurate population estimates to refine the protection measures for each region of the giant panda's range[5.6-5.7].

Cardiff's work on the genetic structure of panda populations has been instrumental in guiding the strategic movement of individual animals into the dwindling Xiaoxiangling population at the south of the species' range[5.8]. This practice of 'targeted translocation' is also included in the revised management guidelines for the fourth national survey on giant pandas [5.6-5.8].

Conclusion

The ultimate impact of these management recommendations based on Cardiff's research will take decades to evaluate, since they are measured over generational timescales. However, by using evidence-based management practices, these emblematic species and others that benefit from the same scientific approach, will have a much greater chance of long-term survival.

5. Sources to corroborate the impact (indicative maximum of 10 references)

5.1 Orangutan Action Plan 2012 – 2016. Sabah Wildlife Department, Ministry of Culture, Tourism and Environment, Kota Kinabalu, Sabah. ISBN: 978-983-40057-4-0. is the state endorsed conservation plan based on Cardiff's findings about orang-utans' genetic and demographic distribution. (document available on request)

5.2 Elephant Action Plan 2012 – 2016. Sabah Wildlife Department, Ministry of Culture, Tourism and Environment, Kota Kinabalu, Sabah. ISBN: 978-983-40057-6-4. is the state endorsed conservation plan based on Cardiff's findings about Bornean Elephants' genetic and demographic distribution. (document available on request)

5.3 Statement from Director SWD, (Confirming MB and BG contribution to conservation in Borneo and adoption of key species management tools) (statement available on request)

5.4 http://www.wildlifeextra.com/go/news/orang-utan-bridge.html#cr. First photographic evidence of orang-utans using rope bridges. The use of bridges was subsequently enshrined in the management plan and additional projects undertaken.

5.5 Yayasan Sime Darby press release: http://www.theborneopost.com/2011/07/21/rm1-5-million-to-conserve-proboscis-monkeys/ confirmation of the collaboration between the field centre and a major charity.

5.6 Statement from Deputy Director of the Institute of Zoology of the Chinese Academy of Sciences (Confirming MB and BG contribution to conservation policy for Panda populations in China) (statement available on request)

5.7 http://chinese.eurekalert.org/en/spotlight/story.php?story=20100608.panda .Confirmation of the implementation of the panda relocation plan.

5.8 Hope for Wild Pandas. *Science* Random Samples. *Science* 328: 553. http://www.sciencemag.org/content/328/5978/553.4.full.pdf Confirmation of the implementation of the panda relocation plan.