Chapter 18
Biodiversity Conservation: History, Protected Areas and Hotspots

Brian J. Huntley, Pedro Beja, Pedro Vaz Pinto, Vladimir Russo, Luís Veríssimo, and Miguel Morais

Abstract Angola is a large country of great physiographic, climatic and habitat diversity, with a corresponding richness in animal and plant species. Legally protected areas (National Parks and Game Reserves) were established from the 1930s and occupied 6% of the country's terrestrial area at the time of independence in 1975. As a consequence of an extended war, the Protected Areas were exposed to serious neglect, poaching and land invasions. Many habitats of biogeographic importance, and many rare and endemic species came under threat. The recently strengthened administration gives cause for optimism that a new era for biodiversity conservation is at hand. The Protected Areas system was greatly expanded in 2011, and increasing resources are being made available towards achieving management effectiveness.

B. J. Huntley (✉)
CIBIO-InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto, Vairão, Portugal
e-mail: brianjhuntley@gmail.com

P. Beja
CIBIO-InBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto, Vairão, Portugal

CEABN-InBio, Centro de Ecologia Aplicada "Professor Baeta Neves", Instituto Superior de Agronomia, Universidade de Lisboa, Lisboa, Portugal
e-mail: pbeja@cibio.up.pt

P. Vaz Pinto
Fundação Kissama, Luanda, Angola

CIBIO-InBIO Centro de Investigação em Biodiversidade e Recursos Genéticos, Universidade do Porto, Campus de Vairão, Vairão, Portugal
e-mail: pedrovazpinto@gmail.com

V. Russo · L. Veríssimo
Fundação Kissama, Luanda, Angola
e-mail: vladyrusso@gmail.com; vladimir.russo@holisticos.co.ao; lmnverissimo@gmail.com

M. Morais
Faculdade de Ciências, Universidade Agostinho Neto, Luanda, Angola
e-mail: dikunji@yahoo.com.br

495

Introduction: Wildlife Conservation During the Colonial Era

In common with most colonial territories in Africa, conserving wildlife was not a general consideration in Angola until the twentieth century. However, the first expression of concern regarding wildlife numbers came much earlier, and from none other than the most famous zoological collector to work in Angola – José Anchieta. In correspondence with the great Barbosa du Bocage, Anchieta (1869, in Andrade 1985:87) noted that inland of Luanda "the big game, abundant until fifty years ago, has moved into the interior because of the increased population and general use of firearms." But worse was to come. In 1880, the 'Angola Boers' arrived in Humpata, having crossed the Kalahari on their fateful Thirstland Trek (Stassen 2016). The Boers' hunting depredations soon spread across the country. Professional hunters such as William Chapman (Stassen 2010) described the wealth of game in the southwest, and personally contributed to its depletion.

Globally, by the end of the nineteenth century many repentant hunters were becoming alarmed at the fate of the once abundant herds and mobilised action to address the problem. The first international agreement on nature conservation was the *Convention for the Preservation of Wild Animals, Birds and Fish in Africa*, otherwise known as the London Convention, held in London in 1900. Attended by 11 European powers, the Convention was not ratified by several countries, including Portugal, and was abandoned with the onset of World War I (Carruthers 2017). Interestingly, the convention was the brain-child of the German hunter/explorer/military officer Hermann von Wissman, who with Paul Pogge collected in Malange and the Lundas in the early1880s, before he crossed Africa on the first of two transcontinental expeditions.

By the early twentieth century the impact of Boer biltong hunters had become notorious, and Thomas Varian, who introduced the Giant Sable Antelope to science, convinced the Governor of Moxico in 1913, and the then Portuguese High Commissioner, Norton de Matos, to close the sable lands to hunting (Varian 1953). The fame of the Giant Sable drew numerous trophy-hunting and scientific expeditions to Angola through the 1920s and 1930s (Walker 2004) and the zoological collections they made contributed much to our knowledge of Angola's biodiversity.

The London Convention of 1900 was followed in 1933 by the *Convention Relative to the Preservation of Fauna and Flora in their Natural State* – also known as the London Convention. Whereas the 1900 convention focused on hunting regulations, the 1933 convention promoted the idea that each colonial power should establish national parks and reserves in their colonial territories, following the model of the Kruger National Park established by South Africa in 1926. The 1933 convention also required states to give special protection to an internationally selected list of species – a list that included Giant Sable Antelope and the enigmatic desert plant *Welwitschia mirabilis*. Interest in protecting Angola's fauna was rising,

and hunters such as Henrique Galvão and Teodósio Cabral, administrators such as Norton da Matos and Abel Pratas, and scientists such as Fernando Frade and Luis Carrisso, immediately championed the National Park model. Portugal set about creating Angola's National Parks and Game Reserves even though it did not ratify the 1933 convention until 1950. The first of these protected areas was Iona, established as a Game Reserve by decree on 2 October 1937, followed by Cameia, Quiçama, Bicuar and Luando proclaimed on 16 April 1938. The first four of these game reserves were raised to National Park status in the 1950 and 1960s.

The good work of the 1930s and 1940s was reversed by the *caça livre* (free hunting) period of the early 1950s, when the wildlife populations of the cattle ranching region of the southwest were decimated because of concerns regarding stock diseases carried by wild species. The voices of reason were raised by a younger generation – Luis Carmo, Armando Malacriz and Newton da Silva (Newton da Silva 1952, 1970) and by 1955 Angola had a new and detailed legislative instrument, the *Decreto 40,040* (*Regulamento sobre a Protecção do Solo, Flora e Fauna*) which was only revoked in 2017. Wildlife conservation was given formal status as a public concern by the establishment of the *Conselho de Protecção da Natureza* (CPN) in 1965, chaired by the Governor General. The CPN played a pivotal role in the expulsion of cattle ranches from Quiçama in the 1970s (Huntley 2017). The increasing support of the Portuguese government for conservation came to a head when a major conference of its African territories was convened in Lubango in 1972. Titled *Reunião para o Estudo dos Problemas da Fauna Selvagem e Protecção da Natureza no Ultramar Português*, the meeting ran for 2 weeks and was attended by 73 delegates. It prepared 53 recommendations for action to improve the protection of nature throughout Angola, leading the government to double the budget of the department responsible for National Parks – the *Repartição Técnica da Fauna*.

Post-independence History of Conservation in Angola

Following the 'Carnation Revolution' of 25 April 1974 in Portugal, and soon after gaining independence, Angola entered a period of increasing difficulty and ultimately war, which only ended in February 2002. The impact of this period of violence and displacement on the wildlife and protected areas of Angola is described elsewhere (Walker 2004; Huntley 2017). During the war years, efforts to bring public support to the National Parks were made through convening annual *Semanas do Ambiente* (Environment Weeks) led by a small network of Angolans, most notably Carlos Pinto Nogueira, Serôdio d'Almeida and Vladimir Russo. Most of the protected areas were abandoned and the wildlife populations decimated during the early years of the war. In 1992 the International Union for the Conservation of Nature (IUCN) led an international study of the situation (IUCN 1992) that concluded:

> Since 1975, most, if not all populations of large mammals have been severely reduced, if not eliminated. Wholesale slaughter of elephant, rhino, eland, roan, oryx, springbok, zebra, bushbuck, reedbuck, lechwe and many other species occurred in all parks and reserves. It is possible that some nucleus herds still survive, sufficient to recover if given effective protection.

In an ironic twist of wildlife conservation practice, in 1995 the Kissama Foundation (KF) was established, led by a group of conservation-minded military generals. Wishing to support Quiçama National Park on its road to recovery, the KF raised funds to re-introduce species that had been severely reduced during the first decades of the war. Unfortunately the initiative, promoted as 'Operation Noah's Ark' in 2000 introduced many species never previously known to occur in Quiçama. Despite international concern regarding the introductions, the programme was continued and expanded in 2014 by the then Minister of Environment, as an essentially private effort to create a mixed collection of animals in the tiny encampment – ca. 1% of Quiçama –that formed the 'Special Protected Area'. Sadly, the remaining 99% of Quiçama has since been left to the ravages of the bushmeat trade and illegal land occupation. Species never previously recorded in Quiçama but introduced with Ministerial approval in 2000 and 2014 included Plains Zebra, Giraffe, Kudu, Nyala, Common Waterbuck, Blue Wildebeest, Red Hartebeest, Blesbok, Oryx, and Common Impala. Nyala and Blesbok have never been recorded in Angola, or within 2300 km of Quiçama. Only two of the species introduced, Savanna Elephant and Eland, were native to the park, but the poorly documented animals introduced by wildlife dealers were from different genepools to the original Quiçama populations.

During the early 2000s, international interest in Angola led to several initiatives, most notably those of the Global Environment Facility (GEF), to support conservation in the country. A fundamental step supported by the GEF was the development of a National Biodiversity Strategy and Action Plan (NBSAP), (GoA 2006) that gave direction to policy established in the Base Law for the Environment (GoA 1998). In support of the objectives of the NBSAP, a survey of the Cuando Cubango paved the way to the proclamation of the Luengue-Luiana National Park (Bergman and Verissimo 2008). The proclamation of the Maiombe National Park in Cabinda resulted from the Mayombe Transfrontier Conservation initiative. GEF funding was raised to help rehabilitate and expand the protected areas system of Angola, and this and other initiatives continue to support the government in its programme.

The Protected Areas System

Angola's protected areas system, proposed in 1936, with the first reserve established in 1937, expanded rapidly through to the 1970s, by which time 13 Protected Areas (PAs) had been established, totaling 75,267 km^2 or 6,0% of national territory. During the early 1970s, extensive surveys were undertaken to identify key biodiversity hotspots or other areas deserving inclusion in an expanded conservation network (Huntley 1974a, b, c, d, 2010). The objective was to increase the representation of Angola's vegetation types and faunal species diversity within the PA system. Unfortunately the interruption of war and the weakness of governance systems delayed the consideration and approval of the recommendations until 2011, when the *Conselho de Ministros* not only approved the proposals of 1974 but added

Table 18.1 Terrestrial protected areas of Angola

Name	Category	Date established	Area 1, km²	Area 2, km²
Iona	National Park	1937	15,150	15,196
Cameia	National Park	1938	14,450	14,688
Quiçama	National Park	1938	9960	9227
Mupa	National Park	1938	6600	6039
Bicuar	National Park	1938	7900	6748
Cangandala	National Park	1963	650	637
Mavinga	National Park	2011	Unknown	Unknown
Luengue-Luiana	National Park	2011	45,818	22,720
Maiombe	National Park	2011	1930	2074
Chimalavera	Regional Nature Park	1971	150	102
Luando	Integral Nature Reserve	1938	8280	9930
Ilhéu dos Pássaros	Integral Nature Reserve	1973	2	1.5
Búfalo	Partial Reserve	1974	400	405
Namibe	Partial Reserve	1957	4450	4642
Total Area, km²			115,740	92,409.5

Two game reserves established in the 1930s – Ambriz, of 1125 km², and Milando, of 6150 km² – and since deproclaimed – are not included in this listing. Furthermore, the boundaries of Mavinga await clarification. Sources for Area – 1: GoA 2018; 2: Veríssimo Unpublished Data 2018

several new areas. In terms of Law 38/11 of 29 December 2011, the PA system increased to over 115,000 km² of national territory in one step, Table 18.1, Fig. 18.1. However, some debate continues regarding the definition of the boundaries of the individual PAs, with recent estimates by Verissimo (2018 Unpublished Data) providing new insights. While the area proclaimed as PAs was nearly doubled, the budget has remained on a very low plateau. Most National Parks still lack the most basic management capacity and effectiveness, despite the wealth of legislation promulgated since the Base Law for the Environment was approved in 1998.

The contradictions of global conservation policy, on one hand pressuring governments to reach a target of 17% of national territory under protected areas by 2020 (CBD 2010) and on the other, expecting the governments of developing countries to provide funds to effectively manage such PAs, is well illustrated by the situation in Angola. The drive to double the area under legislation has been accompanied by the neglect of iconic protected areas such as Quiçama, Iona and Luando. Since peace was achieved in 2002, the illegal occupation of the vulnerable Quiçama coastline by tourism lodges, fishing villages, oil exploration infrastructure, commercial enterprises and quarries, and by cattle ranches and commercial agricultural schemes, in addition to the rampant activities of bushmeat poachers and charcoal producers, has continued unabated. Iona, once a pristine desert environment, is now occupied by nomadic pastoralists who have invaded the heart of the park, supported by government sponsored water points which give permanence to the occupation. While some of the land invasions were a consequence of the war, most have occurred since the peace of 2002.
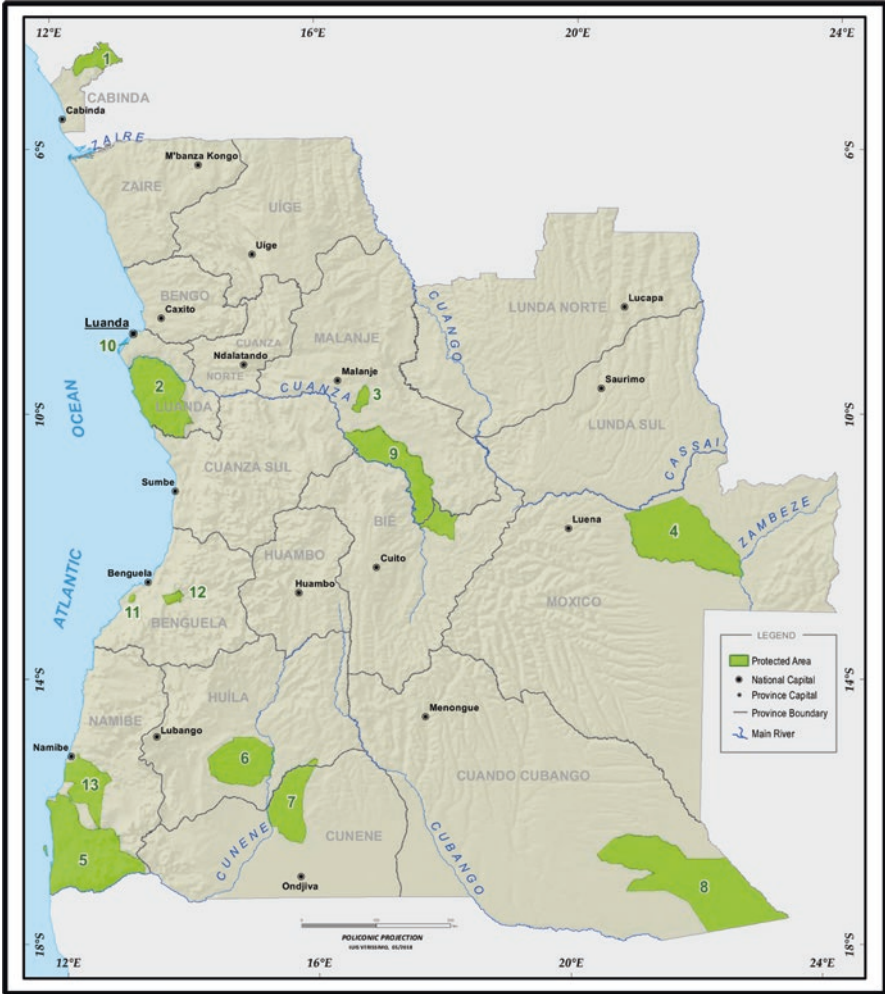
Fig. 18.1 Protected areas of Angola: • 1 Maiombe • 2 Quiçama • 3 Cangandala • 4 Cameia • 5 Iona • 6 Bicuar • 7 Mupa • 8 Luengue-Luiana • 9 Luando • 11 Chimalavera • 12 Búfalo • 13 Namibe. (Mavinga is not indicated on this map due to incomplete details regarding its boundaries in its gazettement)

The difficulties attending limited budgets, weak technical capacity and poorly trained human resources suggests that a triage approach should be considered to bring a focus to where the government's limited conservation resources should be targeted (Huntley 2017). Recent government policy has been to expand the PA estate, regardless of the management capacity of such 'paper parks'. Fortunately, despite the reverses of the past decades, each protected area still includes areas of sufficient dimension that can, with effective management, achieve significant biodiversity conservation goals. Since 2017, the new government leadership gives prom-

ise for a revitalised and energetic approach to conservation in Angola, as demonstrated in the recent Strategic Plan for the Conservation Areas System of Angola (GoA 2018).

Wildlife Populations

In contrast to most southern African countries, where reliable statistics of wildlife population dynamics have been recorded over many decades, the data sets for Angola are extremely sparse. Estimates made during the 1970s tended to be conservative, but indicated robust populations of Elephant (600), Forest Buffalo (6000), Eland (3000) and Roan Antelope (3000) in Quiçama (Huntley 1971). These species were extinct or nearly so in the park by 1992 (IUCN 1992). The populations of Giant Sable Antelope and Red Lechwe in Luando, each estimated at 2000 in 1972 (Huntley 1972), had dropped to less than 100 Giant Sable and with Lechwe on the verge of extinction by 2017 (Vaz Pinto 2018, 2019). Savanna Elephant, Blue Wildebeest and Eland, abundant in Bicuar in the 1970s, had fallen to low numbers by 2017 (Beja et al. 2019). Across Angola, wildlife populations declined precipitously after 1974, but remarkably, very small but tenacious surviving populations of most species, including top predators such as Lion, Leopard, Cheetah and Wild Dog, have held out (Beja et al. 2019). Of considerable conservation concern is the number of large mammal species for which no recently confirmed records are available, including Gorilla, Black Rhinoceros, Puku, Red Hartebeest and Lichtenstein's Hartebeest (Beja et al. 2019).

The wildlife population densities and biomasses of Angolan protected areas have never been comparable to those in eastern and southern Africa. While this might be a factor of hunting pressure, more fundamental ecological factors are at play. As demonstrated by Bell (1982), herbivore population density and biomass in Africa is related to rainfall and soil nutrients, and more directly to the ratio of soluble to structural carbohydrates in plant material available to herbivores. The vast area of Angola covered by miombo woodlands with low-nutrient grasses, shrubs and trees accounts for the notoriously low game populations of central Angola. Only in the more arid savannas of the southwest and southeast were relatively large populations of herbivores found in colonial times. The popular perception of vast populations of game across Angola in the nineteenth century is an illusion, certainly if compared with eastern Africa, as manifest by the much lower volumes of ivory exported from Angola relative to Kenya throughout the period (Walker 2009). The highest biomasses for ungulates during the 1970s, based on estimates from field surveys, were the western littoral grasslands of Quiçama, occupied by Eland, Roan and cattle, and the northern 'Baixa dos Elefantes' forests and floodplains of the Cuanza, occupied by Savanna Elephant, Forest Buffalo and Hippopotamus. Ungulate biomass in Cangandala, Luando and Bicuar, in dense miombo woodlands, was very low, as was that of Iona. The richest hunting areas (*Coutadas*) of the southeastern Cuando

Cubango (Mucusso and Luiana) possibly had biomasses approximating those of similar nutrient poor mixed miombo woodlands of eastern Africa, such as Selous Game Reserve (Huntley Unpublished Data).

Species Richness, Endemism, Threatened Species and Biodiversity Hotspots

The seminal paper on Systematic Conservation Planning by Margules and Pressey (2000) triggered the wide adoption of objective measures for the identification of biodiversity conservation priorities. The process has been effectively applied in southern Africa, where fine-scale spatial data on species distribution and status are available, such as that required by IUCN categories of threat (Raimondo et al. 2009), vegetation and habitat maps (Mucina and Rutherford 2006), and surveys of marine ecosystems and their dynamics (Kirkman et al. 2016; Holness et al. 2014). These rich data sets have been used to produce detailed national and regional biodiversity conservation management plans (Driver et al. 2012; Kirkman et al. 2016) which provide models for future work in Angola.

A preliminary survey of the conservation status of Angolan mammals (Huntley 1973) gave subjective estimates for 70 species, none of which were considered threatened with extinction but several, in particular Gorilla, Chimpanzee and Black Rhinoceros, were deemed vulnerable. A summary of recent assessments of rarity and threat in various taxonomic groups in Angola are presented in Table 18.2. More specific details of conservation status or threats are provided in the sources for each major taxonomic group referenced in Table 18.2.

In an early objective assessment of habitats, the areas of 32 vegetation units mapped by Barbosa (1970) were measured to evaluate the proportional representation of each unit in the protected areas system (Huntley 1974a). The results were then used to focus attention on under-represented types, taking into consideration faunal as well as floral distribution and status (Huntley 1974c). Of the 32 vegetation types described by Barbosa (1970), only 11 fell within protected areas in 1974. The disparity of protection afforded to representatives of the major biogeographic divisions was considerable. The Karoo-Namib, represented by Barbosa vegetation types 27, 28 and 29, which occupy 2.6% of the country's land surface, had 50.6% of its area conserved, while the Guineo-Congolian forest/savanna mosaic, comprising 25.7% of Angola's total area, and holding probably over 70% of its biodiversity, was not represented in any protected area. The small relict fragments of Afromontane forest, without doubt the most threatened of all ecosystems in Angola, and currently reduced to less than 1000 ha in area, were also without protection. Both the Afromontane forests (Humbert 1940; Hall and Moreau 1962) and the Angolan Escarpment Zone (Hall 1960) have long been regarded as key centres of avifaunal speciation and floristic importance. But both remain unmapped and unprotected.

Table 18.2 Species richness, endemism and threatened status for selected taxa

Group	Total species	Endemic species n°	Endemic species %	IUCN status	Source
Plants	6850 indigenous species	997	14.6	399 species have been formally assessed, of which: 36 threatened:	1–3
	230 naturalised species			32 vulnerable,	
				4 endangered,	
				49 threatened or near-threatened	
Butterflies & Skippers	792	57	7.2	Not evaluated	4
Dragonflies & Damselflies	260	16	6.1	1 vulnerable	5
				4 near threatened	
				16 data deficient	
				6 not evaluated	
Fishes	358	78	22	0	6
Amphibians	111	21	19.3	Not evaluated	7
Reptiles	278			Not evaluated	8
Birds	940	29	3.1	Not evaluated	9
Mammals	291	12	4.1	2 critically endangered,	10
				2 endangered	
				11 vulnerable	
				14 near threatened	
				12 data deficient	
				235 least concern	

1: Figuerido and Smith (2008), 2: Goyder and Gonçalves (2019), 3: IUCN (2018), 4: Mendes et al. (2019), 5: Kipping et al. (2019), 6: Skelton Unpublished Data, 7: Baptista et al. (2019), 8: Branch et al. (2019), Dean et al. (2019), 10: Beja et al. (2019)

The identification of sites of high biodiversity importance (in terms of endemism, species richness, and threat) – popularly termed biodiversity 'hotspots' (Myers 1988; Myers et al. 2000) – was the focus of the Angolan Protected Areas Expansion Strategy (Huntley 2010) submitted to the Minister of Environment and adopted, with additional recommendations in 2011 (GoA 2011, 2018). The sites recommended for future gazettement included examples of:

- *Guineo-Congolian Forest and Savanna*: (Maiombe – Cabinda; Serra Pingano – Uíge; Lagoa Carumbo – Lunda-Norte; Serra Mbango – Malange; Gabela forest – Cuanza-Sul; Cumbira forest – Cuanza-Sul;
- *Afromontane Forest and Grassland*: (Mount Namba – Cuanza-Sul; Mount Moco – Huambo; Serra da Neve – Namibe; Serra da Chela – Huíla Province);
- *Zambezian Flooded Grassland*: (Luiana – Cuando Cubango).

The inclusion of these proposals in the Angolan protected areas system would effectively address the asymmetry of ecosystem representation, with the number of

Barbosa vegetation units increasing from 11 to 23. To date, Maiombe forest and Luiana (with adjacent Luengue, and Mavinga) have been gazetted as additional National Parks.

Recent studies by the National Geographic Okavango Wilderness Project have identified further biodiversity hotspots in the upper reaches of the Cuando and Cubango drainages (NGOWP 2018). Field surveys in Huíla (Mendelsohn Unpublished Data) and Zaire (Vaz Pinto Unpublished Data) and Cuanza-Norte (Hines Unpublished Data) have identified sites of high biodiversity interest that are also deserving of further study and evaluation as future protected areas. As biodiversity surveys become more inclusive of Angola's less accessible areas, more sites of conservation merit will undoubtedly be added to the list of priorities.

Coastal and Marine Ecosystems

At the vast scale of marine environments, the recently concluded multinational programme of research in the Benguela Current Large Marine Ecosystem (BCLME) has provided very detailed assessments of the demersal fish biodiversity hotspots and the dynamics of the oceanic and climatic systems that influence this biodiversity (Kirkman et al. 2013, 2016; Kirkman and Nsingi 2019). These researchers found that hotspots of species richness were associated with greater water depths and cooler bottom temperatures. From consideration of the relevance of measured climate changes, they concluded that range shifts in species associated with warming temperatures could conceivably affect the spatio-temporal persistence of hotspots in the long term (Kirkman et al. 2013).

In a detailed analysis of the spatial characterisation of the BCLME, based on the physical driving forces, primary and secondary production, trophic structures and species richness, Kirkman et al. (2016) found four different sub-systems, of which two fall within Angolan waters. The first lies to the north of the Angola-Benguela Front and the second between the Angola-Benguela Front and Luderitz. Using the products of the BCLME projects, Holness et al. (2014) used Systematic Conservation Planning concepts and approaches to identify potential marine protected areas for the benthic and coastal ecosystems of Angola, Namibia and South Africa. A total of 248 distinct ecosystem types within the BCLME of these countries were mapped and classified according to Ecosystem Threat Assessments and Ecosystem Protection Level Assessments. In Angola, five ecosystem types were found to be both Critically Endangered and Not Protected, mainly situated in areas subject to intensive coastal development, in the oil and gas fields in the north, or in particular inshore areas subject to more intense fishing pressure. If the Endangered and Poorly Protected categories are also included, there are an additional 23 priority ecosystem types for protection in Angola. The BCLME studies (Kirkman et al. 2013, 2016; Holness et al. 2014) provide excellent models for the application of Systematic Conservation Planning meriting replication across the terrestrial ecosystems of Angola.

The coastal ecosystems of Angola are particularly vulnerable to human disturbance, both directly through over-exploitation of living resources and indirectly through urbanisation and industrialisation within coastal environments (Weir et al. 2007; Morais et al. 2005, 2008, 2016). The marine turtle species that depend on Angola's sandy beaches for nesting are particularly vulnerable. Despite these challenges, Angola remains a very important sea turtle conservation nation, with Olive Ridley (*Lepidochelys olivacea*), Leatherback (*Dermochelys coriacea*) and Green (*Chelonia mydas*) sea turtles nesting regularly during the summer (Morais 2016, 2017). Loggerhead (*Caretta caretta*) nest very sporadically, while Hawksbill (*Eretmochelys imbricata*) sea turtles are not known to nest on Angolan shores although juveniles have been recorded on the Soyo and Cabinda coast (Morais 2016). Recent studies estimate that between 33,000 and 102,000 Olive Ridley Sea Turtles made use of the Angolan coast to nest during the 2015/2016 summer, showing a decrease from between 38,000 and 110,000 estimated during the 2014/2015 season. These figures demonstrate that the coast of Angola is one of the most important nesting regions for this species in the Eastern Atlantic (Morais 2016; Kitabanga Project 2017). Leatherback Sea Turtle are much less abundant, with estimates of between 495 and 1320 animals nesting along the entire coast of Angola during the 2015/2016 breeding season (Morais 2016). Angola provides the southern extension of the Gabon nesting grounds, where 6000 to 7000 females nest annually (Billes et al. 2006). As such, Angola may be second in importance on the Eastern Atlantic coastline for the nesting of this species. Inadequate data are available to determine trends in Green Sea Turtle populations on the Angolan coast (Morais 2015, 2016).

Drivers of Species Loss

One of the immediate causes of population declines and species loss in vertebrates since 1975 has been hunting for bushmeat during the prolonged war, undertaken by rural communities faced with starvation, or by soldiers seeking to supplement very limited rations. Moreover, the illegal trade in wildlife products (ivory, rhino horn and teak) became significant during the war as the leaders of UNITA (*União Nacional para a Independencia Total de Angola*) sought funds to purchase arms (Breytenbach 2015). Luanda has long provided an open market for the illegal trade in wildlife products (Milliken et al. 2006; Svensson et al. 2014) and was described by Martin and Vigne (2014) as the biggest ivory market in Africa. The *Mercado do Artesanato* in Luanda has openly traded in ivory (mainly sourced from the DRC), leopard skins and other wildlife products, in the full knowledge of the Angolan authorities. Following international condemnation of the practice, trading in ivory has been banned in Angola since 2017. Despite the proclamation of two mega-parks in the Cuando Cubango in 2011, the poaching of elephants for ivory has increased in the parks and the elephant population is estimated to have decreased by 21% from 2005 to 2015 (Schlossberg et al. 2018). The inclusion of the area within the

much-publicised Kavango-Zambezi Transfrontier Conservation Area, promoted as the largest TFCA on Earth (Peace Parks Foundation 2016) has yet to demonstrate conservation benefits.

A more pervasive impact than ivory poaching, recorded across the country despite the prohibition of hunting since the late 1970s, is the informal trade in bushmeat (Bersacola et al. 2014). During a survey in September 2013, travelling 1700 km along the Angolan Escarpment, Bersacola and colleagues stopped at 13 market places and counted 71 specimens of 15 prey species. The surveys were mostly in forested areas, where mammals have been more resilient to poaching pressures than in open savannas and woodlands. The most numerous species found were Blue Duikers (45%), Blue (Pluto) Monkeys (11%), Bush Hyraxes (10%) and Yellow-backed Duikers (8%). "For 25 fresh carcasses, the hunting technique was evident. A total of 84% of these fresh carcasses were hunted with shotguns, 16% were trapped using metal or string snares." The National Geographic Okavango Wilderness Project has described 'industrial-scale' bushmeat harvesting operations in many areas of the Cuando Cubango (NGOWP 2018).

While the illegal trade in wildlife products has been documented for animal species, a much larger trade in timber products has exploded over the past 5 years but without any measurement or monitoring. In an effort to stimulate alternative foreign income streams following the global collapse of oil prices, the then Angolan president signed decrees in 2016 that facilitated the rapid issue of concessions for timber extraction over much of the country. Chinese agents have mobilised the massive extraction of hardwoods from across Angola, accelerating the deforestation of vast areas, even in the previously near-pristine woodlands of Moxico and Cuando Cubango provinces (Mendelsohn 2019 Unpublished Data).

Land transformation, as described by Mendelsohn (2019), is perhaps the most potent of all drivers of biodiversity loss, but like the timber trade, its impacts on biodiversity have not been quantified at a species level. Mendelsohn and Mendelsohn (2018) draw attention to the transformation of rural to urban economies, and from subsistence to cash-based economies. The result has been the demand of the newly urbanised populations for cash to purchase goods and services previously provided by rural ecosystems. For rural dwellers, cash is now derived from the sale of bushmeat and charcoal, not of fruit and vegetables.

Another insidious driver of species loss is that of invasive alien species. The presence of potentially invasive alien fish species introduced for aquaculture has been reported for *Oreochromis mossambicus* in the Cuanza and *Oreochromis niloticus* in Cabinda, and recently in the upper Cubango (Skelton 2019). Invasive alien plants have already become established over extensive areas of western Angola. Rejmánek et al. (2017) conducted a rapid assessment of invasive plant species across 13 primary vegetation types (Barbosa 1970) in western Angola and recorded populations of 44 naturalised plant species, 19 of which are conclusively invasive (spreading far from introduction sites). They found that dense invasive populations of *Chromolaena odorata*, *Inga vera* and *Opuntia stricta* pose the greatest threats. *Opuntia stricta* has invaded large areas of the arid coastal plain northwards from Dombe Grande, and along the Chela escarpment. *Inga vera* is widespread in the moist 'coffee forests' of the central escarpment, while *Chromolaena odorata* is prevalent in the northern

escarpment. These species have become major environmental and economic problems elsewhere in Africa and the lack of any control actions in Angola is cause for concern.

Science and Protected Area Management

The development during the nineteenth century of pragmatic wildlife management practices into a sophisticated conservation science is reflected in the histories of the protected areas systems of South Africa, Namibia and Tanzania (Carruthers 2017). Angola has had very limited investment in research in its national parks and reserves until the present decade. Notwithstanding limited resources, biologists from the *Instituto de Investigação Científica de Angola* (IICA) and the *Instituto de Investigação Agronómica de Angola* conducted important surveys of birds (Pinto 1983), mammals (Frade 1956, 1960; Crawford-Cabral 1970, 1971) and vegetation (Teixeira et al. 1967; Teixeira 1968; Barbosa 1970) in various parks during the 1960s and 1970s. Estes and Estes (1974) undertook detailed behavioural studies of Giant Sable in Luando in 1970/71. Huntley undertook general ecological surveys in the protected areas and across most of Angola (Huntley 1973, 1974d, 2017), while Dean (2000) studied the avifauna of Angola in the field and in the key collections of museums of Angola, Europe and the USA. But it was not until the present century that more detailed studies were initiated in the protected areas of Angola, such as the long-term studies of Giant Sable in Cangandala and Luando by Vaz Pinto (2018) and of sea turtles on the Angolan coast (Kitabanga Project 2017). Nevertheless, there have recently been important surveys of the remnant populations of large mammals in the protected areas of Angola (Beja et al. 2019), and on the threatened and endemic avifauna of the escarpment (Dean et al. 2019).

Despite these recent advances, the need for full-time biologists posted to and living in Angola's protected areas is urgent. This is a vacuum that should be filled by young Angolan researchers, with the guidance and support of mentors from across the globe, as the successful models of many other African countries have demonstrated. The modern tools of remote sensing, geographic information systems, immobilisation drugs, radio-tracking collars, trap-cameras, drones, genetic fingerprinting, and much more are readily available. The opportunities are endless and the difficult challenges of the past are being resolved each year as access to Angola improves and both international and national government support increases.

Key Priorities for Biodiversity Conservation

Priorities for the conservation of species within different taxonomic groups (plants, invertebrates, vertebrates) are summarised by Russo et al. 2019). Here we focus on generic issues of concern.

The effective management of protected areas is one of the key mechanisms that governments have available to achieve biodiversity conservation goals (CBD 2010). With over 10 million ha of Protected Areas (PAs) gazetted (GoA 2018), Angola has a considerable proportion of its terrestrial landscape under formal legislation. This provides the potential for a broad base to the PA estate, with many species and ecoregions represented in the system. However, many of the biodiversity hotspots identified in successive PA expansion strategies (Huntley 1973, 2010; GoA 2011, 2018) are yet to be accurately surveyed, described and gazetted. A first priority would be to ensure that legislative protection is given to Angola's most critically endangered biodiversity hotspots, such as the forests of the escarpment, the central highlands and the northern borders with the Democratic Republic of Congo.

As urgently important as legal protection is effective management of PAs. The existing network of extensive PAs such as Iona, Quiçama, Cangandala, Luando, Bicuar, and Luengue-Luiana lack adequate resources, and these need reinforcement through provision of personnel, training, equipment and operational budgets. The options of joint ventures with international conservation organisations and public/private partnerships such as those that have succeeded in Botswana, Mozambique, Namibia, Zambia and other southern African countries needs consideration. Field training of rangers and researchers with ongoing mentoring is a fundamental process for professional development. At a national scale, Angola has excellent conservation strategies (GOA 2006, 2018), and several parks already have pragmatic 'emergency' management plans (Huntley 1974b, 2003; Anderson and Morkel 2009). These need adaptation and implementation rather than repetition. For many PAs, a triage approach to zonation and investment is appropriate where land invasions, illegal infrastructure developments and other irreversible developments have taken place (Huntley 2017).

Concluding Remarks

The engagement of the public at large in conservation is a first priority for Angola's biodiversity agenda. The use of social media has already born unexpected results. The Facebook forum *Angola Ambiente* has over 1000 members and the posting of dragonfly photos on its page has led to 12 species being identified as new to science (Chris Hines, pers. comm.). The conservation of flagship species that attract public attention at national and international scales is also of the utmost importance. A well-publicised example is the conservation project that has successfully saved the Giant Sable Antelope in Cangandala and Luando protected areas, as described by Vaz Pinto (2019). Another noteworthy example is the Kitabanga Project of Agostinho Neto University, which has monitored sea turtle populations and undertaken conservation actions since 2013 (Projecto Kitabanga 2017). The project involves research and environmental education on sea turtles, with specific emphasis on protecting the nesting beaches. The Kitabanga Project provides an excellent model of a locally driven conservation research and education initiative and deserves

replication in Angola. The National Geographic Okavango Wilderness Project (NGOWP 2018) has also brought wide attention to Angola's biodiversity, and stimulated young Angolans to join biodiversity exploration and research initiatives. These and other projects that will be developed in the future contribute effectively to leveraging conservation action in Angola, attracting funders and the public administration to initiatives with high visibility and meaningful impact. The conservation of Angola's remarkably rich biodiversity is first and last an Angolan responsibility, to be led to success by Angolans.

References

Anderson JL, Morkel PV (2009) Parque Nacional da Quiçama. Status quo, as ameaças e a necessidade de acções eficazes. Report to Ministry of Environment, Luanda, 24 pp

Andrade AA (1985) O Naturalista José de Anchieta. Instituto de Investigação Científica Tropical, Lisboa, 187 pp

Baptista N, Conradie W, Vaz Pinto P et al (2019) The amphibians of Angola: early studies and the current state of knowledge. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Barbosa LAG (1970) Carta Fitogeográfica de Angola. Instituto de Investigação Científica de Angola, Luanda, 343 pp

Beja P, Vaz Pinto P, Veríssimo L et al (2019) The mammals of Angola. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Bell RHV (1982) The effect of soil nutrient availability on community structure in African ecosystems. In: Huntley BJ, Walker BH (eds) Ecology of tropical savannas. Springer, Heidelberg, pp 193–216

Bergman B, Verissimo L (2008) Avaliação do Estatuto de Áreas Protegidas do Sudeste do Kuando Kubango,- Projecto Integrado de Gestão da Bacia Hidrográfica do rio Okavango. OKACOM-USAID, 48 pp

Bersacola E, Svensson M, Bearder S et al (2014) Hunted in Angola. Surveying the Bushmeat trade. SWARA, January–March 2014:31–36

Billes A, Fretey J, Verhage B et al (2006) First evidence of leatherback movement from Africa to South America. Mar Turt Newsl 111:13–14

Branch WR, Vaz Pinto P, Baptista N et al (2019) The reptiles of Angola: history, diversity, endemism and hotspots. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Breytenbach J (2015) Eden's Exiles. Protea Boekhuis, Pretoria, 306 pp

Carruthers J (2017) National park science. A century of research in South Africa. Cambridge University Press, Cambridge, 512 pp

CBD (2010) Strategic plan for biodiversity 2011–2020 and the Aichi targets. Secretariat for the Convention on Biodiversity, Montreal

Crawford-Cabral JC (1970) Alguns aspectos da ecologia da Palanca real. Bol Instituto de Investigação Cientifica de Angola 7:7–42

Crawford-Cabral JC (1971) A Suricata do Iona, subspécie nova. Bol Instituto de Investigação Cientifica de Angola 8:65–83

Dean WRJ (2000) The birds of Angola. An annotated checklist. British Ornithologists Union, Tring, 433 pp

Dean WRJ, Melo M, Mills MSL (2019) The avifauna of Angola: richness, endemism and rarity. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Driver A, Sink KJ, Nel JL et al (2012) National Biodiversity Assessment 2011: an assessment of South Africa's biodiversity and ecosystems. Synthesis Report. South African National Biodiversity Institute and Department of Environmental Affairs, Pretoria

Estes RD, Estes RK (1974) The biology and conservation of the Giant Sable Antelope *Hippotragus niger variani* Thomas, 1916. Proc Acad Natl Sci Phila 126(7):73–104

Figueiredo E, Smith GF (2008) Plants of Angola/Plantas de Angola. Strelitzia 22:1–279

Frade F (1956) Reservas naturais de Angola – I. Alguns mamíferos da Reserva da Quiçama. Anais Junta Invest Ultram 11(3):228–245

Frade F (1960) Os animais na etnologia ultramarina. Estudos, Ensaios e Documentos 84:211–240

GoA (Government of Angola) (1998) Lei de Bases do Ambiente. Ministry of Fisheries and Environment, Luanda

GoA (Government of Angola) (2006) National biodiversity strategy and action plan. Ministry of Urban Affairs and Environment, Luanda, 54 pp

GoA (Government of Angola) (2011) Plano Estratégico da Rede Nacional de Áreas de Conservação de Angola (PLENARCA). Ministry of Environment, Luanda

GoA (Government of Angola) (2018) Plano Estratégico para o Sistema de Áreas de Conservação de Angola (PESAC). Ministry of Environment, Luanda

Goyder DJ, Gonçalves FMP (2019) The flora of Angola: collectors, richness and endemism. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Hall BP (1960) The faunistic importance of the scarp of Angola. Ibis 102:420–442

Hall BP, Moreau RE (1962) The rare birds of Africa. Bull Brit Mus Nat Hist (Zool) 8:315–381

Holness S, Kirkman S, Samaai T et al (2014) Spatial biodiversity assessment and spatial management, including marine protected areas. Final report for the Benguela current commission project BEH 09-01

Humbert H (1940) Zones e Étages de Végétation dans le Sud-Oest de l'Angola. *C.R. somm*. Scéanc Soc Biogèogra 17:47–57

Huntley BJ (1971) Preliminary guide to the National parks and reserves of Angola. Report 3. Repartição Tecnica da Fauna, Direcção Provincial dos Serviços de Veterinária, Luanda, Mimeograph report, 17 pp

Huntley BJ (1972) A Plan for the future of the Giant Sable of Angola. Report 11. Repartição Tecnica da Fauna, Direcção Provincial dos Serviços de Veterinária, Luanda, Mimeograph report, 9 pp

Huntley BJ (1973) Distribution and status of the larger mammals of Angola, with particular reference to rare and endangered species. Report 21. Repartição Tecnica da Fauna, Direcção Provincial dos Serviços de Veterinária, Luanda, Mimeograph report, 14 pp

Huntley BJ (1974a) Vegetation and Flora Conservation in Angola. Report 22. Repartição Tecnica da Fauna, Direcção Provincial dos Serviços de Veterinária, Luanda, Mimeograph report, 13 pp

Huntley BJ (1974b) Iona national park: administration, management, research and tourism. Report 23. Repartição Tecnica da Fauna, Direcção Provincial dos Serviços de Veterinária, Luanda, Mimeograph report, 19 pp, 5 Figs

Huntley BJ (1974c) Ecosystem conservation priorities in Angola. Report 28. Repartição Tecnica da Fauna, Direcção Provincial dos Serviços de Veterinária, Luanda, Mimeograph report, 22 pp

Huntley BJ (1974d) Outlines of wildlife conservation in Angola. J S Afr Wildl Manag Assoc 4:157–166

Huntley BJ (2003) Quiçama national park. Integrated conservation management plan. Report to Ministry of Urban Affairs and Environment, Luanda, 20 pp

Huntley BJ (2010) Estratégia de Expansão de Rede da Áreas Protegidas da Angola/proposals for an Angolan protected area expansion strategy (APAES). Unpublished report to the Ministry of Environment, Luanda, 28 pp, map

Huntley BJ (2017) Wildlife at war in Angola. The rise and fall of an African Eden. Protea Book House, Pretoria, 432 pp

IUCN (1992) Environment status quo assessment report. IUCN Regional Office for Southern Africa, Harare, 255 pp

IUCN (2018) The IUCN Red List of threatened species. Ver. 2017–3. http://www.iucnredlist.org

Kipping J, Clausnitzer V, Fernandes Elizalde SRF et al (2019) The dragonflies and damselflies of Angola. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Kirkman SP, Nsingi KK (2019) Marine biodiversity of Angola: biogeography and conservation. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Kirkman SP, Yemane D, Kathena J et al (2013) Identifying and characterizing demersal fish biodiversity hotspots in the Benguela current large marine ecosystem: relevance in the light of global changes. ICES J Mar Sci 70:943–954

Kirkman SP, Blamey L, Lamont T et al (2016) Spatial characterization of the Benguela ecosystem for ecosystem-based management. Afr J Mar Sci 38:7–22

Margules CR, Pressey RI (2000) Systematic conservation planning. Nature 405:243–253

Martin E, Vigne L (2014) Luanda – the largest illegal ivory market in Africa. Pachyderm 55:30–37

Mendelsohn JM (2019) Landscape changes in Angola. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Mendelsohn JM, Mendelsohn S (2018) Sudoeste de Angola: um retrato da terra e da vida. South West Angola: a portrait of land and life. Raison, Windhoek

Mendes L, Bivar-De-Sousa A, Williams M (2019) The butterflies and skippers of Angola. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Milliken T, Pole A, Huongo A (2006) No peace for elephants: unregulated domestic ivory markets in Angola and Mozambique. TRAFFIC online report series no. 11. Traffic East/Southern Africa, Harare, Zimbabwe, 46 pp

Morais M (2008) Tartarugas Marinhas na Costa de Cabinda. Plano de conservação e gestão para a implementação do projecto de prospecção sísmica "on shore". Holisticos/Chevron, 67p

Morais M (2015) Projecto Kitabanga – Conservação de tartarugas marinhas. Relatório final da temporada 2014/2015. Universidade Agostinho Neto/Faculdade de Ciências, Luanda

Morais M (2016) Projecto Kitabanga – Conservação de tartarugas marinhas. Relatório final da temporada 2015/2016. Universidade Agostinho Neto/Faculdade de Ciências, Luanda

Morais M (2017) Projecto Kitabanga – Conservação de tartarugas marinhas. Relatório final da temporada 2016/2017. Universidade Agostinho Neto/Faculdade de Ciências, Luanda

Morais M, Torres MOF, Martins MJ (2005) Análise da Biodiversidade Marinha e Costeira e Identificação das Pressões de Origem Humana sobre os Ecossistemas Marinhos e Costeiros. Ministerio do Urbanismo e Ambiente, Luanda, 140 pp

Mucina L, Rutherford MC (2006) The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19:1–807

Myers N (1988) Threatened biotas: 'hotspots' in tropical forests. Environmentalist 8:120

Myers N, Mittermeier RA, Mittermeier CG et al (2000) Biodiversity hotspots for conservation priorities. Nature 403:853–858

Newton da Silva S (1952) Wild life and its protection in Angola. Oryx 1:7

Newton da Silva S (1970) A Grande Fauna Selvagem de Angola. Serviços de Veterinária, Luanda, 151 pp

NGOWP (2018) National Geographic Okavango wilderness project. Initial findings from exploration of the upper catchments of the Cuito, Cuanavale and Cuando Rivers in Central and South-Eastern Angola (May 2015 to December 2016). National Geographic Okavango Wilderness Project, 352 pp

Peace Parks Foundation (2016) Annual review 2016. Peace Parks Foundation, Stellenbosch

Pinto AA d R (1983) Ornitologia de Angola, vol 1. Instituto de Investigação Científica Tropical, Lisbon, 696 pp

Projecto Kitabanga (2017) Projecto Kitabanga – Conservação de tartarugas marinhas – Folhetos 2017. Universidade Agostinho Neto/Faculdade de Ciências, Luanda

Raimondo D, von Staden L, Foden W et al (2009) Red list of South African plants 2009. Strelitzia 25:1–668

Rejmánek M, Huntley BJ, le Roux JJ et al (2017) A rapid survey of the invasive plant species in western Angola. Afr J Ecol 55:56–69

Russo V, Huntley BJ, Lages F, Ferrand N (2019) Conclusions: biodiversity research and conservation opportunities. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & Conservation: a modern synthesis. Springer, Cham

Schlossberg S, Chase MJ, Griffin CR (2018) Poaching and human encroachment reverse recovery of African savannah elephants in south-East Angola despite 14 years of peace. PLoS One 13(3):e0193469. https://doi.org/10.1371/journal.pone.0193469

Skelton PH (2019) The freshwater fishes of Angola. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Stassen N (ed) (2010) Reminiscences concerning the life of William James Bushnell Chapman & An account of the entry of the Trek Boers into Angola and of their sojourn during the forty-eight years they struggled in that country under Portuguese rule. Protea Book House, Pretoria, 476 pp

Stassen N (2016) The Thirstland Trek, 1874–1881. Protea Book House, Pretoria, 73 pp

Svensson MS, Bersacola E, Bearder SK et al (2014) Open sale of elephant ivory in Luanda, Angola. Oryx 48:13–14

Teixeira JB (1968) Parque Nacional do Bicuar. Carta da vegetação (1a aproximação) e memória descritiva. Instituto de Investigação Agronómica de Angola, Nova Lisboa

Teixeira JB, Matos GC, Sousa JNB (1967) Parque Nacional da Quiçama. Carta da vegetação e memória descritiva. Instituto de Investigação Agronómica de Angola, Nova Lisboa

Varian HF (1953) Some African milestones. Books of Rhodesia, Bulawayo, 78 pp

Vaz Pinto P (2018) Evolutionary history of the critically endangered giant sable antelope (Hippotragus niger variani): insights into its phylogeography, population genetics, demography and conservation. PhD thesis. University of Porto, Porto

Vaz Pinto P (2019) The Giant Sable Antelope: Angola's national icon. In: Huntley BJ, Russo V, Lages F, Ferrand N (eds) Biodiversity of Angola. Science & conservation: A modern synthesis. Springer, Cham

Walker JF (2004) A certain curve of horn. The hundred-year quest for the Giant Sable Antelope of Angola. Grove/Atlantic Inc., New York, 514 pp

Walker JF (2009) Ivory's ghosts. The white gold of history and the fate of elephants. Atlantic Monthly Press, New York, 296 pp

Weir CR, Ron T, Morais M (2007) Nesting and at-sea distribution of marine turtles in Angola, West Africa, 2000–2006: occurrence, threats and conservation implications. Oryx 41(2):224–231