Okapi *(Okapia johnstoni)*

Conservation Strategy and Status Review

Edited by Noëlle F. Kümpel, Alex Quinn, Elise Queslin, Sophie Grange, David Mallon and Jean-Joseph Mapilanga

International Union for Conservation of Nature

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Edited by Noëlle F. Kümpel[a,b], Alex Quinn[b], Elise Queslin[a,b], Sophie Grange[b], David Mallon[a] and Jean-Joseph Mapilanga[a,c]

with contributions from the participants of the IUCN SSC GOSG / ICCN / ZSL workshop on okapi status and conservation (Kisangani, 22-25 May 2013), the members of the IUCN SSC GOSG and fieldworkers across the okapi's range, including: Fidele Amsini, Honore Balikwisha, Heri Baraka, Rene Beyers, Mbamgamuabo Biriku, Mike Bruford, Robert Fuamba, John Hart, Terese Hart, Cleve Hicks, Sander Hofman, Omari Ilambo, Bernard Iyomi Iyatshi, Alphonse Kakaya, Zabiti Kandolo, Nathanel Kasongo, Kimputu Kembe, Polycarpe Kisangola, Kristin Leus, Milton Lonu Lonema, John Lukas, Gaudens Maheshe, Fiona Maisels, Henri Mbale, Guy Mbayma, Ménard Mbende, Thomas Mfu N'Sankete, Pascal Mombi Opana, Urbain Moponga, Ephrem Mpaka, Boji Munguakonkwa, Norbert Mushenzi, Robert Mwinyihali, Joseph Ndia Amsini, Stuart Nixon, Linda Penfold, Ann Petric, Andrew Plumptre, Rosmarie Ruf, Steve Shurter, Dave Stanton, Paulin Tshikaya, Ashley Vosper

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Cover photos: [front] An okapi photographed by camera trap in northern Virunga National Park during a joint ZSL-ICCN survey, December 2009. © ZSL
[back] Sir Harry Johnston's initial drawing of the okapi, published in the 1901 Proceedings of the Zoological Society of London

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Forewords

The okapi is an iconic species for DRC and the world. While the scientific community only learnt of the existence of this elusive species at the turn of the 20th century, it has long been known and revered by the Congolese people sharing its rainforest home, particularly the Mbuti, from whom its name originates. Today, the okapi is a precious national treasure, featuring on the logo of my organisation, ICCN, in popular culture and on our banknotes, but it retains its enigma. As this status review highlights, we still have much to learn about the species, including exactly how it is faring in the face of multiple threats.

Despite conservation efforts at various levels, both populations of okapi and the network of protected areas and surrounding forests that they inhabit are threatened by the armed conflict and civil war that has been raging across much of their range over the past decade. This was exemplified by the June 2012 militia attack on the headquarters of its namesake protected area, the Okapi Wildlife Reserve – one of two World Heritage sites (the other being Virunga National Park) providing sanctuary for the okapi – killing all captive okapi held at the station. This elusive species is also adversely affected by illegal mining for gold, diamonds and coltan, other illegal activities within protected areas, and other extractive industries causing the destruction of habitat.

Through its strategic management approach as defined in the National Conservation Strategy (SNCB), ICCN works with international, state, private sector, United Nations and local community stakeholders across the okapi's range to counter these threats and pressures. This struggle for the conservation of okapi and other Congolese wildlife is accompanied by risks and sacrifices that have cost the lives of around 350 rangers during the course of their duties in the last ten years alone.

This first conservation strategy for the okapi emphasises the need for us all to intensify our collective and collaborative efforts to better understand the issues surrounding the distribution and conservation of the forest giraffe, as well as its habitat, the dense but beautiful Congolese forests. The support of the entire international community is therefore required to help ICCN and its partners working on the ground to achieve this.

Pasteur Dr Cosma Wilungula
Director General, *Institut Congolais pour la Conservation de la Nature* (ICCN)

We are rapidly losing the world's biodiversity, with global vertebrate populations having halved in the past 40 years. The pressures from a growing human population and demand for natural resources on the last spaces for nature, including the Congo Basin forests, have never been greater. But even though the situation may appear bleak, and conservation efforts ineffective, recent IUCN research suggests that ungulate species would be faring eight times worse without such conservation, highlighting that conservation does make a difference.

This comprehensive, ten-year conservation strategy provides an important roadmap for joint action to ensure the continued survival of this unique and irreplaceable Congolese species. Many years in conception and development, it is the result of the efforts of a large number of partners and stakeholders from across the okapi's range and internationally. While some bring real okapi expertise (while often focusing on the better-known flagships living alongside them, such as elephants, gorillas and chimpanzees), others have a more incidental connection, reflecting the reality of okapi conservation. To protect the okapi, we must protect its entire forest ecosystem, and this year's Sustainable Development Goals and climate change negotiations show commitment from governments to achieve this. IUCN, and the newly established IUCN SSC Giraffe and Okapi Specialist Group, look forward to supporting ICCN and other partners in the implementation of this strategy, in support of a more sustainable development path.

Dr Simon Stuart
Chair of the Species Survival Commission (SSC), IUCN

Background and summary

The iconic but elusive okapi (*Okapia johnstoni*) is endemic to the central and north-eastern tropical rainforest of the Democratic Republic of Congo (DRC). As a species, it is underfunded and understudied, with no coherent strategy in place for its conservation. It was widely agreed that its 2008 IUCN Red List status of 'Near Threatened' severely misrepresented the threats the okapi is facing. To address these concerns, in 2010 the *Institut Congolais pour la Conservation de la Nature* (ICCN) and the Zoological Society of London (ZSL) initiated a range-wide okapi conservation project in collaboration with a number of partners working across the range and internationally. As part of this project, a workshop was held under the auspices of the newly-formed IUCN SSC Giraffe and Okapi Specialist Group (GOSG) in Kisangani, DRC, from 22-25th May 2013 with the joint aims of gathering together and recording local and expert knowledge on the okapi, reviewing its conservation status, carrying out a Red List reassessment of the species (resulting in its listing as Endangered by IUCN in November 2013; section 4.3), and developing the first-ever conservation strategy for the okapi. Around 40 participants attended including government officials (including site directors from all major protected areas in the okapi's range), representatives from local and international NGOs, representatives of local communities and scientific experts (see Appendix 3 for a full list).

The ten-year okapi conservation strategy (2015-2025) was developed within the framework of the ICCN national strategy for biodiversity conservation (ICCN 2012) and the IUCN guidelines for strategic planning (IUCN SSC 2008[1]). The IUCN strategic planning process is designed to be participatory and collaborative, with all stakeholders engaged in the development of the plan.

A thorough knowledge of the status and biology of a species is an essential prerequisite to the development of a conservation strategy, so a detailed, desk-based status review of the okapi was compiled by ZSL in preparation for the workshop (Quinn *et al.* 2013). The review contained draft versions of the first chapters of this report, as follows: a species description (section 1), the species' value and functions (section 2), survey methods (section 3), distribution and populations (section 4), information from recent conservation genetics work (section 5), the role of the captive population (section 6), conservation actions (section 7), and a desk-based summary of direct and indirect threats to the okapi's persistence in the wild (sections 8.1 and 8.2). The review included digitised historical and current distribution maps, based on data on records of past occurrence and location of historic samples, information from wildlife surveys and current expert knowledge of okapi presence, as well as estimates and/or trends in known okapi populations, compiled by the ZSL team.

The review was sent out to all workshop invitees, members of the GOSG and other interested parties in advance of the workshop, to prepare them for the workshop and to allow those unable to attend in person to provide feedback and missing information. Maps and relevant information from the status review were assessed and updated both during and after the workshop. The revised status review forms part of this document and represents the most detailed and up-to-date account of the status and biology of the okapi produced to date, including a full bibliography, details of museum samples and other information used to map the historic distribution of the okapi (Appendix 1) and summary information on all recent (post-2003) okapi field surveys (Appendix 2).

At the workshop a participatory threat analysis based on participants' knowledge was conducted to identify important threats across the okapi's range (section 8.3), which was then used to define a strategy to conserve wild populations of okapi that would address these threats (section 9). The conservation strategy itself is designed to provide a long-term framework for action, beginning with a long-term, idealised vision, followed by a more concrete goal, through a logical, hierarchical structure down to individual actions. This was developed in a participatory way during the workshop in Kisangani through a series of plenary discussions and working group sessions and then reviewed and finalised over email following the workshop with the wider group as for the status review[2].

This conservation strategy and status review was made possible by the strong collaboration, support (technical, logistical and financial) and data freely provided by a large number of organisations and individuals working across the okapi range and internationally. We look forward to continued collaboration and coordination, and welcome the involvement of others, to ensure the successful implementation of this strategy to conserve the Endangered okapi.

[1] http://cmsdata.iucn.org/downloads/scshandbook_2_12_08_compressed.pdf
[2] Actors and timelines were largely drafted by the strategy editorial team following the workshop and then reviewed by the wider group over email, due to limited time to discuss during the workshop itself.

1. Species description

1.1 Status

Scientific name: *Okapia johnstoni*

IUCN Red List status: Endangered (2013)

Legal status: Full legal protection in DRC since 1933.
Not listed by CITES[3]

Figure 1. Okapi in Epulu, DRC.
© Scientific American

1.2 Taxonomy

Class: Mammalia
Order: Artiodactyla
Suborder: Ruminantia
Infraorder: Pecora
Family: Giraffidae
Subfamily: Palaeotraginae
Genus: *Okapia*
Species: *Okapia johnstoni* [Sclater 1901]

1.3 Discovery

Following the first account of a mysterious horse-like animal in the Ituri forest by Henry Morton Stanley in 1890, the British High Commissioner of Uganda and Fellow of the Zoological Society of London Sir Harry Johnston took an expedition into the then Belgian Congo to track this animal (Lindsey *et al.* 1999). Though failing to obtain a specimen, M'buti pygmies told him that the local name for this animal was the o'api and that it was a zebra-like animal with striped legs but a dark brown upper body (Johnson 1900). Johnston managed to obtain two traditional bandoliers made from striped pieces of okapi skin and sent them to Dr P.L. Sclater, Secretary of the Zoological Society of London. The specimens were exhibited at a meeting of the Society in December 1900 and early in 1901 Sclater tentatively named the okapi *Equus johnstoni* because of its apparent similarities to the zebra (Sclater 1901).

Some months later, Johnston received an entire skin and two skulls of okapi collected in the Semliki (Watalinga) forest. Realising this was in fact a relative of the giraffe, he sent these specimens and his own brilliant pictorial reconstructions (see back cover) to the Zoological Society of London, where they were displayed in May 1901, and proposed that the scientific name for the new species should be *Helladotherium tigrinum*, due to its relationship to the ancient giraffid and its striped hindquarters. Later in 1901, however, Sir Edwin Ray Lankester of the British Museum (Natural History) gave a short communication recognising that this new mammal was an ally of the extant giraffe *Giraffa camelopardalis*, though with some relation to the extinct *Helladotherium* (Lankester 1901). He therefore proposed the genus name *Okapia*, from its native name 'okapi' and decided to retain the specific name given by Sclater, thus defining the scientific name of okapi as *Okapia johnstoni* (Lankester 1902).

1.4 Description

The okapi is a close relative of the giraffe, even once considered a degenerated giraffe (Colbert 1938), endemic to the central and north-eastern tropical rainforest of DRC (Figures 1 & 2). Like the giraffe, the okapi has long legs in proportion to a compact and robust body. Okapi pelage is chestnut brown, made of short oily hair which acts as waterproofing in the damp rainforest environment. They have distinctive stripes resembling those of a zebra on the rump and forelegs. The stripes are thought to act as camouflage by breaking up the outline of the body in the light and shade of the forest understory (Skinner & Mitchell 2011). They are unique to each individual and therefore helpful for individual identification. Okapi usually weigh 200-300 kg, with females taller and heavier than males (Gijzen 1959). The species has bilobate canine teeth and males display skin covered horn-like structures called ossicones, both characteristics shared with the giraffe (Bodmer & Rabb 1992). The ossicones develop between 1 and 5 years of age and can grow to be 10-15 cm long (Wilson & Mittermeier 2011). The dark blue prehensile tongue is adapted for

[3] Convention on International Trade in Endangered Species of Wild Fauna and Flora

selective browsing and can be up to 18 inches (30 cm) in length, long enough that the animal uses it to clean its own eyes and ears (Skinner & Mitchell 2011). As with the giraffe, it has been suggested that in a captive environment okapi use their tongue to investigate novel stimuli (Bashaw *et al*. 2001).

Both the auditory and olfactory senses are well developed. Okapi can move their large ears independently, and have large auditory bullae and auditory lobes in the brain, leading to an enhanced ability to detect sound (Lindsey *et al*. 1999). Much of the okapi's anatomy is specifically adapted to its dense forest environment, providing both excellent hearing and camouflage for protection and the ability to interact with its environment using a highly sensitive olfactory system and tongue.

Figure 2. An okapi in its natural habitat, photographed in northern Virunga National Park by camera trap in 2008. © ZSL

1.5 Biology and ecology

The okapi is rarely observed directly in the wild state, because of its secretive nature, cryptic markings and dense rainforest habitat. As a result our knowledge of the behaviour and ecology of this species is limited. In 1986 John and Terese Hart started a five-year study of the okapi's ecology in the Ituri forest, using radio telemetry methods to track individuals through the forest (Hart & Hart 1988a; Figure 3). They concluded that the okapi is unique among the large mammals of the Ituri forest in having a diet composed solely of understory foliage. Okapi predominantly feed on young and emerging leaves from a range of over 100 plant species. No single species compromises more than a small fraction of their total dietary intake (Hart & Hart 1988b). Okapi have well-defined, non-exclusive home ranges, the most stable of which belong to mature adult females and are in the range of 4-7 km^2 (Hart & Hart 1989). Adult males' ranges can cover between 10 and 17 km^2 (Hart 2013), the larger range presumably to give access to a number of females (Skinner & Mitchell 2011). Okapi do not return to regular feeding sites and their daily movement varies between 2.5 km and 4 km for an adult (Hart & Hart 1988b). They follow regular pathways through the trees, a trait making them vulnerable to pitfall and large snare traps (Bodmer & Rabb 1992).

The Hart and Hart (1988b) concluded that okapi were vulnerable to predation by leopards, with three of the 11 okapi followed over three years dying as a result of leopard attack and others found with scars inflicted by leopards. Longevity in the wild is unknown, but okapi typically live 15-30 years in captivity, becoming sexually mature at around 2 years of age (Bodmer & Rabb 1992; Leus & Hofman 2012; Hofman & Leus 2015). Generation time for the okapi has been estimated at 10 years based on analysis of the European and North American captive populations (Leus & Hofman 2012; Hofman & Leus, 2015). Gestation lasts an average of 426 days in captive females, who give birth to a single calf normally weighing around 22 kg (Schwarzenberger *et al*. 1993). Calves are usually able to stand after 30 minutes, but for the first few months of their life they spend most of the day hiding while their mothers forage (Bodmer & Rabb 1992). Infants first defecate 1-2 months after birth, perhaps as an adaptation to reduce the chances of predator detection (*ibid.)*. One calf tracked by radio-collar was independent at approximately 9 months of age (Hart & Hart 1992).

Figure 3. A radio-collared okapi in the Ituri forest. © John & Terese Hart, WCS

Preliminary studies indicate that okapi are not highly social animals. Bodmer and Gubista (1990) found that while individuals may utilise sections of forest simultaneously, they do not form bonds or tight-knit groups. However they are more social than would be predicted by the term solitary. Hart and Hart (1989) used data from eight radio-collared individuals, and inferred that okapi appeared to be solitary. Stanton *et al*. (2015a) used genetics on dung samples from the Okapi Wildlife Reserve (*Réserve de Faune à Okapis*, RFO) and also concluded that okapi appear to be solitary. Okapi demonstrate male-biased dispersal, appear to be able to disperse large distances in the wild, and are genetically polygamous or promiscuous (Stanton *et al*. 2015a). Okapi are mostly diurnal, though nocturnal movements have also been recorded (Nixon & Lusenge 2008). Typically they show peaks of feeding activity during mid-morning and late afternoon, and a period of resting towards midday (Hart & Hart 1988a).

1.6 Habitat

The okapi occurs between 450 m and 1500 m elevation, and prefers mixed primary and secondary forest formations, where the dense understory cover provides excellent camouflage and offers a large variety of plant species (Hart & Hart 1988b; Figures 2 & 3). In mono-dominated *Gilbertiodendron dewevrei* forests, signs of okapi are less frequently observed (*ibid*.), suggesting that the diversity of plant species within a habitat influences okapi distribution and density. Their range is limited by the high altitude forests to the east, the swamp forests to the west, the savannah to the north and open woodland to the south (Skinner & Mitchell 2011). They will browse in seasonally inundated areas while the substrate is still wet, but do not occur in areas of extensive swamp forest. Tree fall gaps are their preferred foraging sites during the primary stages of regeneration (*ibid*.).

2. Species' values and functions

The okapi is a charismatic and iconic animal for DRC in general and a flagship species for the Ituri forest in particular, which supports the core population and includes a UNESCO World Heritage site named in its honour, the Okapi Wildlife Reserve (*Réserve de Faune à Okapis*, RFO). A significant okapi population is also found in Maiko National Park to the south of RFO. DRC is the only country in the world to harbour this instantly recognisable and unique animal, although it has been reported that okapi have occurred occasionally in the adjoining Semliki forest of western Uganda (Kingdon 1979; A. Rwetsiba, Uganda Wildlife Authority, pers. comm. 2015). The okapi has the ability to instil a strong sense of pride in the Congolese people. It features both on the logo of ICCN (*Institut Congolais pour la Conservation de la Nature*; the government conservation authority) and on Congolese Franc banknotes (*cf.* Table 1). The okapi has always been revered and admired by locals, with pygmy tribes having many customs related to the okapi (Hart and Hart 1986).

Table 1. Values and functions of the okapi

Ecological function	Representative references
Prey for leopards.	Hart & Hart 1988b
Flagship species and ambassador for the Ituri forest in the RFO, and more generally for DRC.	IUCN SSC Antelope Specialist Group 2008
Cultural value	**Representative references**
Considered sacred by local tribes in the RFO. Mbuti pygmies consider the killing of an okapi a major event and grieve for the dead animal. Respect for okapi is common in local tradition, for example in some villages only the chief is allowed to wear or sit on an okapi skin.	Hart & Hart 1986
Features prominently throughout DRC: for example, on Congolese Franc banknotes (Figure 4), on the ICCN logo, in the name of the national radio station 'Radio Okapi', in the names of restaurants, household items (Figure 5) and on the front cover of the 2009 DRC report to the Convention on Biological Diversity (CBD).	**Figure 4. Congolese Franc banknote** 
Socio-economic value	**Representative references**
Skins and meat. Skins are used for drums, chairs and belts (Figures 6 & 7), but in most areas these are opportunistic uses when the animal happens to be caught. One study concluded that okapi are specifically targeted by hunters in the Twabinga-Mundo region, east of Maiko. Workshop participants confirmed this.	J. Hart pers. comm.; Nixon & Lusenge 2008; Nixon 2010
Served as a basis for planned ecotourism in DRC (*e.g.* viewing captive okapi at the RFO headquarters at Epulu was a key attraction for the Ituri forest, including for overland tours passing through DRC).	Okapi Conservation Project 2011
Historically, export of okapi to zoos generated income for capture stations, with almost all captive okapi coming from the okapi capture station at Epulu.	Barongi 1985
Distinctiveness value	**Representative references**
One of only two remaining giraffid species in the world, providing a unique insight into the evolution of the giraffe. A 'living fossil' which appears to have diverged from the giraffe in the Miocene.	Bodmer & Rabb 1992; Stanton *et al*. 2014b
The only African ungulate to have a diet composed solely of understory foliage. This role in ecosystem function has not been studied.	Hart & Hart 1988a

Figure 5. Okapi water bottle, Kisangani, DRC, 2013. © Noëlle Kümpel, ZSL

Figure 6. Okapi deckchairs near Buta, DRC. 2008. © Cleve Hicks, Wasmoeth Wildlife Foundation

Figure 7. Okapi drum near Rubi Tele, DRC. 2011. © Ephrem Mpaka, Lukuru Wildlife Research Foundation

3. Survey methods

3.1 Dung count methods

Direct observations of okapi are very rare, and for this reason surveys are generally done *via* indirect methods, most commonly observations of their dung. With such methods, there are two risks: the relative imprecision regarding dung decay rates (see sections below for more details) and the risk of dung being misidentified. This latter issue may be a significant source of error – of 12 samples collected during surveys of the TL2 landscape and genetically tested, 50% were bongo dung that had been incorrectly identified as okapi dung (Stanton *et al*. 2014b). The rate of misidentification will depend considerably on the experience those conducting the survey have in identifying okapi dung as well as the relative abundance and (potentially) variations in local diet of okapi and other similar, sympatric species. The high misidentification rate within the TL2 landscape may be because okapi are scarce there (Stanton *et al*. 2014b) and so their dung is rarely encountered, particularly relative to bongo. In the RFO, where okapi are more common (and bongo rare: J. Hart, pers. comm.), none of the 160 dung samples collected by experienced wildlife teams had been misidentified when genetically tested. Subtle variations in the appearance, size and colouration of okapi dung between individuals, across the range and between *in situ* and *ex situ* populations, are also apparent but to date inadequately documented and understood (N. Kümpel pers. comm.) and are also likely to contribute to misidentification.

3.1.1 Transect-based distance sampling

The density of objects within a given area – in the case of central African forests this means great ape nests and dung - is typically estimated using distance sampling along line transects (Buckland *et al*. 2001). Ideally, a systematic design comprising a series of lines is drawn up across the whole of the area of interest, usually with the Distance software (Thomas *et al*. 2010[4]). If the area is known or suspected to contain spatially distinct areas that will affect animal density (usually variations in vegetation type and/or hunting pressure), the area is stratified to increase the precision of density estimates within each stratum. To estimate the density of the objects of interest, the perpendicular distance between the centre of the transect and the centre of each dung pile observed is measured. As this distance increases, visibility (i.e. detection) decreases due to a combination of distance and vegetation, so a proportion of dung is missed by the observers. Using the Distance software, this proportion can be estimated. If survey teams miss, for example, half the dung that is lying on the forest floor, and the proportion of dung missed was not calculated, then dung density would be underestimated by a factor of two. Calculation of the detectability function using the Distance software allows dung density (and the precision of that density) to be estimated. Many protected and other areas in DRC (Salonga, TL2, Kahuzi-Biega, the RFO and parts of Mai Tatu, parts of the Lac Tumba and Maringa Lopori landscape) have recently, or are currently, being surveyed using line transect methods.

To convert the density of objects such as dung or nests to animal density, production (i.e. defecation or nest-building) and decay (i.e. disappearance) rates of these objects need to be known: the density of the objects is divided by the product of production and decay rate. The population size of the species of interest can then be estimated by multiplying density by the area within the surveyed area. However, both dung production and decay rates for okapi are poorly known. The only available estimates come from the RFO population. The okapi dung production rate was given as 4.5 dung/okapi/day (SE 0.052) and the dung decay rate at 75 days by Hart *et al*. (2008), which are the figures usually used in calculating okapi population estimates from dung density. However, Hart and Hall (1996) reported dung production rate at 3.5 dung/okapi/day from captives maintained on natural diets at the Epulu facility in the RFO and dung decay rate at 7 and 21 days in the wet and dry season respectively, from cohorts of known-age dung pellet groups collected from captives and placed in the forest. In addition, according to Rosmarie Ruf of GIC (pers. comm., and see citation in Vosper *et al.* 2012) the decay rate could be a year or more, as some dung piles in the pens of the captive okapi at Epulu remained visible for over a year without fully decaying. An okapi dung pile was also still visible after around 6 months in the forest of the Watalinga region in northern Virunga National Park (S. Nixon, pers. comm.). Vosper *et al*. (2012) therefore used two dung decay rates to calculate okapi densities in 2005-2007 and 2010-2011 in the RFO: 75 and 180 days, the latter to account for Ruf's observations. The decay rate is expected to vary between sites and throughout the year; as for most species, dung is likely to decay quicker in the rainy season (Barnes *et al*. 1997, Breuer *et al*. 2010, Hart & Hall 1996, White 1995) although dung beetle activity may cause the inverse to occur (van Vliet *et al.* 2009). Consequently, and taking into account the potential for dung misidentification discussed above,

[4] http://distancesampling.org/Distance/index.html

previous extrapolations of okapi population numbers from dung-based distance surveys are likely to be inaccurate; reliable, site-specific estimates of okapi dung production and decay rates are needed if population numbers are to be estimated using these methods.

3.1.2 Recce methods

There are two types of 'recce' (reconnaissance walk) used in wildlife surveys in the region. One (a 'travel recce') is similar to the type of data collected on patrols (see below), where the most rapid trajectory between two points is augmented with selected georeferenced data records of human sign (as a rapid overview of the spatial distribution of threats: Hedges 2012), and sometimes unusual or key species sign (usually elephant, great ape, leopard sign, and, in our case, okapi sign).

The second type of recce survey (a 'guided recce') is carried out following a predetermined compass bearing, as straight as possible without cutting the vegetation, along what has been termed the 'path of least resistance' (Walsh *et al*. 2001). Usually, all human sign, all ape nests visible from the line, and all dung or animal footprints within a two-metre band are recorded (one metre each side of the observer). This method is used to provide additional spatial information in areas where a line transect survey is being carried out (in which case each transect is followed by one or two kilometres of guided recce). Alternatively, where wildlife densities are known to be very low, where insecurity is a concern necessitating minimal time to be spent in an area or where a first-cut survey is being employed as little is known about an area of suspected low wildlife density, a design consisting entirely of guided recces is carried out. The advantage is essentially lower cost: guided recces take roughly a quarter to a third of the time of a transect survey - but they cannot provide a density of the objects of interest. Guided recces provide both a relative abundance index (known either as the 'kilometric index' or encounter rate of sign per km) and, when mapped, provide distribution of abundance of sign (such as animal dung, human sign, ape nests, *etc*.) which can be used to compare distribution and relative abundance over time and space. Data from combinations of transects and recce surveys are increasingly analysed using occupancy methods in order to map the proportion of area occupied (PO) by a species, where the probability of detection is estimated (Mackenzie *et al.* 2002, 2006; Strindberg & O'Brien 2012).

As for other indirect methods, if the decay rate is comparable between years (per season), it is therefore possible to detect trends in the relative abundance of okapi. Nevertheless, when transect studies are feasible, it is highly preferable to use them because they avoid biases between observers, biases in the spatial locations of rangers, and biases caused by a focus on the monitoring of illegal activities (discussed below).

3.1.3 Patrol data

ICCN rangers carry out regular patrols through the forest, and collect some types of wildlife data as well as human sign data. Annually, anti-poaching teams cover far greater distances than survey teams, as they are deployed throughout the year; wildlife survey teams usually only carry out complete surveys once every 3-5 years in the region (Maisels 2010).

Spatial and temporal coverage, however, are both biased: they are subject to both security issues and the target of the patrols. Rangers cannot operate in zones where very dangerous militias are present, but tend to focus on areas where non-militia poaching is concentrated. Temporal coverage varies over time, as areas that are safe for rangers to patrol in one year may become too dangerous in other years. Wildlife data collection is low priority for rangers, as their focus is law enforcement. Dung encounter rates on patrols are typically 100 times lower than on recce surveys (Kasongo 2013). Finally, if hunting pressure increases over time, rangers pay less attention to mammal signs, and more attention to human signs, and will increase their speed during the patrols in order to pursue poachers across the forest, greatly reducing the probability of seeing and recording animal signs on the ground.

However, where censuses based on transects (first option) or guided recces (second option) are not feasible, and if it is not possible to monitor by camera trap or DNA analysis of dung, patrol data can show where animals are present (although not, for the reasons outlined above, where they are absent). A decreasing trend in the encounter rate of animal signs by patrols is not necessarily linked to a wildlife decline, and is generally discouraged unless the biases above are understood and controlled for. Other factors such as the rate of detection and spatial coverage of illegal activities can be examined to understand threats. For example, an increase in the number or extent of occurrence of poaching signs clearly demonstrates an increased pressure on wildlife. Areas are usually never patrolled in the same way each month or each year, as they are reactive (they rely on the results of intelligence and/or the most recent patrols to guide where each patrol is sent), so using such data from patrols to paint a picture of wildlife trends is unreliable.

A final problem with using patrol data to monitor certain wildlife species is that rangers are usually not given training in the identification of wildlife sign. Elephant dung is unmistakable, but there are several sympatric ungulate species in the region which produce pellet dung, including bongo, sitatunga, several duiker species, and two species of wild hog. Well-trained wildlife survey teams and rangers can usually distinguish between the dung of okapi and other species (Stanton *et al*. 2014a), but there is the possibility of mis-identification by untrained personnel; thus the 'okapi' dung recorded on patrols is likely to sometimes be that of other species.

3.1.4 Community monitoring

In the community forests (reserves) around Maiko National Park, wildlife monitoring has been adapted for use by local communities. Data on okapi presence was collected by trained forest 'guides' (often ex-hunters) from local communities between 2003 and 2009 as part of USAID-funded Central African Regional Program for the Environment (CARPE) activities for the Maiko-Tayna-Kahuzi Biega landscape and collated by UGADEC for inclusion into this okapi status review. Observations of okapi dung, tracks and feeding sign were recorded and geo-referenced during regular (usually monthly) forest surveillance and wildlife monitoring patrols. While it is not possible to calculate indices of abundance or survey effort from these records, they are important in documenting okapi presence, particularly towards the southern limits of the species' range.

3.2 Camera trapping

Camera traps have successfully captured images of wild okapi in the past (ZSL 2008; Figures 2 & 17). For species where individuals can be identified, such as okapi by the striped patterns on their hindquarters, capture-mark-recapture analysis can be applied to camera trap data. Repeated surveys are conducted in an area and the proportion of individuals found in multiple surveys can be used to estimate the population size. All okapi population estimates so far have been based on dung counts, with associated issues regarding estimates of dung production and decay rates, so this method could provide an important opportunity for independent evaluation of these population estimates.

Preliminary camera trap surveys by ZSL (Figure 8) found that it was possible to identify okapi individuals based on the markings on their hindquarters (Nixon & Lusenge 2008; Kümpel 2010), but not all okapi could be identified from the camera trap photos. In cases where identification is not possible, occupancy estimates can be derived from camera trap data when a minimum number of trapping days (*e.g.* 1,000) has been recorded in a survey grid. These do not provide an absolute population estimate, but can be used to detect trends in population. One relatively new technique which shows promise is the Random Encounter Model (Rowcliffe *et al*. 2008), which may allow population estimates without the requirement for individual identification; validation and refinement of this model is on-going.

Figure 8. Training an ICCN ranger in camera trap set-up and survey techniques, Virunga National Park. © Stuart Nixon, ZSL

Because camera trap methods do not rely on estimates of dung production or decay rate and have a low risk of misidentification errors, they have the potential to be very useful. While camera traps are set in the forest, images of many other species are also captured, providing data for additional studies at no additional effort or cost. One potential drawback to this type of survey is the high cost of camera traps, which are relatively fragile and liable to be stolen or destroyed if not adequately camouflaged and/or the local population is not supportive.

3.3 Genetic capture-mark-recapture

This method uses genetic analysis to identify individuals from the DNA contained in their dung (Figures 9 & 10). Surveys to collect dung samples are carried out at intervals, and as with camera trapping the proportion of individuals identified multiple times allows population estimates to be made. DNA analysis of dung samples can also provide information on population ecology at local scale and population structure across the species' range (Stanton 2014).

A long-term study in the RFO to compare all the above methods, including testing the potential for genetic population surveys *via* dung sampling, had been planned by ZSL as part of its range-wide okapi project, but this had to be cancelled after a serious attack by militia on the Reserve headquarters in 2012 (see Case Study 3 below), just when the study was due to commence, with the heightened insecurity preventing subsequent fieldwork in the reserve.

Figure 9. Okapi dung in the RFO. © Stuart Nixon, ZSL

Figure 10. Collecting okapi dung for genetic analysis. © Dave Stanton, ZSL/Cardiff University

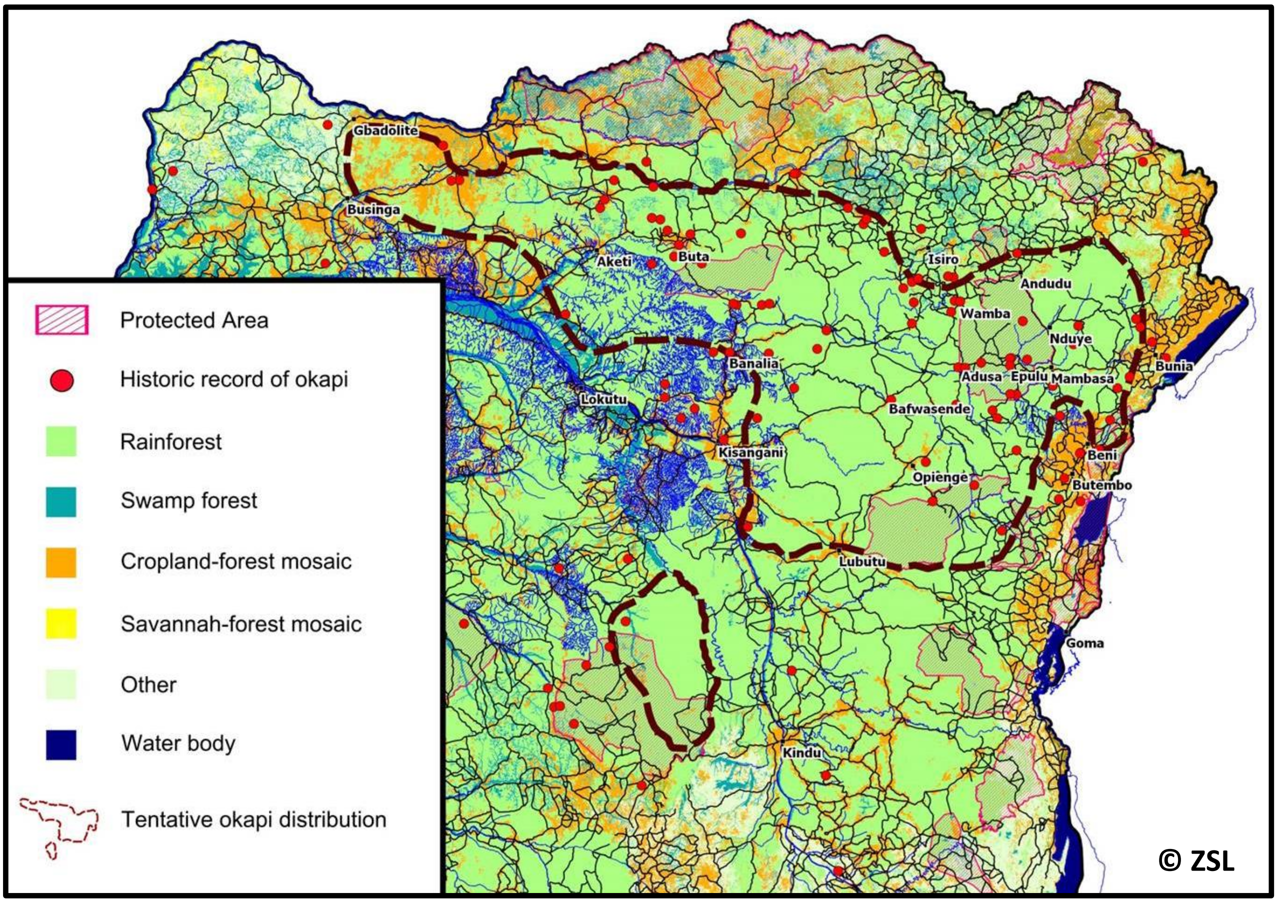
4. Distribution and populations

4.1 Distribution

4.1.1 Historic distribution

Since its discovery all confirmed records of the okapi originate from DRC, though its presence has also been occasionally reported in the Semliki forest of Uganda (Kingdon 1979; A. Rwetsiba, Uganda Wildlife Authority, pers. comm. 2015). Historically, the okapi has been recorded across most of northern and central Congo. Figure 11 shows historic records of okapi, based on Gijzen (1959), with additional points added from Kingdon (1979), and from a map showing historical records provided by the *Centre de Recherche en Sciences Naturelles* (CRSN, Lwiro, DRC). Historical samples provided by the Royal Museum for Central Africa, Tervuren, Belgium, were also mapped; the GPS coordinates were estimated based on the provenance of the sample and the information recorded when it was collected (typically “a day’s walk east from Stanleyville”, “5 km north of Kindu” or similar). These records have been used to develop a map showing the maximum geographical range over which okapi have been shown to occur historically (Figure 11). More detailed information on these historic records is provided in Appendix 1.

Figure 11. Map showing historic records of okapi occurrence, north-eastern DRC (land cover derived from satellite data [Globcover 2010]; tentative current okapi range adapted from shapefile provided by John Hart). © ZSL

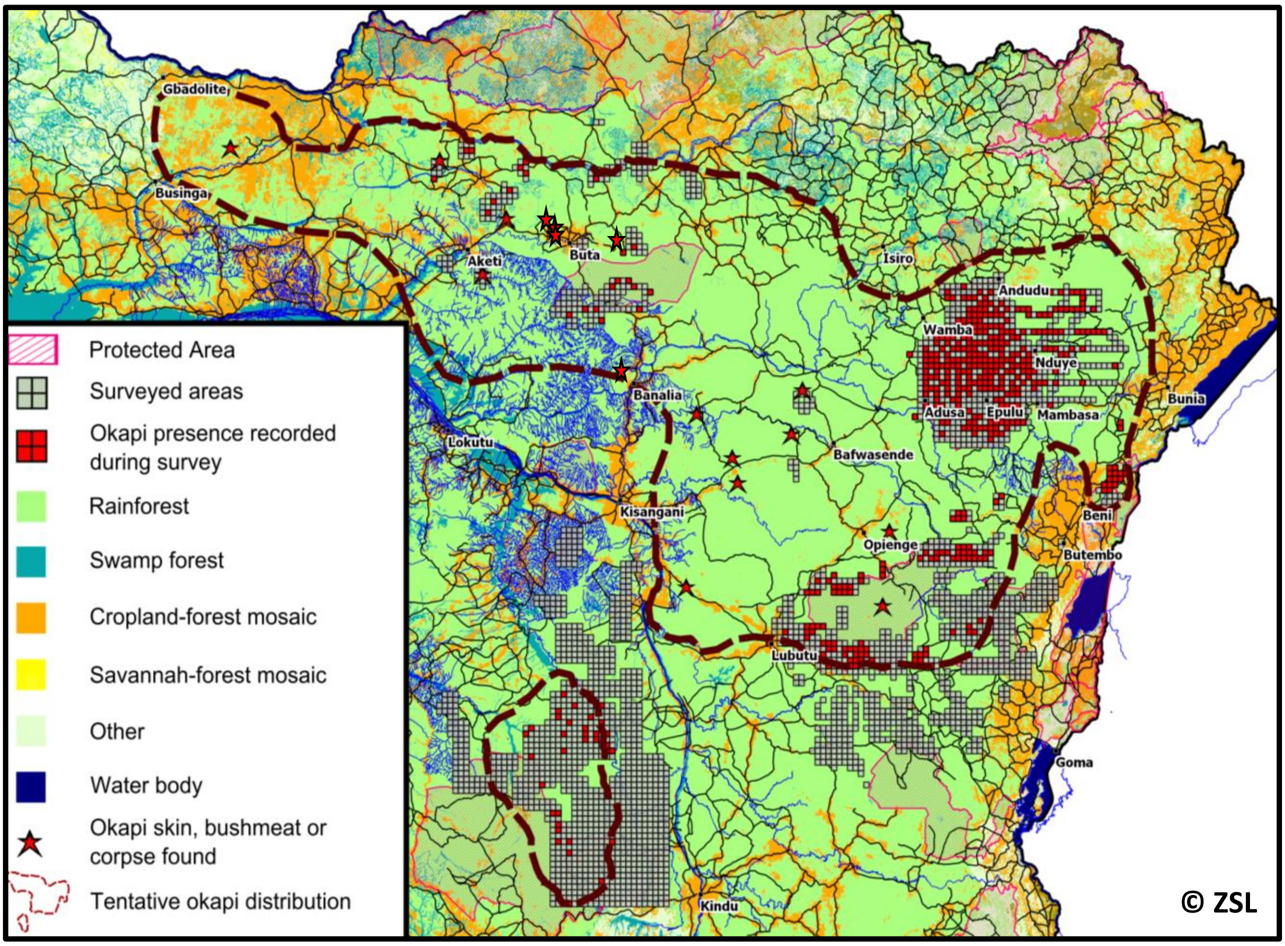


Some decline has undoubtedly occurred in association with the reduction of suitable habitat due to deforestation. For instance, okapi were recorded in the very west of northern DRC (at Libenge on the Ubangi River) in 1946, but by 1965, with the construction of a dense road network and associated environmental impacts, the presence of okapi in this area became very unlikely (Sidney 1965). Figure 11 shows that a number of historic records occur in areas that are no longer forested, such as in the north-east and north-west of the country, around Virunga National Park, and at the very southern limit of the historic range. In the past, a large part of the forest located between protected areas sheltered okapis. While okapi presence has been confirmed from some such areas (*e.g.* Usala, Buta-Aketi, Regolu, Mai Tatu, *etc*.), without comprehensive surveys we cannot draw conclusions about the full extent of their occurrence here.

4.1.2 Current distribution

Prior to the 2013 okapi conservation strategy workshop, a map of recently recorded (post-2003) okapi presence across the range was compiled by ZSL by georeferencing data from published literature and reports and unpublished field surveys where provided (Quinn *et al.* 2013). During the workshop, participants with on-the-ground local knowledge studied this map and added further information. Participants also provided datasets that had not been available during the review process (*e.g.* Maiko and RFO ranger patrol data and data from surveys in Rubi-Tele in 2011 and in the area around Bafwasende) and others have provided data collected subsequently for inclusion in an okapi survey database (Appendix 2). Figure 12 maps the known recent geographic waypoints for okapi presence collated during the review process and the workshop, based on a grid of 5.6 x 5.6 km cells, the size used by most reported surveys, with each surveyed grid square registering either presence or absence. Appendix 2 gives the sources of all data presented in Figure 12 and provides further information on the datasets, and greater detail is provided in Annex 1 of Quinn *et al.* 2013.

Figure 12. Map showing tentative current (post-2003) okapi distribution across north-eastern DRC, and presence/absence within 5.6 x 5.6 km cells recorded during field surveys, supplemented by expert participatory mapping during the Kisangani workshop (land cover derived from satellite data [Globcover 2010]; okapi range adapted from shapefile provided by John Hart). © ZSL



As Figure 12 shows, recorded presence is patchy and concentrated in and around protected areas; which also suggests that these data are biased towards regions where surveys have been conducted and monitoring information was available. The remoteness and inaccessibility of much of the okapi's habitat make fieldwork logistically difficult, and insecurity in DRC over the past two decades has further restricted survey activity. As a consequence, extensive parts of the okapi range are poorly studied. In addition, okapi are rarely observed and their occurrence can easily go undetected, especially at low densities. A tentative okapi range has been constructed by combining available recent survey data - utilising molecular species identification where this information was available (Stanton *et al*. 2014a) - with community reports which confirmed recent findings of skins or bushmeat, and knowledge of the historic range coupled with present forest cover and habitat type. This range – the Extent of Occurrence (EOO) - is 383,190 km^2 and is shown as a dashed outline on Figure 12. However, this includes unsuitable habitat such as degraded forest, swamp forest and urban areas; the estimated area of suitable forest habitat within this range, based on a map of land cover

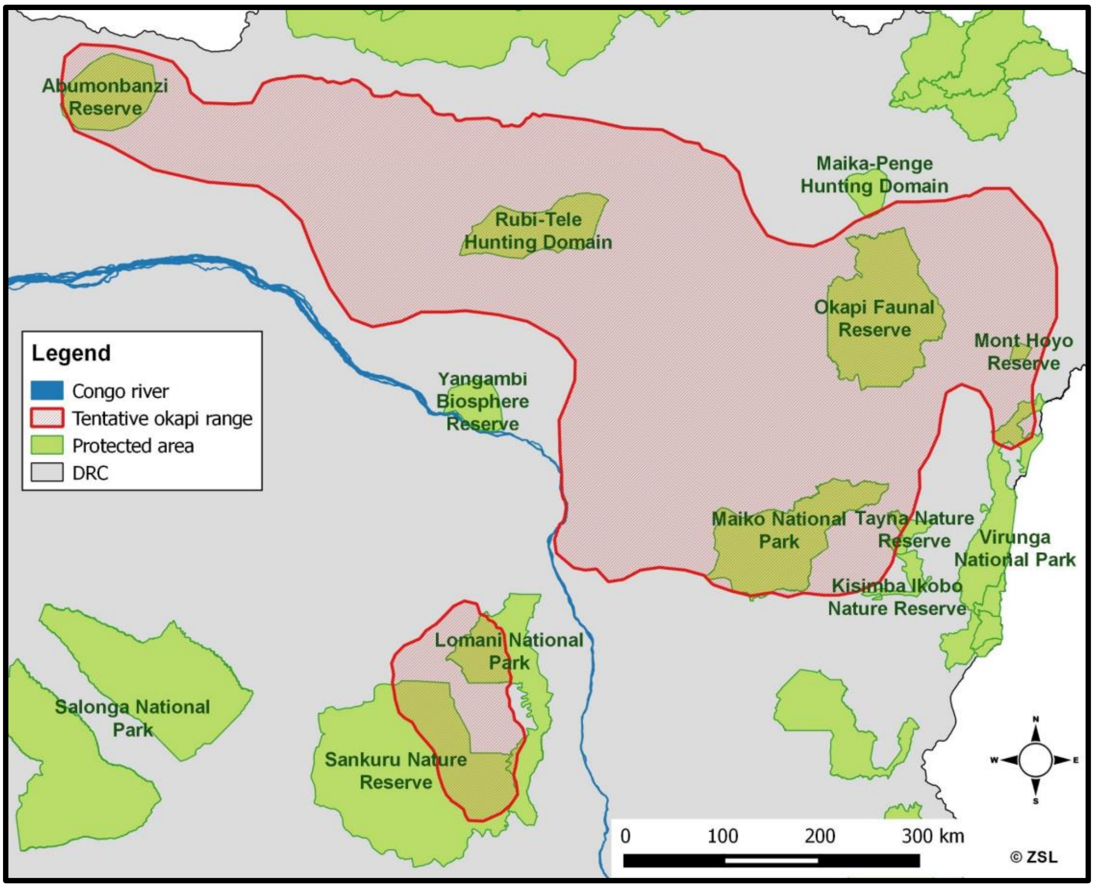
(Globcover 2010), is 244,405km². Within this, the known Area of Occupancy (AOO) is 14,112 km^2, based on 450 (3.5%) of 12,764 grid squares with confirmed presence, though this is likely to be a substantial underestimate as surveys have been conducted in only 1,994 (15.6%) out of these 12,764 grid squares so far.

The majority of the okapi distribution is to the north and east of the Congo river, from Maiko forest north to the Ituri forest, then west through the Rubi, Tele and Ebola river basins, extending north towards the Ubangi river, and east as far as the eastern side of the Semliki river. Okapi have a much smaller, distinct distribution to the west and south of the Congo river, extending from the west bank of the Lomami river west to the upper Lomela and Tshuapa basins (Hart 2013, Figure 12). Population genetic analysis indicates that the current okapi populations on the same and opposite sides of the Congo river diverged at similar times, during the Pleistocene, and identical genetic lineages present on both sides of the Congo river show that okapi have moved across this large geographic feature in the past (Figure 19). This indicates that the current, 'disjunct' distribution of okapi is more related to Pleistocene forest fragmentation in the Congo Basin than population isolation due to riverine barriers (Stanton *et al*. 2014b).

4.2 Known populations

This section summarises known populations of okapi and their status. Most survey work has consisted of recce surveys, and as a result few population estimates have been made. Currently the only post-conflict okapi population estimates are those for the RFO (Hart *et al*. 2008; Vosper *et al*. 2012). The location of nationally protected areas across the tentative present okapi range is shown in Figure 13.

Figure 13. Map of protected areas across the tentative current okapi range in DRC. © ZSL



4.2.1 Okapi Wildlife Reserve (RFO)

The 13,729 km^2 Okapi Wildlife Reserve (RFO) protects one-fifth of the Ituri Forest, in the north-east of the okapi range (Figure 13). Three management areas have been proposed, though at present they have no legal basis. Okapi occur in all three of these zones:

1) A fully protected core zone of 2,820 km^2 where all hunting would be prohibited. The government is being encouraged to make this proposed core zone a national park (J. Hart, pers. comm.).

2) An area of 9,500 km^2 dedicated to traditional use and self-regulated hunting using traditional methods.
3) Agricultural and human settlement zones. These exist to accommodate populations living within the reserve, but expansion of agriculture is carefully managed.

The first scientific wildlife surveys of the park were conducted during the dry and wet seasons from 1993-1995. Okapi dung density was estimated from line transects using distance sampling. Transects were spread out over most of the reserve but the design involved some arbitrary decisions and was not therefore not random or systematic (Hart & Hall 1996). Aside from a set of incomplete surveys carried out as part of the MIKE (Monitoring the Illegal Killing of Elephants) programme in 2000-2002 (Beyers 2008), insecurity caused by the civil war made further study impossible until 2005, when the same 'monitoring transects' were repeated over another two-year period. In addition to the repetition of the original transects, systematically placed transects were conducted from 2005-2007 to provide a statistically more robust baseline for future monitoring. Further systematic transects, following a similar design, were conducted in 2010-2011 (Vosper *et al*. 2012). Unlike all previous surveys these were done exclusively in the dry season, over a period of three months, to allow for future surveys to be carried out when dung and nest decay rates were likely to be less variable than when spread out over several seasons and multiple years (Table 2). A decline in okapi dung density of 43% was observed between the monitoring transects in 1993-1995 and 2005-2007 when the same transects were compared. Hart *et al*. (2008) attribute this to the impact of the civil war that took place in the intervening period. Between 2005-2007 and 2010-2011, the surveys based on the systematically designed transects suggested okapi dung density increased significantly at reserve-level (Vosper *et al*. 2012; though see below). Of the other medium-large mammal species (elephants, chimpanzees, and forest duikers), only elephants declined over the 2007-2011 period, suggesting that poaching pressure during this period was especially skewed towards obtaining ivory.

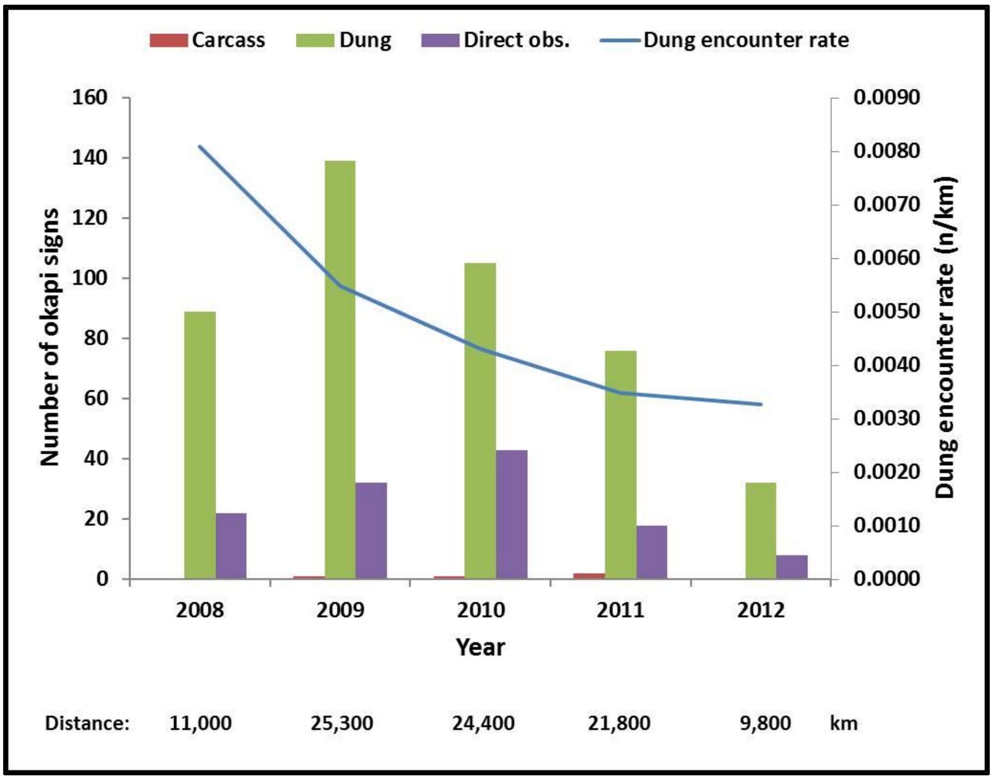
Table 2. Scientific surveys recording okapi in the Okapi Wildlife Reserve (RFO). Information compiled from data provided by survey teams. [1,3] Hart *et al*. 2008; [2] R. Beyers, pers. comm.; [4] Vosper *et al*. 2012

Survey period	Surveyed months (n)	Season	Method	Distance covered (km)	Okapi dung encountered (n)	Okapi dung encounter rate (/km)
Oct 1993 - Nov 1995[1]	19	Dry + wet	Non-random transects	586.8	176	0.30
May 2000 - Mar 2002[2]	13	Dry + wet	Non-random transects	273.58	64	0.23
Apr 2005 - May 2007[3]	11	Dry + wet	Non-random transects	280	57	0.20
			Systematic transects	128	36	0.28
			Guided recces	1369.6	342	0.25
Dec 2010 - Feb 2011[4]	3	Dry	Systematic transects	144	82	0.57
			Guided recces	1216	562	0.46

As discussed above, rainfall is usually - but not always - inversely correlated with dung decay rate. The higher dung density recorded in 2010-2011 than in 2005-2007 could be because the 2010-2011 survey was conducted over the dry season, resulting in a higher standing crop of dung than an average over many seasons. Interestingly, using all of the data, there was no significant difference in duiker dung density between 2005-2007 and 2010-2011, despite the fact that duiker dung was an order of magnitude more abundant in both survey periods than okapi dung. Nevertheless, when okapi dung density data from the 2005-2007 transects were compared with the 2010-2011 data from the same months (December, January, February) and the exact same area (the north-eastern 'red zone' of the RFO - 5,143 km^2 - which was 36-40% of the whole area surveyed in both periods), there was no significant difference in okapi dung density between these two samples (Maisels 2014). This suggests that within that area, okapi numbers might have been stable between these two periods, or at least that no change was detected.

A second dataset running from 2008-2013 was collected by ICCN rangers patrolling the RFO and who had recorded okapi carcasses, dung and number of individuals encountered during their patrols (Kasongo 2013; Stokes 2014). Up to 25,000 km were covered by patrols each year. Patrol data can, in some situations at least, offer a valid means of monitoring populations, but must be treated with great caution (see section 3.1.3 above). The patrol data show a trend towards a decline in the dung encounter rate between 2008 and 2012 (Figure 14), but the high spatial variation in patrol coverage means that these data are also likely to show high bias (Stokes 2014). Because rangers tend to patrol more often in the heavily human-influenced regions of the park, they are more likely to be increasingly covering the areas where okapi do not occur. However, on the basis of the precautionary principle, this could indicate that the situation for okapi may be worsening and further monitoring is warranted.

Figure 14. Trends in okapi signs and dung encounter rates during ICCN patrols conducted in 2008-2012, including information on distance covered each year (produced from data provided by ICCN, as presented by Kasongo 2013).



A population genetic study (Stanton *et al*. 2015a) was carried out using the dung samples collected from the RFO in 2010-2011 (Vosper *et al*. 2012). There was no genetic structure detected in the park, and no isolation by distance. This indicates that there are no barriers to dispersal for okapi within the RFO, and it is one freely-intermixing population. This suggests that, at present, okapi in the RFO have not been impacted by population fragmentation. Also, their apparent high dispersal ability, unrestricted by landscape features, implies that the population may be robust to fragmentation (at least by rivers). The RFO contains a relatively high level of genetic diversity, with five mitochondrial genetic lineages found in the reserve, compared to the total of six found throughout the species' range (Stanton *et al*. 2014b), and relatively high levels of heterozygosity (Stanton *et al*. 2015a). This high genetic diversity suggests that the RFO still contains a viable okapi population, and therefore should be a priority area for okapi conservation.

In June 2012 the reserve headquarters were attacked by a heavily armed gang of illegal gold miners and elephant poachers who killed 7 people and all 14 of the captive okapi kept at the headquarters (see Case Study 3). Following this attack, with the leader of the gang, 'Morgan', at large until April 2014, when he was killed in a shoot-out with Congolese army forces, the influence of ICCN within the reserve significantly decreased. Thousands of illegal miners entered the reserve and hunting increased dramatically with ICCN unable to maintain control (A. Vosper, pers. comm.), but as of early 2015 ICCN had rebuilt infrastructure, cleared out over 10,000 miners and over 20 mines and re-established control of over 50% of the reserve (Mapilanga, 2015; Okapi Conservation Project 2015; Figure 15).

Figure 15. ICCN office building in Okapi Wildlife Reserve headquarters, burnt-out following rebel attack in June 2012 (top) and rebuilt in March 2014 (bottom). © OCP 2015

4.2.2 Maiko National Park and adjacent forests

Maiko National Park covers an area of 10,800 km^2 and is located in one of the most remote areas of the Congo forest, to the south of the Ituri forest (Figure 13). As a result of its seclusion, for more than 40 years it has been a refuge for armed rebels (the Simba Mai Mai) who hunt, mine and farm within the park. Hart & Sikubwabo (1994) surveyed the park from 1989-1992 using transects and recces and estimated the okapi population at 2,300-4,300 individuals based on dung encounters. More recent surveys conducted by Dian Fossey Gorilla Fund International (Nixon 2005) and the Wildlife Conservation Society (Amsini *et al*. 2006) in the southern (Lubutu) sector of the park used recce methodology. It was concluded that dung encounter rates and distribution were similar to those obtained previously, suggesting that the population here may not yet have experienced a significant decline. Another survey in the north-eastern sector of the park concluded that large mammal populations there were also relatively intact (Amsini *et al*. 2005). This study suggested that, in the north sector, hunting was limited to local populations' needs, without export of bushmeat outside this area. However, these surveys covered only a limited area of the park, and no scientific surveys within the park have been conducted in over six years. The evidence suggests, however, that wildlife populations are severely threatened, and may have decreased significantly since 2006 (Nixon 2010). During the okapi conservation strategy workshop ICCN provided patrol data on Maiko National Park, including records of okapi. These data were collected in 2012 and therefore offer the most recent snapshot of the okapi population in Maiko, though they cannot be directly compared with the recce surveys, which obviously have a different focus to patrols. Reports from those working in the park are that okapi populations are being hunted, and two infant okapi were confiscated by ICCN within the park in 2013 from rebels who claimed they had been orphaned.

Several surveys have also been conducted in the forests adjacent to the southern sector of the south of the park (in 2005, Nixon *et al.* 2005, 2010, Nixon 2010, and 2014, S. Nixon, pers. comm.), confirming okapi presence in the region of Mundo, towards the headwaters of the Lubutu river and on the east and west banks of the Okungo river. Surveys south of the Kisangani-Walikale road between 2005 and 2014 (S. Nixon, pers. comm.) have not identified the presence of okapi on the north bank of the Lowa river (Figure 16). Historic records of okapi are lacking for this region and anecdotal evidence from local hunters and village elders suggests okapi have either never ranged this far to the south or have been extirpated for at least several generations.

Figure 16. Map of Maiko National Park sectors and adjacent community reserves (adapted from source map and shapefiles provided by Stuart Nixon). © ZSL

Usala

To the east of Maiko National Park lies the extensive Usala forest. Covering approximately 10,000 km^2 it is among the most intact, remote, roadless and inaccessible expanses of tropical rainforest remaining on the African continent. With Maiko National Park to the west and north, the Tayna and Kisimba-Ikoba natural reserves to the east and a chain of rugged mountains to the south, the Usala forest remains largely unexplored. Historical records of okapi in Usala are sparse, but surveys in the western part of Usala (in 2007, Nixon *et al.* 2007, and 2014, S. Nixon, pers. comm.) have confirmed the presence of a low density okapi population between the Lindi, Etabiri and Tamaria rivers. Community monitoring programmes implemented between 2004 and 2008 north of the Oso river in Walikale territory (UGADEC, pers. comm.) have also confirmed okapi presence at a number of localities between the eastern Maiko National Park boundary and the town of Pinga to the east. These observations support historical records that the Oso river is the (current) southern range limit for okapi. The overall remoteness and low human population density of the Usala forest suggest that this largely unexplored region has great potential for the conservation of okapi, however widespread presence of armed groups and illegal mining operations currently present serious challenges for the implementation of conservation activities.

Tayna Nature Reserve

Anecdotal reports exist for okapi presence in the low altitude forests at the north-western limit of the Tayna Nature Reserve and towards the eastern limit of Maiko National Park, but these are yet to be confirmed (S. Nixon, pers. comm. 2015).

4.2.3 Virunga National Park and nearby Mont Hoyo Reserve

In the extreme east of the okapi's range, Virunga National Park covers around 7,500 km^2 and is the oldest national park and first UNESCO natural World Heritage site in Africa (Figure 13). Okapi are found in the Watalinga forest (also referred as 'Semuliki' or 'Semliki' forest) in the northern part of the park, from where the type specimen originates (Sclater 1901). More recently, okapi presence was first recorded by patrol and then confirmed on both sides of the Semliki river in 2008 during ZSL-ICCN recce surveys (Nixon & Lusenge 2008). These and subsequent surveys also tested out camera traps as a potential method of surveying okapi and captured the first full images of wild okapi by camera trap (Nixon & Lusenge 2008, ZSL 2008, Kümpel 2010, Figure 2). Across the whole of the survey region, the dung encounter rate gave an estimate for okapi density of 0.095/km^2 (with the caveat that density cannot be accurately determined *via* recces), though in the region containing okapi the localised encounter rate was similar to that in the RFO (Nixon & Lusenge 2008). The study suggested that the total population of okapi within the survey area may be only 50-100 individuals, though this estimate is based on extrapolations from dung encountered on recces so, due to the reasons discussed above, serves as a signpost rather than a scientific estimate. There were reports of okapi found to the north of the survey area that the survey team had not been able to access due to insecurity (*ibid.),* but a chimpanzee-focused survey covering other forested areas of Virunga National Park did not find evidence that okapi were more widespread beyond the Watalinga forest (Plumptre *et al*. 2008). The okapi population here is clearly small and vulnerable, and incursions, disturbance and hunting have increased as security declines (J. Hart, pers. comm.).

Mont Hoyo Reserve covers roughly 200 km^2 and is located approximately 40 km to the north of Virunga National Park. Mont Hoyo was abandoned by rangers in 1998 due to the presence of armed groups. In 2010 ICCN re-established a presence in the reserve, but resistance from local inhabitants has at times been fierce, with them not recognising the legitimacy of the reserve (J. Fataki Bolingo, pers. comm., A. Plumptre, pers. comm.). Nonetheless, patrols are once again being conducted and an okapi dung sample has been obtained from Mont Hoyo for genetic analysis. The forest between Virunga and Mont Hoyo is relatively intact, offering significant potential to develop a 'conservation corridor' between these two protected areas (Plumptre *et al*. 2008; Kümpel 2008). Such a corridor may be essential to ensure the long term viability of the okapi population in the area given the small size of the Virunga population.

4.2.4 Rubi-Tele Hunting Reserve

The Rubi-Tele Hunting Reserve is located in the middle of the okapi range (Figure 13). Unlike the reserves discussed above, this area is not fully protected - it is classed by UNEP as a reserve for resource management - though it does have a contingent of ICCN guards. However, the precise legal status and indeed area of this reserve is unclear (Hart 2007). The acknowledged protected area is 9,080 km^2. The most recent quantitative survey completed, in 2011, used recce methodology and found that the dung encounter rate for this area was the lowest for any of the protected areas known to contain okapi populations, suggesting that the population exists at low density (Lukuru Foundation, unpubl. data). This is perhaps partly due to the fact that hunting with snares and firearms has been ongoing for longer here than in other reserves (Hart 2007), though probably more important is that the habitat here is less suited to okapi than elsewhere in the range (J. Hart, pers. comm.). In 2007, four guards with one gun between them were charged with controlling the whole of the reserve (Wildlife Direct 2007), though the capacity of the rangers and station has improved since then (Hicks 2013). Diamond mining and the associated reliance of miners on bushmeat is the major threat to the wildlife within the reserve, with one area near the Aruwimi river reported to contain 5,000 miners (Wildlife Direct 2007), and okapi skins and carcasses have been recorded and in some cases confiscated from the area (Hicks 2013, 2014). The presence of okapi in the reserve was also confirmed by interviews conducted in 2011-2013 (Hicks 2014) and okapi were captured by camera traps by the Max Planck Institute PanAfrican team in 2015 (Figure 17).

Figure 17. Okapi captured by camera trap in 2015 in the Rubi-Tele Hunting Reserve. © PanAfrican Programme: The cultured chimpanzee, MPI-EVA

4.2.5 Tshuapa Lomami Lualaba (TL2) landscape and the proposed Lomami National Park

This landscape, between the Tshuapa, Lomami and Lualaba (TL2) rivers, is found on the western side of the Congo river. Very little was known about the biodiversity of this area until surveys were conducted from 2007 to 2009 (Hart 2009a). Exploratory surveys documented okapi presence, with molecular confirmation that dung samples were from okapi (Stanton *et al*. 2014a), representing an extension of the known present-day range. An estimate of okapi population size is not available, though observations suggest okapi are uncommon (Hart 2009a) and that distribution is localised, with the species occurring only between the Lomami and Tshuapa rivers (J. Hart, pers. comm.). The area is relatively untouched and free of roads, as can be appreciated from Figures 11 and 22. Within this landscape an area of 8,874 km^2 has been proposed as a national park, running down the Lomami river. Created in 2011, the Lomami park has been ratified by two successive administrations in Maniema and Orientale provinces as a provincial park and is recognised by ICCN and actively patrolled; the proposal for national park status is as of 2015 with the Prime Minister (J. Hart, pers. comm. 2015). Although all of the okapi genetic lineages found in TL2 are also found elsewhere in the range, the landscape contains a high occurrence of 'rare' genetic lineages (Stanton *et al*. 2014b). Alongside the RFO, the TL2 landscape is therefore also a priority area for okapi conservation.

4.2.6 Buta Aketi area

This area, in the north of the okapi's range, was surveyed in 2007-2009 (Hicks 2009, 2010). Okapi were found only to the south of the Uele river, and Hicks reports that judging by dung encounter rates they have a localised distribution (*ibid*.). Okapi dung was found in the forests adjacent to the villages of Leguga, Mbange (near Aketi), Zongia (near Likati) and Ngume (east of Buta and north of the Rubi river). Freshly-poached okapi carcasses and/or skins were found in the Ngume and Mbange forests, in addition to a number of skins of unknown provenance found in and around Buta. Okapi appeared to be completely absent from the forests to the east of the relatively small tributary of the Uele, the Bima river, despite the fact that the forest-types seemed similar to areas of occurrence and there were still elephants and many chimpanzees there (thus indicating that hunting is an unlikely explanation for their absence). Okapi sign was also absent south of the town of Aketi and in proximity to the town of Buta. Locals said that okapi had been present in those areas before, but had recently been hunted out by Bangalema nomadic hunters (*ibid*.).

4.2.7 Abumonbanzi/North Ubangi/Gbadolite-Businga region

On 14th June 2013 Radio Okapi carried a report that 30 okapi had been killed in the last year in the '*Réserve d'Abumonbanzi*' near Gbadolite in North Ubangi, in the extreme north-west of the okapi's range (Figure 13). Soon afterwards, Omari Ilambu of WWF forwarded photographic evidence provided by the ICCN representative from Gbadolite, who also acts as the reserve's site manager, of a recently killed okapi in the reserve. Scientific evidence of the presence of okapi in the North Ubangi rainforest was recently confirmed in a formal publication (Ngbolua *et al*. 2014; Figure 24).

4.3 Population status

East (1999) estimated that the total okapi population may be over 10,000 and Hart (2013) estimated 35,000-50,000, but both – notably differing - sets of figures are perhaps better regarded as 'guesstimates' as they rely on extrapolation of a limited number of patchily distributed, dung-based surveys. Current numbers are believed to be low and declining, but there is no reliable estimate of current population size.

The only data on okapi population size come from the line transects conducted in the RFO and Maiko National Park detailed above. Given the issues described above, related to seasonality and specific survey location and the large uncertainty over okapi dung decay rates, population size and trends even within the relatively well-studied RFO should be treated cautiously. In addition, the Maiko survey was conducted over 20 years ago, before the civil war (Hart & Sikubwabo 1994).

Estimates of the total population combine these studies with the best guesses of experts working throughout the range. These should also be treated with caution as okapi density is known to vary significantly and unpredictably throughout the range, often being uncommon or dispersed in localised areas, the extent and cause of which is poorly known. Okapi dung is found at low densities, commonly resulting in inadequate sample sizes for statistical analysis, and even those frequenting okapi areas such as local villagers and those conducting wildlife surveys rarely encounter okapi in the field.

The 2008 IUCN Red List assessment estimated the total okapi population at 10,000-35,000 animals and classed the species as 'Near Threatened' (IUCN SSC Antelope Specialist Group 2008). However, this assessment was based on data collected up to 1998 only (East 1999; Hart 2013), and key to the assessment was that the large population in the RFO remained stable. With more up to date (albeit still limited) information available, a Red List reassessment was one of the first priorities of the newly formed IUCN SSC Giraffe and Okapi Specialist Group and this was carried out by the participants of the conservation strategy workshop in Kisangani in May 2013 (Mallon *et al.* 2013).

It is widely considered that there was a decline in the okapi population, along with other species, following the decade-long civil war which ended in the early 2000s, as indicated by the 43% decline in RFO okapi dung density recorded in transect surveys between 1993-1995 and 2005-2007 (Hart *et al*. 2008). While it is unclear whether or to what extent this decline has continued following the end of the civil war, with conflicting trends from the systematic surveys and patrol reports conducted in RFO since 2005-2007 (see section 4.2.1 above), the threats to the okapi have certainly increased (see section 8 below). Since 1980, expansion of human settlement, deforestation and forest degradation have eliminated important portions of the okapi range, in particular in the southern and eastern Ituri forest where the species was at one time abundant, and approximately one-third of the okapi's known distribution is likely to be at risk by major incursions during the first quarter of this century (Hart 2013). While okapi can coexist with small-scale, low-level human occupation of the forest, they disappear in areas of active settlement or disturbance (*ibid.)*

For the RFO, since the rebel attack on its headquarters in June 2012 (see section 4.2.1), the presence of armed groups and an influx of illegal miners and poachers has reduced the ability of the reserve authorities to protect the reserve and this is likely to have ongoing implications for resident wildlife populations. RFO was until recently the most effectively protected okapi site with resident rangers and an active conservation programme and the overall rate of decline here is inferred to have been equalled or exceeded elsewhere (Mallon *et al.* 2013).

Given this, all workshop participants agreed that, taking the precautionary principle into account, the okapi population was in decline and that the 2008 Red List status did not reflect reality (Figure 18). A Red List reassessment was submitted to IUCN following the workshop, and on 26th November 2013 the okapi was officially reclassified as 'Endangered' (under criteria A2abcd+4abcd) on the IUCN Red List, according to a decline in population size >50%, observed during the last three generations (where generation length = 8-10 years; Leus & Hofman 2012), *i.e*. 24 years (Mallon *et al*. 2013; Box 1).

Box 1. Justification for assessment of okapi as Endangered (A2abcd+4abcd) on the IUCN Red List of Threatened Species (Mallon *et al.* 2013; http://www.iucnredlist.org/details/15188/0)

Okapi have been undergoing a decline since at least 1995 that is ongoing and projected to continue, in the face of severe, intensifying threats and lack of effective conservation action which is hindered by the lack of security. The rate of decline is estimated to have exceeded 50% over 3 generations (24 years), based on figures from surveys in the Okapi Wildlife Reserve (*Réserve de Faune à Okapis*; RFO) suggesting a 43% decline over the period 1995-2007, which some reports suggest continued in the period thereafter. The RFO has until recently been the best protected site and it is inferred that the rate of decline here is at least equalled in other parts of the okapi range. Although monitoring is only available to support estimates of declines in RFO since 1995, reports of declines or extirpations in other parts of the range and loss and degradation of habitat have been ongoing since 1980. The change in category between 2008 (Near Threatened) and present (Endangered) is non-genuine as the new information suggests that the current categorisation should have been applied in 2008.

Figure 18. Group okapi Red List assessment at the okapi conservation strategy workshop, Kisangani, 2013. © ZSL

5. Population genetics

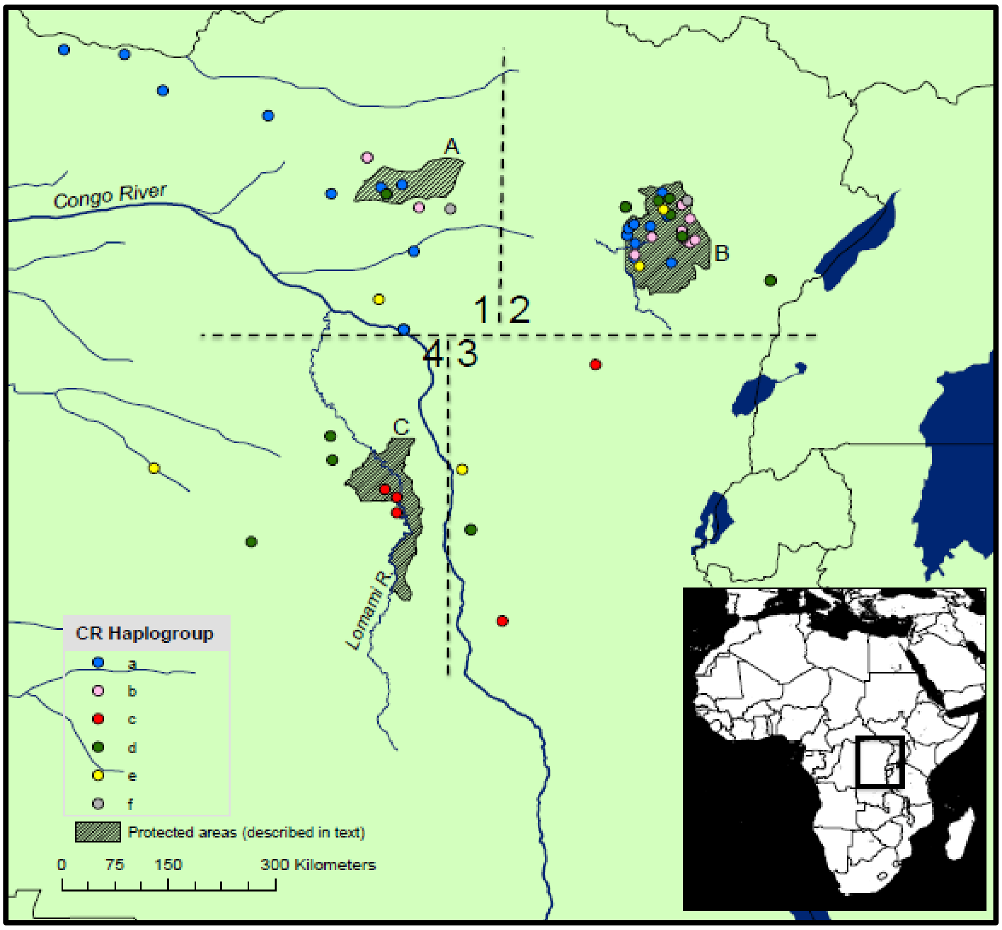
Population genetics can be used to determine aspects of species' ecology, distribution, population sizes and evolutionary history. This type of genetics can be carried out using non-invasively collected samples such as dung, dried skins or museum samples. This can be particularly useful for cryptic or elusive species like okapi, which are difficult to study by more traditional methods.

Okapi population genetics has been investigated as a part of a PhD project entitled 'Phylogeography, population genetics and conservation of the okapi (*Okapia johnstoni*)' (Stanton 2014). This was a NERC (UK Natural Environment Research Council) CASE (Collaborative Awards in Science and Engineering) studentship between Cardiff University and ZSL's Institute of Zoology with ZSL-DRC as the CASE partner. The PhD was carried out from October 2010 to March 2014. The objective of this PhD was to use genetics to further scientific knowledge of okapi and inform *in situ* and *ex situ* okapi conservation management.

This translated to a number of aims, each of which formed a chapter of the thesis and corresponding peer-reviewed papers:

- Create genetic resources for okapi to allow further study: 'Microsatellite loci for the okapi' (Stanton *et al*. 2010)
- Further knowledge of okapi distribution: 'Okapi south-west of the Congo River' (Stanton *et al*. 2014a)
- Enhance knowledge of evolutionary history of okapi: 'Range-wide phylogeography of okapi' (Figures 19 & 20; Stanton *et al*. 2014b)
- Further understanding of okapi behavioural ecology: 'Enhancing knowledge of the okapi using non-invasive genetics' (Stanton *et al*. 2015a)
- Genetically characterise the captive okapi population: 'Genetic structure of captive and free-ranging okapi.' (Stanton *et al*. 2015b)

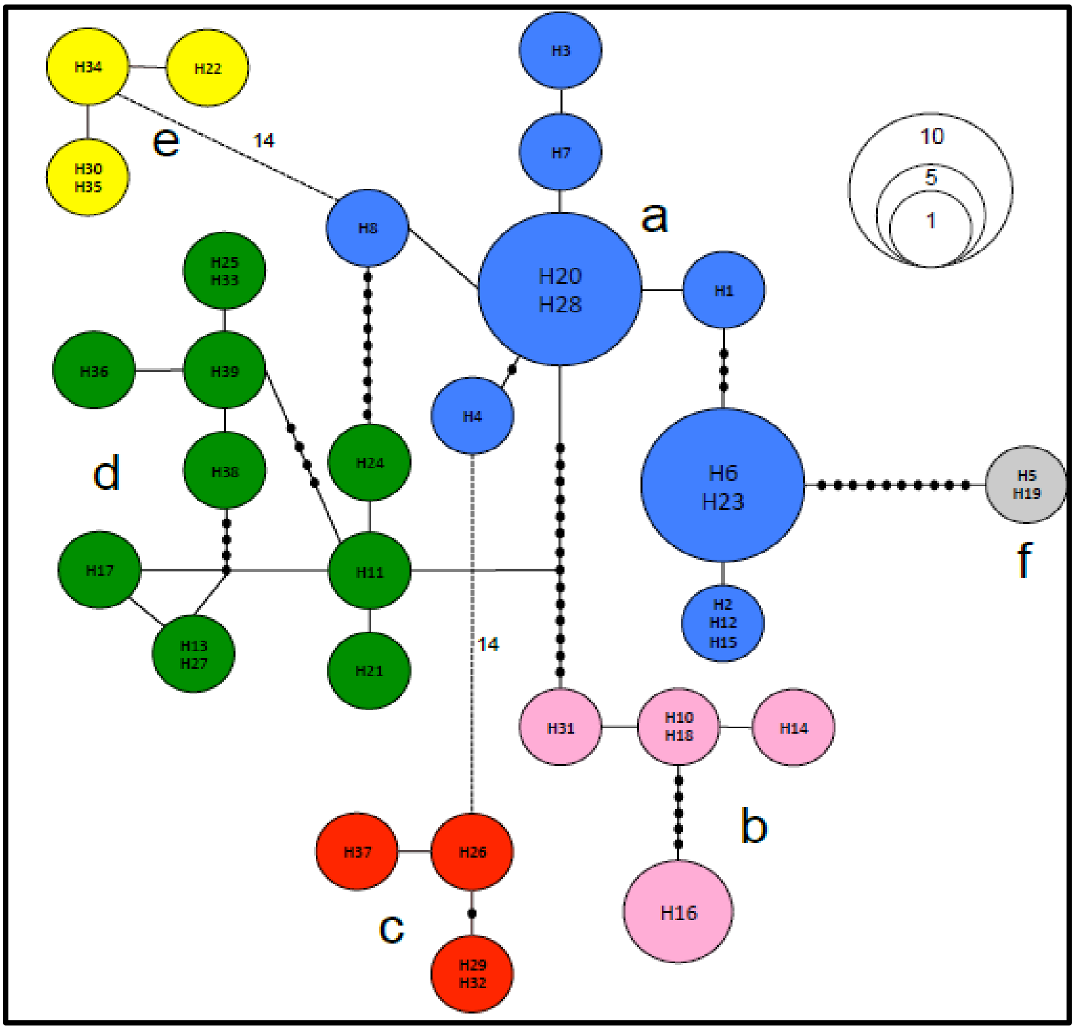
Figure 19. Sampling locations of the six major genetic lineages (a-f) detected for okapi (from Stanton *et al*. 2014b).



Analysis was carried out on a combination of faecal, skin and museum samples. The majority of the samples were provided by or in collaboration with partners (Royal Zoological Society of Antwerp, Lukuru Foundation, WCS, ICCN and ZSL; all with permission of ICCN).

Genetics has been a very useful tool for addressing a wide variety of ecological and conservation questions for this elusive species. Further work should focus on more comprehensive sampling throughout the okapi's range. In particular, extending sampling outwards from the RFO toward Maiko NP would help to get a better idea of population connectivity between protected areas. In addition, more samples from south-west of the Congo river would help to get a better idea of the conservation situation (in particular population size) for okapi in and around the new Lomami National Park. Moreover, more samples from captive okapi outside of Europe, in particular the US, will help to guide future captive management. Finally, genetic identification of dung could also be useful for the future monitoring of okapi populations in the wild.

Figure 20. Genetic network with the six major genetic lineages (a-f) detected for okapi (from Stanton *et al*. 2014b). Haplotypes are grouped into haplogroups by colour. The circle diameter is approximately proportional to the number of samples with that particular sequence. Black dots (or numbers on lines) represent the number of mutational steps between sequences.



6. Role of the captive population

In November 2011 representatives of the Okapi Species Survival Plan (SSP) and the Okapi European Endangered Species Programme (EEP), as well as representatives of the Okapi Conservation Project in RFO, held a meeting to discuss the role of the captive population in okapi conservation work (Petric 2012; Figure 21). The mission statement agreed by participants was: "to maintain a sustainable, cooperatively managed global *ex situ* okapi population that through conservation awareness, education, fundraising, the exhibition of animals and focused scientific research contributes to a viable *in situ* population."

Key areas to which the captive population should contribute were identified during the meeting:

- Education materials targeted at specific focus groups, with all zoos producing a common message;
- Exhibit strategies and signage to include conservation messages (*e.g.* video updates of conservation initiatives);
- Development of a documentary on the okapi and its conservation situation;
- Research, by providing a unique opportunity to study okapi up close;
- An increase in the number of zoos holding okapi. This will contribute to greater public awareness, and provide an incentive for more zoos to contribute funding to *in situ* work;
- Development of peer pressure, marketing and involvement techniques to encourage zoos with okapi to contribute to *in situ* conservation work;
- Targeted fundraising focused on zoos with an interest in other species in the Ituri forest, pushing the okapi's role as a flagship species.

On 31st December 2014 the global *ex situ* okapi population contained 172 individuals housed in 50 institutions. Pedigree analysis indicates that this population is descended from 29 wild caught individuals, has an average inbreeding coefficient of 0.0229 and has maintained 94.73% of the gene diversity of the source population (Hofman & Leus 2015).

Genetics plays an increasingly important role in captive breeding management. Genetic data can be used to (amongst other things) evaluate how genetically representative a captive population is of its wild counterpart. This is important because an increase of alleles in captivity that are rare in the wild may be detrimental in wild populations and may consequently affect the success of any future reintroductions (Frankham 2008; Griffith *et al*. 1989; Fischer & Lindenmayer 2000; Wolf *et al*. 1996; Jule *et al*. 2008). Stanton *et al*. (2015b) carried out a genetic assessment of the *ex-situ* okapi population. The study primarily focussed on European captive individuals. Patterns of genetic variation in captive samples were considerably different to those of the wild samples, but levels of genetic diversity were similar, indicating that the okapi ex-situ breeding program has been successful in preventing inbreeding in captivity. There is now a need to further genetically characterise the captive US okapi population to guide management of translocations between European and US captive populations (Stanton *et al*. 2015b).

The zoo community donates generously to *in situ* okapi conservation work, with a focus on the activities of the Okapi Conservation Project's activities in RFO. In 2010 Okapi EEP and Okapi SSP zoo partners donated US$225,000 to the Okapi Conservation Project, making up a third of its entire budget (Gilman International Conservation 2010).

Figure 21. Participants of the International Okapi Meeting held at Jacksonville Zoo, 2011. © Jacksonville Zoo

7. Conservation management

The CoCoCongo (*Coalition pour la Conservation au Congo*) is the national conservation planning mechanism. The *Institut Congolais pour la Conservation de la Nature* (ICCN) manages DRC's protected areas, usually supported technically and financially by partners, and implemented at site-level *via* the CoCoSi (*Comité de Coordination du Site*), where management plans are discussed and drawn up. Below are a few key organisations which have carried out okapi-specific conservation activities or okapi-related surveys in recent years, though this list is far from exhaustive.

7.1 *Institut Congolais pour la Conservation de la Nature* (ICCN)

The *Institut Congolais pour la Conservation de la Nature* (ICCN) was first conceived to protect Virunga National Park, which was created in 1925 as the first park in Africa. ICCN's scope has subsequently expanded to include all of DRC's protected areas and its duties now include:

- Management and conservation of DRC's biodiversity in protected areas;
- Promotion of scientific research;
- Development of eco-tourism within the framework of conservation;
- Development of human populations living around protected areas.

ICCN rangers risk their lives on a daily basis patrolling protected areas, removing snares, arresting poachers and clearing out hunting and mining camps, making ICCN the primary partner essential in all the initiatives below.

7.2 Okapi Conservation Project (OCP)

Established in 1987, the OCP works within the RFO to protect the tropical forest habitat of the okapi, as well as the culture of the local indigenous people, the Mbuti pygmies. The OCP's work on the ground includes:

- Capacity building: the OCP trains and equips ICCN guards, and seeks to improve ICCN infrastructure, building accommodation, security stations, *etc.* within the RFO.
- Agroforestry: the OCP agroforestry team has introduced an alternative to slash and burn agriculture in the form of nitrogen fixing plants called legumes. The *Leucaena* tree can increase crop yields by 25% and extend the productivity of the soil by 3-4 years when planted between rows of crops. Land can be returned to agricultural use within 3 years instead of the 15 years experienced with more traditional farming methods, significantly slowing the spread of slash and burn practices. When the trees are cut back they provide timber, firewood and browse for goats. The OCP reports high levels of interest in the programme and that improving food production has resulted in people being more inclined to be supportive of the rules and restrictions that protect the forest from overexploitation.
- Community assistance: the OCP has provided assistance by constructing schools, health clinics and fresh water sources, and supplying school materials and medicines. These efforts provide tangible assistance to people living in the reserve and engender a vested interest in the preservation of the RFO's forests and wildlife. The main objective here is to raise awareness of and support for conservation amongst local populations.

7.3 Wildlife Conservation Society (WCS)

WCS has supported great ape conservation and wildlife research in DRC since the 1950s when it undertook the first long term study of gorillas in the east of the country. In 1985, WCS initiated a field programme in the Ituri forest, including the first field study of radio-collared okapi (1986-1991), leading in 1992 to the creation of the Okapi Wildlife Reserve. WCS remained active in DRC through the recent period of civil war, including management of emergency support for DRC's World Heritage sites through UNESCO.

Operating under agreements with ICCN and the Congolese Ministry of the Environment, the goal of the current WCS programme is to support the protection and management of DRC's national parks and to develop policy and political support for nature conservation and natural resource management during the post-conflict transition. Field programmes include wildlife inventory, infrastructure rehabilitation, protected area boundary demarcation, community conservation, ranger training, habitat mapping and applied forestry programmes. WCS programmes at all levels place an emphasis on training and evaluation of national staff and collaborators.

WCS works extensively within the RFO, running a conservation research and training centre, monitoring human impacts and carbon stocks and working with local communities to restore respect for the RFO's protected status while alleviating poverty. Where possible, its Inventory and Monitoring Unit (IMU) seeks to conduct regular systematic surveys throughout the range of okapi and other mammalian species (*e.g*. Vosper *et al*. 2012).

7.4 The Lukuru Foundation / TL2 Project

The Lukuru Foundation leads the TL2 project, operating in the area between the Tshuapa, Lomami and Lualaba rivers, which is seeking to establish a new protected area, the Lomami National Park, which will encompass the population of okapi discovered in 2007. The current focus of the project is on reducing the impact of hunting on the fauna within the TL2 landscape by implementing a closed hunting season and supporting education and law enforcement (see case study 1). The Foundation has also conducted surveys around Rubi-Tele and Bafwasende which have recorded okapi.

7.5 Zoological Society of London (ZSL)

ZSL's connection with the okapi dates from its discovery (section 1.3). ZSL started working with ICCN in DRC in 2001 in support of its five World Heritage sites. Since 2004 ZSL has been focusing on support and capacity building of Virunga National Park and more recently the nearby Mont Hoyo Reserve, and in 2010 ZSL started leading a collaborative range-wide okapi project on behalf of ICCN. ZSL has led on okapi-focused surveys in Virunga (Nixon & Lusenge 2008; Kümpel 2010) and partnered on field surveys in RFO (Vosper *et al*. 2012) and Maiko National Park and the surrounding area (Nixon 2010; ZSL, unpublished data). ZSL has supported the okapi genetics project of joint ZSL Institute of Zoology/Cardiff University PhD student David Stanton logistically and technically. ZSL developed a major multi-partner REDD+ (reducing emissions from deforestation and forest degradation) project to develop incentives and alternatives for local people to conserve and benefit from the Virunga-Hoyo forest corridor, using okapi as a flagship species (okapi may still persist in this corridor, which links the remaining okapi populations in these two protected areas). ZSL drafted and edited this okapi status review, co-organised the multi-stakeholder okapi conservation strategy workshop and led the 2013 okapi Red List assessment. ZSL is now the institutional co-host for okapi for the new IUCN SSC Giraffe and Okapi Specialist Group (GOSG), which came into being in March 2013 and supports the development and implementation of the okapi conservation strategy.

7.6 Other international organisations

The **Fauna & Flora International** (FFI) DRC Programme focuses on supporting ICCN to manage DRC's biodiversity and engaging with the local communities who are dependent on natural resources found within DRC's protected areas, many of which are within the okapi range.

The **Frankfurt Zoological Society** (FZS) supports ICCN through two projects in DRC within the okapi range. The Virunga Conservation Project aims at conserving and protecting the threatened wildlife of Virunga National Park. With its Maiko Conservation Project, FZS supports the management and protection of Maiko National Park and local communities on the periphery and works to assess biodiversity within the park and then create strategies for protection and future monitoring.

Cardiff University's School of Biosciences, in collaboration with ZSL's Institute of Zoology and with permission of ICCN, has been carrying out *in situ* and *ex situ* genetics research on the okapi through the abovementioned PhD project on 'Phylogeography, population genetics and conservation of the okapi (*Okapia johnstoni*)', using historic skin, bone and tissue samples provided by museum partners and recent okapi dung samples collected by the PhD project team and partners across the range.

7.7 Other local organisations

UGADEC (Union of Associations for Gorilla Conservation and Community Development in Eastern DRC) is a federation of eight local NGOs intending to build community-managed reserves, providing a biological corridor zone between Maiko and Kahuzi-Biega national parks in eastern DRC.

Fondation Kumu is a representative network for local communities living around Maiko National Park. The foundation aims to help forest-based communities living around the Maiko and Kahuzi Biega national parks to achieve sustainable development from the durable use of natural resources.

8. Threat analysis

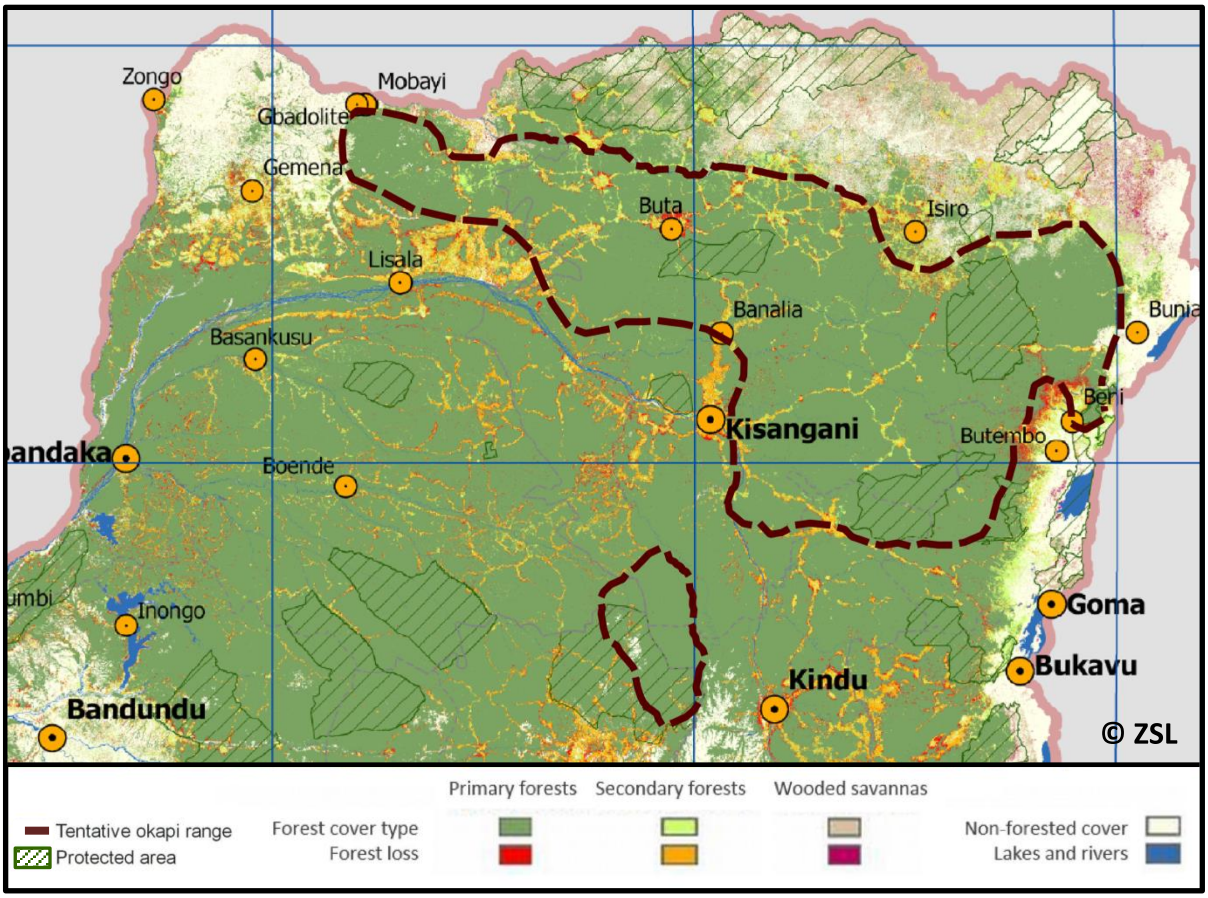
The threats to okapi identified during the status review and clarified during the workshop are detailed below. Case studies 1, 2 and 3 provide more detailed examples of how these threats can have an impact.

8.1 Direct threats

8.1.1. Habitat loss and fragmentation

Okapi can coexist with small-scale, low-level human use of the forest, but disappear in areas of active settlement or disturbance (Hart *et al*. 2008). This tendency to avoid any signs of human activity may make elusive species such as the okapi particularly susceptible to habitat fragmentation.

Figure 22. Forest loss from 2000-2010 (FACET 2010). Orange areas show loss of secondary forest, red areas show loss of primary forest. The hatched area is the tentative current okapi distribution (shapefile provided by John Hart). © ZSL



While DRC's forests are still relatively intact compared to those in many other African countries, estimates from satellite data suggest that almost two million hectares, or 2.3% of the total forest cover present in the year 2000, was lost between 2000 and 2010 (Potapov *et al*. 2012). Figure 22 summarises the forest loss that occurred from 2000-2010 (FACET 2010). Protected areas in theory provide large expanses which are unaffected by deforestation and should act as safe havens for forest-dependent species such as okapi. In reality protected areas still suffer deforestation, but their status does appear to shelter them from forest loss to some extent. The mean loss of primary forest across DRC from 2000-2010 was 1.1% per decade, while the mean rate of loss in protected areas was 0.4% per decade (Potapov *et al*. 2012). Virunga National Park suffered relatively high levels of deforestation for a protected area, losing 0.87% of its primary forest per decade (*ibid.)*. This rate of loss was attributed to the extensive charcoal collection and agricultural expansion taking place over this 10 year period around Goma in the south west of the park. The threat posed by deforestation is likely to increase over the coming years; approximately one-third of the okapi's known area of occupancy is likely to be at risk of major incursions during the first quarter of this century (Hart 2013). Areas of forest at greatest risk include the Beni and Kisangani areas, the Rubi-Tele Reserve, and the western limits of the species' historic range in the Ebola river basin.

The United Nations Environment Programme (UNEP 2011) identified the key drivers of forest degradation and deforestation in DRC in the following order of priority:

Figure 23. Charcoal being confiscated at a checkpoint in Virunga National Park. © ZSL

(i) Slash and burn agriculture; this traditional method of farming is sustainable at low levels, but UNEP estimates it becomes unsustainable at population densities above 20 people/km^2. The nature of the technique means that the damage caused increases disproportionately as demand increases; as farmers exhaust land of its nutrients they have to move further into the forest, and so further from their target markets, meaning the proportion of food lost in transport increases. Over 50% of farmers live more than 8 hours from a trading post, and post-harvest losses reach 80% in some places. A lack of secure land tenure means there is little incentive for farmers to make the permanent improvements to the land that are a prerequisite for more sustainable methods.
(ii) Fuelwood and charcoal collection, which accounts for 95% of the population's energy needs, with annual production estimated at 72 million m^3 (Figure 23).
(iii) Unregulated artisanal and small-scale logging, which is estimated to represent 75% of total timber exports from DRC. Annual production was estimated at 1.4-2.5 million m^3 in 2003 (8 times the official logging figures).

Improved road infrastructure can worsen these by allowing the opening of previously pristine areas for human activities (*e.g*. Nixon & Lusenge 2008).

8.1.2 Hunting

Bushmeat provides protein and income for poverty-stricken rural communities in the DRC (de Merode *et al*. 2004). In Kisangani bushmeat is cheaper than many other alternative sources of protein (van Vliet *et al*. 2012) or in effect a 'lower cost' protein as it can be captured rather than purchased (Kümpel 2006). A recent study showed that mammal species became depleted in the close surroundings of Kisangani due to overexploitation; duikers are the most important group of bushmeat species, but endangered species such as the chimpanzee and the okapi are also hunted (Dauwe 2014). UNEP (2011) estimates that the trade in illegal bushmeat in DRC is worth over $1 billion/year - roughly 7% of GDP. As the infrastructure of the country improves, the area of forest affected by hunting is likely to increase. Increases in hunting activity were observed following the rehabilitation of the road running through Virunga National Park (Nixon & Lusenge 2008), because it opened up access to the forest and to markets for bushmeat. The opening up of forests for mining or logging has had a similar effect (Wilkie *et al*. 2000).

Although data on the abundance of snares and hunting camps in the okapi's range are available, such data are not collected in a consistent fashion. Some studies report occurrence of all hunting signs, others only of snares, and there is variation in how or whether the age of hunting signs is reported. Hunting signs have been found in all areas surveyed since 2005, often in large numbers, despite the fact that most of the surveys took place in protected areas where hunting is prohibited. The extent to which hunting impacts okapi remains poorly understood. Bushmeat research in DRC has tended to focus on primates and smaller ungulates such as duiker which are easier prey to manage and more heavily targeted by hunters. This emphasis means that the severity of okapi hunting has rarely been quantified, with most studies reporting anecdotal evidence only. In some areas, such as around Virunga National Park, okapi are not a preferred bushmeat species for either hunters or consumers (Nixon & Lusenge 2008) but are nonetheless killed opportunistically. In others, for instance in the Twabinga-Mundo region, locals report that okapi is the most prized bushmeat available (Nixon 2010). In the area around Buta and Aketi, hunting is believed by locals to have been directly responsible for the extirpation of okapi populations (Hicks 2010). Hicks's team documented 10 okapi skins and carcasses being found in the Buta-Aketi area between 2007 and 2008 (Hicks *et al*. 2010), two okapi skins confiscated by ICCN from the Rubi Tele Reserve in July 2012 (Hicks 2013) and an additional 11 skins and carcasses from the Rubi-Tele area in September 2011 (Hicks 2013, 2014). One of the few studies to obtain quantitative data on okapi hunting looked at changes in the bushmeat market in Kisangani over two twelve month periods in 2002 and 2008-2009 (van Vliet *et al*. 2012). While no okapi bushmeat was recorded for sale in 2002, in 2008-2009 three instances of okapi bushmeat were recorded. This increase was attributed to a rise in hunting within the nearby RFO, made possible by the rehabilitation of the Kisangani-Ituri road.

Case Study 1. TL2: measures to reduce the impact of hunting (Hart 2009 a, b)

Hunting is the major threat to the TL2 area, which at present is relatively unthreatened by mining and logging. At the start of the TL2 project it was found that most hunters and traders could not identify all the integrally protected species and that sanctions for possessing illegal bushmeat were rarely specified, let alone enforced. A pilot study was undertaken to test whether agriculture was a suitable alternative to hunting for the local population. It was determined that there was little potential for an agricultural alternative due to the large distance to market; unlike bushmeat the agricultural products frequently spoiled before reaching market. As a result, it was decided effort should be focused on informing people of the law and supporting its enforcement, a move backed by many locals who perceived their game resources disappearing. As well as publicising the species already protected by law (including okapi), the project lobbied for a closed hunting season in the area which was eventually signed into law. The first closed hunting season in 2009 was surprisingly successful given the difficulty in enforcement. Before the closure, an average of 18.6 bushmeat loads a day (based on 387 surveyed loads) were transported into Kindu (the main market for TL2 bushmeat) over the three Kasuku river crossings, whereas afterwards bushmeat was recorded only twice in 736 transport loads surveyed at the same crossings. Undercover market investigations revealed that bushmeat was almost entirely absent from the market in Kindu. The success of this closure was attributed to the extensive education efforts made by the project, though there was concern that it would be difficult to sustain this level of success into future years unless effective enforcement was also brought in.

Figure 24. Dead okapi at Gbadolite, 2013. © ICCN

Local taboos around hunting okapi seem to vary between regions (Nixon & Lusenge 2008; Nixon 2010); as people move around the country and cultures mix the threat posed by hunting in different areas may change (Kümpel 2006). Hunting habits are changing: large groups with vehicles can carry okapi carcasses out of the forest where local tribes may not hunt such large animals. As smaller animals become scarcer due to overhunting, extra pressure may be transferred onto okapi. On 14th June 2013 Radio Okapi carried a report that 30 okapi had been killed in the last year in the '*Réserve d'Abumonbanzi*' near Gbadolite in North Ubangi district (Radio Okapi 2013). Photographic evidence confirming that at least two okapi had recently been killed in the region has been published (Ngbolua *et al*. 2014; O. Ilambu, pers. comm.; Figure 24).

8.2 Indirect threats

8.2.1 Extractive industries

Several types of extractives industries are operating in the okapi range, including commercial and artisanal logging, mining and oil exploration (Figures 25 & 26). Mining of iron ore, diamonds, gold, coltan and many other mineral resources is widespread and largely unregulated, with the revenue often used to fund ongoing conflicts. While the direct environmental impact of artisanal mining is believed to be relatively small (Tshombe *et al*. 2005), the reliance of miners and their families on bushmeat is a concern. Industrial-scale mining is likely to become a severe threat in the near future; there are plans for a huge iron ore mine with a railway to serve it close to the RFO (S. Nixon, pers. comm.). Oil and gas exploration in DRC has raised environmental concerns at the international level, especially with the awarding of oil concessions covering around 85% of Virunga National Park and the subsequent exploration for oil by SOCO International in 2014 in one of these concessions (Global Witness 2014). In 2014, the company announced the end of its activities in Virunga National Park, though drilling operations continued across the border in neighbouring Uganda (*ibid.*).

Figure 25. Industrial-scale logging and mining concessions across the okapi range (sources: extractives data from World Resources Institute 2013, protected area data from IUCN and UNEP-WCMC 2015 and tentative current okapi distribution provided by John Hart). © ZSL

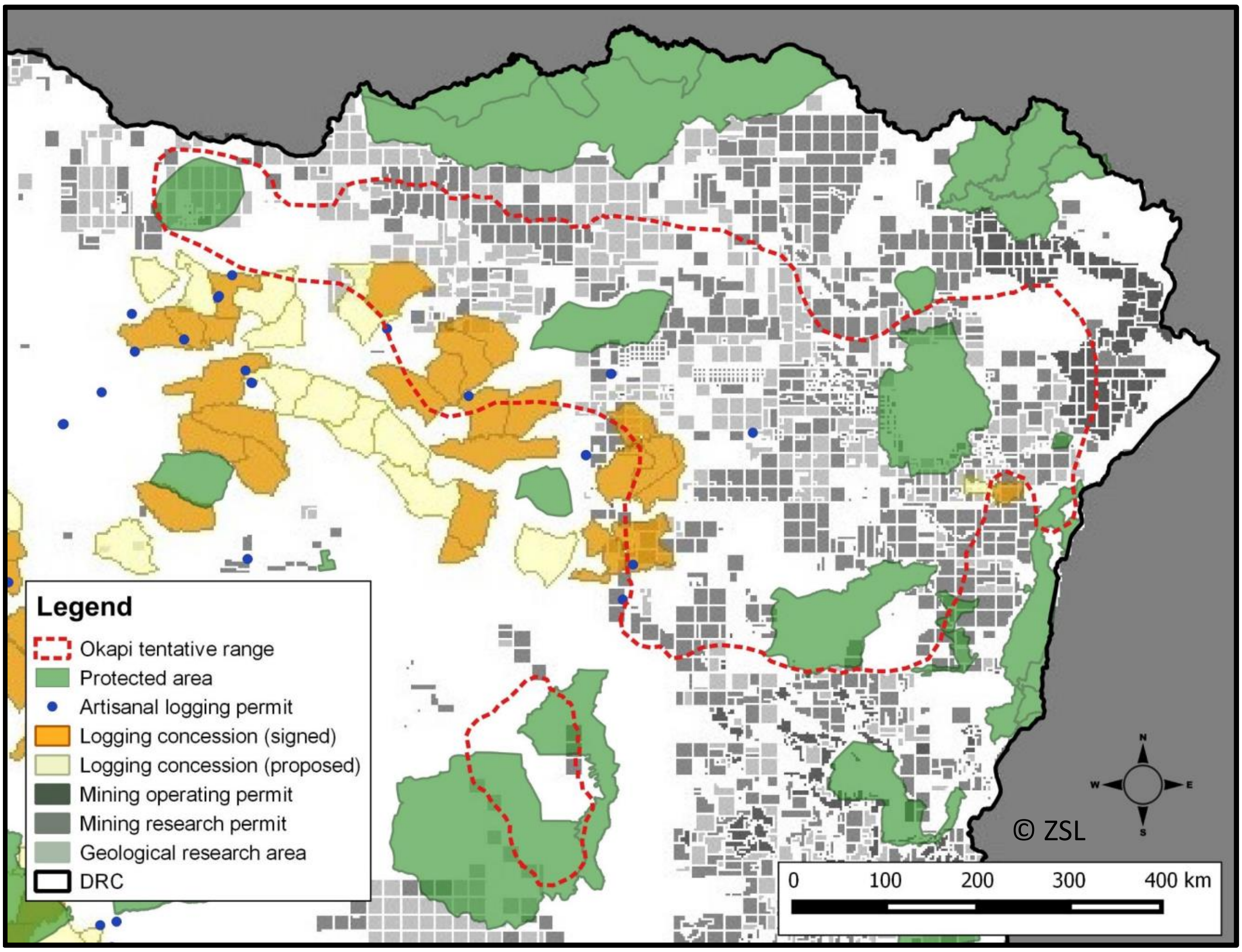
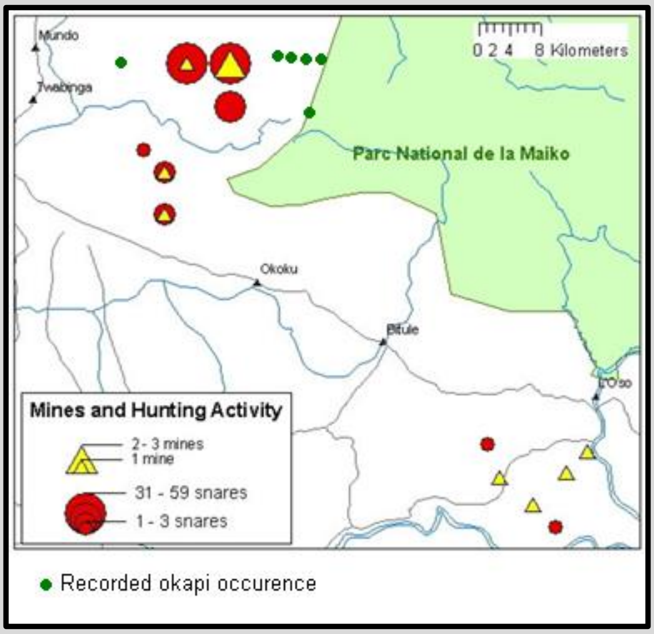


Figure 26. Mining camp destroyed after departure of miners, Okapi Wildlife Reserve. © OCP, 2015

Case Study 2. The forest around the Lubutu sector of Maiko National Park: association between mining and hunting (Nixon 2010)

In the Twabinga-Mundo region, to the south-west of Maiko National Park, a positive relationship between mining and hunting activity can be seen (Figure 27). At all mines teams observed evidence of bushmeat consumption, and mine workers reported eating bushmeat as regularly as they could individually afford. Anecdotal evidence suggests that in this region okapi are targeted for their skins and meat, and have undergone a drastic decline in number over the past two decades. Locals reported that okapi is the most prized bushmeat available. Several local participants in the Oso-Lowa survey conducted as part of the study reported eating okapi on at least one occasion within the past 10 years, but okapi meat is now considered a rarity. These reports were further supported by a Lubutu-based mine operator who claimed to have eaten okapi while prospecting for mining sites along the Oso river.

Figure 27. Mining and hunting activity observed around the Lubutu sector of Maiko National Park. Green dots are okapi presence points recorded during 2010 recce surveys (reproduced from Nixon 2010)



8.2.2 Civil conflict / political instability

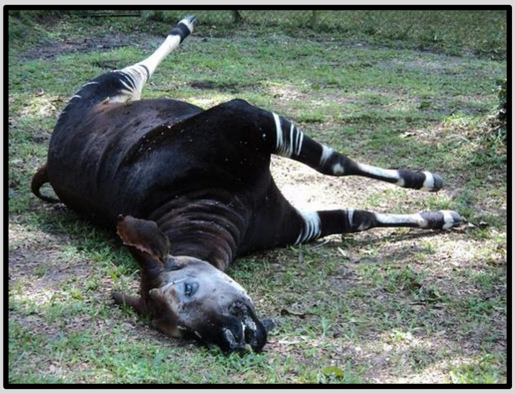
While infrastructure was developed through the Belgian colonial period, during the subsequent rule of President Mobutu (1965-1997) it was allowed to deteriorate significantly. The conflicts and stagnant economy that have afflicted DRC ever since mean that basic infrastructure has in many cases only recently begun to be redeveloped. With the onset of intense armed conflict and humanitarian disaster throughout the Great Lakes region in 1994, hundreds of thousands of refugees displaced by the Rwandan genocide took up occupation of Virunga National Park and the surrounding areas, placing an unprecedented pressure on biodiversity. Two consecutive civil wars between 1996 and 2003 and the collapse of the central government in Kinshasa led to further damage. Continued civil conflict, a struggling economy, high poverty levels and the ongoing illegal occupation of protected areas by armed militias and displaced people have resulted in widespread exploitation of the parks' natural resources. For example, Maiko National Park has been occupied by Simba rebels ever since 1964.

Hunting for other species can indirectly impact okapi. A recent study showed that the current increase in ivory poaching reduced forest elephant density by 62% between 2002-2011 (Maisels *et al*. 2013). The huge sums of money that can be made from ivory undermine protection efforts by ICCN and can result in a rapid deterioration of the security situation in seemingly relatively stable areas. In the RFO, an area which had been relatively well-protected since the end of the civil war, the efforts of ICCN to preserve wildlife populations have been severely challenged in recent years by the presence of armed rebels and the increasing number of miners and it is only recently that ICCN has started to regain control of the reserve (see Case Study 3).

Case Study 3. The Okapi Wildlife Reserve (RFO): the impact of civil instability

The predominant ultimate cause of the decline in okapi population documented by Hart *et al*. (2008) from 1995-2007 is thought to be the civil war that occurred during that period. The war led to widespread lawlessness, and the collapse of wildlife conservation and enforcement during the conflict was profound. Many wildlife staff were killed, and most of those remaining ceased normal operations or moved out of the protected area (though see Hart & Hart [2003] for inspiring reports of personnel who stayed to protect the reserve despite the risk to their life). Militias and military occupied much of the protected area and 2,000-3,000 people entered the reserve to mine coltan (Tshombe *et al*. 2005). Hunting for bushmeat occurred on a large scale to feed soldiers and miners and to generate revenue to fund further resource extraction (Beyers *et al*. 2011). Since the war ended, ICCN has re-established its presence in the reserve, carrying out regular patrols, arresting poachers and confiscating bushmeat. Nonetheless, the threat to the okapi population continued; in the second quarter of 2011, 1237 wire and nylon snares were removed by ICCN rangers and 11 poachers were arrested (Gilman International Conservation 2011). Poachers are however often released following arrest due to intervention by high-ranking officials.

Figure 28. Captive okapi at Epulu killed by militia in the June 2012 attack. © WCS



The situation dramatically worsened in June 2012 when the Epulu headquarters of the reserve were attacked by militia led by an elephant poacher/illegal miner going by the name of Morgan. Buildings were set on fire, equipment looted and destroyed, and 7 people were slaughtered along with all 14 captive okapi housed there (Figure 28). For some time, no effective response to Morgan was mounted and he continued to loot the area in and around the reserve, for example attacking the ICCN Zunguluka guard post, killing one guard, before briefly occupying the town of Mambasa on 5th January 2013 (IRIN 2013).

In April 2014, Morgan was killed in a shoot-out with Congolese army forces. Since then ICCN has reduced illegal activities, and by April 2015 more than 10,000 miners had been evicted and 23 mines had been cleared out, with ICCN re-establishing control of over 50% of the reserve (Mapilanga 2015).

8.2.3 Population growth

The annual human population growth rate in DRC is estimated at 2.7% (2010-2015 estimate; see UNDP 2014). In the context of widespread poverty and breakdown of state services, this growth intensifies the negative impacts due to deforestation, exploitation and unsustainable use of natural resources.

8.2.4 Inadequate protected area network and law enforcement

RFO, Maiko National Park and Virunga National Park have legal protection, and hunting okapi is prohibited throughout the entire country. Given the widespread insecurity discussed above, however, the extent to which this protection can be enforced is limited. Fully armed rebel forces are amongst those conducting illegal activities and ICCN rangers are poorly equipped to deal with them. In the RFO rangers sometimes do not confiscate illegally hunted bushmeat as they know the hunters are backed by high ranking military commanders or government officials (Stiles 2010). When poachers are arrested, they are often released following intervention by officials.

Limited resources are available from the government for protected area management, and as a result ICCN staff are underpaid and overworked, facing enormous threats to the areas they protect from mining, hunting, and the military. The small number of rangers that can be employed to cover vast areas demonstrates how inadequate resources are. However, efforts have been recently made to increase the number of rangers. This is the case in the RFO, where ICCN, in collaboration with the Okapi Conservation Project and Wildlife Conservation Society, has trained 50 new rangers in 2015 that will be added to the current team, to give a total of 120 rangers in the reserve (J. Lukas, pers. comm.).

8.2.5 Policy and institutional factors

Legislative frameworks are in theory largely adequate - the okapi is fully protected and protected areas are not allowed to be logged, mined, hunted, *etc.* - but a lack of respect for the law, poverty, weak enforcement and corruption are widespread. For many, bushmeat and other illegal or unsustainable activities are the only way they can earn a living, and defiance of the law is therefore to some extent inevitable until alternatives are found. Where development is seen to be particularly profitable, the integrity of a protected area can be at risk, as is the case for Virunga National Park, Africa's oldest park and first natural World Heritage site, where the British company SOCO has been permitted to explore for oil (see above).

8.2.6 Lack of co-ordination at the regional level

Understanding the relative size of and linkages between populations of okapi and how this may impact conservation work is an area that is only beginning to be developed. Okapi conservation has been almost entirely centred on the RFO, which is understandable given the limited resources available and the important and relatively well-studied population there, but populations throughout the rest of the range have so far received little attention. A lack of communication and co-operation between government and communities can also hinder progress on conservation, as is the case around Mont Hoyo Reserve where local people have not accepted the legitimacy of the reserve or the authority of the park warden (J. Fataki Bolingo, pers. comm.), but high-level political support and involvement of all stakeholders can rapidly help to restore security and improve local support for conservation efforts (Figure 29).

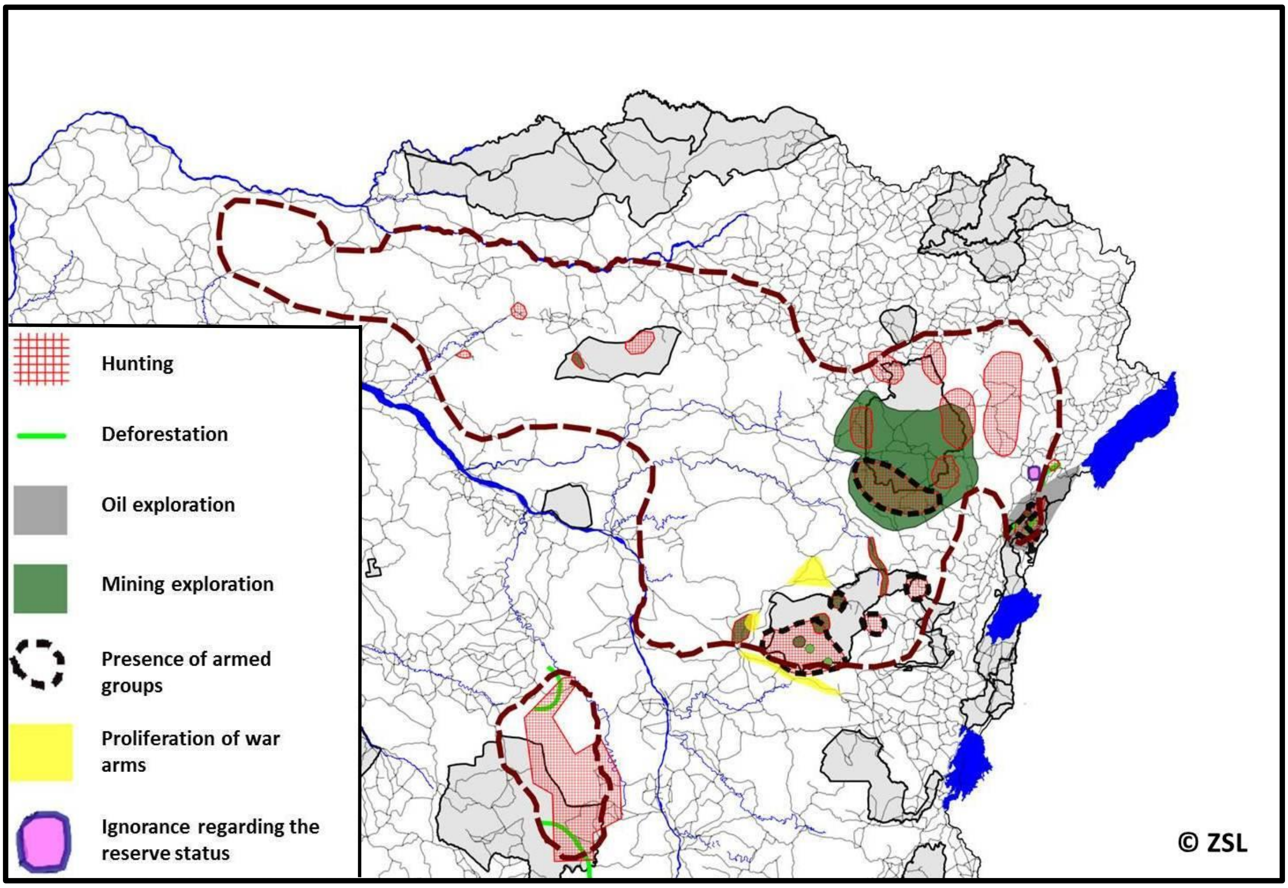
Figure 29. Provincial Governor Bamanisa, Okapi Conservation Project's Rosmarie Ruf, President Kabila and General Fall in Epulu in 2015, demonstrating important high-level, multi-stakeholder political support for re-establishing security in the Okapi Wildlife Reserve. © OCP

8.3 Participatory mapping and classification of threats

A full evaluation of the major threats to okapi and their habitat is an essential prerequisite for identification of measures needed to mitigate threats and improve okapi conservation status. Workshop participants therefore conducted a focused threat assessment. Working in groups by protected area, participants identified the major threats in and around their area and mapped these to show how and where each threat affected their area. The resulting map of major threats is presented in Figure 30. Within each area, threats were prioritised on a scale of 1-3 (low, medium, high), as presented in Table 3 (for a fuller description of the methodology, see IUCN's guidance on strategic planning for species conservation [IUCN SSC 2008][5]).

[5] IUCN SSC. 2008. Strategic Planning for Species Conservation: A Handbook. Version 1.0. Gland, Switzerland: IUCN Species Survival Commission. 104pp ; https://portals.iucn.org/library/efiles/documents/2008-047.pdf

Figure 30. Distribution of threats (non-exhaustive) in and around key protected areas in the okapi range as determined by working groups during the workshop. The dashed red line shows the tentative current okapi range (shapefile provided by John Hart). © ZSL



Next, a range-wide threat assessment was carried out, with each threat categorised according to its trend (increasing, stable, decreasing) and then scored on a scale of 1-3 for each of extent (<33%, 33-66%, >66%), severity, urgency and irreversibility (difficulty to reverse the threat; low, medium, high for each category) across the range as a whole by all workshop participants (Table 4). The notation was based on the subjective evaluations of workshop participants and was only focused on protected areas (and the areas around them) that contain okapi. The total scores were then used to rank the principal threats across the whole range.

'Poaching' was differentiated into targeted killing of okapi and general bushmeat hunting, which may kill okapi incidentally. There is a further distinction between subsistence hunting by local villagers and commercial hunting for trade to towns and cities. This practice operates at much higher volumes with a much more severe impact on forest animal populations. Elephant poaching, driven by rising demand for ivory, is pursued by organised criminal gangs and armed groups who no doubt rely on bushmeat, potentially including okapi, for food.

Mining consists of large-scale, commercial operations and artisanal mining. Commercial mining is a high intensity activity producing severe impacts at site level but is usually limited in geographical extent. Artisanal mining, *e.g*. for gold, has less intense impacts but is far more extensive and is also unregulated. There is a widespread view that artisanal mining presents a more serious threat to the environment than commercial mining.

Threats were divided broadly into direct and indirect, but in practice these often overlap. There was overall agreement among participants that at a national scale the most important threat to okapi was the presence of armed groups, which was the driving factor behind many other threats. These armed groups prevent effective conservation action and management, their members rely on bushmeat and they engage in or facilitate encroachment on okapi habitat, exacerbating the full range of illegal activities.

Table 3. Threats to the okapi per site, including the surrounding area, as determined by working groups during the Kisangani okapi conservation strategy workshop

DIRECT THREAT		INDIRECT THREAT	
OKAPI WILDLIFE RESERVE (RFO)			
Poaching	2	Bushmeat and wildlife hunting and trade	3
Habitat loss/degradation	1	Mining (artisanal)	3
		Mining (semi-industrial)	2
		Mining (industrial)	1
		Demographic pressure and immigration	3
		Insecurity and presence of armed groups	2
		Artisanal logging	2
		Expansion of urban areas	2
		Lack of information	2
		Lack of law enforcement	2
		Expanding agriculture	1
MAIKO NATIONAL PARK			
Poaching	3	Insecurity and presence of armed groups	3
Habitat loss/degradation	2	Proliferation of firearms	2
Trade of living specimens (okapi calves)	2	Mining	2
		Poor governance (poor collaboration between stakeholders)	2
		Poverty	1
VIRUNGA NATIONAL PARK (WATALINGA AREA)			
Habitat loss/degradation	2	Insecurity and presence of armed groups	3
Poaching	2	Oil exploration (potential)	2
		Artisanal logging	2
		Charcoal production	1
		Slash-and-burn agriculture	1
		Mining (artisanal)	1
MT HOYO RESERVE			
Habitat loss/degradation	3	Artisanal logging	3
Poaching	2	Ignorance of reserve status	3
		Insecurity and presence of armed groups	2
		Slash-and-burn agriculture	2
RUBI-TELE HUNTING RESERVE / BUTA AKETI			
Habitat loss/degradation	3	Illegal human occupation	3
Poaching by a local tribe (trapping and hunting with guns)	3	Slash-and-burn agriculture and camps	3
		Mining (gold and diamond)	2
BAFWASENDE			
Poaching	3	Insecurity and presence of armed groups	3
Habitat loss/degradation	2	Bushmeat and wildlife hunting and trade	3
		Proliferation of firearms	2
		Mining (gold and diamond)	2
		Logging	2
		Poor governance (poor collaboration between stakeholders)	2
		Poverty	1
FUTURE LOMAMI NATIONAL PARK AND ADJACENT AREAS / TL2			
Poaching	3	Bushmeat and wildlife hunting and trade (especially elephant poaching)	1
Habitat loss/degradation	1	Insecurity and presence of armed groups	1
		Expansion of agriculture	1
Classification: 1 = low, 2 = medium, 3 = high			

Table 4. Threats to the okapi across its range, as determined by the participants of the Kisangani workshop

	Trend[1]	Extent[2]	Severity[3]	Urgency[3]	Irreversibility[3]	TOTAL SCORE
DIRECT						
Armed groups	I	3	3	3	3	12
Poaching	I	3	2	3	1	9
Bushmeat and wildlife hunting and trade	S I (RFO) I (TL2)	3	2	3	1	9
Mining activities	I	2	2	3	1	8
Illegal occupation	I	2	2	3	1	8
Slash-and-burn agriculture	I	2	2	2	1	7
Charcoal production (Virunga)	I	1	3	3	1	8
Oil exploration (Virunga)	I	1	2	1	3	7
Trade of living specimens (Maiko)	S	1	2	3	1	7
INDIRECT						
Lack of resources	I	3	3	3	2	11
Lack of information	S	2	2	3	2	9
Lack of collaboration	I	1	2	3	2	8

Classification:
[1] I = increasing, S = stable, D = decreasing
[2] 1= 0-33%, 2 = 34-66%, 3 = 67-100% of okapi range
[3] 1 = low, 2 = medium, 3 = high

Figure 31. Working group at the okapi conservation strategy workshop, Kisangani, 2013. © Noëlle Kümpel, ZSL

9. Okapi conservation strategy 2015-2025

At the okapi conservation strategy workshop held in Kisangani in May 2013 (Figure 32), participants jointly developed and agreed the following vision and goals for the ten-year strategy:

9.1 Vision

Viable populations of the okapi, an emblematic and endemic species, are conserved sustainably across its range for the benefit of current and future generations, in collaboration with all stakeholders, and especially with local communities, thanks to the promotion of good governance

9.2 Goals

1. From now until 2025, viable populations of okapi are effectively protected, threats are reduced and populations are stable or increasing, in relation to the baseline data[6]

2. *Ex situ* populations of okapi are managed to maximise their benefit to the conservation of wild okapi

Objectives and actions were also agreed during the workshop, and are described in the logframe in section 9.3 below (Table 5). Objectives were aligned with the strategic programmes of DRC's National Strategy on Biodiversity Conservation in Protected Areas (ICCN 2012), or 'SNCBAP'. These aimed to address the threats determined during the participatory threat assessment described above (section 8.3).

Figure 32. Participants at the okapi conservation strategy workshop, Kisangani, May 2013. © ZSL

[6] As indicated here, this baseline is compared to the data available in this review on the status of okapi, but should be improved as soon as better quality data are available

9.3 Objectives, activities, actors and chronology presented under a logical framework

Table 5. Objectives, activities, actors and chronology of the okapi conservation strategy, 2015-2025 [7]

OBJECTIVE	ACTIVITY	ACTORS	DATE OF COMPLETION
STRATEGIC ORIENTATION, PLANNING AND MONITORING-EVALUATION (~SNCBAP Programme 1)			
Objective 1. A programme for the planning, monitoring and evaluation of okapi is implemented	1.1. Ensure that the strategy contributes to the application of the Convention on Biological Diversity and the SNCBAP at the national level	ICCN	Ongoing
	1.2. Elaborate an appropriate plan for the monitoring and evaluation of the strategy application	ICCN, GOSG[8]	2016
DEVELOPMENT AND PROMOTION OF SCIENTIFIC RESEARCH AND BIOMONITORING (~SNCBAP Programme 2)			
Objective 2. From now until 2023, knowledge on the okapi's distribution, status, biology, ecology, eco-ethology and genetics will be improved	2.1. Delimit the geographic range of okapi	ICCN, ZSL, GOSG	2015 / 2025
	2.2. Establish a database of okapi surveys	ICCN, ZSL, GOSG	2015/ongoing
	2.3. Conduct specific research studies on the okapi	ICCN, NGOs, universities	Ongoing
	2.4. Continue the genetic and phylogeographic study of the okapi	University of Cardiff, ZSL, GOSG, ICCN	2015 (current study) / to be defined (future studies)
	2.5. Start biological surveys in 50% of the potential accessible area within the okapi range	ICCN, NGOs	2025
Objective 3. A monitoring programme for the okapi in key[9] protected areas (PAs) within its geographic range is implemented	3.1. Develop and implement a standardised monitoring methodology for the okapi	ICCN, GOSG, NGOs, universities	2016
	3.2. Train and equip biomonitoring staff in key PAs selected within the okapi range	ICCN, OCP, WCS, ZSL, Lukuru Foundation, FZS, other ICCN partners[10]	2016
	3.3. Strengthen the monitoring mechanisms of the okapi and their application in range PAs	ICCN, OCP, WCS, ZSL, Lukuru Foundation, FZS, other ICCN partners	2018

[7] Following the system of the Strategic Programmes of the National Strategy on Biodiversity Conservation in Protected Areas of the Democratic Republic of Congo (ICCN 2012), or 'SNCBAP' (where possible)

[8] IUCN SSC Giraffe and Okapi Specialist Group or 'GOSG'

[9] Key protected areas include at least the Okapi Wildlife Reserve, Maiko National Park, Virunga National Park, Rubi-Tele Hunting Reserve and the future Lomami National Park; selected for their importance regarding the okapi genetic diversity, population size and their general biological integrity

[10] OCP = Okapi Conservation Project, WCS = Wildlife Conservation Society, ZSL = Zoological Society of London, FZS = Frankfurt Zoological Society

STRENGTHENING AND EXPANSION OF THE NETWORK OF PROTECTED AREAS FOR THE OKAPI (~SNCBAP Programme 3)			
Objective 4. The population status of the okapi is strengthened through the creation and inclusion of new conservation areas in DRC's protected area network	4.1. Initiate a decree to strengthen the status of the integral conservation zone of the RFO as a national park	Ministry of the Environment, ICCN	2016
	4.2. Continue and complete the process regarding the official creation of Lomami National Park	Ministry of the Environment, ICCN, Lukuru Foundation	2016
Objective 5. Connectivity between the priority populations of okapi is secured	5.1. Identify ecological corridors between priority populations of okapi	ICCN, GOSG	2016
	5.2. Define and demarcate at least one ecological corridor to conserve the okapi	Ministry of the Environment, ICCN, local communities, NGOs	2018
	5.3. Produce a draft of the management plan for the identified corridor	Ministry of the Environment, ICCN, local communities, NGOs	2018
MANAGEMENT AND INTEGRITY OF PROTECTED AREAS IN OKAPI RANGE (~SNCBAP Programme 5)			
Objective 6. The climate of insecurity induced by armed groups in the key protected areas (PAs) of the okapi's range is reduced	6.1 Lobby government/inter-governmental agencies (*e.g.* UN) at provincial, national and international levels to eradicate harmful actions of armed groups and illegal extractives activities in the okapi's range	ICCN, IUCN, GOSG, NGOs	2015/ongoing
	6.2. Organise clean-up and awareness operations to expel armed groups from the key PAs of the okapi's range	FARDC[11], ICCN, UN, provincial/national government	2015/ongoing
	6.3. Monitor and evaluate the impacts of clean-up and awareness operations to expel armed groups	ICCN, FARDC, UNESCO, IUCN, GOSG, NGOs	Ongoing
Objective 7. Protected areas (PAs) are effectively managed	7.1. Organise operations to evacuate the sites of human occupation and illegal activities in the key PAs	ICCN, FARDC, ICCN partners	2015
	7.2. Secure sufficient resources for the effective management of key PAs within the okapi's range	Government, donors, ICCN partners	Ongoing
	7.3. Define areas to be covered by regular patrols in order to limit illegal activities	ICCN	Ongoing
	7.4. Strengthen law enforcement regarding the protection of okapi	ICCN, police, Ministry of Justice, FARDC, INTERPOL	Ongoing
	7.5. Produce and/or complete management plans for each key PA	ICCN, ICCN partners	Every 5 years / 1 year
	7.6. Equip the management structure with appropriate and adequate resources (human, financial and materials)	ICCN, NGOs, donors	Ongoing

[11] DRC armed forces

GOVERNANCE, PARTICIPATION, ACCESS AND BENEFIT-SHARING (~SNCBAP Programme 6)			
Objective 8. Enforcement of the ABS (access and benefit-sharing) mechanism with local communities is implemented in protected areas of the okapi's range	8.1. Implement consultation platforms between local communities and other stakeholders in, at least, 4 priority areas of the okapi's range	ICCN, NGOs inc. civil society organisations (CSOs)	2015
	8.2. Ensure involvement of all stakeholders in the application of the okapi conservation strategy	ICCN, NGOs inc. CSOs	Ongoing
	8.3. Organise workshops between stakeholders to exchange information on the issue of okapi conservation	ICCN, NGOs inc. CSOs	Ongoing
POLITICAL, INSTITUTIONAL AND SOCIO-ECONOMIC ENVIRONMENT (~SNCBAP Programme 7)			
Objective 9. The support of national institutions for better protection of the okapi is ensured	9.1. Strengthen institutional competences	NGOs, ICCN, donors	Ongoing
	9.2. Convince decision-makers of the importance of okapi conservation	ICCN, GOSG, NGOs	2016/ongoing
	9.3. Popularise information on the protection of okapi at the local, provincial, national and international levels	ICCN, GOSG, NGOs, civil society	2016/ongoing
Objective 10. The socio-economic development of local communities is ensured in areas where there is a negative impact on the conservation status of the okapi	10.1. Strengthen alternative livelihoods that generate income and are compatible with and linked to the conservation of okapi to support the development of local communities living in the okapi's range	ICCN, NGOs, local communities	2018
	10.2. Identify and develop alternative actions to the non-sustainable use of natural resources around okapi-priority protected areas	ICCN, NGOs, local communities	2018
	10.3. Organise training sessions in agro-forestry and reforestation techniques in the buffer zones of okapi-priority protected areas	ICCN, NGOs, local communities	2018
	10.4. Create micro-projects related to okapi conservation efforts and improvements in the conservation status of the okapi	ICCN, NGOs, local communities	2018
INFORMATION, COMMUNICATION AND AWARENESS (~SNCBAP Programme 9)			
Objective 11. The okapi, national animal of the DRC, is seen as a unique species, evolutionarily distinct, and as a symbol of the rainforests of the Congo Basin, which deserves particular attention and status	11.1. Raise awareness about the conservation of okapi among local communities living around PAs	ICCN, NGOs, local communities	Ongoing
	11.2. Implement an okapi education programme targeting children, adults and hunters	ICCN, NGOs, local communities	2016 / ongoing
	11.3. Promote the distribution of books, documentation, brochures and other information on okapi across DRC	ICCN, GOSG, NGOs, local communities	2016/ongoing
	11.4. Produce posters on the okapi in towns and villages located across its range	ICCN, GOSG, NGOs, local communities	2016/ongoing
	11.5. Organise sessions to raise awareness of the endemicity and conservation of the okapi amongst international donors and the general public, through workshops, public events, exhibitions and the media	GOSG, ICCN	Ongoing

***EX SITU* OKAPI POPULATION**			
Objective 12.The okapi captive population is managed to maximise its contribution to the conservation and survival of okapi in the wild	12.1. Develop and continue research activities in zoos to improve the survival and management of okapi in the wild	SSP[12], EEP[13], GOSG	Ongoing
	12.2. Ensure the genetic management of *ex situ* and *in situ* okapi populations to ensure the long-term survival of the species and its genetic diversity as well as a representative genetic reservoir for the species	SSP, EEP, University of Cardiff, RZSA[14]	2016/ongoing
	12.3. Increase the number of zoological institutions with okapi breeding programmes (using captive-bred individuals) to increase the number of people exposed to this unique mammal and collect more funds to support ICCN's efforts and conserve the okapi in DRC	SSP, EEP	Ongoing
	12.4. Promote to visitors this Congolese national icon that deserves attention and status	SSP, EEP, GOSG	2016/ongoing
	12.5. Work in collaboration with the GOSG and the Okapi Conservation Project to raise awareness at a global level of okapi conservation issues and provide sufficient funds to support the management and protection of wild okapi	SSP, EEP, GOSG, OCP	2016/ongoing
SUSTAINABLE FINANCING (~SNCBAP Programme 4)			
Objective 13.A sustainable funding mechanism to implement the conservation strategy is in place	13.1. Develop a strategy for the sustainable funding of okapi conservation	ICCN, GOSG	2016
	13.2. Launch a campaign to raise funds among international donors	ICCN, GOSG, all stakeholders	2016
	13.3. Develop a programme for ecotourism in and around priority PAs	ICCN, GOSG, all stakeholders	2017

[12] Species Survival Programme (SSP), administered by the Association of Zoos and Aquariums (AZA)
[13] European Endangered species Programme (EEP), administered by the European Association of Zoos and Aquaria (EAZA)
[14] Royal Zoological Society of Antwerp

References

Amsini, F., Grossmann, F., Hart, J., Kibambe, C., Nyembo, B. & Vyahavwa, C. 2005. *Identifying conservation priorities for the recovery of the Maiko National Park: Post-conflict surveys of wildlife populations and human impact in the North Sector of the park*. IMU Technical Report No. 4, Inventory Monitoring Unit, Wildlife Conservation Society, New York

Amsini, F., Grossmann, F., Hart, J., Kibambe, C., Nyembo, B. & Vyahavwa, C. 2006. *Identifying conservation priorities for the recovery of the Maiko National Park Part 2: Post-conflict surveys of wildlife populations and human impact in the South Sector (Oso Block)*. IMU Technical Report No. 6. Inventory Monitoring Unit, Wildlife Conservation Society, New York

Bahati-Eliba, A. 2011. *Rapport synthèse sur l'identification de l'Okapi, dans la Réserve Communautaire de la Biodiversité de Lenda, à l'Est de la RDCongo, Octobre-Novembre 2011*. Unpublished report, KUMU Foundation, Goma

Barnes, R.F.W., Asamoah-Boateng, B., Naada Majam, J. & Agyei-Ohemeng, J. 1997. Rainfall and the population dynamics of elephant dung-piles in the forests of southern Ghana. *African Journal of Ecology* 35: 39–52. DOI: 10.1111/j.1365-2028.1997.061-89061.x

Barongi, R.A. 1985. Okapi and Epulu - a long term conservation project. *Association of Zoos and Aquariums Annual Proceedings* 1985: 476-487

Bashaw, M.J., Maki, T.S. & Maple, T.L. 2001. A survey assessment of variables related to stereotypy in captive giraffe and okapi. *Applied Animal Behaviour Science* 73(3): 235-247

Bashonga, M.G. 2006. *A propos de la présence d'okapi et autres mammifères sur la rive gauche de la moyenne Semliki: Secteur nord, Parc National des Virunga*. Rapport Technique, WWF-PEVi

Bashonga, M.G. 2007. *Etude de la répartition de l'okapi (Okapia johnstoni) et autres mammifères dans le secteur nord du Parc National des Virunga*. Rapport Technique. WWF-PEVi

Bashonga, G. & Languy, M. 2008. *Inventaires des grands mammifères de la vallée de la Semliki du Parc National des Virunga : références particulières sur l'okapi (Okapia johnstoni)*. Report from WWF Eastern Africa Regional Programme Office, Nairobi, 36 pp.

Beyers, R.L. 2008. *Natural and anthropogenic influences on elephants and other ungulates in the Congo forest*. PhD Thesis, University of British Columbia, Vancouver. 167pp. Available at: https://circle.ubc.ca/bitstream/handle/2429/960/UBC_2008_fall_beyers_rene.pdf?sequence=1

Beyers, R.L., Hart, J.A., Sinclair, A.R.E., Grossmann, F., Klinkenberg, B. & Dino, S. 2011. Resource wars and conflict ivory: the impact of civil conflict on elephants in the Democratic Republic of Congo - the case of the Okapi Reserve. *PLoS ONE* 6(11): e27129

Bodmer, R.E. & Gubista, K.R. 1990. A note on the social structure of free ranging okapi. *International Journal on Nature Conservation in Africa* 6(4): 24-28

Bodmer, R.E. & Rabb, G.B. 1992. *Okapia johnstoni*. *Mammalian Species* 422: 1-8

Braum, D.M. & Mufabule, K. 2008.Biodiversity Surveys of the Maiko National Park and UGADEC community-based wildlife corridor, Eastern DR Congo: Distribution and status surveys of Grauer's gorilla *Gorilla beringei graueri* and other wildlife. DFGFI Unpublished report submitted to US Fish and Wildlife Service

Breuer, T., Mavinga, F.B. & Hockemba, M.B.N. 2010. Dung decay and its implication for population estimates of duikers (*Cephalophus* and *Philantoba spp*.) and red river hogs (*Potamochaerus porcus*) in the Nouabale-Ndoki National Park, Republic of Congo. *African Journal of Ecology* 48: 551-554

Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D. & Thomas, L. 2001. *Distance sampling: estimating abundance of biological populations. 2nd edition*. Oxford University Press, Oxford. 432 pp.

Colbert, E.H. 1938. The relationship of the okapi. *Journal of Mammalogy* 19: 47-64

Dauwe, D. 2014. *Bushmeat trade in the region of Kisangani, DR Congo - a pilot study*. MSc Thesis, Antwerp University, 111pp.

de Merode, E., Homewood, K. & Cowlishaw, G. 2004. The value of bushmeat and other wild foods to rural households living in extreme poverty in the eastern Democratic Republic of Congo. *Biological Conservation* 118: 573- 581

East, R. 1999. *African Antelope Database 1998*. IUCN, Gland and Cambridge

FACET (Monitoring the forests of central Africa using remotely sensed data sets). 2010. *Forest cover and forest cover loss in the Democratic Republic of Congo from 2000 to 2010*. Available at http://carpe.umd.edu/forest_monitoring/monitoring.php

Fischer, J. & Lindenmayer, D.B. 2000. An assessment of the published results of animal relocations. *Biological Conservation* 96, 1-11

Frankham, R. 2008. Genetic adaptation to captivity in species conservation programs. *Molecular Ecology* 17, 325-333

Gijzen, A. 1959. Das Okapi; *Okapia johnstoni*. Wittenberg: A. Ziemsen. 120 pp.

Gilman International Conservation. 2010. *Okapi Conservation Project Annual Report 2010*. Available at http://www.theokapi.org/News/teksten/OCP%20Annual%20Report%202010.pdf

Gilman International Conservation. 2011. *Annual Report 2011*. Available at http://www.okapiconservation.org/okapi_site/wp-content/uploads/2012/04/OCPAnnualReport2011.pdf

Global Witness. 2014. *Drillers in the mist*. Global Witness, London

GlobCover. 2010. *Global land cover map*. European Space Agency. Available at http://due.esrin.esa.int/globcover/

Griffith, B., Scott, M.J., Carpenter, J.W. & Reed, C. 1989. Translocation as a species conservation tool: status and strategy. *Science* 245, 477-480

Hart, J.A. & Hall, J.S. 1996. Status of eastern Zaire's national parks and reserves. *Conservation Biology* 10(2): 316-327

Hart, J.A. & Hart, T.B. 1986. *L'éco-éthologie de l'okapi dans les forêts du nord-est du Zaïre*. 19 pp. Unpublished Special Project Report

Hart, J.A. & Hart, T.B. 1988a. Tracking the rainforest giraffe. *Animal Kingdom* 91(1): 26-32

Hart, J.A. & Hart, T.B. 1988b. A summary report on the behaviour, ecology and conservation of the okapi (*Okapia johnstoni*) in Zaire. *Acta Zoologica Et Pathologica Antverpiensia* 80: 19-28

Hart, J.A. & Hart, T.B. 1989. Ranging and feeding behaviour of okapi (*Okapia johnstoni*) in the Ituri Forest of Zaire: food limitation in a rain-forest herbivore? *Symposia of the Zoological Society of London* 61: 31-50

Hart, J.A. & Hart, T.B. 1992. Between sun and shadow. *Natural History* 101(11): 29-35

Hart, J.A. & Hart, T.B. 2003. Rules of engagement for conservation: lessons from the Democratic Republic of Congo. *Conservation in Practice* 4: 14–22

Hart, J.A. & Sikubwabo, C. 1994. *Exploration of the Maiko National Park of Zaire 1989-92: history, environment, and the distribution status of large mammals*. Unpublished report, Wildlife Conservation Society, Bronx, New York

Hart, J. 2006. *WCS biodiversity surveys in the Salonga National Park 2003 – 2006: Faunal distribution and abundance and impact of hunting – a summary of major findings and recommendations*. Inventory and Monitoring Unit (IMU), Wildlife Conservation Society DRC

Hart, J., Beyers, R., Grossmann, F., Carbo, M., Dino, S. & Kahindo, F. 2008. *La Réserve de Faune à Okapis. La distribution et fréquence de la grande faune et des activités humaines. Avec une évaluation de l'impact de 10 ans de conflit: 1996 - 2006.* IMU technical report No. 9, Inventory Monitoring Unit, New York: Wildlife Conservation Society. Available at http://www.elephantdatabase.org/population_submission_attachments/download/243

Hart, T.B. 2007. *Evaluation de l'etat de conservation du Domaine de Chasse de Rubi-Télé*. Unpublished Report submitted to AGRECO, Bruxelles, Belgium

Hart, T. 2009a. *A new conservation landscape for bonobo: Discovery and conservation of the Tshuapa-Lomami-Lualaba Landscape in the Democratic Republic of Congo*. Final report submitted to USFWS

Hart, T. 2009b. *A summary report on a project to control and monitor the commercial bushmeat chain supplying the city of Kindu*. Annex 7 to Final Report submitted to ARCUS Foundation

Hart, J.A. 2013. *Okapia johnstoni* Okapi; pp 110–115 in Kingdon, J. & Hoffmann, M. (eds) 2013. *Mammals of Africa: Volume VI*. Bloomsbury Publishing, London

Hedges, S. 2012. *Monitoring elephants and assessing threats: a manual for researchers, managers and conservationists,* Universities Press, Himayatnagar, Hyderabad, India.

Hicks, T.C. 2009. *Trading chimpanzees for baubles: a bushmeat crisis in northern DR Congo. Aketi field season 2007-2008: Part 2.* Pages 17-24. Wasmoeth Wildlife Foundation. Available at: http://www.wasmoethwildlife.org/folder2007-2008/part2/index.html

Hicks, T.C. 2010. *A chimpanzee mega-culture? Exploring behavioral continuity in* Pan troglodytes schweinfurthii *across northern DR Congo*. PhD Thesis. University of Amsterdam, Netherlands

Hicks, T.C. 2013. *Along the bushmeat highway, Part 1*. Chimpanzee Sanctuary Northwest. Available at: http://www.chimpsanctuarynw.org/blog/2013/05/along-the-bushmeat-highway-part-1/

Hicks, T.C. 2014. *Faunal diversity and human impact in two protected areas of northern DR Congo: Bili-Uéré and Rubi-Télé*. Lukuru Foundation, USFWS Final Report, January 2014, 169 pp. http://www.bonoboincongo.com/wp-content/uploads/2014/10/HicksUSFWSBiliFinalReport2014.pdf

Hicks, T. C., Darby, L., Hart, J., Swinkels, J., van Hooff, J., January, N., & Menken, S. 2010. Trade in orphans and bushmeat threatens one of the Democratic Republic of the Congo's most important populations of eastern chimpanzees, *Pan troglodytes schweinfurthii*. *African Primates 7*.

Hofman, S. & Leus, K., 2015. *International studbook for the okapi (Okapia johnstoni) – 31 December 2014*. Royal Zoological Society of Antwerp: Antwerp.

ICCN. 2012. *Stratégie nationale de conservation de la biodiversité dans les aires protégées de la République Démocratique du Congo*. Institut Congolais pour la Conservation de la Nature, République Démocratique du Congo

IRIN (Integrated Regional Information Networks, a UN project). 2013. Rainforest riches a curse for civilians in northeast DRC. http://www.irinnews.org/Report/97314/Rainforest-riches-a-curse-for-civilians-in-northeast-DRC

IUCN SSC. 2008. *Strategic planning for species conservation: an overview. Version 1.0*. IUCN, Gland, Switzerland. 22pp.

IUCN SSC Antelope Specialist Group. 2008. *Okapia johnstoni*. In: IUCN 2012. IUCN Red List of Threatened Species. Version 2012.2. Available at http://www.iucnredlist.org

IUCN and UNEP-WCMC. 2015. *The World Database on Protected Areas (WDPA)*. UNEP-WCMC, Cambridge, UK. Available at www.protectedplanet.net

Johnston, H. 1900. [On a new horse]. *Proceedings of the Zoological Society of London* 69(5): 774-775

Jule, K.R., Leaver, L.A. & Lea, S.E.G. 2008. The effects of captive experience on reintroduction survival in carnivores: A review and analysis. *Biological Conservation* 141, 355-363

Kasongo, N. 2013. *Réserve de Faune à Okapis – law enforcement monitoring (LEM)*. Presentation given at IUCN-ICCN-ZSL okapi conservation strategy development workshop, Kisangani, 22-25 May 2013

Kingdon, J. 1979. *Okapi*. In: East Africa Mammals, volume 3 (Part B). New York: Academic Press. pp. 338-345

Kümpel, N. 2006. *Incentives for sustainable hunting of bushmeat in Río Muni, Equatorial Guinea*. PhD Thesis, Institute of Zoology, Zoological Society of London and Imperial College London, University of London, London. 247pp. Available at https://static.zsl.org/files/kumpel-2006-phd-thesis-765.pdf

Kümpel, N. 2008. *Working with communities to reduce deforestation and alleviate poverty in the Virunga Hoyo region, DRC*. Proposal for funding to the Congo Basin Forest Fund, Zoological Society of London. London. Available at http://www.cbf-fund.org

Kümpel, N. 2010. *Building capacity for wildlife monitoring and management in the northern sector of Virunga National Park, DRC*. Unpublished report submitted to US Fish and Wildlife Service, Zoological Society of London, London

Lankester, E.R. 1901. [On *Okapia johnstoni*]. *Nature* 64: 247

Lankester, E.R. 1902. On *Okapia*, a new genus of Giraffidae from central Africa. *Transactions of the Zoological Society of London* 16(6): 279-314 and Plates XXX-XXXII

Leus, K. & Hofman, S. 2012. *International studbook for the okapi (Okapia johnstoni) – 12 October 2011*. Royal Zoological Society of Antwerp: Antwerp

Liengola, I., Vosper, A., Maisels, F., Bonyenge, A. & Nkumu, P. 2009. *Conserving bonobos in the last unexplored forest of the Democratic Republic of Congo, the Tshuapa-Lomami-Lualaba Landscape*. Wildlife Conservation Society report to the Beneficia Foundation

Lindsey, S.L., Green, M.N. & Bennett, C.L. 1999. *The okapi: mysterious animal of Congo-Zaire*. University of Texas Press

Mackenzie, D.I., Nichols, J.D., Lachman, G.B., Droege, S., Royle, J.A. & A., L.C. 2002. Estimating site occupancy when detection probabilities are less than one. *Ecology* 83**:** 2248-2255

MacKenzie, D.I., Nichols, J.D., Royle, J.A., Pollock, K.H., Bailey, L.L. & Hines, J.E. 2006. *Occupancy estimation and modeling: Inferring patterns and dynamics of species occurrence,* Academic Press, Burlington, MA, USA

Madidi, J., Masselink, J., Umunay, P. & Makana, J.R. 2009. *Evaluation des ressources biologiques dans les zones de gestion communautaire des ressources naturelles de Bakwanza et Andikau*. Unpublished report by Wildlife Conservation Society DRC Forestry Project to CARPE

Maisels, F. 2010. *Case study 4: Monitoring of wildlife populations: lessons learned from central Africa*. In *landscape-scale conservation in the Congo Basin : lessons learned from the Central Africa Regional Program for the Environment (CARPE)* (ed K.A. David Yanggen, & Nicodeme Tchamou), pp. 335-343. IUCN

Maisels, F. 2014. *Monitoring of okapi: current issues in the RFO.* Memo for IUCN SSC Giraffe and Okapi Specialist Group/Zoological Society of London meeting on okapi status and monitoring. Wildlife Conservation Society

Maisels, F., Nkumu, P., Bonyenge, A. & Naky, P. 2010. *Salonga National Park, Democratic Republic of Congo: Terrestrial wildlife and human impact monitoring programme. Survey report - eastern sector of park*. Unpublished report by Wildlife Conservation Society

Maisels, F., Strindberg, S., Blake, S., Wittemyer, G., Hart, J., *et al*. 2013. Devastating decline of forest elephants in central Africa. *PLoS ONE* 8(3): e59469. DOI:10.1371/journal.pone.0059469

Makana, J.R., Madidi, J., Masselink, J., Vyahavwa, C. & Mukinzi, J. 2010. *Rapport des explorations biologiques dans le Sud de la Zone CBNRM Bakwanza (Bloc Samboko)*. Unpublished report by Wildlife Conservation Society to CARPE

Makana, J.R., Madidi, J., Vyahavwa, C., Maisels, F., Masselink, J., & Vosper, A. 2012. *Preliminary surveys of chimpanzees in Eastern Ituri Forest, DRC*. Final Report: USFWS Agreement nº 98210-8-G642. Unpublished report by Wildlife Conservation Society

Mallon, D., Kümpel, N., Quinn, A., Shurter, S., Lukas, J., Hart, J. & Mapilanga, J. 2013. *Okapia johnstoni*.. IUCN Red List of Threatened Species: Version 2013.2. <www.iucnredlist.org>

Mapilanga, J. 2015. Restoring the integrity of the Okapi Wildlife Reserve in the Democratic Republic of Congo. *Giraffid* 9(1): 13-14. Available at http://www.giraffeconservation.org/newsletters.php

Ngbolua, K., Mafoto, A., Molongo, M., Magbukudua, J.P., Ngemale, G.M., Masengo, C.A., Patrick, K., Yabuda, H., Zama, J. & Veke, F. 2014. Evidence of new geographic localization of *Okapia johnstoni* (Giraffidae) in Republic Democratic of the Congo: the rainforest of "Nord Ubangi" District. *Journal of Advanced Botany and Zoology* 2 (1): 1-2. DOI: 10.15297/JABZ.V2I1.02

Nixon, S.C. 2005. *A preliminary survey of the Maiko National Park southern sector and adjacent forests, January-May 2005*. Unpublished report submitted to Dian Fossey Gorilla Fund International, Goma, DRC

Nixon, S.C. 2010. *Participatory assessment of Grauer's Eastern Gorilla and other wildlife in the Lubutu sector of Maiko National Park and adjacent forests*. Unpublished report submitted to Fauna & Flora International, Frankfurt Zoological Society, Institut Congolais pour la Conservation de la Nature & Zoological Society of London, Cambridge, UK

Nixon, S.C. & Lusenge, T. 2008. *Conservation status of okapi in Virunga National Park, Democratic Republic of Congo*. ZSL Conservation Report 9. Zoological Society of London, London. 50pp. Available at www.zsl.org/okapi

Nixon, S.C., Mufabule, K., Eliba, A. & Patule, I.M. 2007. *A prospection survey of the Usala Forest and proposed Usala Community Reserve, Democratic Republic of Congo*. Unpublished report submitted to DFGI, Dian Fossey Gorilla Fund International, Goma, DRC. Available at http://fondationkumu.files.wordpress.com/2012/05/usala-prospection-2007.pdf

Okapi Conservation Project. 2011. Annual Report 2011. Published by White Oak Conservation Center. Available at: http://theokapi.org/News/teksten/OCP%20Annual%20Report%202011.pdf

Okapi Conservation Project. 2015. *Evacuation of mining camps – changing the dynamic for conservation*. Posted 25 May 2015 on http://www.okapiconservation.org/blog/

Petric, A. (ed.) 2012. *Proceedings of the International Okapi Meeting, Jacksonville Zoo 8-11 November 2011*

Plumptre, A.J., Kujirakwinja, D. & Matunguru, J. 2008. *Survey of chimpanzees in the Virunga Park and an assessment of a potential corridor to Mt Hoyo*. Unpublished report submitted to USFWS. Available at http://programs.wcs.org/DesktopModules/Bring2mind/DMX/Download.aspx?EntryId=11575&PortalId=49&DownloadMethod=attachment

Potapov, P.V., Turubanova, S.A., Hansen, M.C., Adusei, B., Broich, M., Altstatt, A., Mane, L. & Justice, C.O. 2012. Quantifying forest cover loss in Democratic Republic of the Congo, 2000–2010, with Landsat ETM + data. *Remote Sensing of Environment* 122: 106-116

Quinn, A., Queslin, E. & Kümpel, N.F. 2013. Okapi (*Okapia johnstoni*) conservation status review. Zoological Society of London (ZSL), London.

Radio Okapi. 2013. *Equateur: 30 okapis abattus dans la réserve d'Abumumbazi à Gbadolite*. Available at: http://radiookapi.net/environnement/2013/06/14/equateur-30-okapis-abattus-dans-la-reserve-dabumumbazi-gbadolite/

Rowcliffe, J.M., Field, J., Turvey, S.T. & Carbone, C. 2008. Estimating animal density using camera traps without the need for individual recognition. *Journal of Applied Ecology* 45: 1228–1236. DOI: 10.1111/j.1365-2664.2008.01473.x

Schwarzenberger, F., Patzl, M., Francke, R., Ochs, A., Buiter, R., Schaftenaar, W. & De Meurichy, W. 1993. Fecal Progestagen Evaluations to monitor the estrous cycle and pregnancy in the okapi (*Okapia johnstoni*). *Zoo Biology* 12: 549-559

Sclater, P. L. 1901. [Exhibition of a painting of an okapi]. *Proceedings of the Zoological Society of London* 71(1): 3-6 and Plate I

Sidney, J. 1965. The past and present distribution of some African ungulates. *Transactions of the Zoological Society of London* 30: 1-397

Skinner, J.D. & Mitchell, G. 2011. Family Giraffidae (Giraffe and Okapi). pp788-802. In: Wilson, D.E. 7 Mittermeier, R.A. 2011. *Handbook of the Mammals of the World, Volume 2: Hoofed Mammals*. Lynx Edicons

Stanton, D.W.G. 2014 Phylogeography, population genetics and conservation of the okapi (*Okapia johnstoni*). PhD Thesis, Cardiff University, 186pp. Available at: http://orca.cf.ac.uk/61273/1/StantondwgPhD.pdf

Stanton, D.W.G., Penfold, L.M., Zhan, X. & Bruford, M.W. 2010. Microsatellite loci for the okapi (*Okapia johnstoni*). *Conservation Genetics Resources* 2: 337-339

Stanton, D.W.G., Hart, J., Vosper, A., Kümpel, N.F., Wang, J., Ewen, J.G. & Bruford, M.W. 2014a. Non-invasive genetic identification confirms the presence of the endangered okapi *Okapia johnstoni* south-west of the Congo river. *Oryx,* 1–4. DOI: 10.1017/S0030605314000593

Stanton, D.W.G., Hart, J., Galbusera, P., Helsen, P., Shephard, J. *et al*. 2014b. Distinct and diverse: range-wide phylogeography reveals ancient lineages and high genetic variation in the endangered okapi (*Okapia johnstoni*). *PLoS ONE* 9(7): e101081. DOI: 10.1371/journal.pone.0101081

Stanton, D.W.G., Hart, J., Kümpel, N.F., Vosper, A., Nixon, S., Bruford, M.W., Ewen, J.G. & Wang, J. 2015a. Enhancing knowledge of an endangered and elusive species, the okapi, using non-invasive genetic techniques. *Journal of Zoology* 295: 233–242. DOI: 10.1111/jzo.12205

Stanton, D.W.G., Helsen, P., Shephard, J., Leus, K., Penfold, L., Hart, J., Kümpel, N.F., Ewen, J.G., Wang, J., Galbusera, P. & Bruford, M.W. 2015b. Genetic structure of captive and free-ranging okapi (*Okapia johnstoni*) with implications for management. *Conservation Genetics*. DOI: 10.1007/s10592-015-0726-0

Stiles, D. 2010. The Okapi Wildlife Reserve: is there hope for the future? *Swara (East African Wildlife Society)* 4: 46-49

Stokes, E. (2014) *Evaluation of law enforcement effort, threats and conservation impact in the RFO using patrol-based data: 2008-2013*. Wildlife Conservation Society.

Strindberg, S. & O'Brien, T. 2012. *A decision tree for monitoring wildlife to assess the effectiveness of conservation interventions.* Global Conservation Program, Wildlife Conservation Society, New York

Thomas, L., Buckland, S.T., Rexstad, E.A., Laake, J.L., Strindberg, S., Hedley, S.L., Bishop, J.R.B., Marques, T.A. & Burnham, K.P. 2010. Distance software: design and analysis of distance sampling surveys for estimating population size. *Journal of Applied Ecology* 47:5-14

Tshombe, R., Hart, T. & Amboya, C. 2005. Impacts of conflicts on forests and people in D.R. Congo. *European Tropical Forest Research Network News* 43/44: 45-47

UNDP. 2014. *Human development report. Sustaining human progress: reducing vulnerability and building resilience*. United Nations Development Programme. Available at: http://hdr.undp.org/sites/default/files/hdr14-report-en-1.pdf

UNEP. 2011. *The Democratic Republic of the Congo: post-conflict environmental assessment, a synthesis for policy makers*. United Nations Environment Programme

van Vliet, N., Nasi, R. & Lumaret, J.P. 2008. Factors influencing duiker dung decay in north-east Gabon: are dung beetles hiding duikers? *African Journal of Ecology* 47**:** 40-47

van Vliet, N., Nebesse, C., Gambalemoke, S., Akaibe, D. & Nasi, R. 2012. The bushmeat market in Kisangani, Democratic Republic of Congo: implications for conservation and food security. *Oryx* 46: 196-203

Vosper, A., Masselink, J. & Maisels, F. 2012. *Great ape and human impact monitoring in Okapi Faunal Reserve, Democratic Republic of Congo*. Unpublished report submitted to USFWS. Available *via* http://www.elephantdatabase.org/population_submissions/242

Walsh, P.D., White, L.J.T., Mbina, C., Idiata, D., Mihindou, Y., Maisels, F. & Thibault, M. 2001. Estimates of forest elephant abundance: projecting the relationship between precision and effort. *Journal of Applied Ecology* 38: 217-228

White, L.J.T. 1995. Factors affecting the duration of elephant dung piles in rain forest in the Lopé Reserve, Gabon. *African Journal of Ecology* 33: 142-150

Wildlife Direct. 2007. *Blog: searching for the elusive bonobo in Congo*. Available at: http://lomami.wildlifedirect.org/2007/06/03/diamonds-are-north-okapi-too/

Wilkie, D., Shaw, E., Rotberg, F., Morelli, G. & Auzel, P. 2000. Roads, development, and conservation in the Congo Basin. *Conservation Biology* 14: 1614–1622

Wilson, D.E. & Mittermeier, R.A. 2011. *Handbook of the Mammals of the World, Volume 2: Hoofed Mammals*. Lynx Edicions

Wolf, C.M., Griffith, B., Reed, C. & Temple, S.A. 1996. Avian and mammalian translocations: update and reanalysis of 1987 survey data. *Conservation Biology* 10: 1142–1154. DOI: 10.1046/j.1523-1739.1996.10041142.x

World Resources Institute, 2013. *Interactive Forest Atlas of the Democratic Republic of Congo*. Available at : https://www.wri.org/our-work/project/congo-basin-forests/democratic-republic-congo#project-tabs

ZSL. 2008. *Photostory: first pictures of the elusive okapi*. http://www.zsl.org/conservation/regions/africa/okapi/photostory-first-pictures-of-the-elusive-okapi,73,PS.html

Appendix 1: List of sources for historical records of okapi

The table below lists the sources, location, year and other details of additional historic samples used to compile the historic okapi range in Figure 11.

Source	Sample type	No.	Location	Latitude	Longitude	Collector	Year	Sex	Age class
***Centre National de la Recherche Scientifique* (Paris)** [a]	Hoof	1	?	?	?	?	?	?	?
	Tooth root	2	?	?	?	?	?	?	?
	Dried skin	4	?	?	?	?	?	?	?
Denmark Museum [a]	Dried skin	4	?	?	?	?	?	?	?
	Bone	3	?	?	?	?	?	?	?
	Tissue	1	?	?	?	?	?	?	?
Field Museum of Natural History (Chicago) [a]	Dried tissue (picked off skulls)	6	?	?	?	?	?	?	?
Royal Museum for Central Africa (Tervuren) [a]	Dried skin	1	Beni	0.4833	29.4500	Bonnevie	received in 1914	M	?
	Dried skin	1	Lomela	-2.3000	23.2833	Ghesquiere	?	?	?
	Dried skin	1	Lungu	-2.1333	26.0500	Dorsinfang	received in 1929	?	Juvenile
	Dried skin	1	Beni	0.4833	29.4500	Bonnevie	received in 1914	M	?
	Dried skin	1	Mawambi	1.0667	28.5667	Van Hulde	received in 1906	?	Juvenile
	Dried skin	1	Mawambi	1.0667	28.5667	Van Hulde	received in 1906	?	Juvenile
	Dried skin	1	Semliki	1.2622	30.4628	David	received in 1904	?	Juvenile
	Dried skin	1	Wamba	2.1500	28.0000	Vermeulen	?	?	?
	Dried skin	1	Dondo	-4.6106	17.8827	Denie	received in 1938	?	?
	Dried skin	1	Banda	-3.2833	22.9833	gouverneur general	?	F	?
	Dried skin	1	Buta	2.8000	24.7333	Hutsebaut	received in 1938	?	?
	Dried skin	1	Moyo river	-5.9656	17.5212	Blondeau	received in 1934	?	?
	Dried skin	1	Moyo river	-5.9656	17.5212	Blondeau	received in 1934	?	?
	Dried skin	1	Angu	3.5287	24.4634	Lebrun	?	F	?
	Dried skin	1	Poko	3.1500	26.8833	?	received in 1905	?	?
	Dried skin	1	Buta	2.8000	24.7333	Hutsebaut	received in 1931	F	Subadult
	Dried skin	1	?	?	?	gouverneur general	received in 1949	F	Juvenile
	Dried skin	1	?	?	?	Zoo Antwerpen	1985	?	?

Source	Sample type	No.	Location	Latitude	Longitude	Collector	Year	Sex	Age class
	Dried skin	1	?	?	?	Zoo Antwerpen	1989	?	?
	Dried skin	1	?	?	?	Zoo Antwerpen	1986	M	Adult
	Dried skin	1	Buta	2.8000	24.7333	Hutsebaut	received in 1938	?	?
	Dried skin	1	Kanwa	2.1547	25.7141	Libois	received in 1931	?	?
	Dried skin	1	Banda	-3.2833	22.9833	gouverneur general	?	M	?
	Dried skin	1	Wamba	2.1500	28.0000	Wilmet	received in 1912	M	Adult
	Dried skin	1	Semliki	1.2622	30.4628	Mertens	received in 1904	M	Adult
	Dried skin	1	Mawambi	1.0667	28.5667	Van Hulde	received in 1906	M	?
	Dried skin	1	Wamba	2.1500	28.0000	Wilmet	received in 1912	F	Adult
	Dried skin	1	Banalia	1.5500	25.3333	De Walf	?	M	?
	Dried skin	1	Lungu	-2.1333	26.0500	Dorsinfang	received in 1929	?	?
	Dried skin	1	Lungu	-2.1333	26.0500	Dorsinfang	received in 1929	?	?
	Dried skin	1	Epulu	1.3979	28.5810	Putnam	received in 1937	M	?
Royal Museum for Central Africa (Tervuren) [a]	Dried skin	1	Epulu	1.3979	28.5810	Epulu station	received in 1957	F	Juvenile
	Skin	1	Lomela	-2.3000	23.2833	Guilmot	received in 1936	?	?
	Skin	1	Angu	3.5287	24.4634	Eydemark	received in 1908	M	?
	?	1	Libenge	3.6500	18.6333	Bertrand	received in 1904	?	Juvenile
	Skin	1	Banzyville	4.3028	21.1895	adm.terr Banzyville	received in 1937	?	?
	Skin	1	Bwatu Abumombazi	3.7002	21.9366	Denie	received in 1938	?	?
	?	1	Lungu	-2.1333	26.0500	Dorsinfang	received in 1929	?	Juvenile
	Skin	1	Molegbe	4.2234	20.8956	Denie	received in 1938	?	?
	Skin	1	Stanleyville (Kisangani)	0.5153	25.1910	delhaise	received in 1911	?	?
	Skin	1	Aruwimi	1.2261	23.5803	Libert	received in 1936	?	?
	Skeleton	1	Angu	3.5287	24.4634	Eydemark	received in 1908	?	?
	Cranium	1	Libenge	3.6500	18.6333	Bertrand	received in 1904	?	Adult
	Skin	1	Banzyville	4.3028	21.1895	adm.terr Banzyville	received in 1937	?	?
	Skin	1	Stanleyville (Kisangani)	0.5153	25.1910	Dufour	received in 1939	?	?
	Skin	1	Stanleyville (Kisangani)	0.5153	25.1910	Dufour	received in 1939	?	?

Source	Sample type	No.	Location	Latitude	Longitude	Collector	Year	Sex	Age class
Lwiro map [b]	Point extracted from a map	1	Aketi area	3.3246	23.8714	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Businga area	3.5433	22.0959	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Aketi area	3.4744	24.4368	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Aketi area	3.1124	24.4196	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Aketi area	2.9658	24.6006	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Aketi area	2.9227	24.8678	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Aketi area	2.5779	24.4196	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Aketi area	2.6641	24.6782	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Aketi area	2.6383	24.9109	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Aketi area	2.1177	25.3643	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Kisangani area	1.5574	25.1316	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Kisangani area	1.1867	24.5713	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Kisangani area	0.9023	24.9161	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Kisangani area	0.5403	25.2522	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	3.6249	26.0711	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	3.2284	26.6917	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	3.0991	26.9072	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	2.1337	27.4563	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	2.2975	27.3356	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	2.4095	27.5080	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	2.4354	27.8528	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	2.1510	27.9304	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Isiro area	2.7026	28.6544	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Epulu (RFO)	1.4842	28.5701	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Epulu (RFO)	1.4713	28.7706	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Epulu (RFO)	1.3743	28.0530	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Epulu area	0.9477	27.9495	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Epulu area	0.8830	28.3697	Gyzen (1959)	?	?	?

Source	Sample type	No.	Location	Latitude	Longitude	Collector	Year	Sex	Age class
	Point extracted from a map	1	Epulu (RFO)	1.0640	28.6477	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Butembo area	0.4175	28.6477	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Epulu area	1.2450	29.2877	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Bunia area	1.8462	30.0816	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Bunia area	1.2709	29.9588	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Virunga	0.4279	29.6032	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Virunga	0.7705	29.7325	Gyzen (1959)	?	?	?
Lwiro map [b]	Point extracted from a map	1	Butembo area	0.3826	29.3834	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Butembo area	0.0012	29.3446	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Butembo area	-0.1475	29.1378	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Butembo area (south)	-0.5121	28.4783	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Bunia area (north)	2.9457	30.6052	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Sankuru Reserve (north)	-0.9473	23.3436	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Sankuru Reserve (west)	-2.3380	23.2172	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Sankuru Reserve	-2.5448	23.3551	Gyzen (1959)	?	?	?
	Point extracted from a map	1	Sankuru Reserve	-2.7517	23.5160	Gyzen (1959)	?	?	?

Notes on sources:
[a] Samples provided to Dave Stanton, Cardiff University, 2011
[b] Georeferenced by ZSL-DRC staff in 2012 from a photograph of a map in *Centre de Recherche en Sciences Naturelles*, Lwiro, DRC

Appendix 2: All known post-conflict (2003-present) field surveys recording okapi presence[15] [16] [17]

Location	Year of survey	Time of year	Focus of survey	Survey type	Distance (km)	Survey area (km^2)	Observation type	Number of observations	Dung encounter rate (/km)	Organisations involved	Reference
Protected areas											
Okapi Wildlife Reserve	2005-2007	April-Sept 2005, Nov/Dec 2006-May 2007	General wildlife inventory	Transects for comparison with 1995 data	280	14,139	Carcass	1	0.20	WCS, ICCN	Beyers 2008; Hart *et al*. 2008
							Dung	57			
				Systematic transects	128		Dung	36	0.28		
				Recces	1369.6		Carcass	2	0.33		
							Direct sighting	3			
							Dung	342			
Okapi Wildlife Reserve	July 2008-June 2012	Year round	ICCN patrol	ICCN patrol	93,099	Unknown	Carcass	4	0.0052	ICCN	ICCN presentation (Kisangani workshop, May 2013); Stokes 2014
							Direct sighting	155			
							Dung	462			
Okapi Wildlife Reserve	2010-2011	December 2010, February 2011	General wildlife inventory	Systematic transects	144	12,787	Dung	82	0.49	WCS, ICCN, ZSL	Vosper *et al*. 2012
				Recces	1216		Direct sighting	4	0.37		
							Dung	562			
							Tracks	1			

[15] The data presented here are predominately from field surveys, as well as some patrols; data from market surveys and anecdotal reports are included in a wider okapi database available at www.giraffidsg.org.

[16] Some anecdotal reports of okapi occurrence were provided by the Buta Aketi and Maiko working groups of the Kisangani workshop. These are shown on Figure 12 as point locations where okapi bushmeat or skin has been found.

[17] No sign of okapi has been observed during extensive studies conducted in Salonga National Park (East sector and corridor; Hart 2006, Maisels *et al*. 2010) and at Sankuru in the Tshuapa-Lomami-Lualaba region (Liengola *et al*. 2009), which confirm that these areas are probably outside the current range of okapi.

Location	Year of survey	Time of year	Focus of survey	Survey type	Distance (km)	Survey area (km^2)	Observation type	Number of observations	Dung encounter rate (/km)	Organisations involved	Reference
Protected areas											
Virunga National Park (Semliki Valley Forest)	2006-2007	May	Okapi	Transects	Unknown	Unknown	Call	1	Unknown	WWF, ICCN	Bashonga & Languy 2008; Bashonga 2007, 2006
							Dung	15			
							Feeding sign	17			
							Tracks	40			
Virunga National Park	2008	January-February / May	Chimpanzee	Recces / transects	123.8	Unknown	Tracks	Unknown	n/a	WCS, ICCN	Plumptre *et al*. 2008
Virunga National Park (Watalinga)	2008	July-August	Okapi	Recces	216.9	550	Dung	33	0.14	ZSL, ICCN	Nixon & Lusenge 2008
							Feeding sign	26			
							Tracks	48			
Virunga National Park (Mukakati South)	2009	August	Okapi (n.b. carried out in small area with known high localised okapi population density)	Recces	39.2	18	Dung	20	0.51	ZSL, ICCN	Kümpel 2010
							Feeding sign	14			
							Tracks	44			
Virunga National Park (Lesse)	2009	November	Okapi (n.b. as above)	Recces	19.6	18	Dung	14	0.71	ZSL, ICCN	Kümpel 2010
							Feeding sign	26			
							Tracks	33			
Virunga National Park (Watalinga)	2008	July-September	Okapi (n.b. as above)	Camera trap	n/a [16 cameras, total of 719 trap days]	n/a	Camera trigger events	6	n/a [0.008 trigger events/trap day]	ZSL, ICCN	Nixon & Lusenge 2008
Virunga National Park (Mukakati South)	2009	August-October	Okapi (n.b. as above)	Camera trap	n/a [16 cameras, total of 880 trap days]	18	Camera trigger events	6	n/a [0.007 trigger events/trap day]	ZSL, ICCN	Kümpel 2010
Virunga National Park (Lesse)	2009	October-December	Okapi (n.b. as above)	Camera trap	n/a [15 cameras, total of 660 trap days]	18	Camera trigger events	5	n/a [0.008 trigger events/trap day]	ZSL, ICCN	Kümpel 2010

Location	Year of survey	Time of year	Focus of survey	Survey type	Distance (km)	Survey area (km^2)	Observation type	Number of observations	Dung encounter rate (/km)	Organisations involved	Reference
Protected areas											
Mont Hoyo Reserve	2012	March	Patrol	Patrol	Unknown	Unknown	Dung	5 samples for genetic analysis	Unknown	ICCN	D. Stanton, pers. comm.
Maiko National Park (South)	2005	January-May	Gorilla/large mammals	Recces inside park, prospection for gorillas outside park	170	875 (recces only)	Dung	6	0.035	DFGFI	Nixon 2005
							Feeding sign	3			
							Tracks	15			
Maiko National Park (North)	2005	July-August	General wildlife inventory	Recces	378	1250	Dung	35	0.093	WCS, ICCN	Amsini *et al*. 2005
							Feeding sign	1			
							Tracks	129			
Maiko National Park (South)	2006	March-May	General wildlife inventory	Recces	300	600	Dung	7	0.023	WCS, ICCN	Amsini *et al*. 2006
							Feeding sign	6			
							Tracks	77			
Maiko National Park (Tayna - Bunyuki and Mutenda)	2006	March	Gorilla	Recces / transects	89	Unknown	Dung	0	0	UGADEC, DFGFI	Nixon & Mufabule, unpublished data 2006
							Feeding sign	0			
							Tracks	0			
Maiko National Park (Usala Gorilla Reserve)	2007	March-April	Gorilla	Recces	204	847	Direct sighting	1	0.02	UGADEC, DFGFI	Nixon *et al*. 2007
							Dung	4			
							Tracks	7			
Maiko National Park (Loya sector - north)	2008	May	Gorilla	Recces	45	Unknown	Unknown	Unknown	Unknown	ICCN, DFGFI	Braum & Mufabule 2008
Maiko National Park (Lubutu sector and forests west - proposed Regolo community reserve)	2010	June-July	General wildlife inventory	Recces	230.3	Unknown	Community mapping reports	Unknown	n/a	FFI, ICCN	Nixon 2010
							Feeding sign	2			
							Tracks	13			

Location	Year of survey	Time of year	Focus of survey	Survey type	Distance (km)	Survey area (km^2)	Observation type	Number of observations	Dung encounter rate (/km)	Organisations involved	Reference
Protected areas											
Maiko National Park (Lenda Community Reserve)	2011	October-November	Community patrol	Community patrol	Unknown	Unknown	Dung Feeding sign Tracks	9 1 23	Unknown	KUMU Foundation	Bahati-Eliba 2011
Maiko National Park	2011-2012	December 2011, Jan-Nov 2012	Patrol	Patrol	Unknown	Unknown	Dung Tracks	2 88	Unknown	ICCN	ICCN patrol data, pers. comm.
Maiko National Park (South) [18]	2014	November	Great ape	Recces	Unknown	Unknown	Dung Tracks	6 9	Unknown	ICCN, FFI, FZS	S. Nixon, pers. comm.
Rubi-Tele Hunting Reserve	2007	May-June	General wildlife inventory	Recces	331	Unknown	Dung Tracks	6 3	0.018	Lukuru Foundation, ICCN	Hart 2007
Rubi-Tele Hunting Reserve	2011	September	General wildlife inventory	Recces	204	Unknown	Dung Feeding sign Tracks	4 7 3	0.02	Lukuru Foundation	J. Hart, pers. comm.; Hicks 2014
Tshuapa-Lomami-Lualaba (TL2) Landscape	2007-2009	Year-round	General inventory	Recces / transects	2550	44000	Dung	Unknown	Unknown	Lukuru Foundation	Hart 2009a
Tshuapa-Lomami-Lualaba (TL2) Landscape	2011	August	Unknown	Recces	Unknown	Unknown	Dung	5	Unknown	Lukuru Foundation	J. Hart, pers. comm.

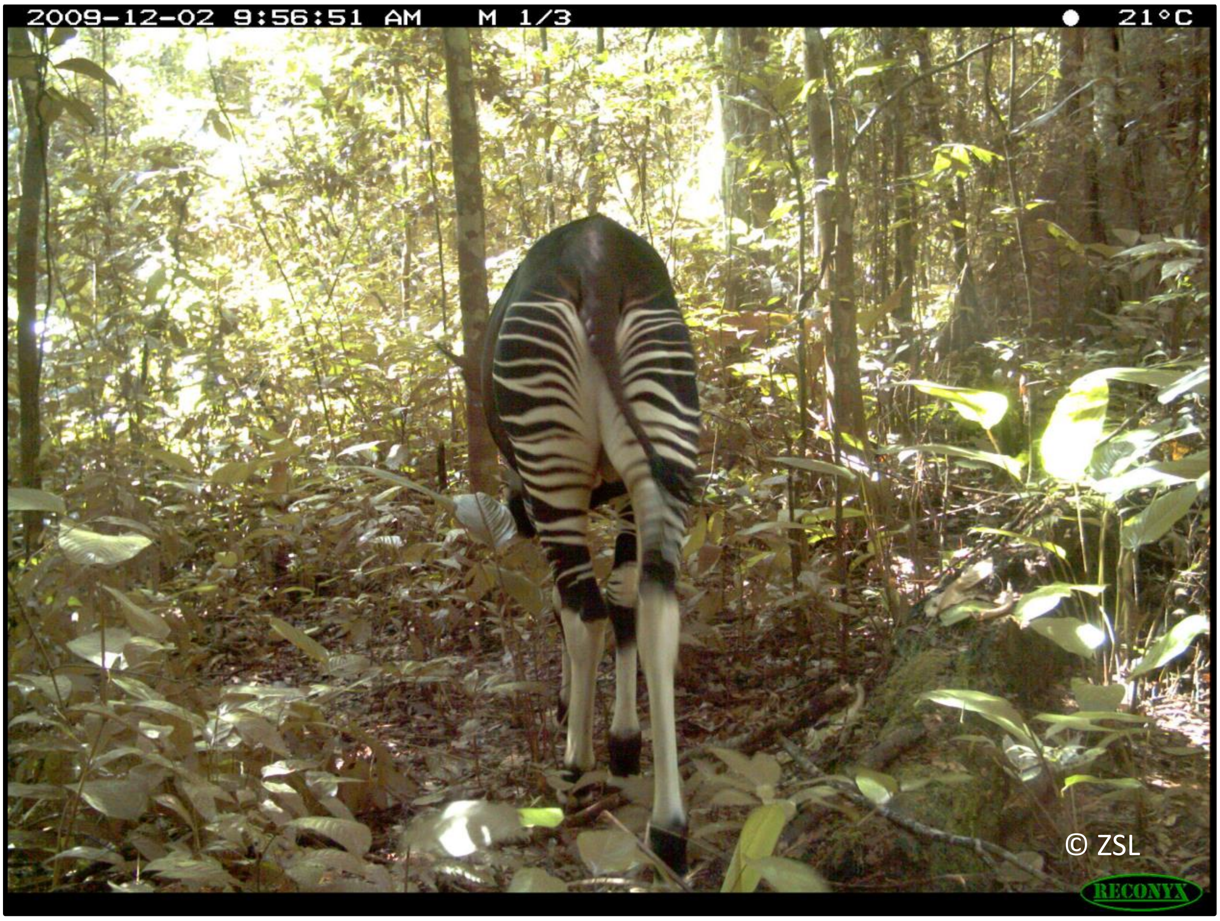
[18] At the time of compiling this status review, full information on general survey coverage was not yet available so these survey datasets are not mapped in terms of presence-absence coverage in Figure 12.

Location	Year of survey	Time of year	Focus of survey	Survey type	Distance (km)	Survey area (km^2)	Observation type	Number of observations	Dung encounter rate (/km)	Organisations involved	Reference
Unprotected areas											
Abumonbanzi Reserve (proposed) in North Ubangi	2013	Unknown	Unknown	Patrol	Unknown	Unknown	Carcass	2	n/a	WWF, ICCN	Omari Ilambu, pers. comm.; Ngbolua *et al*. 2014
Buta Aketi	2006-2009	Year round	Chimpanzee	Transects, forest walks	506.2 (south of Uele river)	Unknown	Dung	11	Unknown	Wasmoeth Wildlife Foundation, Lucie Burgers Stichting, Amsterdam University	Hicks 2010
							Feeding sign	5			
							Tracks	33			
Mundo (west of Maiko) [18]	2013	July, September	Large mammals	Prospection	125	Unknown	Dung	17	Unknown	FFI, REGOLUS	S. Nixon, pers. comm.
							Feeding sign	7			
							Tracks	6			
Usala (east of Maiko) [18]	2014	February-March	Large mammals	Recces	201	Unknown	Dung	8	Unknown	FFI, WCS	S. Nixon, pers. comm.
							Tracks	7			
Tshopo-Lindi-Aruwimi (TLA) region (north of Bafwasende)	2012	February, April	Okapi, elephant, chimpanzee	Questionnaire	Unknown	Unknown	Carcass	3	n/a	Lukuru Foundation	J. Hart, pers. comm.
Zone Bakwanza (east of RFO)	2010	April-June	General wildlife inventory	Recces	224	Unknown	Dung	3	0.01	WCS	Makana *et al*. 2010
							Feeding sign	3			
							Tracks	10			
Mai-Tatu (east of RFO)	2009	March-November	General wildlife inventory	Recces	598	Unknown	Direct sighting	4	0.06	WCS	Makana *et al*. 2012; Madidi *et al*. 2009
							Dung	48			
							Feeding sign	40			
							Tracks	142			

Appendix 3: Okapi conservation strategy workshop participants

	Participant	Organisation	Position
1	Guy Mbayma	Government - ICCN	Head Director of the Technical and Scientific Department
2	Henri Mbale	Government - ICCN	Scientific and Technical Director
3	Jean Joseph Mapilanga	Government - ICCN	Director of National Parks and Reserves
4	Paulin Tshikaya	Government - ICCN	Director of Eastern Province
5	Norbert Mushenzi	Government - ICCN	Deputy Chief Warden - Virunga National Park
6	Honore Balikwisha	Government - ICCN	Chief Warden - Mont Hoyo Reserve
7	Bernard Iyomi Iyatshi	Government - ICCN	Chief Warden - Okapi Wildlife Reserve (RFO)
8	Boji Munguakonkwa	Government - ICCN	Chief Warden - Maiko National Park
9	Thomas Mfu N'Sankete	Government - ICCN	Chief Warden - Rubi-Tele Hunting Reserve
10	Hon. Pascal Mombi Opana	Government - Provincial	Vice-Governor of Eastern Province
11	Hon. Milton Lonu Lonema	Government - Ministry	Provincial Minister for the Environment
12	Urbain Moponga	Government - Ministry	Technical and Environmental Advisor
13	Hon. Heri Baraka	Provincial Parliament	Provincial MP - Eastern Province
14	Hon. Joseph Ndia Amsini	Provincial Parliament	Provincial MP - Eastern Province
15	Nathanel Kasongo	Government - ICCN	Officer in charge of Law Enforcement Monitoring - RFO
16	Zabiti Kandolo	Government - ICCN	Monitoring Officer – Maiko National Park
17	Mbamgamuabo Biriku	Government - ICCN	Monitoring Team Leader - Mont Hoyo Reserve
18	Noëlle Kümpel	NGO/IGO - ZSL/IUCN SSC Okapi and Giraffe Specialist Group	Central, East and Southern Africa Programme Manager / Co-Chair
19	David Mallon	IGO - IUCN	Workshop Facilitator
20	Elise Queslin	NGO - ZSL	Okapi Project Co-ordinator
21	Dave Stanton	University - ZSL Institute of Zoology/ Cardiff University	PhD Student
22	Alex Quinn	NGO - ZSL	GIS Technician
23	John Hart	NGO - Lukuru Foundation/TL2	Scientific Manager of TL2 Project
24	Terese Hart	NGO - Lukuru Foundation/TL2	Manager of TL2 Project
25	Ephrem Mpaka	NGO - Lukuru Foundation/TL2	Research Assistant for TL2/Rubi Tele/Bafwasende
26	Omari Ilambo	NGO - WWF/PARAP	Senior Technical Advisor, Protected Areas
27	Ménard Mbende	NGO - WWF/PARAP	Technical Assistant in charge of biological surveys
28	Robert Mwinyihali	NGO - WCS	Project Manager - RFO
29	Rosmarie Ruf	NGO - OCP	Project Manager - RFO
30	John Lukas	NGO - OCP	Director
31	Fidele Amsini	NGO - FZS	Project Manager- Maiko
32	Gaudens Maheshe	NGO - KUMU Foundation	Programme Manager
33	Alphonse Kakaya	NGO - KUMU Foundation	Supervisor of Bafwasende Territory
34	Kimputu Kembe	Local community	Local Chief of Bandisende - RFO
35	Robert Fuamba	Local community	Chief of Bitule sector, south Maiko
36	Polycarpe Kisangola	Local community	Research Assistant / Local Chief for the Aketi region

Okapi captured by camera trap in northern Virginga National Park, 2009. © ZSL



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