

African Wild Dog *Lycaon pictus*

4

CANIDAE



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Namibian conservation status	Critically Endangered
Global IUCN status	Endangered
Namibian range	131,700 km ²
Global range	~963,000 km ² resident range in Southern Africa ~1,303,500 km ² area of occupancy in Africa
Namibian population estimate	137–359 adults and yearlings
Population trend	Stable in Namibia; decreasing globally
Habitat	Habitat generalists favouring wooded savanna, short grassland, montane and coastal forest and semi-desert
Threats	▶ Conflict with humans: direct persecution (especially during breeding time at dens) and negative perceptions of the species ▶ Habitat loss and subsequent fragmentation of the population ▶ Road mortality ▶ Diseases from domestic dogs ▶ Mortality in snares set for other wildlife ▶ Secondary poisoning

DISTRIBUTION

African wild dogs (or wild dogs) were historically distributed throughout Africa south of the Sahara, excluding the Congo

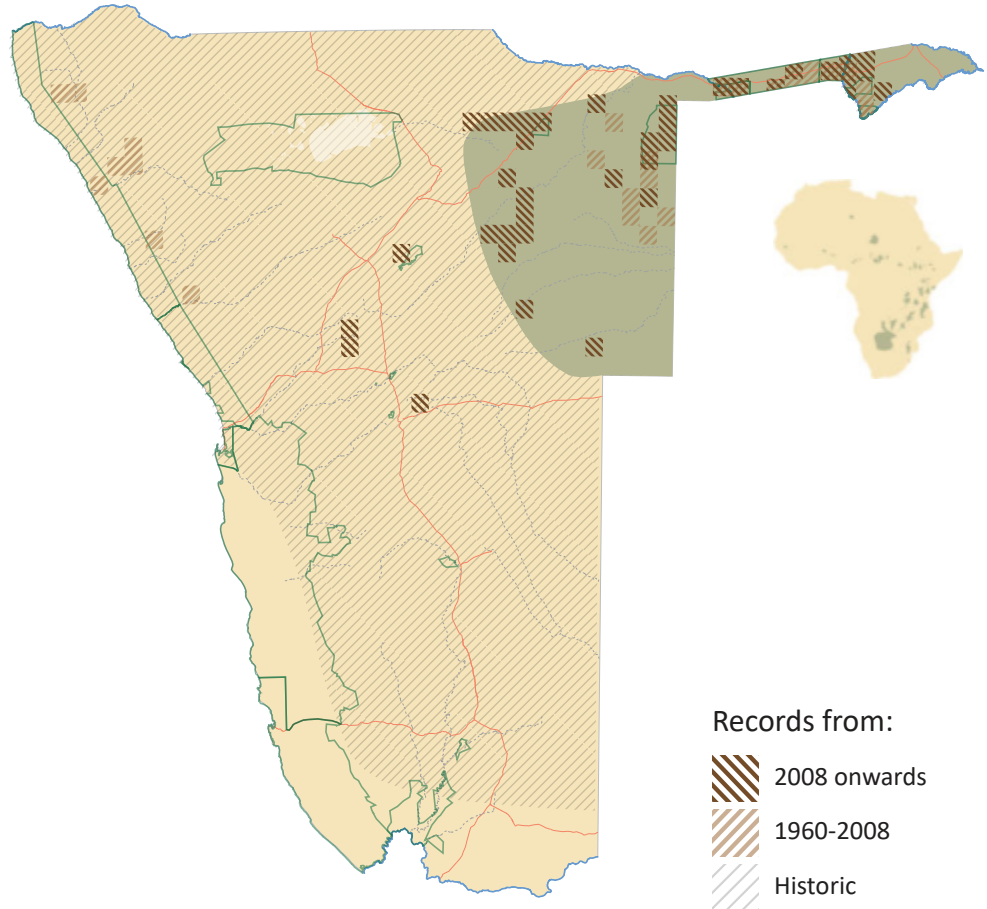
basin (Creel & Creel 1998). They have been extirpated from 44% of their historical range, of which only 2% is thought to be possibly recoverable. African wild dogs are considered to still be resident in approximately 17% of their historical

Distribution records of African wild dog, and present estimated area of distribution in Namibia, including vagrant sightings in the west and managed populations in fenced reserves (Erindi and Zannier) further south of the free-ranging resident range.

The hatched area shows the estimated distribution in the 1940s (Shortridge 1934).

Inset: African distribution of African wild dog according to IUCN (IUCN/SSC 2015).

The Namibian distribution in the main map is more up to date and does not necessarily agree with the distribution shown in the inset.



range, highlighting the major contraction in geographic range that has occurred in this species over the last century (IUCN/SSC 2015). Studies from non-protected populations in Africa show continued widespread declines in population numbers (Woodroffe & Sillero-Zubiri 2012).

Wild dogs were widespread in Namibia historically, with records from as far south as 150 km north of the Orange River mouth (1967) and 65 km from Warmbad (1834), and from the Namib (1930s and 1940s) and former Kaokoland (1970s) in the west (Hines 1990). The populations in the south and west were, however, largely eradicated by the 1990s, with only the north and east remaining as strongholds for the species (Hines 1990).

In the 1920s the population in Etosha National Park (at that stage called Game Reserve No. 2, covering 99,526 km² – a much larger area than the present day Park) was estimated to be greater than 2,000 individuals (South West Africa Administrator report of 1923 quoted in Shortridge 1934). This population was depleted due to conflict with farmers on its borders, the treatment of this species as vermin by Game Wardens and other unknown factors, to the point that the species was no longer considered resident in Etosha by 1990 (Hines 1990, Scheepers & Venzke 1995, Fanshawe *et al.* 1991). Three attempts at reintroducing the species

into Etosha have failed; the last attempt, in 1990, largely failed due to captive-bred wild dogs being introduced that were not experienced hunters and did not avoid larger predators such as lions (Scheepers & Venzke 1995). Etosha and communal conservancies to the west of it are still considered recoverable range (IUCN/SSC 2015).

The current wild dog population in Namibia is part of a dynamic transboundary population that falls over five countries that include Angola, Botswana, Zambia and Zimbabwe (IUCN/SSC 2015). In Namibia itself, their range is currently restricted to the Zambezi, East and West Kavango, eastern Otjozondjupa and northern Omaheke regions, an area of 181,441 km² (IUCN/SSC 2015). Some conservancies such as Nyae Nyae, Okamatapati and Otjituuo the Otjozondjupa Region have important wild dog habitat, despite not holding protected area status (IUCN/SSC 2015).

In the current distribution (see map), records from near Windhoek are packs within N/a'an ku sê's Zannier Reserve (with several dogs awaiting release), while the records north west of Okahandja are from packs reintroduced into Erindi Game Reserve. These are therefore not part of the naturally occurring resident range in the east. The sighting near the Waterberg National Park was likely a transient or vagrant individual or pack, rather than resident.

POPULATION ESTIMATE AND TREND

The Kavango-Zambezi (KAZA) Trans-Frontier Conservation Area (TFCA) is an important area for African wild dogs, where an estimated 2,300 individuals in 235 packs, or 25% of the world's population, is located. Of these, only 725 individuals are within protected areas (IUCN/SSC 2015).

In the 2015 Southern African Conservation Strategy for Cheetahs and Wild Dogs (IUCN/SSC 2015), population estimates for Namibia were based on an average density of 0.3/100 km² for the entire resident range. This gives an estimated population of 544 dogs in 45 packs (assuming an average of 12 dogs per pack). The experts at the IUCN strategy workshop also estimated the Namibian wild dog range to be 181,441 km², of which only 11,672 km² falls within protected areas in which an estimated 35 of 45 (77.8%) packs occur (IUCN/SSC 2015). Some recent work, presented here, provides finer details for specific areas that were studied within the Namibian wild dog range.

In a 2018 spoor survey of Nyae Nyae Conservancy, wild dog density was calculated as 0.62/100 km², which is likely to be valid for southern Khaudum National Park as the habitat is similar, although other factors like prey population and competing predator densities may influence that (P Beytell pers. comm., J Robinson & M Roodbool unpublished data). In Bwabwata National Park, two spoor surveys using the same methodology resulted in density estimates of 1 to 1.2/100 km² (Funston *et al.* 2014, Hanssen *et al.* 2017).

Based on these densities, population estimates for the study sites were calculated as follows:

- 75 individuals (range 51 to 100) in southern Khaudum National Park/northern Nyae Nyae Conservancy covering approximately 8,000 km² (J Robertson & M Roodbool unpublished data, P Beytell pers. comm.)
- 60 individuals (range 23 to 99) in four to six packs in Bwabwata National Park (Funston *et al.* 2014; Hanssen *et al.* 2015, 2017).

Based on insights from field researchers and anecdotal observations, further possible numbers of African wild dogs can be conservatively estimated as follows:

- Between 30 and 100 adults and yearlings in up to five packs in southern Nyae Nyae Conservancy and north-east Otjozondjupa.
- Between 10 and 30 African wild dogs in the less productive northern Khaudum National Park along with George Mukoya and Muduva Nyangana Conservancies to the north. This area covers approximately 3,000 km² with habitat that is similar to the woodlands of the Zambezi

Region (P Beytell & L Hanssen unpublished data).

- Up to 15 adults and yearlings in and around the Mangetti National Park (C Luyt & N/a'an ku sê unpublished data). These animals are likely to move over enormous areas and even shift their home range to accommodate growing human settlement surrounding the park.
- Between 8 and 15 adults and yearlings in the Mudumu Complexes in two small packs in the Zambezi Region. A pack of three adults increased to nine after a breeding season in the Mudumu North Complex; they use Mayuni Conservancy and the State Forest as part of their home range, and probably move into the adjacent Sioma Ngwezi National Park in Zambia. A separate breeding pack was recorded in Mudumu National Park during the same period of time (L Hanssen unpublished data) and probably uses the woodlands in the surrounding conservancies as part of its home range. A pack of 12 wild dogs was observed in Mudumu National Park during the breeding season in 2020 (E Simataa pers. comm.).

Wild dogs have been recorded in Event Books in most conservancies that have woodland in the east Zambezi Region, but these are likely to be transient. They are not resident in Nkasa Rupara National Park, but transient groups have been recorded.

The total of these estimates ranges between 137–359 dogs, covering key areas of wild dog habitat in the north-east where some research and monitoring has been done. Spoor surveys are the most cost-effective way of determining wild dog density, and we suggest that more surveys are done in Otjozondjupa and Omaheke where little is currently known of their numbers. Spoor surveys are a first step for finding out more about this population, but they may produce imprecise and/or inaccurate population estimates for large carnivores (Balme *et al.* 2009, Stander 1998). These should ideally be combined with more intensive survey methods such as camera trapping in smaller study areas within these regions (Torrents-Ticó *et al.* 2017). The current IUCN estimate of 544 represents a best guess based on known range and a fixed expert-derived density estimate. The two spoor surveys reported above from protected areas and a conservancy with low human-wild dog conflict reveal higher densities than this estimate, although there are large areas of the range where the densities are lower and even decline to zero during some years due to conflict and other threats. Estimating long-term density in these areas is difficult as packs move in and occasionally breed, but are often destroyed by farmers.

Notwithstanding the above uncertainties, it appears that the wild dog population in Namibia is stable. The maintenance of wild prey in national parks and communal conservancies is likely to be responsible for allowing wild dogs to persist in

Namibia, although human-wild dog conflict is the greatest limiting factor for population growth in some parts of their range. In the eastern communal conservancies there are very limited numbers of natural prey for the wild dogs (Rust & Marker 2014, Verschueren *et al.* 2020). Outside protected areas, the numbers of lion and spotted hyaena are limited, which probably benefits wild dogs because they are subordinate competitors to these species (Creel & Creel 1998, Swanson *et al.* 2014).

ECOLOGY

African wild dogs are highly social and cooperative carnivores, hunting, breeding and rearing their young in a pack. Breeding is dominated by an alpha female and male; occasionally a beta female may breed although often unsuccessfully (Malcolm & Marten 1982). Breeding season often occurs in winter (Namibia Nature Foundation 2009), although in the fenced Erindi Private Game Reserve where packs were introduced as part of a managed population, breeding has occurred from as early as April through July (N de Woronin Britz pers. comm.). The suppression of subordinate breeding limits the growth rate of this species and has implications for conservation efforts. If either alpha individual is killed, then the pack is likely to disintegrate until unrelated individuals immigrate to form new packs (Woodroffe & Sillero-Zubiri 2012).

Pack size can range from 3 to 25 in different parts of Namibia and during different time periods, depending on environmental conditions and levels of persecution. The alpha female will only produce one litter of pups per year. The pups will stay in the den for three months and the mother will stay at the den for six weeks post-partum to protect them (Malcolm & Marten 1982). Individual pack sizes increase dramatically after denning seasons as the growing pups join the pack, provided a successful denning event and adequate pup survival. In Bwabwata National Park, litter sizes of 12 to 14 pups have been recorded (Hanssen *et al.* 2016). In the Otjituuo Conservancy in Otjozondjupa Region, Cheetah Conservation Fund (CCF) recorded litter sizes of two, seven and nine in 2017–2018 (Marker *et al.* in revision). The first of these was rescued from being destroyed by farmers (CCF unpublished data). Long-term field studies have shown an average juvenile mortality of 56% in the wild without human interference (Creel & Creel 2002).

While their dietary range is wide, small to medium-sized ungulates make up the majority of wild dog prey (Hayward *et al.* 2006c). In the Zambezi and Kavango Regions, prey species include duiker, steenbok, impala, reedbuck, kudu, sable and buffalo calves with duiker, steenbok and bushbuck making up 65% of their diet in Bwabwata National Park (Ball 2019). In Nyae Nyae Conservancy and Khaudum National Park, kudu, roan (in Khaudum only), duiker and steenbok

are the primary prey species (Lines 2008). Wild dogs occasionally scavenge on the kills of other carnivores and on road kills along the Trans-Zambezi Highway. Wild dogs use multiple short-distance hunting attempts and individuals have low successful kill rate but high group feeding from sharing of prey (Hubel *et al.* 2016). It has been suggested that simultaneous and opportunistic short chases by dogs pursuing multiple prey could be key to their hunting success in mixed woodland habitats (Hubel *et al.* 2016). In the Otjozondjupa Region, packs have been shown to hunt further away from their den sites than expected, likely due to low prey availability (Le Roux & Marker 2020).

African wild dogs generally avoid areas of high prey density due to competition with lions and spotted hyaenas that can kill adults and their pups, and steal their kills (Darnell *et al.* 2014, Swanson *et al.* 2014). Possibly as a result of this avoidance of other large predators, African wild dogs are found at low densities and range widely (Creel & Creel 1998), although this is less of a threat in Namibia (see Threats section). Wild dogs are not water dependent and in all the areas they frequent in Namibia, established packs live in areas where ephemeral pans provide the only water until they dry up in the late dry season.

Home ranges average 450–800 km² per pack in southern Africa (Woodroffe & Ginsberg 1998) but can exceed 2,000 km² (Woodroffe 2012) and have been recorded as large as 3,600 km² in Namibia (Ministry of Environment and Tourism 2013a). Home ranges in Kavango East (Nyae Nyae and Khaudum National Park) contract to as little as 150 km² during the denning season (P Beytell unpublished data), and 15 km² in the Eastern Otjituuo and Okamatapati packs, but home ranges increase dramatically once the pups and the pack are no longer bound to the den.

THREATS

Throughout Africa, the major threats to African wild dogs are habitat loss and fragmentation, prey loss, direct and indirect human persecution, disease, road mortality and poisoning (Woodroffe & Sillero-Zubiri 2012). Over 65% of Africa's wild dogs are found outside formally protected areas (IUCN/SSC 2015). Even where they occur in protected areas, their ranging behaviour means that few areas are large enough to fully protect them, and packs are likely to encounter the edges of all but the largest reserves (Woodroffe & Ginsberg 1999a). Packs ranging beyond the boundaries of protected areas commonly come into contact and conflict with farming communities over real or perceived threats to their livelihood, often driven by inherited prejudices and misunderstandings surrounding wild dogs' threats to livestock (Woodroffe & Ginsberg 1999a).

Within Namibia, conflict with humans is the primary direct threat to the population, which is exacerbated by lack

of wild prey (in some areas) that in turn is caused by a combination of habitat degradation through overgrazing and poaching. Human perceptions of the species are generally more negative than can be explained by livestock loss alone, and the ecological value of this species is underappreciated. Even in places where prey species are conserved on fenced game farms, this land use is (at least perceived to be) incompatible with wild dogs. Road mortalities and disease are localised threats that can be severe in some cases. Wild dogs being caught as by-catch in snares set for other wildlife and interspecific competition with lions and spotted hyaenas are less of a threat in Namibia than elsewhere.

Human-wildlife conflict and negative perceptions

In the Kavango, Otjozondjupa and Omaheke Regions, wild dogs are actively persecuted by humans targeting dens and either digging out the pups or killing them inside by filling in or setting fire to the dens. Farmers in Otjozondjupa will typically set gin traps around known dens to catch adults and then burn the den after capturing adult dogs with the most conflict occurring between April and September (Le Roux & Marker 2020). Although wild dogs have been shown to be responsible for only 15% of cattle depredation in these communal lands (Verschuere *et al.* 2020), they are still highly persecuted by farmers that suffer high losses in specific conflict hotspots.

The communal lands of Otjozondjupa and Omaheke, particularly, support very low densities of medium-sized herbivore species, which results in increased livestock losses to wild dog packs (Le Roux & Marker 2020). Farmers around the remote eastern farms of Otjituuo and Okamatapati in Otjozondjupa report that wild dogs cause most of their livestock losses and are frequently responsible for injuring livestock, as the packs in this region tend to be small (4-8 individuals) and thus not capable of killing cattle older than 18 months (Le Roux & Marker 2020).

Four dens from four different packs were found and mapped by researchers in this area in 2017 and 2018; farmers destroyed all four and killed numerous adults and subadults (13 confirmed mortalities) and all of the pups. In 2019, three known packs remained with two dens; in 2020 the three known packs using the same traditional denning sites were identified, although one pack consisted of a lone pair; the single male caused high levels of conflict (often injuring prey it could not take down) while trying to provision the female and pups (Le Roux & Marker 2020).

Human perceptions are influenced by culture, tradition and livelihoods (amongst other factors), and this is seen clearly with perceptions towards wild dogs. The conflict described above is mainly between the Herero people who rely heavily on traditional livestock farming and wild dogs. By contrast the San people living in the Tsumkwe District

of Otjozondjupa see the dogs in a positive light as hunter-gatherers can use the meat from wild dog kills (Lines 2008). Similarly, wild dogs are not persecuted as a result of livestock depredation in the Zambezi Region, where livelihoods do not rely solely on livestock and different cultural norms prevail (L Hanssen pers. obs.).

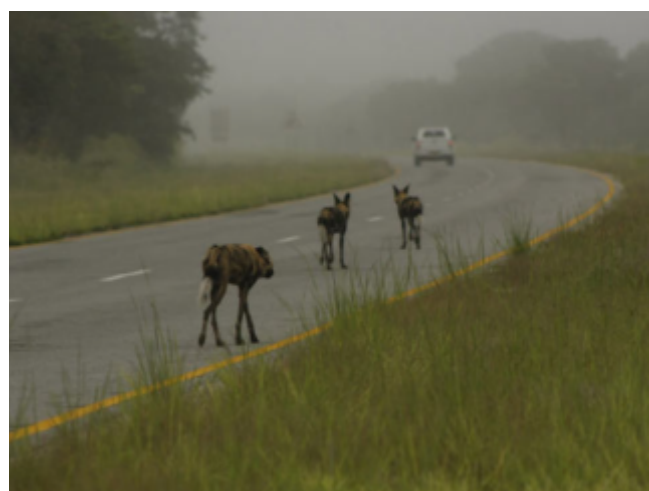
Freehold farmers in Namibia also generally express negative attitudes towards this species. While the rise of game farming has led to an increase in wild dog prey species, game ranchers do not tolerate this species, particularly on smaller game-fenced farms (Lindsey *et al.* 2013c). The population of wild dogs within Erindi Private Game Reserve has been shown to predate on sick and weak animals, therefore effectively removing these individuals from the population (N de Woronin Britz pers. comm). This reflects a lack of awareness of the conservation value of the species and a lack of direct economic value attached to the species by game farmers, particularly those that rely entirely on hunting or antelope live sales rather than photographic tourism.

Habitat loss and fragmentation

Habitat connectivity is threatened in the Kavango and Zambezi Regions through excessive timber harvesting, slash-and-burn agriculture and expanding human settlement. Denning packs move over smaller areas than usual and have higher food requirements, so some of these may start targeting livestock, especially in the absence of wild prey (Woodroffe *et al.* 2005). In South Africa, the loss of habitat connectivity has not been shown to reduce genetic diversity but instead, Girman *et al.* (2001) showed a large admixture zone between populations from Botswana, Zimbabwe and south-eastern Tanzania.

Road mortality

Wild dogs are susceptible to road mortalities throughout Africa (Woodroffe *et al.* 2007a, IUCN/SSC 2015). In one



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extreme case in the Bwabwata National Park, which is bisected by the Trans-Zambezi Highway, motor vehicles were known to be responsible for deaths of over 10% of the park's population where ten wild dogs were killed in three incidents within two days (L Hanssen pers. obs.). Deliberate road mortalities have been reported for several cases in the Otjozondjupa Region (R Lines & CCF pers. comm.), which links back to human-wildlife conflict and negative perceptions of the species.

Disease

African wild dogs are susceptible to canine distemper and rabies which are often transmitted by unvaccinated domestic dogs (Woodroffe *et al.* 1997, Alexander & Appel 1994). In the eastern communal conservancies, domesticated dogs are not vaccinated for these diseases which are therefore a threat in this area (Le Roux & Marker 2020). Studies have shown it is possible to vaccinate wild dogs via oral immunisation with 100% vaccination coverage over two days (Knobel & du Toit 2003).

By-catch in snares and poisoning

Accidental snaring represents a major impact on African wild dog populations in southern Africa (Woodroffe *et al.* 2007a), but this has not been recorded as a major threat in Namibia. Bushmeat poaching is not as rampant here as elsewhere, and some livestock farmers are concerned about accidentally snaring livestock. There has been one confirmed case of a snare-related mortality in eastern Zambezi Region (L Hanssen pers. obs.).

Wild dogs do infrequently scavenge which makes them vulnerable to poisoning (Woodroffe *et al.* 2007a). Wild dogs from the protected areas of the north-east regularly cross into Angola and Botswana where poisoning happens more frequently. In Botswana, they have been known to succumb along with vultures at some of these carcasses (P Hancock & T McNutt pers. comm.).

Intraguild competition

In the core conservation areas of Bwabwata National Park, wild dogs share the landscape with lions and spotted hyaenas and have been known to den in areas frequented by both. Wild dogs have been observed mobbing spotted hyaenas and female lions in Bwabwata National Park (P Funston & A Cillier pers. comm.) and a pack of wild dogs, a clan of spotted hyaenas as well as three lions all responded to a calling station in the Kwando Core Area with little consequence. However, lion and spotted hyaena densities in wild dog range within Namibia are very low, so their competition with wild dogs is limited (Lines 2008). Lines (2008) found evidence of spotted hyaena presence for only 5% of wild dog kills in Nyae Nyae Conservancy.

CONSERVATION STATUS

Southern Africa supports a globally important population of African wild dogs. However, wild dogs have experienced major contractions in their geographic range, now inhabiting perhaps only 17% of their historic range in this region (IUCN/SSC 2015). The African wild dog is a Specially Protected Species in Namibia (Ministry of Environment and Tourism 1975), although illegal killing of this species is fairly common, as we report here. Given their ranging ecology and protected area coverage, it is unlikely any single pack is protected from direct or indirect human threats throughout their lifetime, and this is considered perhaps the greatest long term, large scale threat to the species survival (Lines 2008). Although they are classified as Endangered globally, Namibia's population is small and relies heavily on transboundary conservation actions, while very few wild dogs appear to range solely within Namibian borders. We therefore classify Namibian wild dogs as Critically Endangered, although the main population in north-eastern Namibia appears to be stable, as pack sizes have remained stable and pup survival is high (L Hanssen & P Beytell pers. obs.).



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ACTIONS

Management

Although wild dogs are currently intensively managed in small- to medium-sized reserves in South Africa, this management system is unnatural, expensive to maintain and wild dog reintroductions from these reserves into large wild spaces is not always successful (Gusset *et al.* 2008b). In Namibia, there are still large areas of land outside protected areas that could host natural wild dog populations, so the key priority is keeping these populations stable and creating conditions where they could increase in numbers and/or expand their range. The mosaic of fully protected areas and conservancies in Namibia, along with similar areas in the broader KAZA landscape, is vital to their long-term persistence. In particular, the Khaudum National Park–George Mukoya–Muduva Nyangana Conservancies, the Mudumu Complexes, as well as the Bwabwata National Park–Luengue-Luiana National Park (in Angola) are vital for the persistence and connectivity of wild dogs.

There are large areas of Namibia where the wild dog population could potentially recover, given the right conditions (Ministry of Environment and Tourism 2013a). The key protected area for this recovery is Etosha National Park, where wild dogs occurred until the 1980s (Hines 1990). Previous reintroduction attempts using captive wild dogs were unsuccessful, as very little was known about reintroducing this species and several mistakes were made (Scheepers & Venzke 1995) that could be avoided in a new reintroduction attempt. For this purpose, much can be learned from the extensive wild dog metapopulation management programme in South Africa (Gusset *et al.* 2008b). A subpopulation in South Africa was established from reintroductions and now occurs across several small fenced and geographical isolated reserves (Nicholson *et al.* 2020). Nicholson *et al.* (2020) have shown that subpopulations can increase significantly – current average annual population size of 107 individuals – due to these intensive management strategies.

Erindi Private Game Reserve has been working to establish new packs since 2008 by releasing groups of males and females that are unrelated to each other onto the reserve. Since then, two packs have formed and they produced four litters of pups by 2020. One group of males has dispersed from their natal pack and will be merged with unrelated females in future. While these packs are self-sustaining, they cannot leave the fenced game reserve and must therefore be managed to avoid inbreeding (N de Woronin Britz pers. comm). A similarly managed population has been established on Zannier Reserve (managed by the N/a'an ku sê Foundation) since 2018 from wild dogs that were translocated due to conflict with livestock farmers in Otjozondjupa. There is currently one pack of seven wild dogs

on this reserve that is self-sustaining, while a further six dogs are in bomas awaiting release (de Schepper pers. comm.).

The above reserves could form the basis of a wild dog metapopulation for Namibia, based on similar principles to those in South Africa, with the ultimate aim of reintroducing the progeny of this metapopulation into Etosha National Park. Other private reserves can be brought on board, including those that share a boundary with Etosha National Park. Once the population is established on private lands, it would be possible to soft-release packs into the park over time.

Although previous wild dog management recommendations suggested encouraging a natural repopulation of this species from the eastern population into Etosha National Park (IUCN/SSC 2015), the high levels of conflict and other barriers to dispersal are severe impediments for this option. Natural pack formation from dispersing groups is also highly unlikely, due to the small number of dogs ranging over a very large area which means that separate small groups of males and females may never find each other to form a pack (R Lines pers. obs.). Further, MEFT has committed to “improving the status of biodiversity by safeguarding ecosystems, species and genetic diversity” as Strategic Goal 3 in the Second National Biodiversity Strategy and Action Plan (NBSAP2; Ministry of Environment and Tourism 2014). Particularly, NBSAP2 aims to improve the status of “threatened and vulnerable species”, which an active reintroduction programme is far more likely to achieve than a passive approach (Ministry of Environment and Tourism 2014).

In developing a plan to reintroduce wild dogs to Etosha National Park, the key threats mentioned in this status assessment (e.g. human-wild dog conflict, intraguild competition, disease) must be carefully considered and actions to mitigate them incorporated. A meta-analysis by one of the authors (R Lines) revealed that successful reintroductions elsewhere included the following features: combining wild-caught and captive-bred dogs; socially integrated packs; long periods spent in pre-release bomas (with pups born in boma); quality of fencing around the release site and low human population beyond the border; habitat quality and quantity; long-term funding available for post-release monitoring and management. We strongly recommend establishing an African Wild Dog Working Group comprising experts and key stakeholders from within Namibia and beyond (e.g. South African wild dog metapopulation managers, international reintroduction experts) as a necessary first step towards developing and implementing this plan.

Although competition with lions is known to suppress wild dog numbers in other protected areas, lion densities in Etosha National Park are lower than in these other areas

(Darnell *et al.* 2014, Swanson *et al.* 2014). Further, the lion population is highest around Etosha Pan and nearby permanent waterpoints, so there are large parts of the park where wild dogs could range with very little interference from lions. The potential for human-wild dog conflict around the border of Etosha National Park must be considered and addressed proactively, since this was one of the key contributing factors (along with disease) to the historical demise of wild dogs in the park (Hines 1990, Trinkel *et al.* 2016). Vaccinating the dogs against common diseases to which they are susceptible would further improve their chances of survival.

Outside protected areas, there remains a significant opportunity to re-establish or expand wild dog ranges. Perhaps the greatest opportunity is on commercial game ranches, which support large numbers of prey species for wild dogs. The key obstacles to overcome here, however, are farmer attitudes towards the species, which could be greatly improved if the full commercial value of this species is realised (Lindsey *et al.* 2013c). Wild dogs may not be trophy-hunted in Namibia, but they are highly valued by photographic tourists (Gusset *et al.* 2008a). Consequently, farms that are part of larger freehold and communal conservancies, without game-proof fencing between properties, and where ecotourism is the primary source of income would be ideal for future reintroductions of wild dogs (Lindsey *et al.* 2005b, 2013c). These conservancies' outer boundaries should nonetheless be fenced (unless bordering a protected area) to reduce conflict with neighbours and improve the chances of wild dog survival (Gusset *et al.* 2008b).

Similarly, communal conservancies where wild dogs occur currently realise no tangible value to hosting the species, due to the lack of tourism operations in conservancies in the Otjozondjupa and Omaheke Regions. Lines (2008) found that wild dog tracking activities with expert San trackers for tourists in Nyae Nyae Conservancy had some earning potential. Creating awareness among tour operators of the presence of these dogs and their potential value for photographic tourism could lead to establishing wild dog-specific tourism products that generate income for these currently under-funded conservancies (Le Roux & Marker 2020). The Wildlife Credits scheme that has been established to boost conservancy income by paying for the conservation of particular species (e.g. lions, rhinos and elephants) on a payment for ecosystem services model could be adapted for wild dogs (Le Roux & Marker 2020) to increase local tolerance. It seems that compensation for livestock losses does not necessarily increase tolerance for wild dogs (Gusset *et al.* 2009).

Ensuring connectivity between wild dog populations at national, transnational and regional scales is a priority for long term population viability, given that >90% of wild dogs

live in populations spanning international boundaries (IUCN/SSC 2015). Research on wild dogs in Namibia has shown that they regularly move over a number of countries including Botswana, Angola and Zambia (O Aschenborn/MEFT unpublished data). Some dogs have been known to travel over all four countries and it is not unknown for Bwabwata wild dogs to move between Botswana, Namibia and Angola in a single day (O Aschenborn/MEFT unpublished data). A collared wild dog from the Buffalo Core Area of Bwabwata National Park travelled 400 km north into Angola and did not return (P Beytell unpublished data).

Controlling the expansion of human populations and adhering to land use plans and zonation will help maintain habitat integrity and reduce scope for conflict and persecution. Recent establishment of small-scale farms west of Khaudum National Park (formerly important wild dog habitat) has already resulted in retaliatory shooting, poisoning and snaring of other large carnivore species. Traffic slowing mechanisms on transit roads through protected areas will reduce road mortality.

There is some potential for improving the chances of wild dog survival on communal farmlands where wild prey has not been depleted. Wild dogs persist in Nyae Nyae Conservancy, but are frequently persecuted in other communal conservancies in Otjozondjupa Region; the difference between these areas is likely due to differences in wild prey densities and distribution and cultural attitudes towards wild dogs. Despite human threats to the species, African wild dogs can and do coexist with livestock farmers where wild prey populations persist (Woodroffe *et al.* 2007b). Improving the wild prey populations within communal conservancies in Otjozondjupa and Omaheke is therefore a key requirement for reducing livestock losses in the long-term.

Awareness

In addition to the availability of wild prey, herding livestock during the day and kraaling vulnerable livestock might be key to reducing livestock losses to wild dogs, thus allowing for coexistence with this species (Ogada *et al.* 2003, Woodroffe *et al.* 2005). Herding during the day is widely practiced in Kenya, where these studies were done, but two studies revealed that fewer than 50% of farmers in Namibia on freehold, resettled, and communal farmlands employ herders (Stein *et al.* 2010, Rust & Marker 2014). Improving coexistence between livestock farmers and wild dogs in Namibia would therefore require targeted education to improve attitudes towards the species, maintain healthy prey populations, and encourage more farmers to employ herders to protect their livestock. In South Africa, posters have been used to raise awareness about free-ranging packs of wild dogs and to encourage the public to report sightings (Nicholson *et al.* 2020). Educational programs have already

been suggested as a possible way to reduce wild dog conflict with livestock and game farmers in Botswana, where 80% of farmers surveyed show a negative attitude towards wild dogs (Fraser-Celin *et al.* 2017).

One option in the communal conservancies is to train selected community game guards as “wild dog rangers”, similar to the lion and rhino rangers in the north-western conservancies, which can increase monitoring capacity and create awareness about the conservation value of the species (Le Roux & Marker 2020). These rangers could further assist by responding rapidly to cases of human-wild dog conflict in the region, which would signal to farmers that their concerns about wild dogs negatively affecting their livelihoods are taken seriously (Le Roux & Marker 2020). These actions may improve farmer tolerance for this species, with the overall goal of reducing den destruction by providing alternative solutions.

Since 2015, livestock and veterinary educational training has been conducted in the eastern communal conservancies to help prevent human-wild dog conflict in this area (Verschuere *et al.* 2020). Widening the access to environmental education in schools and training facilities, as well as amongst communities in and around the species’ resident range will help combat misunderstanding and inherited prejudice towards African wild dogs and other large carnivores among the future generation of livestock owners. Younger farmers in southern Africa tend to show a more positive attitude towards having wild dogs on their farms compared to older farmers, suggesting traditional prejudices against the species are fading, however negative attitudes were typically linked to economic costs associated with wild dogs (Lindsey *et al.* 2005b). Over half of the 209 farmers surveyed indicated they would like to have wild dogs on their farms (Lindsey *et al.* 2005b).

Research

Reintroducing wild dogs into Etosha National Park will require research and extensive engagement with other stakeholders prior to a reintroduction attempt. A full risk analysis and population habitat viability analysis (PHVA) should guide decisions regarding where to establish the first packs and what steps must be taken before, during and after reintroduction to mitigate identified risks. All released packs should be monitored using GPS and VHF collars over a substantial period of time (several years) to evaluate success and feed into future reintroduction attempts.

The population in Otjozondjupa and Omaheke that occurs in the Okakarara and Otjinene Districts respectively is heavily persecuted and persists with little wild prey (Lines 2008, Le Roux & Marker 2020). While more needs to be known about the wild dog population through spoor and camera trap surveys, genetic studies, GPS collaring for key individuals and den monitoring (Le Roux & Marker 2020), research is also required on the broader socio-ecological system. The communal conservancies in these districts face multiple interlinked challenges – rangeland degradation, depletion of wild herbivore populations, poor livestock husbandry, little/no wildlife-based economic activity, and prevailing negative attitudes towards conservancies and especially towards wild dogs (Lines 2008, Le Roux & Marker 2020). Research in this area is therefore required on multiple fronts to address these complex challenges in a holistic manner. These studies should focus on identifying key interventions – e.g. conservancy income generation, land use planning and livestock management systems to improve rangeland condition – that will improve the state of the entire socio-ecological system, of which wild dogs are one part.

The wild dog population in the Zambezi Region is part of a larger transboundary population in the KAZA TFCA, so research questions must be framed within the context of this landscape. A more rigorous threat assessment is required for this population to identify “source” and “sink” areas, and to elucidate the specific reasons for particular locations being “sinks” for wild dogs. Wherever possible, lessons learned in one country (e.g. on mitigating conflict) should be shared with others for adaptation and implementation.

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