

Conserving the Whistling Canid: Management Plan for the Dhole (*Cuon alpinus*)
Population in Jigme Dorji National Park, Bhutan (2019-2049)

Julie Dickerson

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Adult dhole (*Cuon alpinus*)

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Executive Summary

The dhole (*Cuon alpinus*) is a highly social canid that inhabits southeast Asia. This crepuscular species typically forms large packs, of up to 30 individuals, and is led by the breeding alpha pair. Dholes are habitat generalists, but primarily select habitats that support their hypercarnivory diet requirements. The International Union for Conservation of Nature (IUCN) lists dholes as endangered based on the ongoing conservation concerns that are causing their populations to decline. The dholes' prey base is decreasing due to land conversion, historic overhunting by humans, and interspecific competition with other larger predators. Dholes are also subjected to persecution by livestock farmers through retaliatory killings, which arise from depredating on cattle. Additionally, dholes are susceptible to the fatal diseases that are transmitted by feral and domestic dogs. Currently, there is no action being taken in any southeast Asian country to conserve the dhole. The goal of this management plan is to increase the dhole population in Jigme Dorji National Park to make Bhutan a model country for dhole conservation. This plan will focus efforts towards increasing pup survivorship by 30% over 30 years through identifying and monitoring dens sites, protecting potential denning sites, and mitigating the spread of diseases, such as rabies. Increasing prey availability by 10% in 20 years will also be addressed, by evaluating prey densities and encouraging alternative grazing practices to reduce pressure in ungulate habitat. Finally, an increase in human acceptance of dholes by 70% in the next ten years will be addressed through the distribution of surveys to the subdistricts within the park. Ultimately, the establishment of this management plan will create Bhutan as a model for dhole conservation by taking action to increase the population size of this endangered canid.

Table of Contents

<i>History</i>	4
<i>Natural History</i>	5
Species Identification	5
Distribution	5
Habitat	5
Diet and Foraging Ecology	6
Reproductive Characteristics	7
<i>Conservation Needs</i>	8
Ecological	8
Economic and Sociocultural	10
Legal	10
Statement of Need	11
<i>Management</i>	12
Goals and Objectives	12
Actions	12
<i>Conclusion</i>	19
<i>Acknowledgements</i>	19
Literature Cited	20
Appendix A.....	23
Appendix B.....	24
Appendix C.....	25
Appendix D.....	26
Appendix E	27

History

The dhole (*Cuon alpinus*), also referred to as the Asiatic wild dog or red dog, is currently listed as endangered on the International Union for Conservation of Nature's (IUCN) Red List of Threatened Species (Kamler et al. 2015). This listing is justified by an estimated decreasing population trend, based on continued declining distributions (Kamler et al. 2015). Additionally, population estimates currently do not exist for any country within the dholes' range. The IUCN has listed Bhutan as having a low population size (250-750 individuals), according to relative abundance estimates (Kamler et al. 2015). This species historically was widely distributed across Asia, but populations have since been restricted by anthropogenic forces (Kamler et al. 2015).

Dholes are highly social canids that hunt in large packs of up to 30 individuals (Katel et al. 2014). The shy and elusive nature of this crepuscular species makes studying their ecology in the wild challenging (Ghaskadbi et al. 2016). Together, these characteristics explain the conflict between dholes and humans, as livestock have been commonly predated upon (Kamler et al. 2015). A string of poisoning campaigns during the 1980s nearly extirpated dholes from Bhutan (Namgyal and Thinley 2017). Since then, dholes have been somewhat re-established, however conservation efforts are still needed to protect this apex predator (Kamler et al. 2015).

With an area of 4,317 km², Jigme Dorji National Park of northwestern Bhutan is the second largest protected area in the country (UNESCO 2012). This park is extremely biodiverse, where inhabitants also include four other canid species, as well as seven felid and ungulate species (Namgyal and Thinley 2017). Due to the existing conservation practices regarding the tiger (*Panthera tigris*) and snow leopard (*Panthera uncia*), this national park holds strong potential to be the first area in southeast Asia to implement a management plan specifically for dholes (Namgyal and Thinley 2017).

Natural History

Species Identification

Adult dholes stand at 42-50 cm tall, while males weigh 15-20 kg and females weigh 10-13 kg (Cohen 1978). Dholes have a rusty-red to dark brown coat with a darker brown to black bushy tail (Durbin et al. 2004). The chest and underside pelage are a lighter red or whitish coloration (Cohen 1978). Their ears are triangular with a rounded tip, and their rostrum is relatively short and slightly convex in profile (Durbin et al. 2004). Dholes have unique dentition (I 3/3, C 1/1, P 4/4, M 2/2), in that they have a reduction in the number and size of their molars compared to other canids (Durbin et al. 2004, Kamler et al. 2012). Additionally, female dholes have six or seven pairs of mammae, compared to the typical five pairs in other canids (Durbin et al. 2004).

Distribution

Historically, dholes were distributed within regions of Russia, Mongolia, Kazakhstan, Kyrgyzstan, Afghanistan, Tajikistan, and Uzbekistan, but are now extirpated from these areas (Kamler et al. 2015). Fragmented populations currently exist in India, Nepal, Bhutan, Bangladesh, Myanmar, Indochina (Laos, Cambodia, Vietnam), Thailand, Indonesia, and Malaysia (Figure 1; Durbin et al. 2004, Kamler et al. 2015).

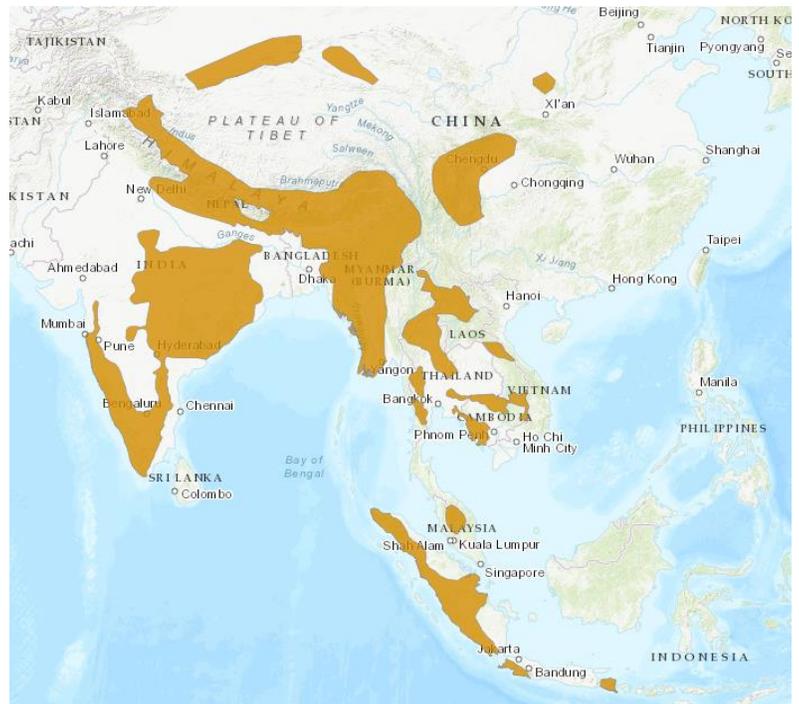


Figure 1. Current geographic range of the dhole (*Cuon alpinus*), map modified from Kamler et al. (2015).

Habitat

Dholes occur in multiple vegetative types, such as tropical dry, moist deciduous, coniferous, semi-coniferous, and dry thorn forests (Durbin et al. 2004). Specifically, in Jigme Dorji National Park, dhole presence has been mostly recorded in cool broadleaved forests, but also in mixed coniferous forests, blue pine forests, chirpine forests, fir forests, hemlock forests,

and alpine meadows (Namgyal and Thinley 2017). Ultimately, dholes are habitat generalists and randomly select habitat variables such as slope, cover type, and ground cover (Aryal et al. 2015, Kamler et al. 2015). During the denning season, however, dholes are more selective of habitat features, suggesting they choose den sites that provide pups with cover from predators (Nurvianto et al. 2015). Additionally, a pack's home range size fluctuates in accordance with pup production (Acharya 2007). Packs will restrict themselves during the denning and nursing season to 15-20 km², then gradually expand their range to 30-60 km² during the pup-rearing season, and will finally expand to 60-70 km² as the ideal home range of the pack (Acharya 2007). Overall, dhole presence and habitat quality are influenced by prey abundance, water availability, human disturbance, and the presence of other larger carnivores (Durbin et al. 2004).

Diet and Foraging Ecology

Dholes are adapted for an exclusively carnivorous diet, or hypercarnivory (Kamler et al. 2012). The dholes' diet predominately consists of ungulates, such as sambar (*Rusa unicolor*), chital (*Axis axis*), muntjac (*Muntiacus* spp.), goral (*Naemorhedus goral*), serow (*Capricornis thar*), and wild pig (*Sus scrofa*) (Kamler et al. 2012, Hayward et al. 2014). Multiple studies conducted across the dholes' range also suggest that sambar is the preferred prey of dholes (Wang and Macdonald 2009, Hayward et al. 2014). Dholes will also resort to killing livestock (domestic cattle and goats) if they are available (Durbin et al. 2004). In Jigme Dorji National Park, the dholes' diet changes seasonally in terms of livestock consumed, since cattle are more available during the wet season (May-Aug) than during the dry season (Nov-Feb) due to grazing practices (Thinley et al. 2011). Additionally, if ungulates are low in biomass, dholes will also consume small mammals, birds, hares (*Lepus* spp.), Indian porcupine (*Hystrix indica*), and langur monkeys (*Semnopithecus entellus*) (Durbin et al. 2004, Hayward et al. 2014).

Dholes exhibit behavioral adaptations to effectively hunt their prey (Kamler et al. 2012). Dholes will congregate into packs of more than 10 individuals to take down large ungulates (Kamler et al. 2012). Dholes also possess a unique vocal repertoire of whistles that assist the pack in communicating within the dense forests during ambush attacks (Ghaskadbi et al. 2016). The hunt is either a chase led by the dominant male, or an interception of the prey as it is led towards other pack members (Hayward et al. 2014). Their prey is subdued by injury to the snout, and ultimately killed by disembowelment (Hayward et al. 2014). Furthermore, dholes have

acquired behavioral and morphological adaptations which allow them to hunt large prey to satisfy their diet requirements.

Reproductive Characteristics

Within a dhole pack, only the dominant pair reproduces once a year (Durbin et al. 2004). The gestation period is typically 9 weeks, and the average litter size is 8 pups (Durbin et al. 2004, Davies-Mostert et al. 2015). The denning and nursing seasons occur during the winter (Nov-Feb), pup-rearing occurs in spring and summer (Mar-Jun), and dispersal and pre-denning occurs during the monsoon season (Jul-Oct) (Acharya 2007). Social structure of the pack resembles that of the African wild dog (*Lycaon pictus*), where subordinate females assist in rearing the pups and males are the dispersing sex (Durbin et al. 2004, Davies-Mostert et al. 2015).

Since data is lacking regarding dhole survivorship at each life stage and fecundity estimates, the African wild dog has been used as a surrogate species (Kamler et al. 2015). Pups are individuals less than a year old, yearlings are considered 1 to 2 years old, and adults are 3 years or older (Figure 2; Davies-Mostert et al. 2015). To construct a stage-based survivorship and fecundity matrix, the adult stage has been divided into 3 categories (Figure 2; Appendix A). Adult 1 are individuals 3 years old and reproductively mature. Adult 2 are those 4 to 5 years old and adult 3 are those 6 to 8 years old, based on similar survivorship and fecundity estimates (Figure 2). Pups may not have the lowest survival rate (64%), but this stage is the most sensitive (Davies-Mostert et al. 2015; Figure 2; Appendix A).

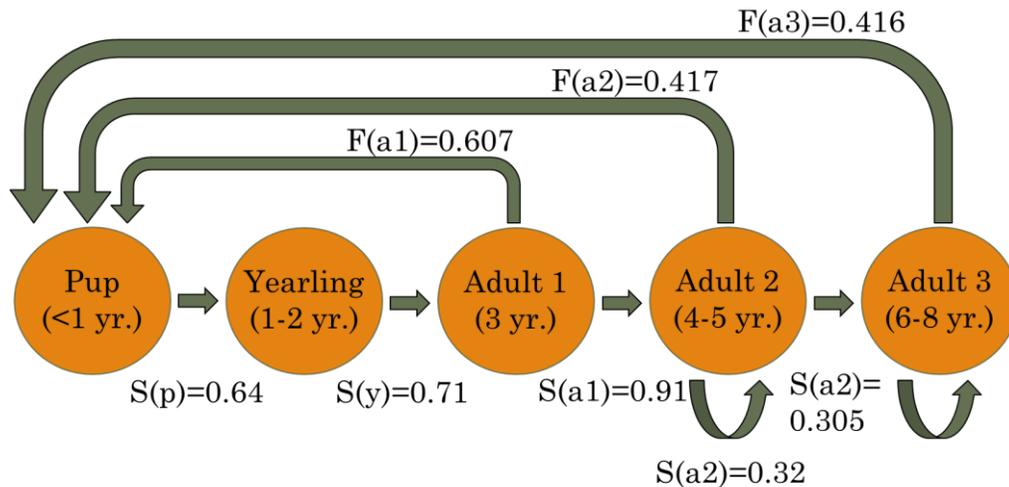


Figure 2. Life cycle diagram for the dhole (*Cuon alpinus*) based on the African wild dog (*Lycaon pictus*) as a surrogate species (Davies-Mostert et al. 2015).

Conservation Needs

Ecological

Dholes (*Cuon alpinus*) are unique among canids in that they are one of the three species with dentition adapted for hypercarnivory (Kamler et al. 2015). Therefore, the primary ecological factor threatening the distribution of dholes is the depletion of their prey base (Kamler et al. 2015). Across Cambodia, Laos, and Vietnam, ungulates occur at low levels, and some species are either ecologically or fully extinct in protected areas (Kamler et al. 2015). This has largely been a consequence of overhunting by humans (Durbin et al. 2004). The lack of a prey base hinders the possibility of recovery of dhole populations within these areas, due to the dholes' hypercarnivory diet requirement (Kamler et al. 2015). However, fragmented populations, such as those in Bhutan, have the potential to be successfully managed within protected areas, so long as prey numbers are adequate (Kamler et al. 2015). Additionally, prey depletion has been a consequence of habitat degradation and transformation (Durbin et al. 2004). Dholes and their prey have been pressured by the transformation of habitat into palm and rubber plantations, livestock pastures, and infrastructure expansion (Kamler et al. 2015).

Asia's large predator guild presents conflicts for the growth of dhole populations. Dholes compete with tigers and leopards (*Panthera pardus*) for resources, putting pressure on the already limited prey base (Kamler et al. 2015). While both the tiger and leopard are larger in body mass, dietary overlap still exists between these three predators (Wang and Macdonald 2009). In Bhutan, large-sized ungulates made up the majority of prey biomass consumed of tigers, leopards and dholes (93.7%, 72.7%, 87.1%, respectively; Wang and Macdonald 2009). Conservation of ungulate prey, such as the preferred prey of sambar, is critical to preserve this overlapping dietary niche (Hayward et al. 2014).

Since dholes are habitat generalists, they occur in a variety of cover types (Kamler et al. 2015, Namgyal and Thinley 2017). However, during the denning and pup-rearing seasons vertical cover and distance to water are the most selected habitat attributes (Johnsingh 1982, Nurvianto et al. 2015). One study observed that three different den sites were used by one pack, in accordance with the development of the pups (Nurvianto et al. 2015). The first den was used by the breeding alpha female as the natal den, then the second and third were used as nurseries (Nurvianto et al. 2015). Den sites were also observed to have 65-70% vertical cover, which serves as protection from predators and provides shade (Nurvianto et al. 2015). As previously

discussed, habitat transformation for agricultural expansion has caused dhole populations to decline by altering prey availability, but this anthropogenic impact also deteriorates the quality of den sites (Kamler et al. 2015). Identifying and preserving the quality of den sites is critical for dhole conservation, since the transition of pups to the yearling stage is the most sensitive (Appendix A).

Due to the sociality and large pack size of dholes, epizootic diseases can be extremely detrimental to populations (Kamler et al. 2015). Dholes are primarily susceptible to diseases and parasites spread by feral and domestic dogs (*Canis lupus familiaris*), such as mange, canine distemper, parvovirus, rabies, trypanosomiasis, cestodes and roundworms (Durbin et al. 2004). In Cambodia, there have been cases where canine distemper outbreaks nearly resulted in the extirpation of dholes from some regions (Kamler et al. 2015). Additionally, the transmission of rabies to dholes has been responsible for drastic fluctuations of local dhole populations, sudden disappearances from protected areas, and reduction in pack size (Kamler et al. 2015). Unfortunately, the extent of the effects of diseases to population dynamics of dholes is unclear, however, the impact of rabies has been studied in other canids, such as the African wild dog, where rabies outbreaks have resulted in reduced pack sizes (McNutt and Silk 2008). This consequently decreases pup survivorship, since larger packs have been observed to produce and successfully rear larger litters (McNutt and Silk 2008). Due to the high levels of intraspecific interactions of dholes, the spread of disease poses a severe threat to population growth and extirpation is still a possibility in some areas of southeast Asia (Kamler et al. 2015).

Economic and Sociocultural

The most substantial sociocultural threat impacting dhole populations is persecution from livestock farmers (Kamler et al. 2015). A study conducted by Wang and Macdonald (2009) evaluated the dietary habits of dholes and other large predators in Bhutan and observed that 15.9% of the dholes' diet was comprised of livestock. This is attributed to the common practice of farmers permitting livestock to freely graze in forested areas that are not fenced-in during the wet season (Wang and Macdonald 2006, Thinley et al. 2011). Unfortunately, retaliatory killings by poisoning carcasses or clubbing dholes at den sites occur in result (Durbin et al. 2004, Kamler et al. 2015). In Bhutan, 69% of the 700,000 human population practices agricultural work, thus, livestock farmers see dholes as pests that threaten their livelihood (Katel et al. 2014). Dholes have been observed to predate on livestock more commonly than leopards and tigers, with an average of 0.19 killed per household, which amounts to about 11% of total income from livestock (Katel et al. 2014). Ultimately, the economic losses of livestock farmers and the resultant sociocultural persecution of dholes poses a threat to this canid's persistence in Bhutan.

Legal

The Royal Government of Bhutan lists dholes as a Schedule I species under the Forest and Nature Conservation Act of 2006 (No. 64 of 2006, Katel et al. 2014). This listing prohibits the hunting, killing, injuring, destroying, capturing, trade, use or taking of dholes in any way, as well as possessing or captive breeding them (No. 64 of 2006). Unfortunately, due to the common occurrence of retaliatory killings as discussed above, this law is not strictly enforced. In addition, the Convention on International Trade in Endangered Species (CITES) lists dholes under Appendix II, which provides the regulation of international trade, however, there has been no exploitation of dholes for any purpose (Katel et al. 2014, CITES 2019).

Statement of Need

Dholes are in critical need for a recovery plan throughout most of southeast Asia. The protected area of Jigme Dorji National Park of northwestern Bhutan poses as an essential location to implement such a plan (Namgyal and Thinley 2017). Due to the lack of knowledge on population estimates and current conservation efforts being allocated towards other species, dholes are certainly threatened with extinction (Kamler et al. 2015). The ecological, sociocultural, and economic threats listed above justify the need for action, and without such action, the dhole population will continue to decline in this national park (Figure 3). Prey depletion, competition with other predators, habitat degradation and transformation, the threat of disease, and persecution from livestock owners will together result in the demise of this canid species (Durbin et al. 2004, Katel et al. 2014, Kamler et al. 2015). With the implementation of this management plan, Bhutan will become the first country in southeast Asia to take conservation measures specifically focused towards dholes (Namgyal and Thinley 2017).

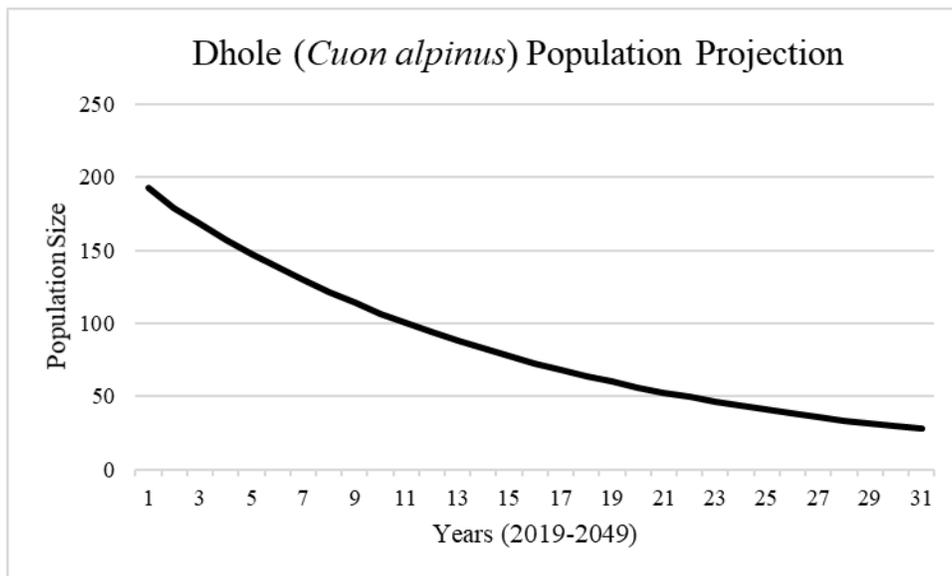


Figure 3. The current dhole (*Cuon alpinus*) population projection from 2019 to 2049 in Jigme Dorji National Park, Bhutan. This projection was formulated based on the survivorship probabilities and fecundity estimates of African wild dogs (*Lycaon pictus*) suggested by Davies-Mostert et al. (2015).

Management

Goals and Objectives

Goal: Monitor and increase the dhole population in Jigme Dorji National Park, Bhutan, from 2019-2049 to achieve a sustainable population, making Bhutan a model for dhole conservation throughout southeast Asia.

Objective 1 – Increase pup survivorship by 30% over the thirty-year period of this management plan.

Objective 2 – Increase prey availability by 10% in twenty years.

Objective 3 – Increase human acceptance of dholes by 70% in ten years.

Actions

Objective 1 – Increase pup survivorship by 30% over the thirty-year period of this management plan.

Action 1.1 - The transition of pups to yearlings is the most sensitive stage as indicated by the sensitivity matrix (Appendix A). To increase pup survivorship into the yearling stage by 30%, den sites in the park need to be identified during the first denning season (Nov-Feb) of this project (Acharya 2007). To accomplish this, field cameras should be placed throughout the areas where dholes are distributed, including Laya, Luana, Khatoe, Khamoe, Geoenshari, Tewang, Lingzhi, Naro, Tsento, Kawang, and Kabji subdistricts (Namgyal and Thinley 2017). Based on the scent marking and physical contact behaviors observed between individuals, the alpha breeding pair of each pack can then be identified (Ghaskadbi et al. 2016). Then, either the alpha female or the subordinate females can be targeted to be immobilized and fitted with a GPS collar to track their movements (Acharya 2007). Since dholes restrict their core area to 15-20 km² during the denning and nursing season, these areas can then be mapped out using GIS techniques (Acharya 2007). In these core areas, ground surveys should then be conducted where slope varies from 30% to 65%, since dhole dens are typically found in hilly areas (Nurvianto et al. 2015). Finally, additional cameras should be set up at each den facing the entrances to monitor litter sizes and record how many have survived following the end of the pup-rearing season (Mar-Jun) (Acharya 2007).

Action 1.2 – Habitat attributes that heavily influence den site selection, such as distance to water, slope, and vertical vegetative cover, should be evaluated at 25% of the dens identified as described in Action 1.1 (Nurvianto et al. 2015). These attributes can then be used to identify additional areas where habitat should be protected for denning sites using GIS techniques (Nurvianto et al. 2015). Additionally, since dholes prefer den sites that oppose the direction of human disturbance, these designated den protection sites should be restricted from human traffic and future conversion to agricultural land use (Johnsingh 1982, Nurvianto et al. 2015). With the implementation of GIS techniques, maps illustrating these protected areas should be distributed to local villages and park information centers, to avoid human interference with pup production and rearing.

Action 1.3 – Due to the high intraspecific contact rates that occur within packs, diseases can spread rapidly and result in premature mortality of pups (Kamler et al. 2015). Rabies outbreaks have been well documented in southern Bhutan in concern for human health, however, the extent of the spread to wildlife populations has been poorly studied (Tenzin et al. 2011, Kamler et al. 2015). To mitigate the spread of rabies to dhole packs within the park, all possible incidences or observations of infected animals should be immediately reported to park officials through the establishment of a hotline telephone number. Educational fact sheets regarding how to identify a rabies infected animal should also be distributed to residences (WHO 2019; Appendix B). Since free-ranging domestic dogs are the primary reservoir for rabies in Bhutan, sterilization and vaccination campaigns may need to be orchestrated in the villages with the greatest free-ranging dog abundances (Tenzin et al. 2011). Ultimately, whether these campaigns occur depends on the number of rabies incidence reports.

This action may not be feasible due to the financial and medical resources needed for sterilization and vaccination campaigns (Tenzin et al. 2011). Alternative efforts may include the culling of feral dogs, however, this method has been regarded as ineffective (WHO 2019). Additionally, this action may not be required, depending on the abundance of rabies cases reported.

Action 1.4 – In African wild dogs, larger packs have been observed to successfully rear larger litters (McNutt and Silk 2008). To increase the number of pups in the dhole

population, translocation of the adult 1 stage class (3 years old) should be considered, since this stage has the highest survivorship probability and fecundity estimate (Appendix A). Translocated individuals should be from the same pack to ensure familiarity between them and be kept together in a fenced-in area or boma (Gusset et al. 2006). Individuals should be kept within the boma for 3 months to monitor health and social interaction, while human contact remains minimal (Gusset et al. 2006). Translocations have been successful with African wild dogs, where soft releases promoted social integration and mate choice, which then increased the likelihood that successful reproductive pairs would form (Gusset et al. 2006).

This action may not be feasible given the financial needs to hold dholes for a 3-month period (Gusset et al. 2006). Additionally, translocations of individuals may not be appropriate if there is an insufficient number of packs within the park. This action should be considered if this plan is redrafted.

No Action – If no action is taken in attempt to increase the survivorship of pups into the yearling stage, the dhole population in Jigme Dorji National Park will continue to decline over the next 30 years (Figure 3). This transition stage is the most sensitive and increasing the survival rate of pups is a necessity to increase the dhole population (Figure 4; Appendix A).

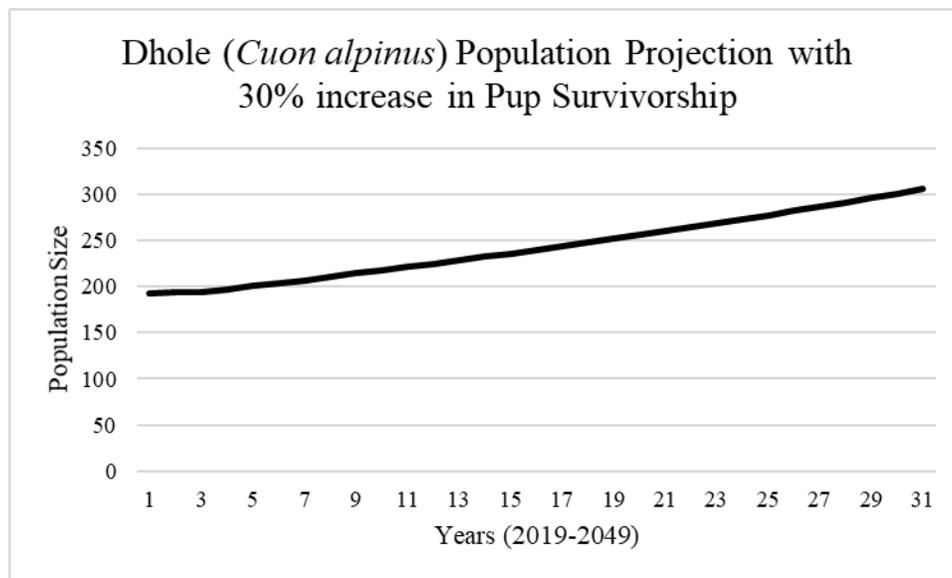


Figure 4. Dhole (*Cuon alpinus*) population projection in Jigme Dorji National Park, Bhutan, from 2019-2049 with proposed management of a 30% increase of pup survivorship.

Final Course of Action: Actions 1.1, 1.2, 1.3

Assessment Protocol: A 30% increase in pup survivorship will be considered successful, if at the 30-year completion of this management plan, pup survivorship increases from 64% to 94%. Pup survivorship will be calculated each year by analyzing the proportion of pups (<1-year-old) that have survived to the yearling stage (1-2 years old) following each breeding season throughout the duration of this project (Davies-Mostert et al. 2015). To accomplish this, the number of pups observed leaving a den will be compared to the number of those that reach at least 1 year old (Woodroffe 2011). Since the survivorship probabilities used for this plan are based on those suggested by Davies-Mostert et al. (2015) for African wild dogs, the survivorship probabilities of dhole pups may differ from the estimated 64% (Appendix A). Nonetheless, objective 1 will be considered successful with a 30% increase in pup survivorship from 2019 to 2049.

If pup survival did not increase 30% by 2049, then the first step is to analyze the survivorship trend observed over the 30-year period. If pup survivorship decreased or remains below 94% from 2019 to 2049, then causes of pup mortality should be investigated. These causes should then be accounted for if this management plan is redrafted in 2049. If pup survivorship remains relatively unchanged from 2019 to 2049, then additional actions should be taken, such as translocations of the adult 1 stage class (see Action 1.4). Overall, the next steps in advancing objective 1 solely depends on the observed trend of pup survivorship following the completion of this project.

Objective 2 – Increase prey availability by 10% in twenty years.

Action 2.1 – Baseline population densities of prey species should be determined during the first year of this project. Densities of wild pig, muntjac, and sambar will be evaluated throughout the subdistricts where dholes are distributed within the park as described in Action 1.1 (Namgyal and Thinley 2017). This will be accomplished by establishing line transects throughout these areas and recording observations of these species along each transect (Wang 2010). Variables such as cluster size and sighting distance should also be recorded for each species observed (Wang 2010). Field crews composed of three or four people should be trained on identifying these species, and each transect should be walked

five times from September (2019) to July (2020) (Wang 2010). Line transects have been successfully implemented in other protected areas in Bhutan, such as Jigme Singye Wangchuck National Park, to estimate ungulate densities (Wang 2010).

Action 2.2 – After determining the baseline population densities of prey species, as described in Action 2.1, methods to increase these densities include reducing the grazing pressure of domestic livestock in prey species habitat (Wang 2010). For the livestock farmers in Bhutan, allowing livestock to freely graze in forested areas is a common practice during the wet season (Wang and Macdonald 2006, Thinley et al. 2011). This not only promotes the probability of human-wildlife conflicts through the depredation by dholes, but also increases competition between wild ungulates and livestock (Wang and Macdonald 2006, Wang 2010). Efforts to reduce this grazing practice should include the implementation of a livestock intensification program, which will enforce the creation of designated fenced-in grazing pastures so that livestock is protected and has adequate space to graze (Wang 2010). Additionally, this program will include the organization of biennial meetings in villages where livestock is raised, so any concerns of farmers are accounted for (Wang 2010). Overall, during the 20-year timeline of objective 3, Jigme Dorji National Park officials should coordinate with appointed local farming spokespeople to accommodate the people’s needs while increasing the availability of grazing areas for wild ungulates.

No Action – If no action is made in attempt to increase the population densities of prey species, the dhole population in Jigme Dorji National Park will not be sustained. The depletion of the dhole’s prey base is the primary reason for the reduction of this canid’s range, and substantial prey numbers are required to satisfy their hypercarnivorous diet (Kamler et al. 2015).

Final Course of Action: Actions 2.1, 2.2

Assessment Protocol: Objective 2 will be considered successful if the combined population densities of wild pig, muntjac, and sambar has increased 10% from 2019 to 2039. The population densities of these ungulates will be evaluated in 2039 through establishing line transects throughout the park (see Action 2.1; Wang 2010). After the

completion of observing these three prey species along each transect, analyses will be conducted with *Distance* software (Wang 2010). These densities will then be compared to those calculated during the first year of this project (see Action 2.1; Wang 2010). If the overall prey density has increased by 10%, objective 2 will be considered successful.

If objective 2 is unsuccessful after the 20-year timeline, an assessment should be done to determine why this objective was not met. If the combined population densities of wild pig, muntjac, and sambar have not increased 10% from 2019 to 2039, then these species may need additional management to sustain the dhole population. A study should be conducted to determine the ecological factors that may limit these prey species abundances and their distribution (Simcharoen et al. 2014). Since prey depletion has heavily restricted dhole population growth, additional actions to increase prey availability may be needed, should this plan be redrafted (Kamler et al. 2015).

Objective 3 – Increase human awareness of dhole endangerment status by 70% in ten years.

Action 3.1 – Prior to the implementation of this management plan, the villages within Jigme Dorji National Park should be made aware of this conservation effort. This may be accomplished through village meetings or mailing out informational flyers (Appendix C). These flyers and meetings should stress the current decreasing population trend of dholes, their ecological importance, and the current conservation issues that need to be addressed for their management (Kamler et al. 2015). A sample flyer has been modelled based on the flyer distributed by the Laikipia Program which focused on African wild dog conservation in Kenya (Zeitz Foundation 2014; Appendix C).

Action 3.2 – During the first year that this management plan is implemented, a survey should be distributed to all subdistricts to acquire a census on public knowledge of endangerment status of dholes (Appendix D). This survey should also be used to gain an understanding on human-dhole encounters within the park, by allowing any concerns with an increase in the dhole population to be disclosed (Slagle et al. 2017). Finally, this survey should also inquire about the occurrences of retaliatory killings but provide insurance of no legal repercussions based on answers so that accurate data is collected (Lyngdoh et al. 2014).

Action 3.3 – If at least half of the subdistricts disclose of retaliatory killings in the survey discussed in Action 3.2, then a livestock insurance incentive should be considered (Namgyal and Thinley 2017). The revenue generated from tourism could be channeled back to the community as compensation for livestock losses (Lyngdoh et al. 2014). This insurance incentive should be explored for Jigme Dorji National Park if livestock predation has been well documented as a concern. Alternatively, the livestock intensification program discussed in Action 2.2 may also provide solutions to the dhole-human conflict, by supplying livestock farmers with information on altering grazing practices to mitigate livestock depredation (Wang 2010).

Action 3.4 – A final survey should be distributed to each subdistrict every 2 years and resemble the one described in Action 3.2 (Appendix E). This survey will ask about public knowledge regarding the endangerment status of dholes, the legal repercussions that follow harming them, and inquire about what steps livestock farmers have taken to minimize the human-dhole conflicts (Slagle et al. 2017; Appendix E).

No Action – Public opinion is a necessary component for any management of predatory species, especially those that pose human-wildlife conflicts (Katel et al. 2014). If no action is made towards increasing public awareness of the endangered status of dholes, then retaliatory killings may persist. Additionally, without financial incentives, there may be little encouragement to conserve this canid species (Lyngdoh et al. 2014, Namgyal and Thinley 2017). Overall, without the education of the public, efforts to increase the dhole population may be hindered.

Final Course of Action: Actions 3.1, 3.2, 3.3, 3.4

Assessment Protocol: Objective 3 will be deemed successful if public acceptance of the dholes in Jigme Dorji National Park has increased by 70% from 2019 to 2029. Dhole acceptance includes public education regarding global endangerment status and mitigation efforts towards reducing retaliatory killings. Objective 3 will be evaluated by comparing the proportions of responses to the surveys discussed in Actions 3.2 and 3.4. If all the subdistricts in Jigme Dorji National Park experience a 70% increase in

acknowledgment of the dhole's ecological importance and the current conservation issues that threaten them, then this objective will be successful.

If objective 3 is unsuccessful, steps should be taken to determine why this outcome occurred. Assessing the perceptions of those affected by wildlife is crucial, especially for carnivore conservation (Slagle et al. 2017). Surveys have been an effective way to incorporate local opinions on wildlife management, however, if this objective is unsuccessful, then alternative methods should be considered (Peterson and Rodriguez 2012). Public meetings may need to be held in the areas that are unwilling to alter grazing practices, or insurance revenue may need to be channeled to where building penned pastures is economically unattainable. Additionally, a demographics study of livestock farmers may need to be conducted, to determine if certain generations of farmers are less likely to change their herding practice and perceptions of dholes. Due to the historic retaliation against dholes, increasing public acceptance is crucial in promoting their conservation.

Conclusion

By implementing this management plan, Bhutan will become the first southeast Asian country to specifically focus on dhole conservation (Namgyal and Thinley 2017). The goal of this plan is to increase the dhole population in Jigme Dorji National Park, and this will be accomplished by increasing pup survivorship, managing prey availability, and increasing the human acceptance of dholes. With the cooperation between park officials, managers, and residents, this plan can be successfully implemented. Throughout the timeline of this management plan, more will be learned about dhole ecology, and this information can then be applied to populations in other countries. Furthermore, if this plan is successful, Bhutan will become a model for conserving the whistling canid.

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Dickerson
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Appendix A

Stage structured matrix for *Cuon alpinus* population projection.

	<i>F(p)</i>	<i>F(y)</i>	<i>F(a1)</i>	<i>F(a2)</i>	<i>F(a3)</i>
Pup (<1yr):	0	0	0.606666667	0.4166667	0.4155556
Yearling (1-2yr):	0.64	0	0	0	0
Adult 1 (3 yr):	0	0.71	0	0	0
Adult 2 (4-5yr):	0	0	0.91	0.32	0
Adult 3 (6-8yr):	0	0	0	0.305	0.6233333

Sensitivity matrix for *Cuon alpinus*.

	Sensitivity matrix				
		<i>F(y)</i>	<i>F(a1)</i>	<i>F(a2)</i>	<i>F(a3)</i>
Pups (<1yr):	0.1912	0.1369	0.1036	0.1527	0.1481
Yearling (1-2yr):	0.2938	0.2005	0.1518	0.2237	0.2170
Adult 1 (3 yr):	0.3880	0.2648	0.2005	0.2954	0.2866
Adult 2 (4-5yr):	0.2661	0.1817	0.1375	0.2026	0.1966
Adult 3 (6-8yr):	0.2651	0.1809	0.1370	0.2018	0.1958

Appendix B

Rabies fact sheet to be distributed to villages in Jigme Dorji National Park, modified from the World Health Organization's FAQs on rabies for the general public.



Image source: Dogster.com

RABIES FACT SHEET

**Help mitigate the spread of rabies to dholes
in Jigme Dorji National Park**



Image source: Australian Government
Department of Agriculture and Water Resources

What is rabies?

Rabies is a virus that is transmitted through the saliva (typically via a bite) from an infected animal. Rabies infects the central nervous system, and eventually travels to the brain where the virus will multiply and cause inflammation, resulting in death. The most common vector for rabies in Bhutan is free-ranging dogs.

What are the symptoms?

Symptoms of a rabies infected dog or dhole include:

- unprovoked or abnormal aggressive behavior;
- uncoordinated movements;
- lethargy;
- abnormal vocalizations, such as hoarse barking and growling;
- excessive salivation or foaming at the mouth.

What should I do if I see an infected dog or dhole?

If you suspect a dog or dhole is rabid, immediately contact your local park range office or call the rabies hotline phone number.

What should I do if I am bitten by a suspected rabid animal?

Rabies is 100% fatal to humans without treatment. If you are bitten by a suspected rabid dog or dhole, immediately seek medical attention.



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Appendix C

A sample informational flyer to be distributed throughout the villages in Jigme Dorji National Park.

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Help Us Conserve the Endangered Dhole!

DID YOU KNOW?

- **DHOLES ARE ENDANGERED**
The International Union for Conservation of Nature (IUCN) listed dholes as endangered in 2015. The population has been decreasing in Bhutan due to disease, competition with other predators, and unlawful killings.
- **DHOLES ARE PROTECTED IN BHUTAN**
Dholes are listed as a Schedule I species under the Nature Conservation Act of 2006, and it is unlawful to harm them in any way.

WITH YOUR HELP, WE CAN PROTECT THIS SPECIES

Without proposed management, dholes face certain extinction. With your help, we can protect this species for future generations. For more information on dhole conservation or questions regarding the proposed management for this species within Jigme Dorji National Park, please contact your local park office.

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Appendix D

The Endangered Dhole (*Cuon alpinus*) and Public Concern

The purpose of this survey is to assess the knowledge of the residents of Jigme Dorji National Park on the endangerment status of dholes. We would also like to evaluate any concerns with their management and address any conflicts. Any information given on the unlawful killings of dholes will not be followed with legal repercussions.

1. Are you aware that dholes are currently listed as endangered?
 - a. Yes
 - b. No
2. Are you aware that dholes are protected under Bhutan’s Nature Conservation Act of 2006?
 - a. Yes
 - b. No
3. Are you aware that under the Nature Conservation Act of 2006, the legal repercussions that follow harming dholes in anyway include imprisonment up to 5 years or a fine of 10,000 Nu.?
 - a. Yes
 - b. No
4. How would you describe any encounters you have had with dholes in the past, generally?
 - a. Somewhat positive
 - b. Positive
 - c. Somewhat negative
 - d. Negative
 - e. I have never encountered dholes
5. If you answered somewhat negative or negative in question 4, please elaborate:

6. Have you ever experienced retaliatory killings of dholes in your village?
 - a. Yes
 - b. No
7. If you answered yes to question 6, please elaborate (no legal action or investigation will take place):

8. Please add any concerns you may have about increasing the dhole population in Jigme Dorji National Park:

Thank you for completing this survey. Your input is appreciated and will be taken into account when applying this management plan.

