Institution: Cardiff University		
Unit of Assessment: Biological Sciences (5)		
Title of case study: Genetic and biogeographic mapping of the okapi underpins designation of a national park and elevates its status to endangered		
Period when the underpinning research was undertaken: 2010 - 2016		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Michael Bruford David Stanton	Professor Research Associate	01/04/1999-present 01/05/2015-31/03/2018
Period when the claimed impact occurred: 2015 - 2020		
Is this case study continued from a case study submitted in 2014? No		

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

The okapi (a relative of the giraffe) is under considerable threat, yet little was known about its evolutionary history and biogeography. Cardiff research demonstrated that wild okapis have greater genetic diversity and geographic subdivision than previously suspected. Discovery of okapis south of the Congo river resulted in the establishment of a new National Park (Lomami) in the Democratic Republic of Congo, supporting greater species protection. The research also led to new okapi conservation strategies, including transformation of the captive breeding programme in Europe, and evidencing the urgent need for the okapi threat status to be upgraded from 'Near Threatened' to 'Endangered'.

2. Underpinning research (indicative maximum 500 words)

Okapis (*Okapia johnstoni*) are shy, solitary creatures that inhabit remote forests of the Democratic Republic of Congo (DR Congo). They are important locally, where they are considered sacred, and globally, with the International Union for the Conservation of Nature (IUCN) designating them a *flagship species* (i.e., a threatened species that can drive conservation efforts that benefit other species). Despite this, the okapi is under considerable threat, both indirectly (from industries like mining) and directly (in 2012 a militia attack on the Okapi Wildlife Reserve Headquarters in the DR Congo resulted in loss of all captive okapis, alongside seven rangers). Establishing population numbers and indicators of species resilience, such as genetic diversity, has been challenging, impacting on the development of successful strategies to protect the species. To address this issue, Cardiff research studied the genetic diversity of the okapi in DR Congo, and also in captive populations.

2.1 Applying genetic tools to study the genetic diversity & geographic range of okapis

To assess the diversity in wild okapi populations, Bruford and Stanton (initially Bruford's PhD student; subsequently research associate from May 2015) established a collaboration with White Oaks Conservation Centre (USA), who were dealing with breeding issues in their captive okapi population. Using blood samples from captive okapis at the Centre, alongside samples from wild individuals, Bruford constructed the first genomic library for the okapi, describing 13 polymorphic microsatellite loci that could be used to measure okapi genetic diversity **[3.1]**.

The Cardiff team subsequently identified key research priorities for okapi in the DR Congo Basin region, including sampling gaps in relevant taxonomic groups across multiple species **[3.2]**. During 2010-2013, the Cardiff team joined the DR Congo TL2 project, which surveyed the activity of large mammals and humans in the Tshuapa-Lomami-Lualaba Conservation Landscape (TL2), a 40,000 km^2 unexplored area of Congolese forest bordered by the Tshuapa, Lomami, and Lualaba Rivers. This area was thought to be far outside the traditional known range of okapis. The research involved collection and genetic analysis of dung samples to identify the presence of animals living in this new forest zone.

Importantly, faecal samples collected during the TL2 expedition yielded positive evidence for the existence of okapis south of the Congo river for the first time **[3.3]**. While some museum specimens collected in the 19th century possessed labelling that implied animals from this region, this had never been independently corroborated, and the population was suspected to be extinct. Bruford also demonstrated that okapis possessed equivalent evolutionary richness to its closest relative, the giraffe, across its entire sub-Saharan range, illustrating its importance as the only close relative to the giraffe **[3.4]**.

The field research also demonstrated limited dispersal of okapis from the area in which they were born, helping Bruford to estimate a geographic range for the okapis based on confirmed genetic locations across DR Congo **[3.5]**. Additional research found that the European and US captive breeding population had retained a very limited portion of the species' range-wide genetic diversity. This presented a high risk of inbreeding depression in breeding programmes, without careful genetic management of the species in captivity **[3.6]**.

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

[3.1] Stanton DWG, Penfold LM, Zhan XJ, Bruford MW (2010) Microsatellite loci for the okapi (Okapia johnstoni). *Conservation Genet. Resour.* 2: 337-339. DOI: 10.1007/s12686-010-9235-0

[3.2] Anthony NM, Atteke C, Bruford MW, Dallmeier F, Freedman A, Hardy O, Ibrahim B, Jeffery Kj, Johnson M, Lahm Sa, Lepengue N, Lowenstein JH, Maisels F, Mboumba JF, Mickala P, Morgan K, Ntie S, Smith TB, Sullivan JP, Verheyen E, Gonder MK (2015) Evolution and conservation of central African biodiversity: priorities for future research and education in the Congo Basin and Gulf of Guinea. *Biotropica* 47: 6-17. DOI: 10.1111/btp.12188

[3.3] Stanton DWG, Hart J, Vosper A, Kümpel NF, Wang J, Ewen JG, Bruford MW (2016) Non-invasive genetic identification confirms the presence of the Endangered okapi Okapia johnstoni south-west of the Congo River. *Oryx* 50: 134-137. DOI: 10.1017/S0030605314000593

[3.4] Stanton DWG, Hart J, Galbusera P, Helsen P, Shephard J, Kumpel NF, Wang J, Ewen JG, Bruford MW (2014) Distinct and diverse: range-wide phylogeography reveals ancient lineages and high genetic variation in the endangered Okapi (Okapia johnstoni). *PLoS ONE* 9: e101081. DOI: 10.1371/journal.pone.0101081

[3.5] Stanton DWG, Hart J, Kümpel NF, Vosper A, Nixon S, Bruford MW, Ewen JG, Wang J (2015) Enhancing knowledge of an endangered and elusive species, the okapi, using non-invasive genetic techniques. *J. Zool.* 295: 233-242. DOI: 10.1111/jzo.12205

[3.6] Stanton DWG, Helsen P, Shephard J, Leus K, Penfold L, Hart J, Kumpel NF, Ewen JG, Wang J, Galbusera P, Bruford MW (2015) Genetic structure of captive and free-ranging okapi (Okapia johnstoni) with implications for management. *Cons Genet* 16: 1115-1126. DOI: 10.1007/s10592-015-0726-0

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

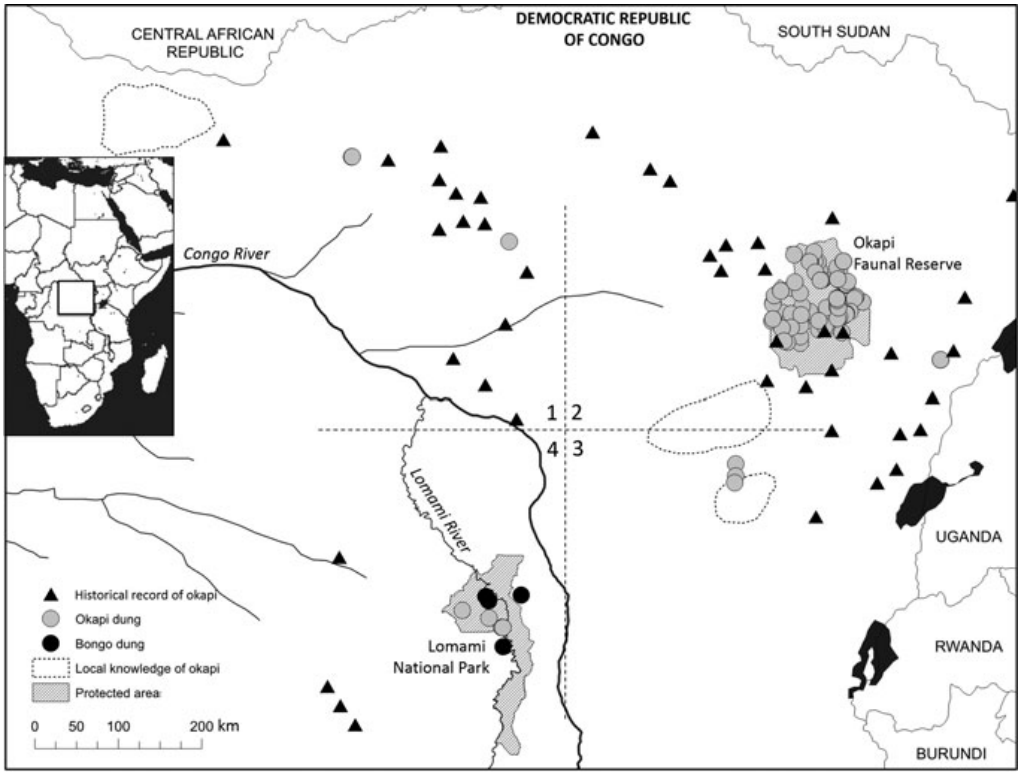
The Cardiff team are members of the International Union for the Conservation of Nature (IUCN) Giraffe and Okapi Special Interest Group. In May 2013, under the auspices of this newly formed group, key stakeholders including the Institut Congolaise pour la Conservation de la Nature (ICCN, a Congolese government department) and the Zoological Society of London, met in Kisangani to discuss future approaches to okapi conservation. Presentation of Cardiff's research findings at this meeting delivered new conservation impacts as follows: (1) establishment of a new national park in DR Congo, designed to protect the newly discovered okapi population in the South West; (2) improved strategies for genetic management of captive okapi breeding; and (3) upgrading of the okapi conservation status to 'Endangered', as well as development of the first ten-year okapi conservation strategy.

4.1 Establishment of the Lomami National Park in DR Congo

As part of the DR Congo TL2 project, the discovery of okapis south of the Congo river **[3.3]**, transformed understanding of the geographical extent of the species. The map below **[**from

3.3] shows where the Cardiff team identified okapi dung in their studies (small grey circles). As well as dung present in the already protected Okapi Faunal Reserve, okapis were clearly active south of the Congo River adjacent to the Lomami River.

Stuart Nixon, Africa Field Programme Coordinator (Chester Zoo) and Co-Chair of the IUCN Giraffe and Okapi Specialist Group, explained that Cardiff research "*unequivocally confirmed the presence of the okapi in the Lomami basin of central DRC--- a significant range extension"* **[5.1]**.



The Cardiff discovery led to the establishment of Lomami National Park in 2016 by the DR Congo Government, the first national park to be created in the area for over 40 years **[5.1]**, covering 5.4 million hectares (shaded grey area at the bottom of the diagram). This new Park aimed to bolster conservation of the okapi population south of the Congo river, but also granted protection to other critical species, including forest elephants, bonobo, the recently discovered Congo peafowl (*Afroparvus congensis*, the only African representative of the peafowl) and a previously unknown primate, the lesula **[5.1, 5.2, 5.3]**.

Notably, Lomami National Park is the first Congolese protected area to be set up in a participatory manner, facilitated by the TL2 project and Institut Congolaise pour la Conservation de la Nature. Conservationists and government officials work directly with local communities within and around the park to ensure protection of the region and promote sustainable livelihoods, such as recruitment as local park guides **[5.2, 5.3]**. John Hart, from the Frankfurt Zoological Society (an NGO operating in the Lomami National Park), noted *"the willingness of this community to collaborate with Congolese national park authorities and TL2 project staff in protecting the buffer zone, and in particular their okapi"* **[5.2]**.

Nixon noted the critical importance of Cardiff research in this new conservation initiative: "*This discovery [of okapi in the region] provided important evidence used in the 2016 creation of the 8,900km^2 Parc National de la Lomami, DRC's first new national park for over 40 years"* **[5.1]**. He further states that the Cardiff research showing the unique genetic diversity of the Lomami population *"carried additional conservation significance"* which was *"also a potentially valuable piece of information for additional conservation prioritisation such as the IUCN's Key Biodiversity Areas initiative*" **[5.1]**.

4.2 Improved management of the captive population

Captive breeding programmes are vital to the survival of endangered species. Cardiff research showed that, while captive okapi breeding programmes had been relatively effective at preventing inbreeding, substantial genetic diversity had been lost **[3.3, 3.4]**. Through the provision of Cardiff genetic tools and research, including analysis of microsatellite loci and novel insights into biodiversity in wild **[3.1]** and captive **[3.3]** okapi populations, Bruford improved the ability of European and US captive breeding programmes to make breeding selections that maximised genetic diversity and long-term species viability.

The Okapi International Studbook Keeper (an international record kept by Antwerp Zoo with genetic information on every okapi that has ever lived in a zoo) confirmed that Cardiff research **[3.3]** "*allowed us to examine the genetic diversity of the captive population, compare with the wild population and additional captive populations"* **[5.4]**. The research transformed the captive breeding programme in Europe, in collaboration with Antwerp Zoo (KMDA) and the European breeding program (EAAP). Antwerp Zoo confirmed that the new insights would "*result in a revised genetic management strategy for the ex situ populations*" **[5.4]**.

They further noted that "*these new insights…[are] guiding the breeding programme and including more efficient exchange of individuals between Europe and the US – a strategy recommended in the recent IUCN species assessment, which followed from the publication* **[3.6]**" **[5.4]**.

4.3 Change in conservation status and creation of conservation strategy

The joint meeting in Kisangani in May 2013, when the Cardiff research findings were presented, led to two further critical positive impacts on okapi conservation: a change in the IUCN conservation status of the okapi, and publication of the first ever okapi conservation strategy.

a. From 'Near Threatened' to 'Endangered'

In November 2013, the IUCN changed the conservation status of the okapi from 'Near Threatened' to 'Endangered' **[5.5]**. Notably, the change to 'Endangered' grants access to funding sources for conservation, such as the People's Trust for Endangered Species, the US Government's Critically Endangered Animals Conservation Fund, and the UN's Global Wildlife Program. Based on the okapi status change, a successful application was made to the IUCN Save Our Species fund by local conservation organisations including Institut Congolaise pour la Conservation de la Nature, for a project combating threats to okapi and African forest elephants in DR Congo **[5.6]**.

b. A new international strategy for the protection of the okapi

In 2015, the IUCN published the first ever okapi conservation strategy and status review **[5.7]**. Co-written by the Cardiff team, the document drew strongly on Cardiff research, and cited Cardiff-led studies **[3.4, 3.5, 3.6]** over 30 times. The ten-year strategy calls for urgent government and international commitment to ensure that key Congolese conservation areas are protected from armed militia and illegal activities **[5.8]**. This document is the first-ever coordinated global strategy to protect the okapi **[5.5, 5.9]**.

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

[5.1] Testimonial: Africa Field Programme Coordinator (Chester Zoo) and Co-Chair of the IUCN Giraffe and Okapi Specialist Group

[5.2] Testimonial: Director of Inventory and Monitoring, Frankfurt Zoological Society (the TL2 NGO)

[5.3] Lomami National Park history – Lukuru Foundation (details the importance of the TL2 project to the gazetting of the national park)

[5.4] Testimonial: General Curator and Okapi International Studbook Keeper, Antwerp Zoo

[5.5] International Union for Conservation of Nature, Okapi entry from *The IUCN Red List of Threatened Species*

[5.6] International Union for Conservation of Nature online newsletter on the SOS emergency fund project: 'Combating the most urgent threats to endangered African Forest Elephant and Okapi in the Ituri Forest of DRC'

[5.7] International Union for Conservation of Nature, *Okapi Conservation Strategy and Status Review* (2015)

[5.8] Blog report on the Okapi workshop and ensuing conservation strategy

[5.9] 'Global plan aims to save elusive okapi from extinction', IUCN press release on Okapi Conservation strategy