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INVITED REVIEW

THE FALLING OUT MAN AND THE WILD - A REVIEW OF INFLUENTIAL FACTORS, CAUSES, IMPACTS, AND STRATEGIES FOR MINIMIZING HUMAN-WILDLIFE CONFLICT

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ABSTRACT

Human-Wildlife Conflict (HWC) is negatively acting on both humans and wildlife equally alike as it affects the co-existence of natural resources leading to loss, fragmentation, and degradations of wildlife habitats. Apart from this, direct and indirect effects result on both humans and wildlife; loss of lives is the major direct impact affecting both counterparts. This paper is reviewing the reasons for arising of HWC, causes of HWC, major impacts on HWC, and different preventive and mitigatory measures practiced in different parts of the world.

Keywords: Human-Wildlife Conflict, Habitat, Inbreeding Depression, Genetic Variations

INTRODUCTION

With the evolution of human beings on earth, positive or negative interactions with wildlife have risen as humans acquired wild habitats and resources. In fact, human-wildlife problem date back to the prehistoric time (Zedrosser *et al.* 2011). Archaeological evidence revealed a fossilized skull of Taung Child (*Australopithecus africanus*) with a bite mark of a predatory bird – Crown hawk-eagle (Berger and McGraw 2007; Lee-Thorp *et al*. 2000; Berger and Clarke 1995; Dart 1925; Berger 1987). It is considered as the first recorded case of Human-wildlife conflict (HWC) during the prehistoric period before 5 million years ago, the last ages of the Miocene Epoch. Through the fossil records of the Woolly Mammoth and Woolly Rhinoceros, it has also been proven that HWC has led to the extinction of those animals within the late Pleistocene of the Glacial period (110,000 – 11,650 years ago) (Surovell *et al*. 2016). As explained by Guthrie (2005) and Somadewa *et al*. (2019), cave and rock paintings in different parts of the world are the other historical evidence that reveals the close association of humans and wildlife. Gordon (2009) states, these types of evidence have been recorded from the soil context of 10,000 years ago in the Neolithic period due to crop and livestock depredations. The conservationists describe the HWC as interactions between wild animals and people (Monney *et al*. 2010). Messmer (2009) described HWC as a negative interaction between humans and wildlife. Adams and Hutton (2007) defined by as any interaction between humans and wildlife which leads to negative impacts on the social, economic or cultural life of the human. Walpole *et al.* (2003), Baruch–Mordo *et al.* (2011), Davison *et al*. (2001), Hoffman and O'Riaia (2012), Dickman (2010), and Okello (2005) have stated that present HWC is occurring in several parts of the world among several different animal taxa and human beings. This happens due to the sympatric nature and co-existence of both humans and wildlife in the same geographic area, using the same resources (Hockings and Humle 2009; Pisa and Katsande 2021; IUCN 2005). Thus, HWC occurs when the needs and behavior of wildlife

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impact negatively on humans or when humans negatively affect the needs of wildlife (Mekonen 2020). Packer *et al.* (2005a) has stated that HWC leads to the occurrence of several consequences such as damage and destruction to crops, livestock predation, increased risk of livestock diseases, competition for grazing and water, and even direct threats to human life. Three main outcomes of HWC can be identified in nature; extinction of numerous species; changes in ecosystem structure and function; and immense loss of human lives, crops, livestock, and property (Waters *et al.* 2016; Woodroffe *et al.* 2005; Estes *et al.* 2011; Conover 2002).

Large-scale environmental changes, increment of human activities in wildlife habitats, and expansion of few wildlife populations have resulted in increasing intensity of HWC (Treves 2008). Apart from those, different authorities previously believed that HWC can be attributed to factors such as close proximity to forests, rural or agricultural problems (Messmer 2000). Despite, in the recent past, different authorities have observed that ever-escalating human population and associated development activities have increased HWC in urban and suburban areas (Soulsbury and White 2015).

There should be a variety in the mitigatory methods introduced to prevent or minimize HWC to aid the protection of both humans and wildlife. The establishment of mitigatory methods requires baseline information, knowledge, and active involvement of ecologists, wildlife biologists, wildlife managers, and other major stakeholders across the globe who will assist protected area management and sustainable livelihood (Messmer 2000; Bowen-Jones 2012; Dickman, 2010). Neglected HWC give rise to deprived conservation in the conflict area (Hill *et al*. 2002) and result in the death of wild species (Mateo-Tomas *et al*. 2016). Ultimately this will lead to threatening the wild fauna and some species reaching the brink of extinction. According to Woodroff *et al.* (2005) and Michalski *et al.* (2006), wildlife declining in an area causes a high degree of conflict between humans and wildlife. Therefore, unmitigated conflict areas will threaten both humans and wildlife by changing their livelihood (Sahoo and Mohnot 2004; Gillingham and Lee 2003; Rao *et al*. 2002). Brara (2013) and Schön (2013) state that these will lead to economic loss due to the damaged crops and livestock. Lamarque *et al*. (2009) further state that, it will directly affect the financial loss of a country that can be observed greatly among developing countries (Anthony and Wasambo 2009).

HWC has shown a high prevalence in areas where there is a high degree of interaction between humans and wildlife (Pack *et al*. 2013). Such conflicts occur at a lower percentage in developed regions compared to developing regions due to less competition for resources (Engemen and Sterner 2002). Developing regions (South and Southeast Asia) show a high degree of HWC due to their rich biological diversity and escalating human population (Madhusudan and Karanth 2002; Birch and Grahn 2007; Seoraj-Pillai and Pillay 2016). In such regions, people depend highly on forest ecosystems because of poverty and due to the conversion of forests into agricultural lands (Chao 2012; Sodhi *et al.* 2010; The World Bank 2015). Sodhi *et al.* (2010) indicated that nearly 14.5 million hectares of forest resources were converted to cash crop plantations from 2000 to 2010 leading to an increment in HWC.

HWC scenario in Sri Lanka may also be considered the same as the conflict situation in South and Southeast Asia. Numerous incidents regarding HWC have been reported from different parts of the country. Out of these conflicts, the most prominent is the conflict between humans and elephants. According to Prakash *et al*. (2020), the intensity of the HWC has been increased over the past few decades. Considering the human population density among the Asian countries, Fernando and Pastorini (2011) revealed that Sri Lanka is in third place. In fact, HWC in Sri Lanka is very high due to the huge densities of both humans and elephants. This has become a major conservation, socio-economic and political issue (Prakash *et al*. 2020).

1. Causative Wildlife for HWC

Human-wildlife conflict is a rising concern and the animals that cause this conflict have been identified from several modes of research conducted around the world (Greeshma *et al.* 2016). The vertebrates who contribute to HWC include the animals that belong to Class Mammalia, Reptilia, and Aves. Orders Primates, Rodentia, Artiodactyla, Perissodactyla, Proboscidea, Carnivora, Chiroptera, and Lagomorpha are the major groups of mammals that are involved in the conflict. Anand and Radhakrishna (2017) summarized that a total of 88 wild species belonging to 9 taxonomic groups are involved in HWC. Among the above-mentioned Orders, the animal species of Carnivora, Artiodactyla, Proboscidea, and Rodentia are the most common contributors to this conflict. To find the solutions to such conflicts, it is very much important to study ecology, behavioural patterns, habitat, and their interactions with the environment. These animals can be further described as carnivores (adapted to eat animal flesh) and herbivores (adapted to eat plant matter) for ease of study, according to their feeding habits. Omnivores are kept under carnivore and herbivore categories based on their major feeding habit. A brief introduction to the causative wildlife of HWC is given below.

1.1 Carnivorous animals

HWC studies have found that carnivorous animals in both terrestrial and amphibious environments are potential conflict contributors. People around the world have a fearful and negative attitude towards these carnivores (Treves and Karanth 2003). The loss of life, health impacts, and other damages caused by them can be cited as the reasons for this (Treves and Karanth 2003). The animals mentioned below are the key wild carnivores responsible for human injuries and casualties, loss of livestock, and other impacts around the world. Family Felidae-lion, tiger, leopard, snow leopard, cheetah, lynx, fishing cat, wild cat; Family Canidae-wolf, jackal, fox, wild dog; Family Hyaenidae-hyena; Family Viverridae-small Indian civet, large Indian civet, Hamilton's Civet, Common palm civet; Family Ursidae-black bear, sloth bear, brown bear; Family Mustelidae-martens and mongoose (Anand and Radhakrishna 2017). Animals of families Felidae and Canidae are more likely to contribute to the conflict due to factors such as large body size, food requirements, and large home ranges (Sillero-Zubiri *et al*. 2004; Macdonald *et al*. 2010). Entry to the human settlements due to the loss of habitats is one of the main ways in which they create a conflict with humans. They roam the villages at night in search of food, resulting in the loss of many lives and causing various damages. Most of the cases are related to human deaths and injuries caused by lions and tigers. Lion (*Panthera leo*) is a large and strong-built animal that belongs to the cat family is most active at night. Their preferred habitats are widespread grasslands, Savanna, dense scrublands, and open woodlands. Tiger (*Panthera tigris*) is the largest member of the Felid, adapted to an array of environments such as grasslands, deciduous forests, and mixed grassland forests. Similar to the lions, they prefer hunting at night (Sinha *et al*. 2011). The crocodile is a large amphibious, carnivorous reptile that belongs to the Class Reptilia. They inhabit rivers, swamps, and lakes. Predatory attacks by Mugger crocodile and Saltwater crocodile on humans, domestic animals, and livestock lead to creating conflict between them and humans. Adverse effects of conflict between these animals and humans include livestock depredation, human injuries, and casualties (Bajimaya, 2012). Ursids and human conflict is a major concern. Brown bear is the most common mammal that belongs to the family Ursidae. Their large body size, diet pattern, and distribution lead to creating conflicts with humans (Can O' *et al.* 2014).

1.2 Herbivorous animals

Ungulates are a group that consists of large mammals. Almost all ungulates are herbivores that feed on different plant species. They can be distinguished from other mammals by their hooves. These ungulates can be further divided into two Orders: Artiodactyla and Perissodactyla. Order Artiodactyla is commonly known as even-toed ungulates. More than 220 extant species can be found within this Order. Among them, the following species contribute to this HWC. Spotted deer, swamp deer, Al-

pine musk deer, sambar, wild buffalo, Indian wild pig, hippopotamus (Anand and Radhakrishna 2017). Order Perissodactyla is commonly known as odd-toed ungulates represented by about 17 extant species which are distributed through Africa, America, and Asia. Among these odd-toed ungulates, rhinos which inhabit grasslands, savannas, and wetlands are the animals that collide with people (Anand and Radhakrishna, 2017). The conflict with these animals is somewhat serious, as they mainly damage crops and attack humans (Eguchi *et al.* 2002). Similarly, Order Proboscidea (Elephants) is another conflict causing Order which causes severe damages in different ways. Due to their large bodies, poor food digestion and absorption, high food requirement, wide distribution, they are in constant conflict with humans (Lindstedt *et al.* 1996). Elephants are responsible for 87.1% of all reported crop-raiding incidents (DNPWC, 2017). According to Madhusudan (2003), the production loss due to crop raiding is about 14% of the annual production. In addition, there are various adverse effects such as human deaths, injuries, and property damages caused by the pachyderm. Order Rodentia is another conflict-causing type that causes crop damages. Three-striped palm squirrel, jungle palm squirrel, giant squirrel, and Indian crested porcupine are some examples of conflict-caused species (Anand and Radhakrishna, 2017). Comparably, rhesus macaque, stump-tailed macaque, pig-tailed macaque, Northern plains langur, capped langur, black-footed grey langur that belong to the Order Primates are animals that make a significant contribution to HWC (Anand and Radhakrishna, 2017). In addition, Order Lagomorpha represents another category of herbivores who contribute to HWC in some parts of the world. Indian hare and Hispid hare can be taken as examples (Anand and Radhakrishna, 2017, Gemeda and Meles 2018). Nocturnal and aerial, greater nosed fruit bat and flying fox (*Pteropus giga*nteas) belong to Order Chiroptera can cause damage to fruit harvest. Omnivorous birds such as Sarus Crane, bank mynah, jungle crow, house sparrow, Indian peafowl, weaver birds, parakeet, common babbler are contributing to HWC (Anand and Radhakrishna, 2017, Gemeda and Meles, 2018).

2. Factors influencing HWC

There is no individual factor that contributes to conflict between man and nature across the continents (Naughton Treves and Treves, 2005). There are many different factors causing HWC including human population growth, land use for agricultural and construction purposes, habitat loss, degradation, fragmentation, garbage, etc (Naughton Treves and Treves, 2005; Liyanage *et al.* 2021; Marasinghe *et al.* 2019). Hoare (1999), Woodroffe *et al.* (2005), Distefano (2005) have stated that escalation of wildlife populations causing problems can be attributed to the commencement of conservation practices, ecotourism orientation and increased access to resources, climate change, development of livestock and changes in social relationships in the rural communities.

2.1 Human population growth and land transformation

The rapid increase in human and some wild animal populations increases basic needs (Madden 2008; Kumara *et al*. 2012, Newmark *et al*. 1993). This is the key factor of direct and indirect transactions between humans and wildlife (Edward and Frank 2012). As a result of this increase in human population, the human settlements are spread into the protected areas due to the limited space available, geographically (IUCN World Park Congress 2003). According to statistics, the human population will grow more than 50% by 2050. That is from 6 billion in 2000 to over 9 billion by 2050 (Taylor -Zubiri and Switzer 2001). This increment can create a competition between humans and wildlife for limited resources such as food, water, and land on earth (Sillero-Zubiri and Switzer 2001). Hence this competition leads to an increase in HWC, when people enjoy limited resources, they tend to migrate into areas with rich resources like forests (Lamarque *et al*. 2009; Joseline 2010; Western 1995). This factor is directly associated with increased basic human needs. Hence, forests, Savannas, and other ecosystems are being used for agriculture and other construction purposes. This leads to a huge

decrease in the natural habitats of wildlife (Silleru-Zubiri and Switzer 2001; Lamarque *et al*. 2009; Eyebe *et al*. 2012). An increase in population means an increase in cultivated lands (Lamprey and Reid 2004; Mukeka *et al*. 2018). This directly contributes to the rise in HWC. Developed countries have access to many resources to meet the needs of people which reduces the competition for resource pursuits thus reducing HWC (Engemen and Sterner 2002; Tzilkowski *et al*. 2002). But the HWC is more prevalent in developing parts of the world like South and South-East Asia than in developed countries (Madhusudan and Karanth 2002). High biodiversity and human attitudes towards nature are the factors influencing this. HWC incidents are common in Kenya where more than 65% of its wildlife is found in private lands outside the protected areas (Western *et al*. 2009). According to the statistics based on South East Asia, 14.5 million hectares of forest cover has been lost due to crop plantation (Sodhi *et al*. 2010). For instance, in Gujarat State in India, on the edge of Gir National Sanctuary, the alteration of land which cultivated millet and groundnut into the mango and sugarcane plantation have been led to increase conflict with leopards (*Panthera pardus*) and lions (*Panthera leo persica*) (Vijayan and Pati 2002). In case of unavailability of the essential components in natural habitats, wild animals are caused to move out causing several types of conflict (Lamarque *et al*. 2009).

2.2 Habitat loss, fragmentation and degradation

Human population growth and land transformation have together led to habitat degradation, fragmentation and habitat loss (Mekonen 2020; Kangwana 1993; Okello *et al*. 2003). Humans severely disrupt natural habitats by cutting trees for timber and charcoal, digging the land, making fires, arranging lands for chena cultivations, *etc* (Mekonen 2020). Due to the gradual loss of habitats due to anthropological impact, wildlife populations become fragmented and eventually leaving smaller habitat pockets for them to survive. For instance, that minimizes the nesting areas, mating sites, and feeding lands. This creates more chances to maintain contact with each animal, which ultimately leads to a rise in HWC (Edward and Frank 2012; Lamarque *et al*. 2009; Mekonen 2020; Sillero-Zubiri and Switzer 2001; Kumar et al. 2012). In most parts of the world due to deforestation habitat loss of primates can be identified which resulting human-primate conflict. Thus the conservation is a major concern when pacifying HWC (Ogra and Badola 2008; Hill 2005; Hill and Wallace 2012). Wildlife corridors that allowed wild animals to cross through forests have been blocked for human needs such as road development, railways, and border fences. Obstruction of habitat corridors can disturb the function of meta-populations (Krebs 2009). Habitat loss can create problems with food security. Thus, human activities over the past decades have contributed to an increase in HWC (Graham *et al*. 2005). Another good case study is from Sumatra where altered forest areas for agricultural activities and grazing have restricted the Sumatra tigers (*Panthera tigrissumatrae*) into few forest patches (Nyhus and Tilson 2004b). These habitat degradations and modifications lead to ecological dislocation of wildlife (Sethy and Mardaraj 2015). Kangwana (1993), Conover (2002), and Okello *et al*. (2003) identified that increasing human population has resulted in encroachment into more marginal lands inhabited by wildlife and leads to habitat loss, fragmentation, and degradation of them due to the conversion of lands to agricultural fields and other activities harming wildlife.

2.3 Impact of conservation management

Interestingly, there are occasions where conflicts have arisen due to the introduction of conservation and management programs to augment declining and threatened wildlife populations. Such programmes aimed to recover and restore declining, threatened or nearly extinct species from over-exploitation have become problematic due to geometric growth of population size, in-situ conservation and their impact on available resources (Fall and Jackson 2002; Messmer, 2000). A classic example is the last free-ranging population of Asian lions (*Panthera leo persica*) which faced a population bottle-neck due to hunting and habitat loss in Gir National Park in the Indian state of Gujarat during the onset of the

19th century (Banarjee and Jhala 2012). Nevertheless, the Asian lion population size in Gir NP doubled between 1970 and 1993 upon implementation of stringent conservation measures that reduced human-caused mortality by appropriate habitat management and effective conservation measures (Vijayan and Pati 2002). Consequently, lions began to roam the surrounding villages of Gir forests in search of prey and caused conflicts with humans (Vijayan and Pati 2002).

2.4 Impact of tourism and ecotourism initiatives

The trend towards ecotourism and natural resource-based tourism increases the number of local people and tourists visiting protected areas causing HWC worse in certain regions (Shannon *et al*. 2017). Number of studies have showed that tourism and ecotourism initiatives can have some negative effects in different ways. Among them habitat destruction, physiological and behavioural changes in animals are some severe impacts on wildlife (Karis *et al*. 2013). Habitat destruction due to various recreational activities such as safaris, camping, fishing, diving is the main effect here. Apart from that deforestation, use of land for hotel constructions also affect the wildlife in direct and indirect manner. In addition, taking close photographs of wild animals, which can be frightening to animals. In 2016, a tourist was attacked by an elephant, used to roam around Minneriya park boundaries when trying to capture a photograph (Prakash and Kumarathunga 2016). Studies have shown that this affects the animals who spent some specific stages of their life cycle, as well as their mating patterns. Feeding wildlife is another conflict causing incident (Shannon *et al*. 2017). This causes changes in the diet and behaviour of the wildlife. Similarly this leads to arise conflicts in between humans and wildlife. As Prakash and Kumarathunga (2016), one tourist has been attacked by Rambo, a free ranging elephant in 2014 at Udawalawa park boundary Sri Lanka. This elephant is used to roam around the electric fence near the Udawalawa park boundary, Thanamalwila road Sri Lanka. According to their case study, Prakash and Kumarathunga (2016) further explained that this lady tourist has tried to follow and fed the Rambo which led to being attacked. The increasement of HWC has a severe impact not only on human life but also on animal life. Hunting, fishing, vehicle collisions, recreational boat rides have been reported as causes for loss of wild species (Fennell 2015; Pienaar 1968; Cannell *et al*. 2016). There are reports of two casualties among visitors involving hippo due to unawareness and ignorance about wildlife (Durrheim and Leggat 1999). They further stated that injuries and deaths from elephants, tigers, lions, crocodiles, and other wildlife are reported every year in different parts of Africa and Asia. In 2004, an American tourist was killed in a crocodile attack in a canoe, Mana Pools National Park in Zimbabwe (United States Department of State 2007). According to Durrheim and Leggat (1999), seven tourists have been killed by wild mammals during 1988 to 1997 period in South Africa. Two of the dead were students from Thailand and the other one was a German traveller. Similarly 14 nonfatal incidents have been reported including hippo(05); buffalo(03); rhino(02); lion(01); leopard(01), zebra(01); musth elephant(01) during the 1988 to 1997.

2.5 Climate change and extreme environmental factors

Climate change and extreme environmental factors can aggravate HWC, even though it is the least concerned. Heavy rainfall, droughts, landslides, and bushfires are some of the threats to wildlife assemblages. Wild animals approaching human settlements are common under such drastic changes (Amaja *et al*. 2016). Observations related to research conducted in Kenya show that there is a direct relationship between seasonal patterns in rainfall and the frequency of occurrence of predators (Patterson *et al*. 2004). Environmental degradation has made climatic and weather changes difficult to predict, thus causing a remarkable impact on HWC. Not only the man-made activities but also some extreme environmental factors such as high temperature and hot waves of winds can cause forest fires resulting in increased HWC (Sethy and Mardaraj 2015). Drought and fires caused by an El Nino due to Southern Oscillation in 1997-1998 destroyed large parts of Sumatran

forests harbouring rich biodiversity (Nyhus and Tilson 2004a). HWC is further increasing indirectly due to air pollution that causes acid rains and destruction of forest cover (McLaughlin *et al*. 1983). People who inhabit wildlife areas always exploit natural water bodies for various purposes which leads to scarcity of water to wildlife, thus augmenting HWC (Fujie and Ying 2000; Odaka and Peterson 2000).

2.6 Influence of livestock development

About 30% of the ice-free arable land area on earth is used for livestock. This is the fastest-growing subfield in agriculture in many developing countries and tropics as livestock is the livelihood of many rural people (Thornton 2010; Else 1991; Treves *et al*. 2006; Eniang *et al*. 2011). The high demand for livestock has created many conflicts including HWC (Sethy and Mardaraj 2015). The rapid growth of the livestock population creates competition for food among wild herbivores due to increased grazing pressure. This leads to overgrazing and a considerable decrease in the wild herbivore population (Mishra *et al*. 2003; Mekonen 2020). Due to this conflict over food, wild animals such as elephants tend to move into the villages. In the meantime, the increased population of livestock becomes victims of carnivores (Sangay and Vernes 2008). Usually, depredation is high in the dry season. Studies conducted in Narok indicate livestock depredation is much higher even in wet, rainy seasons if migratory ungulates are absent. Studies have shown that carnivores such as lions, leopards move towards the livestock for hunting their prey due to the scarcity of ungulates in the forests (Mekonen 2020).

2.7 Changes in social relationships in the rural community

People's power in rural areas has declined and there is no adequate human labour to guard their agricultural fields. Thus, cultivations are easily raided by the wild animals increasing HWC (Lahm 1996). In other words, HWC is affected by changes in social interactions in rural communities. Among those changes, the migration of villagers to the city for employment is a major factor contributing to HWC. Similarly, with the increase in educational opportunities, children also move away from their traditional lifestyle (Goldman 1996). In addition, due to certain cultural and religious beliefs people allow certain animals to reach into their villages (Dickman *et al*. 2013; Manfredo and Dayer, 2004). Those animals also can make an impact on the HWC. As an example, the attitude of some Orthodox Hindus in India towards monkeys led to an increase in the conflict (Imam et al. 2002; Anand *et al*. 2018; Beisner *et al*. 2015; Saraswat *et al*. 2015). As described by Butchart *et al*. (2010), the increasing human pressure on biological diversity leads to a decline in their populations during the last four decades in South East Asia. Overexploitation of biological diversity is resulting in habitat loss including microhabitats of some animal species, especially influence on bird populations (Mallari *et al*. 2011; Holmes and Sherry 2001). Birdlife International (2014), and McGowan *et al*. (1999) have categorized Green Peafowl as vulnerable to endangered bird species in South East Asia due to anthropogenic activities. Hoffman *et al*. (2018) also named peafowl species as a threatened species in South East Asia. However, In Sri Lanka the peafowl population is increasing due to two main reasons; the peacock is not hunted or killed due to religious beliefs (Fitzpatrick 1923; Choskyi 1988; Ali and Ripley 1980), and lack of jackal population in natural habitats. Rodrigo (2020) mentioned that jackals are always co-existing with the human landscapes, which leads to the ultimate kill of jackals by humans due to predation of their livestock or human bites. Rodrigo (2020) further states that jackals are the top predators of herbivores in most of Sri Lankan wild localities, and the decline of their population promotes peafowl populations and finally, now they have become a major pest in our agricultural crops, especially on grain crops.

2.8 Zoonosis and disease transmission

Human activities such as the transformation of lands into agricultural lands or industries, human and animal migrations, overgrazing in wild habitats are major driving forces in the transmission of zoonotic diseases from wildlife to domestic animals and vice versa

(Phukon 2015). Thereby, livestock brings the above closer to wildlife (Phukon 2015). In this case, the transmission of zoonotic diseases by wildlife to humans or livestock has a major impact on wildlife, livestock, and human health (Karesh and Cook 2005; Woodroffe *et al*. 2005). The rapid growth of the human population by 4 folds over the last century is the major factor causing the spread and transmission of diseases. Apart from those factors, meat consumption, live animal markets, use of animals in transportation, habitat destruction are other risk factors (Greger 2007). Therefore, it is important to know the causative animals and the spreading method to minimize the conflict. Wild animals can be interpreted as a pool of zoonotic diseases caused by viruses, bacteria, and parasites (Kruse *et al*. 2004). The total number of zoonotic diseases has not been confirmed. According to Taylor *et al*. (2001), 62% have been classified as zoonotic from a total of 1415 pathogens. As revealed by Woolhouse and Gowtage-Sequeria (2005), there are about 1407 species of human pathogenic organisms, out of them 816 were classified as zoonotic. This is a significant figure of about 58%. Thus, humans are at a higher risk of getting diseases from wild animals. Out of 177 reported cases, 73% were zoonotic (Greger 2007). Mosquitoes, flies, reptiles, wild passerine birds, vultures, wild rodents, shrews, fruit bats, hares, hedgehogs, deer, deer mouse, monkeys, pigs, and horses are some examples of the animals who spread diseases (Barbour and Fish 1993; Schmaljohn and Hjelle 1997; Dumler and Walker 2001). Based on studies done in Europe, the mode of transmission of these diseases is widespread and multifaceted (Gortazar 2007). Infections can be transmitted directly from wild animals, through direct skin contact (tularemia) with sick or dead hares and rodents, through animal bites (rabies virus), and by rodent aerosols in the dust (Hantaviruses) (Kruse *et al*. 2004; Peterson *et al*. 2004). Contaminated water and food are indirect methods of disease (*Salmonella* spp. and *Leptospira* spp.) transmission. SARS, Tuberculosis, Rabies, Hepatitis, Anthrax, Hantavirus, Lyme borreliosis, Rift valley fever, Equine encephalitis, Japanese encephalitis, Leishmania, Anaplasma, Ebola, Marburg disease, Nipah virus, Monkey fox are examples of few zoonotic diseases which affect both humans and livestock (Kruse et al. 2004; Peterson et al. 2004; Reed *et al*. 2004; Chua 2003; Hofshagen *et al*. 2003). Rabies is one of the major zoonotic viral diseases which attacks the central nervous system and causes paralysis followed by death. Several wild animals have been identified as rabies reservoirs in Sri Lanka. Among them Mongoose (*Herpestes* sp.), Grizzled giant squirrels (*Ratufa macr*oura), Asian palm civets (*Paradoxurus hermaphrodites*), Golden palm civets (*Paradoxurus zeylonensis*), and small Indian civets (*Viverricula in*dica) are more common (Rodrigo, 2020). This has a high impact on livestock and domestic pets (Woodroffe *et al*. 2005). When considering SARS, according to the WHO, 8,098 cases were reported with 774 fatalities (Kruse *et al*. 2004). Also, Aftosa (2007) states that transmission of the Foot and Mouth Disease Virus (FMDV) has occurred in cattle and European hedgehogs. Livestock movements tend to increase disease transmission and make it difficult to control (Wright 2001). However, livestock plays an important role in contributing economy. FAO (2006) has mentioned that, as a result of livestock diseases, the global livestock market has shown its lowest growth rate within the last decade. The diseases associated with livestock directly affect the livelihood of many people. This increases the economic instability by spending money to treat diseases. As a result, the conflict between wildlife and humans is constantly intensifying.

3. Impacts of human-wildlife conflict

The history of HWC runs back to the humans evolved on the earth. Since then, various impacts have occurred to both humans and animals in many directions which can be classified as direct and indirect impacts.

3.1 Direct impacts on humans

The conflict between wildlife and humans has widely spread. It affects both groups at different levels. These effects can be categorized in different areas. Direct impacts on humans lead to loss of human lives, damage, and destruction of crops, livestock losses destruction of properties (Conover 2002; Dickman and

Hazzah 2016; Gemeda and Meles 2018; Norton-Griffiths 1996; Campbell *et al*. 2000). Similarly, the loss of lives and their habitats can be taken as a direct influence on wildlife.

3.1.1 Human casualties and injuries

The direct impact of HWC leads to injuries or loss of human life (Nyhus 2016; Nyhus and Tilson 2000; Bandara and Tisdell 2002; Santiapillai *et al*. 2010; Lamichhane *et al*. 2018). The most harmful effect of HWC is the fear of losing lives due to the large carnivores and mega-herbivores. Human carnivore conflict is currently the most common global crisis in rural areas surrounded by forests as well as semi-urban areas all over the world (Dickman 2008). Wild animal migration and distribution patterns are controlled by the availability of water, food, and mates (Mace and Paul 1983). Wild animals tend to emigrate from the forest due to the lack of the above-mentioned needs and it results in conflict with humans. The fear of carnivores in the human mind can be identified as an impulsive anti-predatory reaction (Kruuk 2002; Quammen 2003; Packer *et al*. 2005b). According to Kruuk (2002), the damages and attacks which have been occurred by cats, bears, and wolves descended from the past to the present day. Generally, most of the cases are simply presented by the villagers, however, due to insufficient evidence and information, those cases cannot be considered as valid data. Despite, reliable evidence and data show that there are hundreds of people killed annually by wild animals (Kruuk 2002). Most of the cases which are related to human deaths and injuries are due to animals in the cat family-such as lions (*Panthera leo*) and tigers (*Panthera tigris*). According to Kruuk (2002), 8 tigers in India, were accused of killing nearly 1000 people. According to Sanyal (1987), nearly 100 human lives have been lost annually in Sundarbans of India and Bangladesh due to the tigers. Deadly attacks are rare in Asia, but 22 people were killed by tiger attacks between 1985 and 2001 in Kanha reserve in Madya Pradesh (Karanth and Gopal 2005). Similarly, Saberwal *et al*. (1994) showed, between 1978 and 1991, 28 people were killed by lions in the Gir forest in Gujarat State. Nyhus and Tilson (2004b) had documented an interesting case analysis on the human-tiger conflict in Sumatra islands. They focused on the distribution and impact of critically endangered Sumatran tiger (*Panthera tigrissumatrae*), by using the incidents reported over 20 years. Their study showed that tiger conflict is more common in intermediate disturbance zones. The areas thus identified are isolated human settlements associated with tiger habitats. However, they revealed that this tiger conflict is lower in the high and low disturbance zones compared to the above intermediate zones.

Crocodile-human conflict is much higher when compared with the other carnivores. Number of large crocodiles roaming around the riversides and human settlements. Due to their wide distribution range, the possibility of having conflict with humans is higher. They also can coexist with people without being caught. According to Magane (2003), it shows that although information and evidence are scarce, crocodiles are largely responsible for human deaths. In Mozambique, the majority of human deaths due to crocodiles are not being reported due to the problems in getting people to government offices. Mombaur (2020) summerized that 10-15 crocodile attacks can be recorded annually especially in the Sothern part of Sri Lanka and one third of them are fatal cases. Ironically, FAO (2005) stated that approximately 300 people are killed by crocodiles within all the regions every year.

According to Acharya *et al*, (2016) and Gubbi (2012), elephants are the leading conflict-causing animals among mega-herbivores. Due to their large bodies, high food requirements, and wide home range, this pachyderm is in constant conflict with humans (Lindstedt *et al*. 1986; Thouless 1996).

As mentioned in section 2.2, habitat loss, fragmentation, and degradation due to human activities and other natural causes are thus major factors influencing Human elephant conflict (HEC). Elephants invade rural areas, due to food shortages in their natural habitats. WWF 2007 states that over 200 people have been killed by elephant attacks within the last seven

years, in Kenya. Similarly, around 10 people were attacked and killed by elephants over the last five years in the Kakum conservation area, Ghana. The largest elephant population in Namibia has been found in the Caprivi region. (O'Connell Rodwell *et al*. 2000). According to Prakash *et al*. (2020), a total of 14516 HEC incidents were recorded in Sri Lanka during 2010-2019. Under this, a total of 807 human casualties and 579 human injuries were recorded. Out of these deaths, the majority represent male animals (Prakash *et al*. 2020). Crop guarding and the presence of males to confront elephants are key factors to male deaths. The home range of male elephants is known to be higher than that of herd dwelling females (Fernando *et al*. 2011). In addition, Fernando *et al*. (2011) had illustrated that the roaming of men around the village at night and being on roads after dark also caused these types of conflicts.

3.1.2 Crop destruction

Crop raiding is one of the most common phenomena and it is a process that has been occurring since the beginning of the human farming era (Blair 2008; Datta-Roy *et al*. 2009; Joseline 2010; Blair *et al*. 1979; Nath and Sukumar 1998; Newmark *et al*. 1994; Sekhar 1998; Williams and John Singh 1996). As per Lamarque *et al*., (2009) and Priston (2009), this is one of the direct effects of HWC, which is common around forests and protected areas. Crop damage by elephants is a global concern, as elephants can destroy a whole cultivation over one night (Treves and Karanth 2003). Elephants enter cultivated lands due to the abundance of nutritious food. Similarly, in drought seasons, water-seeking animals invade villages and destroy the crops. This is most common in dry zones. Even though people are blamed only for the damage-causing elephants, they are not the only animals who damage the crops. Red-tailed monkeys cause severe damage to farmlands. Damage due to these red-tailed monkeys throughout the year is greater than the damage caused by elephants. (Naughton-Treves 1997, 1998). Therefore, attention should be paid to big losses as well as small scale massive losses (Treves *et al*. 2006). There are many other different types of wild animals that cause destructions, such as huge mammals, birds, smaller animals like rodents (Saj *et al*. 2001; Rao *et al.* 2002; Osborn and Parker 2003; Sitati et al. 2003; Gunn 2009). Apart from the above-mentioned animals, barking deer, Eurasian wild boar, Himalayan black bear, Indian crested porcupine, Indian hare (Rufous-tailed), Nilgai, one-horned rhinoceros, rhesus monkey, spotted deer are among the animals who create conflict by damaging crops (DNPWC 2017). Thus, crop-raiding leads to reduced crop yield, quality, and post-harvest losses. This situation has a direct impact on the economic status of farmers (Osborn and Parker 2003: Marchal and Hill 2009). At the same time damages to farmlands is a significant impact on humans (Mayberry *et al*. 2017). These damages affect the production of staple food grains like rice, wheat, millet, maize, and other food crops such as vegetables, sugar cane, coconut, potatoes, manioc, *etc* (Sethy and Mardaraj, 2015). According to Parker and Osborn (2001), Malima *et al*. (2005), Jackson *et al.* (2008), Gunn (2009) and Malugu (2010) the peak level of this crop raiding is around the harvest season. According to a study report by Gyelmo (2016), at least two people were needed to guard the paddy fields at night in the Punakha district, Bhutan. They had to spend sleepless nights to save the field from wild boars, monkeys, and deer and this scenario are common to many localities where human-elephant conflict prevails in Sri Lanka. This vast damage often results in food shortage for the poverty-laden rural communities, as they used to consume some simple staple food (Osborn and Parker 2003; Marchal and Hill 2009). Prakash *et al*. (2020) documented destruction of the post-harvest crop stored at farmer's homes as well as grain huts, would occur due to elephants raiding villages in search of food, however, such happenings are common in the dry zone of Sri Lanka.

3.1.3 Damages to livestock

Another destructive effect is the killing of domestic or livestock animals by wild predators. This livestock depredation by large carnivores is a widespread phenomenon around the world (Sillero-Zubiri and Laurenson 2001; Mekonen 2020). One of the reasons for this is

anti-predator behavior shown by domestic animals and overgrazing by livestock. The number of domestic animals that are hunted varies according to the species, the abundance of prey, time of the year, and other factors (Treves and Karanth 2003). Pastoralism or livestock raising in savanna and grasslands is the main source of income for the people who live in such areas. Loss of livestock due to predation has become a threat to people's livelihoods. While this may not seem like much of an impact on a large and national scale, it does put a strain on small-scale livelihoods. The detrimental effects of this are the collapse of the economic status of those people and the emergence of poverty. Both large and small carnivores are also responsible for the damages to livestock. Research conducted in Bhutan and Pakistan has shown that leopards are major livestock predators (Wang and Macdonald 2006; Sangay and Vernes 2008). A study in Pakistan shows that the percentage of goats and sheep killed by leopards was very high. Similarly, Bhutan reports indicate that the number of goats and horses killed by leopards is higher than expected (Sangay and Vernes 2008). In the Sariska tiger reserve in India, leopards kill 88% of livestock including goats, sheep, and calves (Sekhar 1998). In terms of livestock damage from black bears, Pakistan and Bhutan reported 6% and 8% casualties respectively (Sangay and Vernes 2008). According to the Ogada and Ogada (2004), the number of domestic animals killed by wild predators in the African Wildlife Foundation (AWF) Samburu Heartland of Kenya is reported to be leopards (35%), lions (35%), hyenas (18%), baboons (4%), elephants (3%), buffalo (2%), wild dogs (2%) and cheetahs (1%). As per Dar et al (2009) 64.2% of these livestock deaths occurred during the night and the remaining 35.8% occurred during the daytime. Lamb captured by large eagles is another problem around the world. Many studies have discussed the diet of eagles and their effect on sheep production (Leopole and Wolfe 1970; Brooker and Ridpath 1980; Berger 1987; Matchett and O'Gara 1987; Phillips and Blom 1988). Therefore, the annual livestock loss due to predator impact is substantial. Although the loss caused by these predators is much lower than the loss caused by animal diseases, the impact on the economy is substantial (Woodroffe *et al*. 2005). Human activities such as hunting, fishing, and poaching make it difficult for carnivores to find their prey. In response, lions tend to enter villages and hunt cattle, sheep, and goats (Nowell and Jackson 1996). According to the study done during 2004 – 2007 in the Azad Jammu and Kashmir in Pakistan, out of 4654 households, 148 were reported to be facing livestock threats (Dar et al, 2009). Due to inland fishing, predators like crocodiles run out of food. As a result, these predators tend to catch up with livestock who come to drink water (Sethy and Mardaraj 2015). Similarly, the effect of wolves on livestock depredation is somewhat significant. According to Distefano (2010), livestock depredation by wolves is a major concern in remote parts of the Abruzzo region in Italy. Even though both wolves and bears inhabit there, wolves tend to cause 94% more livestock killings than bears. Similarly, in the Alberta region of Canada, wolves caused 2086 deaths of livestock from the year 1982 to 1996. In natural ecosystems, the Indian Grey Mongooses control ecological balance by regulating the wild populations of reptiles, ground Birds, small mammals and insects (Furqan *et al*. 2021). As described by Fedriani et al. (2001) and Santiapillai *et al*. (2000) there are several depredations of poultry occurring in different parts of the countries like, India, Pakistan and Sri Lanka which creates HWC. According to Jayewardene (2008) in Sri Lanka, Polecat (*Paradoxurus hermaphroditus*) and Mongoose (*Herpestes* sp.) raid poultry cages and kill the chicken. Thus, damage to livestock can be considered as an indicator of the magnitude of HWC. Wild Animals like wild boars, giant squirrels and porcupines cause HWC in agricultural sector in Sri Lanka (Mombauer 2020).

3.1.4 Property damage

Even though casualties and injuries are equally reported, property damage is another common negative effect. This varies from severe damages to homes and other properties. Although the number of reported cases is low, the actual number of damages is relatively high (Gross *et al*. 2020). When elephants roam in search of food, they cause severe damage to

the houses where the grain is stored. In addition to the damages that happen to houses, damage to other properties such as fences, ponds, canals, pipes, roads in national parks, electric goods like TV, radio, bicycles, and other structures in villages is also a major concern (Muruthi 2005; Eniang *et al*. 2011). For example, in Namibia, elephants in the arid Northwest damage the water storages (Government of Namibia 2007) which results in loss of resources. Thouless (1994) revealed that artificially maintained water sources attract elephants to human settlements during droughts.

3.2 Direct impacts on wildlife

Losses of lives of wild animals are a major problem in almost all countries due to HWC. Some of this wildlife is endangered. In Sri Lanka, elephants and leopards are the main animals facing these threats. Similarly, this is a major concern in countries in Asia, Europe, Africa and all over the world (Swenson and Andre'n 2005; Pletscher *et al*. 1997; Bangs *et al*. 2005).

3.2.1 Loss of lives and habitats of animals

HWC causes huge damages to human lives as well as wildlife. Animals show their habitual behaviours even after they lose their habitats due to human activities. Migrating in search of food is a characteristic feature of many wild animals. During this migration, these animals tend to enter rural areas bordering their sites. Animals such as elephants, tigers, leopards, and lions often move towards the villages. In addition, animals such as wolves, bears, wild boars, and monkeys can be considered. Fear and other attitudes towards this wildlife lead to conflict between these two parties (Woodroffe 2000). People often tend to kill wild animals when they are fighting against them in aid of protecting their lives. According to Fernando *et al*. (2011), 263 elephants causalities were recorded within Sri Lanka from 2010 - 2019. During the 1992 – 2001 period, there were 137 reported elephant deaths (Perera 2009). Therefore, the elephant death rate has increased by 31% over the last decade and increased by 92% over the past twenty years. The annual elephant death in India is approximately 124 (Ganesh 2019); Sabah (Borneo) 10–16 (Alfred *et al*. 2011); Indonesia 9 (Azmi and Gunaryadi 2011); Bangladesh 4 (Islam *et al*. 2011); Malaysia 1 (Saaban et al. 2011). The annual number of elephant death in Kenya is 50 – 120 (Shaffer *et al.* 2019). Through the reported incidents it is clear that Sri Lanka has a high number of annual elephant deaths. In comparison, the rate of elephant deaths due to HEC in Sri Lanka is higher than that of humans. Further compared human to elephant death ratio due to HEC is about 0.30 in Sri Lanka while it is at 0.2-0.5 in Kenya, 0.2 in Indonesia, and 0.2-0.5 in Sabha-Borneo (Prakash *et al*. 2020). According to the Department of wildlife conservation, 100 elephants had been killed within Sri Lanka from January to March 2021. Among them, 21 had died from electrocution, 18 from jaw exploders (hakkapatas), and 12 from gunshots. Significantly many male elephant deaths were reported. The male, female elephant death ratio in Sri Lanka is around 2.01 while it was 1.29 in South India from 1976 to 2000 (Haturusinghe and Weerakoon 2012; Ecology Centre 2019). Similarly, carnivores such as tigers, leopards, lions enter villages in search of food. People show more fear of these carnivores than the mega-herbivores such as elephants or rhinos. Ultimately, this conflict ends by killing both carnivore and herbivore animals. According to Bhattarai (2009), in Nepal 29 tigers has been killed between 1989 to 2009 in Bardia National Park. The small carnivorous population of red fox, stoat, weasel, and other common animals were reduced due to trapping, snaring, and shooting (Reynolds and Tapper 1996). Due to human population pressure and urbanization in South African reserves over 200 vertebrates are known to have culled between 2010 to 2012 which is driven by lack of space and habitat (Manfredo et al, 1998). Meantime, in the African continent, some illegal culling and poaching have been identified as elephants for ivory and rhinoceros for horns (Naughton-Treves 1999; Nemtzov 2003). As per Pletscher *et al*. (1997), Bangs *et al.* (cited in Bangs *et al*. 2005) humans have been accused of 85% of adult wolf deaths in the Northern Rocky Mountains of the UK. Sweden and Norway have granted permission to culled wild Lynx and culling bear allowed

only in Sweden under quoted regulations. However, people tend to kill both the animals with other large carnivores in Sweden illegally due to livestock depredation (Swenson and Andre'n 2005). Although it is difficult, some estimations have been taken regarding those mortalities. Between 1984 to 1998, it has been estimated that nearly 40 bears have become the victims of illegal killing within Sweden (Swenson and Sandegren cited in Swenson and Andre'n, 2005). Also according to Andre´n (cited in Swenson and Andre'n 2005) the annual mortality of Lynx in Sweden due to illegal killings is between 133-157. Other than the above-listed animals, large numbers of snakes, monkeys, giant squirrels, birds such as peacocks, and game birds have been killed. These killings have been done purposely and some were by road accidents as most of the transport lines are crossing wildlife habitats in several countries and animals are used to visit or attracted by roadsides.

3.3 Indirect effects on humans

Other than general direct impacts, there are also unreported hidden effects that are associated with HWC (Hunter *et al*. 1990). People also have to suffer from these kinds of effects, both physically and mentally (Chowdhury *et al*. 2008; Dixon *et al*. 2009). These effects are more likely to have long-term impacts than immediate losses and damages. Though great attention has been focused on finding solutions for directly visible problems, very little attention has been paid to these indirect effects (Sangay and Vernes 2008; Treves 2009; Treves *et al.* 2006; Vidya and Thuppil 2010; Woodroffe *et al*. 2005). Therefore, the damage caused by these types of problems is severe. Chronic injuries and disabilities are the most common indirect effects that can be experienced. Most of the rural people survive from farming and related activities. Often the men in the family are the principal earners. Due to the chronic disabilities of men that occur from HWC, all the responsibilities are transferred to women and children. In addition to household work, women have to bear the burden of earning for the family. Jadhav (2011), Jadhav and Barua (2012) have explained that this fatality of men leads to an increase in the burden of living and eventually falls into poverty. Lamarque *et al*. (2009) state that if the injury or disability is caused to the woman in the family, the responsibilities and burden of earning shifted to children. As a result, the education of children will be interrupted and it will affect them mentally as well as socially (Hoare 1992; Treves *et al.* 2006; Muruthi 2005). Similarly, education is disrupted due to fear of being caught by animals such as elephants and bears while traveling to school. So, there is a risk of declining literacy among children living in rural areas and this can affect their career goals later in their life (Barua *et al*. 2013; Ogra 2008). This can be described as a hidden tragedy in the HWC. In addition, it affects the interactions between family members and leads to conflicts and even unnecessary quarrels. Loss of crops and livestock also have important roles in indirect impact. Loss of crops and other food sources leads to an increase in severe economic unbalances. With the collapse of the economy, difficulties in reaching the nutritional needs of the family would be a problem. Several health issues would occur due to the lack of high-quality nutrition (Ogra 2008). Breastfeeding women would have to face malnutrition. In the meantime, there is a high risk of having babies with low birth weights, even premature births. According to Jadhav (2011), Barua *et al.* (2013), Chowdhury (2014), Ogra, (2008) and Jadhav and Barua (2012) some children have been found with various mental disorders because of the loss of their beloved. Clinical depression, post-traumatic stress disorder, and childhood emotional disorders are also some other examples of the indirect effects on humans (Chowdhury 2014). Sometimes, social and spiritual long-term adverse effects other than the issues regarding mental health can also occur. Due to the continuous crop-raiding and destructions, people also tend to abandon their inherited lands and farms. Such conditions can even lead to breakdown the family relationships and increase stress.

3.4 Indirect effects on the wildlife

The impacts of HWC are not affecting only individuals but also the entire ecosystem. Most of the species that contribute to these conflicts are keystone species, where their

presence is highly important for the conflicts. Removal of these species affects the stability of the entire ecosystem. Preparation of agricultural lands, modification of forests and grasslands for various activities lead to a decrease in the population as well as habitat degradation and fragmentation (Treves *et al*. 2006; Haddad *et al*. 2015). According to a study in Kenya, the wildlife population has been declined by 50%, between the year 1978 to 1998 (Okello 2009). Ecological consequences and impacts result in the isolation of populations. When the population becomes small and isolated, inbreeding within the animals increase. Inbreeding is a way of mating closely related sexual organisms within the same breed (Ceballos *et al*. 2017). Thus, genetic variation seems to be reduced by decreasing heterozygosity. The major aim of inbreeding is to increase the homozygosity in the progeny (Huisman *et al*. 2016; Keller 1998; Chapman *et al*. 2009; Camillo *et al*. 2016). This accompanies the loss of fertility, loss of efficiency, strength, and productivity which is called inbreeding depression of an organism (Stoffel *et al*. 2021; Darwin 1876). Comparable, this reduces the body size, reproduction ability, increases the risk of getting diseases, and quality of progeny. Therefore, if there is a prevailing epidemic situation within the population, there is a high risk of the whole population being vanished. Thus, animals that are highly exposed to conflicts are at a high risk of extinction (Ogada *et al*. 2003). Small population sizes are often associated with poor age structure and skewed sex composition of populations that are vulnerable to such stochasticity. The population of elephants (*Elephas maximus maximus*) in the world heritage site, the Sinharaja forest reserve situated in the wet zone of Sri Lanka, is composed of two male adult elephants and no females, thus exists at the brink of extinction due to demographic stochasticity and imbalanced sex composition. In addition, extinction of animals can be happened by killing animals, hunting, shooting, road, and railway accidents, falling into farm wells, and trapping (Sethy and Mardaraj 2015). It is apparent that HWC indirectly threatens biodiversity, ecological balance, and social sustainability (Mojo *et al*. 2013). Deforestation is a major cause of soil erosion and other types of environmental pollution (Tefera 2011). Global warming is the result of increasing CO_2 levels in the atmosphere along with deforestation and environmental pollution. Adverse effects of global warming include climate change, melting of glaciers, rising sea levels, severe droughts, and massive flooding which guide to declining wildlife populations. In addition to the loss of life, being disabled is another misfortune faced by wild animals (Betty and Frank 2010).

4. Prevention and mitigation strategies

Several practices are prevailing to prevent and mitigate HWC in different parts of the world. Some practices are very much unique to a particular region. Geography and several other factors prevent the application of those techniques to all countries which have HWC.

These strategic approaches are varying from region to region and as well as species to species (Hoare 1995; Western 1989; Muldere and Copolillo 2005; Hulme and Murphree 2001). Due to the exponential growth of the worldwide human population, people used to encroach into wildlife habitats. This may result in the loss of wild habitats, their degradations, and fragmentations, and such conditions are very common in highly populated regions like Africa and Asia. With the establishment of human settlements and agricultural fields in the wild areas, other than the habitat loss, degraded forage and reduced landscape connectivity would result. Eventually, this is accompanied by the devaluation of large mammal populations like elephants (Thouless *et al*. 2016, Calabrese et al. 2017). Explanations have been given by Leimgruber et al, (2003), Newmark (2008), Mcdonald et al. (2009), White and Ward (2011), and Liu *et al*. (2017) about the consequences of human and wildlife conflict over space and resources ranging from crop-raiding to reciprocal loss of life. As per Fernando et al, (2005), Baruch – Mordo et al., (2013), and Hoare (2012) there are several suggestions for the development and adoption of a wide range of approaches for prevention and mitigation of the HWC.

Prevention and mitigation are the basic concepts used to manage HWC. Preventive methods are generally applied for symptom management strategies. There are several preventive measures adopted to minimize HWC. However, in extreme situations of competition completely removing either human or wildlife in a particular area or physically separating the two parties by the use of barriers or applying scares and repelling techniques are employed (Muruthi 2005). Kangwana, (1993), Conover (2002), and Treves and Karanth (2003) classified preventive techniques as short-term conservation of individuals, mid-term conservations of species, and long-term conservation of species. However, finding lasting solutions to HWC needs cause management of the problems which is rare throughout the world (Sitati *et al*. 2003; Hoare 2012; Thomassen *et al*. 2010). As per Leakey (1990), Kenya Wildlife Service maintains a greater job to the surrounding communities at their National Park by providing a portion of the entrance fee in the aid of encouraging them for conservation.

4.1 Role of protected areas and ecological corridors

This is a kind of physical separation applied in both humans and wildlife conflict areas which are declared by wildlife authorities (Rodrigues *et al*. 2004; Hansen and Defries 2007). The concept of ecological corridors is adapted to combining isolated protected areas or fragmented habitats to minimize genetic disorders of wildlife species having inbreeding depression (Brown and Kodric Brown 1977; Blair 2008; Rabinowitz and Zeller 2010). Other than that, these corridors allow wild animals as an additional routing to move between habitats during different seasons and also assist especially elephants in their raging behaviour for food and water (Adams *et al*. 2017). As to Roever *et al*. (2013) and Adams *et al.* (2017) these types of corridors are very popular among some countries in Asia and Africa. During the early time, MacArthur and Wilson (1967) have pointed out the importance of establishing corridors or stepping-stones between isolated habitats. Diamond (1975) and Ratcliff (1977) have confirmed this idea of establishing conservation corridors to ensure gene flow and reducing inbreeding depression among wild populations. Paradoxically, Krebs (2009) has listed some disadvantages of establishing conservation corridors as invasive species, fire can spread, and gene pool can be contaminated.

4.2 Electric fences and trenches

Electric fences and trenches are other kinds of physical barriers and are used to deter elephants from agricultural fields and human settlements. Considerable costs have to be spent on the construction and long-term maintenance of these fences (Perera 2009; Kioko et al. 2008; Wijayagunawardane et al. 2016). Properly designed fences are very much effective to prevent conflicts between humans and wild animals. The cost of these fences varies according to the topography and the type of materials used (Muruthi 2005; Massey et al. 2014). However, elephants are adapted to break up electric fences using several behavioural techniques; i.e. using tusk, throwing timber. This can be considered as the main disadvantage of using electric fences (Mutinda et al. 2014; Graham et al. 2009). Electric fences are normally arranged to surround the protected areas, which will hinder the gene flow among the species due to the lack of random mating (Lee and Graham 2006).

Some countries use stone walls to protect crops from the wild buffalos. Trenches and moats are also used to keep elephants away from the cultivated lands and villages in India. Bengis et al. (2002) had mentioned that practicing fences surrounding agricultural lands also helps in reducing crop damages. Combining some traditional methods along with electric fences helps to reduce crop damages and livestock predations considerably within a conflict area (Ogada et al. 2003).

4.3 Eradication

This technique is largely used in Africa to manage the damages causing to people and their livestock by animals. Large mammals like lions, leopards, elephants, buffaloes, rhinoceros, and large antelope species were eradicated in the large areas of Africa (Treves and Karanth, 2003). Today this is also practiced by wildlife managers in the African continent

if the animal is identified as a threat to people or their crops (Treves and Naughton Treves 1999). For these eradication practices, several different methods are used by different regions, such as different traps, snares, hunting with dogs, shooting, roast sprays, poisons, and the deliberate introduction of diseases (Naughton-Treves 1999). Also, games or hunting for sports have been applied to eradicate large carnivorous animals to give better livelihood to people who live in adjacent protected areas (Naughton-Treves 1999). Today, other than the alien species, there are no applications to eliminate the entire population (Muruthi 2005).

Some farmers are practicing illegal persecution in some parts of the world to prevent predatory attacks by applying poisons, shooting, using jaw explosives, and/ or trapping. As described by Crook (2002), once large predators are eradicated from a particular area, it will result in an increasing population density of small and medium-sized carnivores within that area and that will affect the ecological balance very highly and sometimes will cause the extinction of some herbivores.

4.4 Regulated harvesting and storing

Regulation of harvested and stored crops or grains would help in managing the property damage caused by wild animals (Prakash *et al*. 2020; Muruthi 2005). If the people are not keeping more stored yields in their houses, it will help to minimize Human-Elephant Conflict (HEC) and that will protect both lives and properties (Prakash *et al*. 2020). Santiapillai et al. (2010) and Fernando et al. (2011) have revealed that HEC has strongly associated with agriculture and higher HEC cases have been observed during the cultivation period in Sri Lanka.

4.5 Acoustic deterrents

Fernando *et al*. (2005), Gunaryadi *et al*. (2017), have mentioned that different types of acoustic deterrents are practiced by farmers such as guarding crop, scaring crop-raiding animals away, yelling, setting off firecrackers, carbide cannons, throwing stones, or other things to hit an animal which are effective to keep animals away from the farm fields (Davies *et al*. 2011). Creating threatening sounds using audio playback also another type of method used to chase crop-raiding animals but it is effective only for short terms and short distance due to quick learning, habituation, and adoption to those by animals and returns to raid crop (Thuppil and Coss 2016; Wijayagunawardane *et al*. 2016; Moss 1988; Gamage and Wijesundara 2014). From history, dogs were the first animal used as a guard to protect the herds in different parts of the world. Archaeological studies conducted in China also had proven this (Axelsson *et al*. 2013; Frantz *et a*l. 2016; Freedman et *al*. 2014; Morey and Jeger 2015; Perri 2016). In addition to dogs, some regions used donkeys as a guard animal to protect flocks of sheep and goats from cheetah (Murathi 2005). According to recent research conducted by Mekonen (2020), 34% of farmers practice group guarding, 26% of live fencing, 22% of scaring, 14% of chasing, whereas 5% used smoking to repel the crop raiders.

4.6 Light-based deterrents

Fernando *et al*. (2005), Davis *et al*. (2011), and Shaffer (2010) highlighted that, to protect ripening crops and deter raiding elephants, farmers use flaming torches or flashlights. In some agricultural fields, some farmers use solar spotlights that shone in elephant's eyes to drive them (Gunaryadi *et al*. 2017; Davis *et al*. 2011) but due to the high cost to purchase, it prevents widespread adoption among rural households and communities. As per Sukumar (1991, 1992) like the acoustic methods, light-based deterrents are also a short-term solution to prevent HWC.

4.7 Agriculture based deterrents

Other than the above-mentioned acoustic and light methods, few other prevention actions are used in different parts of the world to protect the crops from wildlife. Bio-fences are used in several African and Asian regions as a strategy to keep wildlife species away from cultivations and property. Among them, farmers practice chili-grease-covered fences, pepper grease-covered fences, and the burning of chili, and elephant dung (Graham *et a*l. 2009; Hedges and Gunaryadi 2010; Chang'a *et al*. 2016). However, due to the high cost and less

effectiveness, these methods are prohibitive for many communities (Sitati and Walpole 2006; Baishya *et al*. 2012). Santiapillai and Read 2010; Gross *et al*. 2016; Gross *et al*. 2017) have mentioned another method to prevent elephant raiding food crop by planting less attractive, less palatable crops like chamomile, coriander, mint, ginger, onion, garlic, lemongrass, and citrus family trees as a barrier for crop-raiding elephants (Osborn 2002; Chang'a *et al*. 2016; Parker and Osborn 2006). Some chemical repellents like lithium chloride used against African carnivores to protect livestock (Forthman-Quick *et al*. 1985).

4.8 Early detection and warning alarm system

Graham *et al*. (2012) revealed that communication between farmers and local wildlife officers is an effective manner to chase problematic animals or herds before crop raiding. Also, establishing an early warning alarm system to identify possible crop-raiding, for instance detecting infrasonic calls of elephants over long distances is possible (Zeppelzauer *et al*. 2015; Dabare *et al*. 2015). The main disadvantage of this technique is lacking internet facilities among farmers and other local wildlife officers in remote areas (Dabare *et al*. 2015). Monitoring radio collard elephants or herd movement using satellite tracking also gives immense benefits to identify crop-raiding elephants or herd (Shaffer *et al*. 2019). Paradoxically, practicing these techniques is very much difficult due to the initial cost for capturing and collaring elephants and the material cost.

4.9 Supply alternative sources to wildlife

This is commonly known as the diversion of some wild animals by supplying their limited resources such as water. According to Conover (2002), this is a successful method that is used to reduce crop damage in the USA. In the natural environment, some animal populations are increased due to immigration, reproduction, and enhance survival. As a result, they try to find their resources from outside of their territory due to natural food scarcity. So as a knowledgeable wildlife manager, it is essential to identify the ecology of different animal groups before starting prevention programs. Liyanage *et al*. (2021) indicate the possibility of the use of organic food such as extra harvest during harvesting of seasonal crops that are discarded daily at markets and agricultural fields to feed wildlife such as elephants.

4.10 Gender balance

Normally, this technique can be applied to control insect pests in agricultural fields using irradiation methods. Other than the above-mentioned methods, to control the fertility of wildlife, several other techniques such as mechanical, surgical endocrine disruptive, or fertility control measure-immuno-contraceptive can be used (Kirkpatrick *et al*. 2009). As mentioned by Butler (1998) some of these are under experimental level but in Kruger National Park immuno-contraceptive methods applied to elephants and some countries applied to wild boar (Tshewang *et al*. 1999; Hobbs and Hinds 2018; Delsink and Kirkpatrick 2015; Emmons 2017).

4.11 Problem animal control

Few techniques can be applied to control problem animals. Domestication, keeping under domestic conditions, culling, and translocations are the main mechanisms used by wildlife managers or authorities for the mitigation of nuisance animals (Makindi *et al*. 2014).

4.11.1 Domestication

Domestication practices were started 10,000 years before present in Neolithic Age. In India, it was about 4,500 BCE and in Sri Lanka, as to Premathilake (2012) incipient domestication started around 17,000 BP. Cave arts suggest that these dates can attribute to more than that (Sukumar 2008; Clutton- Brock 2012). Domestication is done to several animals. If their populations increased in the wild; they face the problem of limited resources and try to move out of their territory that guides for HWC. Such a nuisance animal or a herd can be captured for domestication, especially this is done for elephants in both Asia and Africa. Clutton-Brock (2012) had illustrated that domestic elephants can be used for various purposes like ceremonial activities, transporting

people and heavy loads, warfare, hunting, and help to capture other wild elephants (Bist *et al*. 2002; Mar *et al*. 2012). Domestication and keeping animals in domestic conditions are different phenomena as the latter can be done to any problem animal.

4.11.2 Culling

Sukumar (1991,1992) had mentioned that generally culling is applied to crop-raiding elephants or to those that kill humans in the African region where there is a large elephant population. This was practiced largely during the pre-colonial and colonial periods in Sri Lanka during the British colonial period (Naughton-Treves 1999). Selective culling is acceptable and periodically practiced in many elephant range countries (Naughton-Treves 1999; Isenberg 2000; Breitenmoser *et al*. 2005; Woodroffe 2000). Van Aarde *et al*. (1999) revealed that culling is practiced largely for bull elephants due to their wide home range. Culling is practiced for a fragmented population of elephants, they show inbreeding depression and already change their genetic variations, and ultimately, they become endangered or vulnerable within many countries. Also, a skewed sex ratio will degrade the genetic health of wild animals, therefore culling is not advisable in such countries (Manferdo *et al*. 1998, Naughton-Treves 1999). In upland Wales, the UK under 'Good neighbour policy, over-winter culling of fox (*Vulpes vulpes*) by driving foxes to guns using dogs and rifle shooting has practiced to reducing the density of fox (Baker and Harris 2006).

4.11.3 Translocation

Translocation involves drugging or immobilization, capturing, and transportation of nuisance animals from human settlements to protected areas for release (Tshewang *et a*l. 2021). This is commonly practiced minimizing HEC (Nyhus 2016; Nyhus *et al*. 2005b, Fernando *et al*. 2012; Saaban *et al*. 2011), however, other nuisance species are treated in the same manner in different parts of the globe. According to Pinter-Wollman (2009), Fernando *et al*. (2012), recorded cases are available for returning some of the translocated elephants to their first territory, There are several disadvantages of translocations such as increased elephant mortality during capture and translocation, deliberate killing in the new location (Fernando *et al*. 2012; Fernando and Pastorni 2011; Conover 2002; Craven *et al*. 1998, Gammons *et al*. 2009; Letty *et al*. 2003). Conover (2002) indicates that due to translocated animals some diseases can transfer to resident populations in the new location or arisen new competition for food resources or territory.

4.11.4 Compensation

This process is usually applied to predetermined causes due to HEC such as casualties or injuries to humans, property damages, livestock, and crop damages. However, compensation for crop damage is not practiced much in several countries. In Sri Lanka, this compensation is given to victims by the government but in other countries, it is governed by NGOs or other private agencies (Murathi 2005; Brooks *et al*. (2013), Hartter *et al*. 2014; Snyman 2014). Although in elephant range countries, these compensation programs are not much successful for HEC because of criticism due to insufficient compensation, logistical challenges, a lack of transparency, and limitations (Bulte and Rondeau 2005; Treves and Karanth 2003; Mishra *et al*. 2003; Nyhus *et al*. 2005a; Li *et al.* 2013).

5. Conclusion

HWC can be depicted as a consequence of sharing the common natural resources by humans and wildlife. Many authors have identified that increasing human population has resulted in encroachment into more marginal lands inhabited by wildlife and leads to habitat loss, fragmentation, and degradation due to the conversion of lands to agricultural fields and other activities imposing an impact on wildlife. In most of the conflict areas in the world, many large mammals including large carnivores and mega-herbivores roam free in marginal rangelands, buffer zones, and transitional areas of protected areas. There are several direct and indirect effects on both humans and wildlife due to these conflicts. Several authors have proved that people inhabiting the areas that depend more on natural resources are intimidated by the threats to their lives and

livelihood within their homelands, finally resulting in conflicts. Crop damages, competition for water and grazing, livestock predation, increasing the risk of livestock diseases, various inconveniences while protecting farmyards, and even human casualties can be observed in the affected areas of HWC. Wildlife has become threatened with various types of conflicts. Apart from the direct human threat to wildlife, inbreeding depression consequence severe damage to them by reducing heterozygosity and increasing homozygosity. The above-mentioned one can be categorized as an indirect effect faced by wildlife.

It was evident that two basic approaches of controlling and managing HWC prevail, namely prevention and mitigation. The major goal of these two strategies is to minimize HWC that is common everywhere in the world. However, different remedial measures have been developed around the world but have not been implemented globally due to different ecological, cultural, and economic realities and they are also targeting a variety of taxonomic groups. In general, preventive measures are practiced minimizing the risk of conflicts or in extreme situations either people or animals have to be completely relocated. Relocating has several advantages as well as disadvantages. The main disadvantage is it associated with a huge cost and longer periods required to establish. Problem-solving using animal control strategies is commonly known as mitigations that are mostly done by the involvement of wildlife authorities. This can be done by culling, keeping under domestic conditions, or capture for translocating. Also, other mitigatory methods have been practiced by the governments in several countries such as to produce compensations to affected parties, however, this is not much successful due to some inefficient organizations.

Better applications for the prevention and mitigation strategies needed to approach the affected communities in different ways rather than practicing traditional ways or remedies must be produced. These include educational programs, consolation payments, the introduction of border sharing benefits associated with the presence of wildlife, detailed study of social and ecology outline and evaluating, monitoring strategies which are more valuable to management. Wildlife Service maintains a greater job to the surrounding communities of protected areas to uplift the social status.

Summary of best solutions to mitigate HWC

For better solutions to HWC, the following steps should be followed.

1. Better understanding, monitoring, and evaluation of the problem
2. Research prioritization in HWC areas
3. Sharing information
4. Work with the affected local communities
5. Build upon existing initiatives
6. Draw up a strategy
7. Strengthen local and national institutions
8. Develop clear policies to enhance HWC mitigation

References

Acharya KP, Paudel PK, Neupane PR and Köhl M 2016 Human-wildlife conflicts in Nepal: Patterns of human fatalities and injuries caused by large mammals. PLOS ONE 11: 1-18.

Adams TSF, Chase MJ, Rogers TL and Leggett KEA 2017 Taking the elephant out of the room and into the corridor: can urban corridors work? Oryx 51: 347-353.

Adams WM and Jon Hutton 2007 People, Park, and Poverty: Political Ecology and Biodiversity Conservation. Conservation and Society 5: 147-183.

Aftosa F 2007 Foot and Mouth Disease CFSPH

Alfred R, Ambu L, Nathan SKSS and Goossens B 2011 Current status of Asian elephants in Borneo. Gajah 35: 29-35.

Ali S, Ripley SD 1980 Handbook of the birds of India and Pakistan. 2 (2nd ed.). Oxford University Press. pp. 123–126. ISBN 0-19 -562063-1.

Amaja LG, Feyssa DH and Gutema TM 2016 Assessment of types of damages and causes of human-wildlife conflict in Gera district, South Western Ethiopia: Journal of Ecology and The Natural Environment, 8 (5):49-54.

Anand S, and Radhakrishna S 2017 Investigating trends in human-wildlife conflict: Is conflict escalation real or imagined? Journal of Asia-Pacific Biodiversity and conservation in Masai Mara, Kenya. IIED Wildlife Development Series 14:1-8.

Anand S, Binoy VV and Radhakrishna S 2018 The monkey is not always a God: Attitudinal differences toward crop-raiding macaques and why it matters for conflict mitigation. Ambio, 47(6):711-720.

Anthony BP, and Wasambo J 2009 Human-wildlife conflict study report: Vwaza Marsh Wildlife Reserve, Malawi. Report prepared for Malawi Department of National Parks and Wildlife, Budapest, Hungary, Central Europian University.

Axelsson E, Ratnakumar A, Arendt ML, Maqbool K, Webster MT, Perloski M. Olof Liberg, Jon M Arnemo, Åke Hedhammar and Kerstin Lindblad-Toh 2013 The Genomic Signature of Dog Domestication Reveals Adaptation to Starch-Rich Diet. Nature 495: 360-364.

Azmi W and Gunaryadi D 2011 Current status of Asian wlephants in Indonesia. Gajah 35: 55-61.

Baishya HK, Dey S, Sarmah A, Sharma A, Gogoi S, Aziz T, Dipankar Ghose and Christy Williams A 2012 Use of chili fences to deter Asian elephants–a pilot study. Gajah 36:11–13.

Bajimaya S 2012 Managing Human-Wildlife Conflict in Nepal. In Acharya KP and Dhakal M (eds) Biodiversity Conservation in Nepal: A Success Story. Department of National Parks and Wildlife Conservation, Nepal, 21-34.

Baker P and Harris S 2006 Does culling reduce fox (*Vulpes vulpes*) density in commercial forests in Wales? European Journal of Wildlife Research 52(2):99-108.

Banarjee K& Jhala Y. V., (2012) Demographic parameters of endangered Asiatic lions (pantheraleo persica) in Gir Forests, India Journal of Mammalogy, 93: 6 1420-140.

Bandara R and Tisdell C 2002 Asian elephants as agricultural pests: economics of control and compensation in Sri Lanka. Natural Resources Journal, 42:491–519.

Bangs EE, Fontaine JA, Jimenez MD, Meier TJ, Bradley EH, Niemeyer CC, Smith DW, Mack CM, Asher V and Oakleaf JK 2005 Managing wolf-human conflict in the north-western United States, People and Wildlife Conflict or Coexistence? Cambridge University Press pp. 340-356.

Barbour AG and Fish D 1993 The biological and social phenomenon of Lyme disease. Science, 260:1610–6.

Barua M, Bhagwat SA and Jadhav S 2013 The hidden dimensions of human–wildlife conflict: health impacts, opportunity and transaction costs. Biological Conservation, 157:309-316.

Baruch-Mordo S, Breck SW, Wilson KR and Broderick J 2011 The Carrot or the Stick? Evaluation of Education and Enforcement as Management Tools for Human-Wildlife Conflicts. PLOS ONE. 6 (1): 5-12.

Baruch-Mordo S, Webb CT, Breck SW and Wilson KR 2013 Use of patch selection models as a decision support tool to evaluate mitigation strategies of human-wildlife conflict. Biological Conservation. 160:263 -271.

Beisner BA, Heagerty A, Seil SK, Balasubramaniam KN, Atwill ER, Gupta BK, Tyagi PC, Chauhan NPS, Bonal BS, Sinha PR, McCowan B 2015 Human-wildlife conflict: Proximate predictors of aggression between humans and rhesus macaques in India. American Journal of Physical Anthropology, 156(2):286-294.

Bengis RG, Kock RA and Fischer J 2002 Infectious animal diseases: the wildlife/ livestock interface. Revue Scientifique et Technique (International Office of Epizootics), 21(1): 53–65.

Berger GA 1987 Territorial behaviour of Golden eagles in western Norway: British birds 80 (8):361-376.

Berger LR and Clarke RJ 1995 Eagle involvement in accumulation of the Taung child fauna. Journal of Human Evolution, 29: 275–299.

Berger LR and Mcgraw WS 2007 Further evidence for eagle predation of, and feeding damage on, the Taung child. South African Journal of Science 103:496–498.

Betty JD and Frank WP 2010 The China-India Challenge: A Comparison Of Causes And Effects Of Global Warming. Inter-

national Business and Economics Research Journal, 9(3):21-26.

Bhattarai BR 2009 Human-Tiger (*Panthera tigristigris*) Conflict in Bardia National Park, Nepal. MSc thesis, Ernst Moritz Arndt University of Greifswald, Germany.

Birch I and Grahn R 2007 "Pastoralism- Managing Multiple Stressors and the Threat of Climate Variability and Change," Human Development Occasional Papers (1992-2007) HDOCPA-2007-45, Human Development Report Office (HDRO), United Nations Development Programme (UNDP).

BirdLife International 2014 Species factsheet: Pavomuticus. [http://www. birdlife.org/ datazone/species/index.html].

Bist SS, Cheeran JV, Choudhury S, Barua P, and Misra MK 2002 The domesticated Asian elephant in India, In Baker I and Kashio M (eds) Giants on Our Hands. Proc.Int. Workshop on the Domesticated Asian Elephant, (Bangkok: FAO Regional Office for Asia and the Pacific), pp.129-148.

Blair A 2008 Human-wildlife conflict in Laikipia North, Kenya: comparing official reports with the experiences of Maasai pastoralists. MSc thesis, Department of Geography McGill University, Montreal.

Blair ASG, Boon C and Noor NM 1979 Conservation or Cultivation: The Confrontation between the Asian Elephant and Land Development in Peninsular Malaysia:Land Development Digest, 2: 27-59.

Bowen-Jones E 2012 Tackling Human-wildlife Conflict: A prerequisite for linking conservation and poverty alleviation, Poverty and Conservation Learning Group. International Institute for Environment and Development, April, 2012.

Brara S 2013 Invaded by simians: The Hindu. https://www.thehindu.com/news/national/ other-states/invaded-by-simians/ article4702837.ece

Breitenmoser U, Angst C, Landry JM, Breitenmoser-Wursten C, Linnell JDC and Weber JM 2005 Non-lethal techniques for reducing depredation. In R Woodroffe, S Thirgood and AR Rabinowitz (eds) People and wildlife: conflict or coexistence? Cambridge, UK, Cambridge University Press, pp. 49–71.

Brooker MG and Ridpath MG 1980 The diet of the wedge-tailed eagle, Aquilaaudax, in Western Australia: Wildlife research 7 (3):433-452.

Brooks J, Waylen KA and Mulder MB 2013 Assessing community-based conservation projects: a systematic review and multilevel analysis of attitudinal, behavioral, ecological, and economic outcomes. Environmental Evidence 2:2.

Brown JH and Kodric-Brown A 1977 Turnover rates in insular biogeography: effect of immigration on extinction. Ecology 58: 445–449.

Bulte EH and Rondeau D 2005 Why compensating wildlife damages may be bad for conservation. Journal of Wildlife Management, 69:14–19.

Butchart SHM, Walpole M, Collen B, Strien AV, Scharlemann JPW, Almond REA, et al (2010). Global biodiversity: Indicators of recent declines. Science 328:1164-1168.

Butler V 1998 Elephants: trimming the herd. Bioscience, 48:76–81.

Calabrese A, Calabrese JM, Songer M, Wegmann M, Hedges S, Rose R and Leimgruber P 2017 Conservation status of Asian elephants: the influence of habitat and governance. Biodiversity Conservation, 26:2067–2081.

Camillo B, Ellis PA, Pilkington JG and Pemberton JM 2016 Genomic analysis reveals depression due to both individual and maternal inbreeding in a free-living mammal population. Molecular Ecology, 25(13): 3152-3168.

Campbell DJ, Gichohi H, Mwangi A and Chege L 2000 Land use conflict in Kajiado District, Kenya. Land Use Policy 17: 337-348.

Can O¨ E, D'Cruze N, Garshelis DL, Beecham J and Macdonald DW 2014 Resolving human-bear conflict: a global survey of countries, experts, and key factors. Conservation Letters, 7:501–13.

Cannell BL, Campbell K, Fitzgerald L, Levis JA, Baran IJ and Stephans NS 2016 Anthropogeic trauma is the most prevalent cause of mortality in pittle penguins

(*Eudyptula minor*) in Perth, Western Australia. Emu - Austral Ornithology 116 (1):52-61

Ceballos G, Ehrlich PR and Dirzo R 2017 Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. Proceedings of the National Academy of Sciences, USA 114:E6089–E6096.

Chang'a A, De NS, Muya J, Keyyu J, Mwakatobe A Malugu L 2016 Scaling-up the use of chili fences for reducing human elephant conflict across landscapes in Tanzania. Tropical Conservation Science, 9:921–930.

Chao S 2012 Forest Peoples: number across the world, Forest Peoples Programs United Kingdom.

Chapman JR, Nakagawa S, Coltman DW, Slate J and Sheldon BC 2009 A quantitative review of heterozygosity-fitness correlations in animal populations. Molecular Ecology,18(13):2746–2765.

Choskyi Ven Jampa 1988 "Symbolism of Animals in Buddhism", Buddhist Hiamalaya. 1 (1).Gakken Co. Ltd. http://ccbs.ntu.edu.tw/FULLTEXT/JR-BH/bh117490.htm

Chowdhury AN 2014 Culture and posttraumatic stress disorder: a case of elephant attack. Dysphrenia, 5: 145-9.

Chowdhury AN, Mondal R, Brahma A and Biswas MK 2008 Eco-psychiatry and environmental conservation: study from Sundarban Delta, India. Environmental Health Insights 2:61-76.

Chua KB 2003 Nipah virus outbreak in Malaysia. Journal of Clinical Virology, 26(3): 265-75.

Clutton-Brock J 2012 Animals as domesticates: a world view through history. MSU Press.

Conover MR 2002 Resolving Human–Wildlife Conflicts: The Science of Wildlife Damage Management. CRC Press, Boca Raton, USA.

Craven S, Barnes T and Kania G 1998 Toward a professional position on the translocation of problem wildlife. Wildlife Society Bulletin, 26:171–177.

Crook KR 2002 Relative sensitivities of mammalian carnivores to habitat fragmentation. Conservation Biology, 16:488-502.

Dabare P, Suduwella C, Sayakkara A, Sandaruwan D, Keppitiyagama C, De Zoysa K, Hewage K and Voigt T 2015 Listening to the giants: Using elephant infra-sound to solve the human-elephant conflict. In Proceedings of the 6th ACM Workshop on Real World Wireless Sensor Networks pp. 23-26.

Dar NI, Minhas RA, Zaman Q, Linkie M 2009 Predicting the patterns, perceptions and causes of human-carnivore conflict in and around Machiara National Park, Pakistan. Biological Conservation, 142:2076-2082.

Dart RA 1925 *Australopithecus africanus*: the man-ape of South Africa. Nature 115:195 –199.

Darwin C 2010 The Works of Charles Darwin, Volume 25: The Effects of Cross and Self Fertilization in the Vegetable Kingdom. NYU Press.

Datta-Roy A, Nimes V, Williams AC 2009 Participatory Elephant Monitoring in South Garo Hills: Efficacy and Utility in Human-Animal Conflict Scenario, Tropical Ecology, 50(1): 163- 171.

Davies TE, Wilson S, Hazarika N, Chakrabarty J, Das D and Hodgson DJ 2011 Effectiveness of intervention methods against crop-raiding elephants. Conservation Letter 4:346–354.

Davison J, Roper TJ, Wilson CJ, Heydon M J and Delahay RJ 2011 Assessing spatiotemporal associations in the occurrence of badger–human conflict in England. European Journal of Wildlife Research, 57 (1):67-76.

Delsink and Kirkpatrick JF 2015 Free-ranging African elephant immune contraception: a new paradigm for elephant management. Research Gate Publications; University of KwaZulu-Natal; Durban, KwaZulu-Natal, South Africa.

Diamond 1975 The Island Dilemma: Lessons of modern biographic studies for the design of natural reserves Biological Conservation, 7(2):129-146.

Dickman AJ and Hazzah L 2016 Money, myths and man-eaters: Complexities of

human–wildlife conflict. In: FM Angelici (ed.) Problematic wildlife. Basel, Switzerland: Springer International Publishing. Discussion Paper No 6, International Institute for Environment and Development. pp. 339–356.

Dickman AJ, Marchini S and Manfredo M 2013 The human dimension in addressing conflict with large carnivores. Key topics in conservation biology 2:110–126.

Dickman AJ 2008 Key determinants of conflict between people and wildlife, particularly large carnivores, around Ruaha National Park, Tanzania. Dissertation, University College London and Institute of Zoology, Zoological Society of London, United Kingdom.

Dickman AJ 2010 Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. Animal Conservation, 13:458–66.

Distefano E 2005 Human-wildlife conflict worldwide: collection of case studies, analysis of management strategies and good practices. Food and Agricultural Organization of the United Nations (FAO), Sustainable Agriculture and Rural Development Initiative (SARDI); Rome, Italy.

Distefano E 2010 Human Wildlife Conflict Worldwide: Collection of case studies, analysis of management strategies and good practices. South Africa:1-34.

Dixon AB, Hailu A, Semu T and Taffa L 2009 Local responses to marginalisation: human–wildlife conflict in Ethiopia's wetlands. Geography, 94:38–47.

DNPWC 2017 Profiling of Protected and Human Wildlife Conflicts Associated Wild Animals in Nepal. Department of National Parks and Wildlife Conservation, Kathmandu, Nepal.

Dumler JS and Walker DH 2001 Tick-borne ehrlichioses. The Lancet Infectious Diseases, 1:21–8.

Durrheim DN and Leggat PA 1999 Risk to tourists posed by wild mammals in South Africa. Journal of Travel Medicine, 6 (3):172-9

Ecology Center 2019 Elephant Population - Causes of Death and Mortality Rates, viewed 30 May 2021, https://www.ecologycenter.us/elephant-populations/causes-of-death-and-mortality-rates.html

Edward DW and Frank SA 2012 Victims Perspectives of Lowe's Monkeys' (*Cercopithecus campbellilowei*) crop raiding events in Ghana: A case of Boabeng-Fiema Monkey Sanctuary. Journal of Biodiversity and Environmental Sciences, 2(2):1-8.

Eguchi Y, Miura S and Fujioka M 2002 Manual for preventing crop damage by birds and mammals: Japan plant protection Association, Tokyo. Pp. 154.

Else JG 1991 Nonhuman primates as pests. In H.O. Box (ed) Primate Responses to Environmental Change (London: Chapman and Hall), pp. 115 - 165.

Emmons M 2017 Auburn University, College of Veterinary Medicine; Researchers developing immune contraception for wild pig population control; January 26, 2017, https://www.vetmed.auburn.edu/blog/cvm-news/researchers-developing-immunocontraception-wild-pig-population-control/

Engemen RM and Sterner RT 2002 Acomparison of potential abor-saving sampling methods for assessing large mammal damage in corn. Crop protection, 21(2):101-105.

Eniang E, Ijeomah HM, Okeyoyin G and Uwatt AE 2011 Assessment of human wildlife conflicts in Filinga Range of Gashaka Gumti National Park, Nigeria. Production Agriculture and Technology, 7 (1):15-30.

Estes JA, Terborgh J, Brashares JS, Power ME and Berger J 2011 Trophic down grading of planet Earth. Science, 333:301–6.

Eyebe A, Dkamela G and Endamana D 2012 Overview of Human Wildlife Conflict In, Poverty and conservation learning group discussion paper 5.

Fall MW and Jackson WB 2002 The Tools and Techniques of Wildlife Damage Management Changing Needs: An Introduction, International Biodeterioration and Biodegradation, 49(2-3): 87-91.

FAO 2005 Strategies to mitigate human-wildlife conflict in Mozambique, by J An-

derson and F Pariela, Report for the National Directorate of Forests and Wildlife, Mozambique.

FAO 2006 Impact of Animal Disease Outbreaks on Livestock Markets.

Fedriani JM, Fuller TK and Sauvajot RM 2001 Does availability of anthropogenic food enhance densities of omnivorous mammals? An example of coyotes in southern California. Ecography, 24:325-331.

Fennell DA 2015 Ecotourism. Routledge, London.

Fernando P, Wikramanayake E, Weerakoon D, Jayasinghe LKA, Gunawardene M and Janaka HK 2005 Perceptions and patterns of human–elephant conflict in old and new settlements in Sri Lanka: insights for mitigation and management. Biodiversity Conservation, 14:2465–2481.

Fernando P and Pastorini J 2011 Range-wide status of Asian elephants. Gajah, 35:15-20.

Fernando P, Jayewardene J, Prasad T, Hendavitharana W and Pastorini J 2011 Current status of Asian elephants in Sri Lanka. Gajah, 35:93- 103.

Fernando P, Leimgruber P, Prasad T and Pastorini J 2012 Problem-elephant translocation: translocating the problem and the elephant? PLOS ONE, 7:e50917 7(12): e50917. https://doi.org/10.1371/journal.pone.0050917 .

Fitzpatrick J 1923 "Folklore of birds and beasts of India". The journal of the Bombay Natural History Society, 28(2):562–565.

Forthman-Quick DL, Gustavson CR, and Rusiniak KW 1985 Coyote control and taste a version. Appetite, 6(3):253-264.

Frantz Laurent A, Mullin VE, Pionnier Captain M, Lebrasseur O, Ollivier M, Perri, A *et al*. 2016 Genomic and Archaeological evidence suggest a dual origin of domestic dogs. Science, 352(6290):1228-1231.

Freedman Adam H, Gronau I, Schweizer RM, Vecchyo DO, Han, E et al. 2014 Genome Sequencing Highlights the Dynamic Early History of Dogs. PLOS Genetics 10(8):10 (8): e1004631.

Fujie K and Hu H Ying 2000 Emission minimization and chemicals management in industries and in regional area, In: Proceeding of the third China-Japan symposium on water environment, 51-65

Furqan M, Ali1 Z, Ali U, Shahzad MM, Khan BN, Ahmed W et al 2021 Human- Indian Grey Mongoose (*Herpestes edwardsii*) Conflict and Threats to Mongoose in Mirpur District, Azad Jammu and Kashmir, Pakistan. Pakistan Jpirnal of Zoology, pp. 1-5.

Gamage A and Wijesundara M 2014 A solution for the elephant-human conflict, in India Educators' Conference (TIIEC), Texas Instruments (IEEE), 169–176.

Gammons DJ, Mengak MT and Conner LM 2009 Translocation of nine-banded armadillo. Human-Wildlife Interactions, 3 (1):14–21.

Ganesh S 2019 Human Elephant Conflict Kills 1,713 People, 373 Pachyderms in 3 Years. The Hindu, 2019.02.10.

Gemeda DO and Meles SK 2018 Impacts of Human-Wildlife Conflict in Developing Countries: Journal of Applied Sciences and Environmental Management, 22(8): 1233–1238.

Gillingham S and Lee PC 2003 People and protected areas: a study of local perceptions of wildlife crop-damage conflict in an area bordering the Selous Game Reserve, Tanzania. Oryx 37:316–325.

Goldman A 1996 Pest and disease hazards and sustainability in African agriculture: Experimental Agriculture, 32:199-211.

Gordon IJ 2009 What is the Future for Wild, Large Herbivores in Human-Modified Agricultural Landscapes? Wildlife Biology 15:1–9.

Gortazar C, Ezio F, Hofle U, Frolich K and Vicente J 2007 Diseased shared between wildlife and livestock: A European Perspective European Journal of Wildlife Research, 53: 241.

Government of Namibia 2007 National Policy on Human-Wildlife Conflict Management. Windhoek, Namibia, Ministry of Environment and Tourism, Nambia.

Graham K, Beckerman AP and Thirgood S 2005 Human-predator-prey conflicts: ecological correlates, prey losses and patterns of management. Biological Conservation, 122: 159-171.

Graham MD, Douglas-Hamilton I, Adams W M and Lee PC 2009 The movement of African elephants in a human-dominated land-use mosaic. Animal Conservation, 12:445–455.

Graham MD, Adams WM and Kahiro GN 2012 Mobile phone communication in effective human elephant–conflict management in Laikipia County, Kenya. Oryx 46, 137–144.

Greeshma P, Jayson EA and Suresh KG 2016 The impact of human-wildlife conflict in Peechi-Vazhani wildlife sanctuary, Thrissur, Kerala: International Research Journal of Natural and Applied Sciences, 3 (1):32-45.

Greger M 2007 The Human/Animal Interface: Emergence and Resurgence of Zoonotic Infectious Diseases Critical Reviews in Microbiology, 33:243–299.

Gross EM, McRobb R and Gross J 2016 Cultivating alternative crops reduces crop losses due to African elephants. Journal of Pest Science, 89:497–506.

Gross EM, Drouet-Hoguet N, Subedi N and Gross J 2017 The potential of medicinal and aromatic plants (MAPs) to reduce crop damages by Asian Elephants (*Elephas maximus*). Crop Protection, 100:29–37.

Gross EM, Lahkar BP, Subedi N, Nyirenda VR, Klebelsberg E and Jakoby O 2020 Elephants in the Village: Causes and Consequences of Property Damage in Asia and Africa. Conservation Science and Practice Wiley, 3(2):2-14.

Gubbi S 2012 Patterns and correlates of human–elephant conflict around a south Indian reserve. Biological Conservation, 148(1): 88-95.

Gunaryadi D, Sugiyo and Hedges S 2017 Community-based human– elephant conflict mitigation: the value of an evidence-based approach in promoting the uptake of effective methods. PLOS ONE, 12(5): e0173742.

Gunn J 2009 Human-elephant conflict around Mikumi National Park, Tazania: A quantitative evaluation. PhD thesis, Anglia Ruskin University, United Kingdom.

Guthrie RD 2005 The Nature of Paleolithic Art. Chicago, IL: Univ. Chicago Press.

Gyelmo D 2016 Wangdue. Human-wildlife conflict leads to abandonment of Amochu village. https://kuenselonline.com/

Haddad NM, Brudvig LA, Clobert J, Davies KF, Gonzalez A, Holt RD et al. 2015 Habitat fragmentation and its lasting impact on Earth's ecosystems. ScienceAdvances, 1 (2):e1500052.

Hansen AJ and Defries R 2007 Ecological Mechanisms Linking Protected Areas to Surrounding Lands. Ecological Applications, 17:974–988.

Hartter J, Solomon J, Ryan SJ, Jacobson SK and Goldman A 2014 Contrasting perceptions of ecosystem services of an African forest park. Environtal Conservation, 41:330–340.

Haturusinghe HS and Weerakoon DK 2012 Crop raiding behaviour of elephants in the North-western region of Sri Lanka: Gajah, 36:26-31.

Hedges S and Gunaryadi D 2010 Reducing human–elephant conflict: do chillies help deter elephants from entering crop fields? Oryx, 44:139–146.

Hill C, Osborn FV and Plumptre AJ 2002 Human-wildlife conflict: Identifying the problem and possible solutions. Albertine Rift Technical Report Series. Vol. 1.

Hill CM 2005 People, Crops and Primates: a Conflict of Interest, Department of Anthropology, Oxford Books University, UK.

Hill CM and Wallace GE 2012 Crop Protection and Conflict mitigation: reducing the cost of living alongside non-human primates, Biodiversity Conservation, 21: 2569-2587.

Hoare RE 1992 The present and future use of fencing in the management of larger African mammals. Environmental Conservation, 19:160–164.

Hoare RE 1995 Options for the control of elephants in conflict with people Pachyderm, 19:54-63.

Hoare RE 1999 Determinants of human-elephant conflict in a land-use mosaic. Journal of Applied Ecology, 36:689-700.

Hoare R 2012 Lessons from 15 years of human–elephant conflict mitigation: Management considerations involving biologi-

cal, physical and governance issues in Africa. Pachyderm, 51:60-74.

Hobbs RJ and Hinds LA 2018 Could current fertility control methods be effective for landscape-scale management of populations of wild horses (*Equus caballus*) in Australia? Wildlife Research, 45:195-207.

Hockings K and Humle T 2009 Best Practicies Guidelines for the Prevention and Mitigations of Conflict between Humans and Great Apes, Occasional Paper of the IUCN Species Survival Commissions, No 37.

Hoffman TS and O'Riain MJ 2012 Monkey management: using spatial ecology to understand the extent and severity of human –baboon conflict in the Cape Peninsula, South Africa. Ecology and Society, 17 (3):Article 13.

Hoffmann M, Arnold J, Duckworth JW, Jhala Y, Kamler JF and Krofel M 2018 *Canis aureus*. The IUCN Red List of Threatened Species 2018:e.T118264161A46194820. http://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T118264161A46194820.en

Hofshagen M, Aavitsland P and Kruse H 2003 Trends and sources of zoonotic agents in animals, feeding stuffs, food, and man in Norway: Norwegian Department of Agriculture.

Holmes RT and Sherry TW 2001 Thirty-year bird population trends in an unfragmented temperate deciduous forest: importance of habitat change. The Auk 118(3): 589–609.

Huisman J, Kruuk LE, Ellis PA, Clutton-Brock T and Pemberton JM 2016 Inbreeding depression across the lifespan in a wild mammal population. Proceedings of the National Acadamy of Science, USA 113:3585–3590.

Hulme D and Murphree M 2001 "African wildlife and livelihoods: The promise and performance of community conservation." Oxford: James Currey Ltd.

Hunter M, Hitchcock R and Wyckoff-Baird B 1990 Women and wildlife in Southern Africa. Conservation Biology, 4:448–451.

Imam E, Yahya H and Malik I 2002 A Successful Mass Translocation of Commensal Rhesus Monkeys *Macaca Mulatta* in Vrindaban, India. Oryx, 36(1):87-93.

Isenberg AC 2000 The destruction of the Bison-an environmental history (1750–1920), Princeton University; Cambridge Press.

Islam MA, Mohsanin S, Chowdhury GW, Chowdhury SU, Aziz MA, Uddin M *et al.* 2011 Current status of Asian elephants in Bangladesh. Gajah, 35:21-24.

IUCN World Park Congress (WPC), Preventing and mitigating human-wildlife conflicts 2003 WPC recommendation 20.

IUCN 2005 Development of Regional Conservation Strategies for the African Lion. IUCN, Switzerland: IUCN.

Jackson TR, Mosojane S, Ferreira SM, Van Aarde RJ 2008 Solutions for elephant Loxodonta africanacrop raiding in northern Botswana: moving away from symptomatic approaches. Oryx, 42:83–91.

Jadhav S 2011 Drunken elephants, Drunken people: mental health dimensions of human–elephant conflict in Assam, India. Research Seminar, Centre for Medical Anthropology. University College, London.

Jadhav S and Barua M 2012 The elephant vanishes: impact of human-elephant conflict on people's wellbeing. Health Place. http://dx.doi.org/10.1016/j.healthplace.

Jayewardene J 2008 Human - Wildlife conflicts in Sri Lanka, Daily news online (30th August 2008).

Joseline N 2010 The impact of crop raiding by wild animals from Bugoma forest reserve on farmers' livelihoods. SmanticScholar, ID: 129966145.

Kangwana K 1993 Elephants and Maasai: Conflict and conservation in Amboseli, Kenya. PhD Thesis University of Cambridge, UK.

Karanth KU and Gopal R 2005 An ecology-based policy framework for human-tiger coexistence in India. Chapter 23 People and Wildlife: Conflict or Coexistence? Woodroffe R, Thirgood S and Rainbow A (eds.) Cambridge University Press, pp.373 -387.

Karesh WB and Cook RA 2005 The Human-Animal Link Foreign Affairs. 84(4):38-50.

Karis A Utouh and Liphafa L 2013 Impact and tourism on wildlife conservation. pp. 18-19.

Keller L 1998 Inbreeding and its fitness effects in an insular population of song sparrows (*Melospiza melodia*). Evolution, 52(1):240–250.

Kioko J, Muruthi P, Omondi P and Chiyo PI 2008 The performance of electric fences as elephant barriers in Amboseli, Kenya. South African Journal of Wildlife Research, 38(1):52–58.

Kirkpatrick JF, Rowanb A, Lamberskic N, Wallaced R, Franka K and Lydaa R 2009 The practical side of immunocontraception: zona proteins and wildlife. Journal of Reproductive Immunology,83:151–157.

Krebs CJ 2009 Ecology: The experimental Analysis of Distribution and Abundance, Persons. Pearson Education. https:// www.nhbs.com/ecology

Kruse H, Kirkemo AM and Handeland K 2004 Wildlife as Source of Zoonotic Infections :Emerging Infectious Diseases 10 (12): 2067–2072.

Kruuk H 2002 Hunter and hinted: relationships between carnivores and people. Cambridge university press, New York, 246pp ISBN 0-521-89109-4.

Kumara H, Rathnakumar S, Kumar MA and Singh M 2012 Estimating Asian Elephant, *Elephas maximus*, density through distance sampling in the tropical forests of Biligiri Rangaswamy Temple Tiger Reserve, India. Tropical Conservation Science, 5 (2):163-172.

Lahm SA 1996 A nationwide survey of crop raiding by elephants and other species in Gabon. Pachyderm, 21:69-77.

Lamarque F, Anderson J, Fergusson R, Lagrange M, Osei-Owusu Y and Bakker L 2009 Human–Wildlife Conflict in Africa: Causes, Consequences and Management Strategies. Food and Agriculture Organization of the United Nations, Rome, p. 112.

Lamichhane BR, Persoon GA, Leirs H, Poudel S, Subedi N, Pokheral CP et al. 2018 Spatio-temporal patterns of attacks on human and economic losses from wildlife in Chitwan National Park, Nepal. PLoS One, 13:e0195373.

Lamprey RH and Reid RS 2004 Expansion of human settlement in Kenya's Maasai Mara: what future for pastoralism and wildlife? Journal of Biogeography, 31(6):997 – 1032.

Leakey R 1990 Richard Leakey talks to Swara. Journal of East African Wildlife Society 15: 4-8.

Lee-Thorp J, Thackeray JF and Van der Merwe N 2000 The hunters and the hunted revisited. Journal of Human Evolution 39:565–576.

Lee PC and Graham MD 2006 African elephants Loxodonta Africana and human-elephant interactions: implications for conservation. Int. Zoo Yearbook 40:9–19.

Leimgruber P, Gagnon JB, Wemmer C, Kelly DS, Songer MA and Selig ER 2003 Fragmentation of Asia's remaining wild lands: Implications for Asian elephant conservation. Animal Conservation, 6:347-359.

Leopole AS and Wolfe TO 1970 Food habits of nesting Wedge-tailed Eagles, Aquilaaudax, in south western Australia: CSIRO Wildlife Research 15(1):1-17.

Letty J, Aubineau J, Marchandeau S and Clobert J 2003 Effect of translocation on survival in wild rabbit (*Oryctolagus cuniculus*) Mammalian Biology - Zeitschrift fur Saugetierkunde. 68(4):250–255.

Li XY, Buzzard P, Chen YC and Jiang XL 2013 Patterns of livestock predation by carnivores: human-wildlife conflict in northwest Yunnan, China. Environmental Management, 52(6):1334–1340.

Lindstedt SL, Miller BJ and Buskirk SW 1986 Home range, time, and body size in mammals. Ecology, 67(2):413-418.

Liu P, Wen H, Harich FK, He C, Wang L and Guo X 2017 Conflict between conservation and development: cash forest encroachment in Asian elephant distributions. Scientific Reports, 7:6404.

Liyanage DJ, Fernando P, Dayawansa PN, Janaka SK and Pastroni J 2021 Elephant at the dump: How does garbage consumption impact Asian elephant? Mammalian Biologyhttps://doi.org/10.1007/s42991-021-00114-5.

MacArthur R and Wilson EO 1967 The Theory of Island Biogeography, Princeton University Press

Macdonald DW, Loveridge AJ and Rabinowitz A 2010 Felid futures: Crossing

disciplines, borders, and generations. In: DW Macdonald and AJ Loveridge (eds.). Biology and Conservation of Wild Felids Oxford, England: Oxford University Press. pp. 599–649.

Mace Georgiana M and Paul H Harvey 1983 Energetic constraints on home-range size. The American Naturalist, 121 (1):120-132.

Madden F 2008The growing conflict between humans and wildlife: law and policy as contributing and mitigating factors. Journal of International Wildlife Law and Policy ,11(2-3):189-206.

Madhusudan MD and Karanth KU 2002 Local hunting and the conservation of large mammals in India. Ambio, 31:49-54.

Madhusudan MD 2003 Living Amidst Large Wildlife: Livestock and Crop Depredation by Large Mammals in the Interior Villages of Bhadra Tiger Reserve, South India, Environmental Management, 31(4):466-475.

Magane S 2003 Unpublished document presented to the thirteenth national meeting on forestry and wildlife, Songo, Mozambique.

Makindi SM, Mutinda MN, Olekaikai NKW, Olelebo WL and Aboud AA 2014 Human –wildlife conflicts: causes and mitigation measures in tsavo conservation area, Kenya. International Journal of Science and Research, 3(6):1025–31.

Malima C, Hoare R and Blank JJ 2005 Systematic recording of human-elephant conflict: A case study in southern-eastern Tanzania. Pachyderm, 38:29-38.

Mallari NAD, Collar NJ, Lee DC, McGowan PJK, Wilkinson R and Marsden SJ 2011 Population densities of understorey birds across a habitat gra-dient in Palawan, Philippines: implications for conservation. Oryx, 45:234–242.

Malugu LT 2010 Assessment of human elephant conflicts in areas adjacent to Grumeti – lkorongo Game Reserves, Northern Tanzania. MSc. Sokoine University of Agriculture, Morogoro, Tanzania.

Manfredo MJ, Zinn HC, Sikorowski L and Jones J 1998 Public acceptance of mountain lion management: a case study of Denver, Colorado, and nearby foothill areas. Wildlife Society Bulletin, 26:964–970.

Manfredo MJ and Dayer AA 2004 Concepts for exploring the socialaspects of Human-Wildlife conflict in a global context. Human Dimensions of Wildlife, 9(4):1–20.

Mar KU, Lahdenper ä M and Lummaa V 2012 Causes and correlates of calf mortality in captive Asian elephants (*Elephas maximus*). PLOS ONE7:e32335.

Marasinghe SS, Perera PKP and Dayawansa PN 2019 Putrescible Waste Landfills as Bird Habitats in Urban Cities: A case from an Urban Landfill in the Colombo District of Sri Lanka. Journal of Tropical Forestry and Environment, 8(2):29-41.

Marchal V and Hill C 2009 Primate crop-raiding: A study of local perceptions in four villages in North Sumatra, Indonesia. Primate Conservation, 24:107-116.

Massey AL, King AA and Foufopoulos J 2014 Fencing protected areas: a long-term assessment of the effects of reserve establishment and fencing on African mammalian diversity. Biological Conservation, 176:162–171.

Matchett MR and Ogara BW 1987 Methods of controlling Golden Eagle depredation on domestic sheep in south-western Montana. Journal of Raptor Research, 21:85-94.

Mateo-Tomas PP, Olea MJ, Moreno PR, Camarero ISS, Barbudo RCR, Martin Doimeadios and Rafael Mateo 2016 Mapping the spatio-temporal risk of lead exposure in apex species for more effective mitigation. Proceedings of the Royal Society, 8:283:1835

Mayberry AL, Hovorka AJ and Evans KE 2017 Well-being impacts of human-elephant conflict in Khumaga, Botswana: exploring visible and hidden dimensions. Conservat Soc, 15:280–291.

Mcdonald, R. I., Forman, R. T. T., Kareiva, P., Neugarten, R., Salzer, D., and Fisher, J., (2009). Urban effects, distance, and protected areas in an urbanizing world. Landsc. Urban Plan. 93, 63–75.

McGowan PJK, Duckworth JW, Wen Xianji, Van Balen B, Xiaojun Y, Mohd et al. 1999 A review of the sta-tus of the Green Peafowl Pavomuticusand recommenda-

tions for future action. Bird Conservation International, 9: 331–348.

McLaughlin SB, Biasing TJ, Mann LK and Duvick DN 1983 Effects of Acid Rain and Gaseous Pollutants on Forest Productivity: A Regional Scale Approach, Journal of the Air Pollution Control Association, 33(11):1042-1048.

Mekonen Sefi 2020 Coexistence between human and wildlife: the nature, causes and mitigations of human wildlife conflict around Bale mountains National park, Southeast Ethiopia. BMC Ecology, 20:51. https://doi.org/10.1186/s12898-020-00319-1.

Messmer TA 2000 The emergence of human-wildlife conflict management:turning challenges into opportunities. International Bio-deterioration and Biodegradation, 45:97–102.

Messmer TA 2009 Human wildlife conflicts: emerging challenges and opportunities. Human Wildlife Conflict, 3(1):10-17.

Michalski F, Boulhosa RLP, Faria A and Peres CA 2006 Human-wildlife conflicts in a fragmented Amazonian Forest landscape: determinants of large field depredation on livestock. Animal Conservation, 9(2):179-188.

Mishra C, Allen P, Mccarthy T, Madhusudan MD, Bayarjargal A and Prins HHT 2003 The role of incentive programs in conserving the snow leopard. Conservation Biology, 17(6):1512– 1520.

Mojo D, Rothschuh J and Alebachew M 2013 Farmers' perceptions of the impacts of human–wildlife conflict on their livelihood and natural resource management efforts in Cheha Woreda of Guraghe Zone, Ethiopia. Human–Wildlife Interactions, 8(1):7.

Mombauer D 2020 Sri Lanka: Rich in Biodiversity, and human-wildlife conflict. Mongabay (New Inspiration from Nature's Frontline).

Monney KA, Dakwa KB and Wiafe ED 2010 Assessment of crop raiding situation by elephants (*Loxodonta africanacyclotis*) in farms around Kakum conservation area, Ghana. International Journal of Biodiversity and Conservation, 2(9):243-249.

Morey DF and Jeger R 2015 Paleolithic Dogs: Why Sustained Domestication Then? Journal of Archaeological Science Reports, 3:420–428.

Moss C 1988 Elephant memories: thirteen years in the life of an elephant family. University of Chicago Press

Mukeka JM, Ogutu JO, Kanga E, Røskaft E 2018 Characteristics of human-wildlife conflicts in Kenya: examples of Tsavo and Maasai Mara regions. Environment and Natural Resources Journal, 8(3):148-165.

Mulder MB and Coppolillo P 2005 "Conservation: Linking ecology, economics and culture." Princeton University Press: Princeton New Jersey.

Muruthi P 2005 Human–wildlife conflict: lessons learned from African Wildlife Foundation's African Heartlands. Working Paper. African Wildlife Foundation, Nairobi, Kenya.

Mutinda M, Chenge G, Gakuya F, Otiende M, Omondi P and Kasiki S 2014 Detusking fence-breaker elephants as an approach in human-elephant conflict mitigation. PLOS ONE,9:e91749.

Nath C and Sukumar R 1998 Elephant-Human Conflict in Southern India: Distribution Patterns, People's Perceptions and Mitigation Methods (Bangalore: Asian Elephant Conservation Centre, Manuscript).

Naughton-Treves L 1997 Farming the forest edge: Vulnerable places and people around Kibale National Park. The Geographical Review, 87:27–46.

Naughton-Treves L 1998 Predicting patterns of crop damage by wildlife around Kibale National Park, Uganda. Conservation Biology, 12:156–168.

Naughton-Treves 1999 Whose animals? A history of property rights to wildlife in Toro, western Uganda; https://doi.org/10.1002/(SICI)1099.

Nemtzov SC 2003 A short-lived wolf depredation compensation program in Israel. Carnivore Damage Prevention News, 6:16–17.

Newmark WD, Leonard N, Sariko HI and Gamassa DG 1993 Conservation attitudes of local people living adjacent to five protected areas in Tanzania. Journal of Biological Conservation, 3:177-183.

Newmark WD, Manyanza DN, Gamassa DM and Sariko HI 1994 The Conflict between Wildlife and Local People Living Adjacent to Protected Areas in Tanzania: Human Density as Predictor, Conservation Biology, 8:249-255.

Newmark WD 2008 Isolation of African protected areas. Frontiers in Ecology and the Environment, 6:321–328.

Norton-Griffiths M 1996 Property-rights and the marginal wildebeest- an economic analysis of wildlife conservation options in Kenya. Biodiversity and Conservation, 5(12):1557-1577

Nowell K and Jackson P 1996 Wild cats. Status survey and conservation action plan. IUCN/SSC Cat specialization group, Gland, Switzerland and Cambridge, UK.

Nyhus PJ and Tilson R 2000 Crop-raiding elephants and conservation implications at Way Kambas National Park, Sumatra, Indonesia. Oryx, 34:262–274.

Nyhus P and Tilson R 2004a. Agroforestry, Elephants and Tigers: Balancing Conservation Theory and Practice in Human-dominated Landscapes of Southeast Asia. Agriculture, Ecosystems and Environment, 104(1):87-97.

Nyhus PJ and Tilson R 2004b Characterizing Human-Tiger Conflict in Sumatra, Indonesia: Implications for Conservation. Oryx, 38(1):68-74.

Nyhus PJ, Osofsky SA, Ferraro P, Fischer H and Madden F 2005a. Bearing the costs of human-wildlife conflict: the challenges of compensation schemes. See Ref. 2:107–121

Nyhus PJ, Osofsky SA, Ferraro P, Madden F and Fischer H 2005b. Bearing the cost of human-wildlife conflict: The challenges of compensation schemes. In R Woodroffe, S Thirgood and A Rabinowitz (eds.). People and wildlife: Conflict or coexistence? Cambridge University Press, Cambridge, UK. pp. 107–121.

Nyhus PJ 2016 Human-Wildlife Conflict and Coexistence. Annual Review of Environment and Resources, 41:143-171.

O'Connell-Rodwell CE, Rodwell T, Rice M and Hart LA 2000 Living with the modern conservation paradigm: can agricultural communities co-exist with elephants? A five-year case study in East Caprivi, Namibia. Biological Conservation, 93(3): 381-391.

Odaka M and Peterson SA 2000 Water Pollution Control Policy and Management: The Japanese Experience, Gyosei, Japan. 287pp.

Ogada M, Woodroffe R, Oguge N and Frank G 2003 Limiting Depredation by African Carnivores: The Role of Livestock Husbandry, Conservation Biology, 17(6): 1521-1530.

Ogada OO and Ogada DL 2004 Factors influencing levels of carnivore-livestock conflicts in Samburu Heartland and proposed mitigation measures. Unpublished consultancy report for African Wildlife Foundation.

Ogra MV and Badola R 2008 Compensating Human-Wildlife Conflict in Protected Area Communities: Ground-Level Perspectives from Uttarakhand, India. Human Ecology, 36:717-729.

Ogra MV 2008 Human–wildlife conflict and gender in protected area borderlands: a case study of costs, perceptions, and vulnerabilities from Uttarakhand (Uttaranchal), India. Geoforum, 39:1408–1422.

Okello M, Seno S and Wishitemi B 2003 Maasai community wildlife sanctuaries is Tsavo-Amboseli, Kenya parks 13(1): 62-75

Okello MM 2005 Land Use Changes and Human–Wildlife Conflicts in the Amboseli Area, Kenya. Human Dimensions of Wildlife 10:19–28.

Okello MM 2009 Community participation challenges in resource conservation in Kenya's rural landscapes: lessons from Amboseli, Kenya. In: T Meguro, (ed.) Reconceptualization of wildlife conservation: towards resonation between subsistence and wildlife. African Centre for Technology Studies Press, Nairobi, Kenya. Pp. 9-17.

Osborn FV 2002 Capsicum Oleoresin as an elephant repellent: field trails in communual lands of Zymbabwe Journal of Wildlife Management, 66: 674-677.

Osborn FV and Parker GE 2003 Towards an integrated approach for reducing the con-

flict between elephants and people: A review of current research. Oryx, 37(1):80–84.

Pack S, Golden R and Walker A 2013 Comparison of national wildlife management strategies: what works where, and why?. 1st ed. Maryland: University of Maryland, Heinz Center for Science Economics and Environment.

Packer C, Ikanda D, Kissui B and Kushnir, H 2005a Lion attacks on humans in Tanzania. Nature, 436(7053): 927–928.

Packer C, Ikanda D, Kissui B and Kushnir H 2005b The ecology of man-eating lions in Tanzania. Nature and Faune 21(2): 10–15.

Parker GE and Osborn FV 2001 Dual season crop damage by elephants in eastern Zimbabwe valley, Zimbabwe. Pachyderm, 30:29-56.

Parker GE and Osborn FV 2006 Investigating the potential for chilli *Capsicum* spp. to reduce human-wildlife conflict in Zimbabwe. Oryx, 40(3):1–4.

Patterson BD, Kasiki SM, Selempo E and Kays RW 2004 Livestock Predation by Lions (*Panthera Leo*) and Other Carnivores on Ranches Neighbouring Tsavo National Parks, Kenya, Biological Conservation, 119(4): 507-516.

Perera BMAO 2009 The human-elephant conflict: A review of current status and mitigation methods. Gajah, 30:41-52.

Perri A 2016 A Wolf in Dog's Clothing: Initial Dog Domestication and Pleistocene Wolf Variation. Journal of Archaeological Science, 68:1–4.

Peterson AT, Bauer JT and Mills JN 2004 Ecologic and Geographic Distribution of Filovirus Disease. Emerging Infectious Diseases, 10(1):40-47.

Phillips R and Blom FS 1988 Distribution and magnitude of eagle/livestock conflicts in the western united states. Proceedings of the Thirteenth Vertebrate Pest Conference. 49.

Phukon D 2015 Wildlife - livestock interface: Role of disease and its Conservation Implications May RM 1988 Conservation and Disease: Conservation Biology, 2:28-30.

Pienaar UDV 1968. The ecological significance of roads in a national park. Koedoe, 11:169-174.

Pinter-Wollman N 2009 Spatial behaviour of translocated African elephants (*Loxodonta africana*) in a novel environment: using behaviour to inform conservation actions. Behaviour, 146:1171-1192.

Pisa LS and Katsande 2021 Human Wildlife Conflict in Relation to Human Security in the Gonarezhou National Park, Zimbabwe. International Journal of Earth Sciences Knowledge and Applications, 3(2): 98-106.

Pletscher DH, Ream RR, Boyd DK, Fairchild MW and Kunkel KE 1997 Population dynamics of a recolonizing wolf population. Journal of Wildlife Management, 61:459–465.

Prakash TGSL and Kumarathunga KAU 2016 A case study of wild elephant attacks on foreign tourists in Sri Lanka. Gajah, 45:33 -34.

Prakash TGSL, Wijeratne AW, Fernando P 2020 Human-Elephant Conflict in Sri Lanka: Patterns and Extent. Gajah, 51:16-25.

Premathilake R 2012 Human used upper montane ecosystem in the Horton Plains, Central Sri Lanka. A link to late glacial and early Holocene climate and environmental changes: Quaternary Science Review, 50: 23-42.

Priston NEC 2009 Exclosure plots as a mechanism for quantifying damage to crops by primates. International Journal of Pest Management, 55:243–249.

Quammen D 2003 Monster of god, the man eating predator in the jungles of history and the mind. Chapter 1 Page 10.

Rabinowitz A and Zeller KA 2010 A range-wide model of landscape connectivity and conservation for the jaguar, Panthera onca. Biological Conservation, 143:939–945.

Rao KS, Maikhuri RK, Nautiyal S and Saxena KG 2002 Crop damage and livestock depredation by wildlife: a case study from Nanda Devi Biosphere Reserve, India. Journal of Environmental Management, 66:317–327.

Ratcliffe DA 1977 A Nature Conservation Review, Cambridge University Press

Reed KD, Melski JW, Graham MB, Regnery RL, Sotir MJ and Wegner MV 2004 The detection of monkeypox in humans in the western hemisphere: The New England Journal of Medicine, 350:342–50.

Reynolds JC and Tapper SC 1996 Control of mammalian predators in game management and conservation. Mammal Review, 26:127–156.

Rodrigo M 2020 Deaths and Media-Driven panic threaten human-jackal co-existence in Sri Lanka. Mongabay-News and Inspiration from natures frontline.

Rodrigues AS, Andelman SJ, Bakarr MI, Boitani L, Brooks TM and Cowling RM 2004 Effectiveness of the global protected area network in representing species diversity. Nature, 428:640–643.

Roever CL, van Aarde RJ and Leggett K 2013 Functional connectivity within conservation networks: delineating corridors for African elephants. Biological Conservation, 157:128–135.

Saaban S, Othman NB, Yasak MNB, Burhanuddin, MN, Zafir A and Campos-Arceiz A 2011 Current status of Asian elephants in Malaysia. Gajah 35: 67-75.

Saberwal VK, Gibbs JP, Chellam R and Johnsingh AJT 1994 Lion–human conflict in the Gir Forest, India. Conservation Biology, 8:501–507.

Sahoo SK and Mohnot SM 2004 A survey of crop damage by Rhesus Monkeys (*Macaca mullata*) and Hanuman Langur (*Semnopithecus entellus*) in Himachal Pradesh, India. Tigerpaper, 31:1–6.

Saj TL, Sicotte P and Paterson JD 2001 The conflict between vervet monkeys and farmers at forest edge in Entebbe, Uganda. African Journal of Ecology, 39(2):195-199.

Sangay T and Vernes K 2008 Human–wildlife conflict in the kingdom of Bhutan, patterns of livestock predation by large mammalian carnivores. Biological Conservation, 141:1272–1282.

Santiapillai C and Read B 2010 Would masking the smell of ripening paddy fields help mitigate human–elephant conflict in Sri Lanka? Oryx, 44:509–511.

Santiapillai C, De Silva M and Dissanayake S 2000 The status of mongooses (family Herpestidae) in Ruhuna National Park, Sri Lanka. Journal of Bombay Natural History Socity, 97: 208-214.

Santiapillai C, Wijeyamohan S, Bandara G, Athurupana R, Dissanayake N and Read B 2010 An assessment of the human-elephant conflict in Sri Lanka. Ceylon Journal of Science, 39:21-33.

Sanyal P 1987 Managing the man eaters in the Sundarbans Tiger Reserve of India: A case study. In RL Tilson and US Seal (eds) Tigers of the word. Noyes Park, New Jersey. pp. 427-434.

Saraswat R, Sinha A and Radhakrishna S 2015 A god becomes a pest? Human-rhesus macaque interactions in Himachal Pradesh, Northern-India. European Journal of Wildlife Research, 61(3): 435–443.

Schmaljohn C and Hjelle B 1997 Hantaviruses-a global disease problem: Emerging Infectious Diseases journal, 3:95–104.

Schon T 2013 The cost of having wild boar: Damage to agriculture in South-Southeast Sweden, Swedish University of agricultural studies - Department of Wildlife, Fish, and Environmental studies.

Sekhar NU 1998 Crop and livestock depredation caused by wild animals in protected areas, the case of Sariska Tiger reserve Rajasthan, India. Environmental Conservation, 25:160-171.

Seoraj-Pillai N and Pillay N 2016 A meta-analysis of human wildlife conflict: South African and global perspectives. Sustainability, 9(1):34, https://doi.org/10.3390/su9010034

Sethy J and Mardaraj PC 2015 Human-Wildlife Conflict: Issues and Managements In Biodiversity Conservation Research, Management, HK Sahu and J Sethy (eds) 1st edition, Himalaya Publishing House. pp.158-173.

Shaffer LJ 2010 Indigenous fire use to manage savanna landscapes in southern: Mozambique. Fire Ecology, 6:43–59.

Shaffer LJ, Khadka KK, Van den Hoek J and Naithani KJ 2019 Human-elephant conflict: A review of current management strategies and future directions. Frontiers in Ecology and Evolution, 6:1-12.

Shannon G, Larson CL, Reed SE, Crooks KR and Angeloni LM 2017 Ecological conse-

quences of Ecotourism for wild life populations and communities. DT. Blumstein et al. (eds.), Ecotourism's Promise and Peril, A biological Evalution. pp. 26-46.

Sillero-Zubiri C and Laurenson K 2001 Interactions between carnivores and local communities: Conflict or co-existence? 5:282-312.

Sillero-Zubiri C and Switzer D 2001 Crop raiding primates: searching for alternatives, human way to solve conflict with farmers in Africa, People and wildlife initiative, Wildlife conservation research unit, Oxford University.

Sillero-Zubiri C, Reynolds J and Novaro AJ 2004 Management and control of wild canids. In D W Macdonald and C Sillero-Zubiri (eds), The biology and conservation of wild canids. Oxford, England: Oxford University Press. pp. 107–122.

Sinha S, Laxmikant S and Mahendra Singh 2011. Retrieving tiger habitats:Conserving wildlife geospatially. Applied Remote Sensing journal, 2(1):1-5

Sitati NW, Walpole MJ and Leader-Williams N 2003 Predicting spatial aspects of human-elephant conflict. Journal of Applied Ecology, 40:667-677.

Sitati NW and Walpole MJ 2006 Assessing farm-based measures for mitigating human-elephant conflict in Transmara District, Kenya. Oryx, 40:279–286.

Snyman S 2014 Assessment of the main factors impacting community members' attitudes towards tourism and protected areas in six southern African countries. Koedoe, 56:1–12.

Sodhi N, Posa M, Lee T, Bickford D, Koh L and Brook B 2010 The State and Conservation of Southeast Asian Biodiversity. Biodiversity and Conservation, 19:317–28.

Somadeva Raj, Wanninayake A and Devage D 2019 A Review of rock art studies in Sri Lanka. Expression 25 Cultural Changes Part II.

Soulsbury CD and White PCL 2015 Human-wildlife interactions in urban areas: a review of conflicts, benefits and opportunities. In A Taylor and P White (eds), Wildlife Research: Interactions Between Humans and Wildlife in Urban Areas. Australia: CSIRO. pp. 541–553.

Stoffel MA, Johnston SE, Pilkington JG and Pemberton JM 2021 Mutation load decreases with haplotype age in wild Soay sheep. Preprint at bioRxiv, https://doi.org/10.1101/2021.03.04.433700.

Sukumar R 1991 Management of Large Mammals in Relation to Male Strategies and Conflict with People. Biological Conservation, 55: 93-102.

Sukumar R 1992 The Asian Elephant: Ecology and Management. Cambridge, UK: Cambridge University Press.

Sukumar R 2008 Elephants in time and space: evolution and ecology, In C Wemmer and CA Christen (eds), Elephants and Ethics: Toward a Morality of Coexistence. Baltimore, MD: Johns Hopkins University Press. pp.17–39.

Surovell TA, Pelton SR, Anderson-Sprecher R and Myers AD 2016 Test of Martin's overkill hypothesis using radiocarbon dates on extinct megafauna. Proceedings of the National Academy of Sciences, 113:886–91.

Swenson JE and Andre'n H 2005 A tale of two countries: large carnivore depredation and compensation schemes in Sweden and Norway, People and Wildlife Conflict or-Coexistence? pp. 323- 339.

Taylor LH, Latham SM and Woolhouse ME 2001 Risk factors for human disease emergence. Philosophical Transactions of the Royal Society Biological Sciences, 356:983–9.

Tefera M 2011 Wildlife in Ethiopia: endemic large mammals, College of Veterinary Medicine. World Journal of Zoology, 6(2): 108-116.

The World Bank 2015 The World Development Indicator.

Thomassen HA, Fuller T, Buermann W, Mila B, Kieswetter CM Jarrı´n-VP et al. 2010 Mapping evolutionary process: a multi-taxa approach to conservation prioritization. Evolutionary Applications, 4:397–413.

Thornton PK 2010 Livestock production: recent trends, future prospects. Philosophical Transactions of the Royal Society Biological Sciences, 365:2853–67.

Thouless C, Dublin HT, Blanc J, Skinner D, Daniel T, Taylor R et al. and Bouche P., (2016). African Elephant Status Report 2016. Occasional Paper Series of the IUCN Species Survival Commission, 60.

Thouless CR 1994 Conflict between humans and elephants on private land in northern Kenya. Oryx, 28:119-127.

Thouless CR 1996 Home ranges and social organization of female elephants in northern Kenya. African Journal of Ecology, 34 (3):284-297.

Thuppil V and Coss RG 2016 Playback of felid growls mitigates cropraiding by elephants *Elephas maximus* in southern India. Oryx, 50:329–335.

Treves A and Naughton-Treves L 1999 Risk and opportunity for humans coexisting with large carnivores. Journal of Human Evolution, 36: 275–282.

Treves A and Karanth KU 2003 Human-Carnivore Conflict and Perspectives on Carnivore Management Worldwide, Conservation Biology, 17(6):1491-1499.

Treves A 2008 Human wildlife conflicts around protected areas. In: Manfredo M, Vaske JJ, Brown P, et al. (eds), Wildlife and society: the science of human dimensions. Washington: Island Press. pp. 214e228.

Treves A, Andiamampianina L, Didier K, Gibson J, Plumptre A, Wilkie D and Zahler P 2006 A simple, cost-effective method for involving stakeholders in spatial assessments of threats to biodiversity. Human Dimensions of Wildlife, 11(1):43–54.

Treves A 2009 The human dimensions of conflicts with wildlife around protected areas. In: Manfredo MJ, Vaske JJ, Brown P, Decker DJ, Duke EA (eds), Wildlife and Society: The Science of Human Dimensions. Island Press, Washington DC, pp. 214–228.

Tshewang U, Dowsett KF and Jackson KL 1999 A. Effect of GnRH immunization on testicular function in colts effect. Asian-Australasian Journal of Animal Sciences, 2(3):348–353.

Tshewang U, Tobies MC and Morison JG 2021 Bhutan: Conservation and Environmental Protection in the Himalayas, Springer Nature Switzerland, AG .

Tzilkowski WM, Brittingham MC and Lovallo MJ 2002 Wildlife damage to corn in Pennsylvania: farmer and on-the-ground estimates. Journal of Wildlife management, pp.678-682.

United States Department of State 2007 Embassy of the United States, Harare, Zimbabwe: Zimbabwe country-specific information. Available at: harare.usembassy.gov/service/, zimbabwe-country-specific-information/

Van Aarde R, Whyte I and Pimm S 1999 Culling and the dynamics of the Kruger National Park African elephant population. Animal Conservation, 2:287–294.

Vidya TNC and Thuppil V 2010 Immediate behavioural responses of humans and Asian elephants in the context of road traffic in Southern India. Biological Conservation, 143:1891–1900.

Vijayan S and Pati BP 2002 Impact of Changing Cropping Patterns on Man-Animal Conflicts around Gir Protected Area with Specific Reference to Talala Sub-district, Gujarat, India, Population and Environment, 23(6):541-559.

Walpole M, Karanja GG, Sitati N et al. 2003 Wildlife and people: conflict and conservation in Masai Mara, Kenya. IIED Wildlife Development Series, 14:17-56.

Wang SW and Macdonald DW 2006 Livestock predation by carnivores in Jigme Singye Wanchuck National Park Bhutan. Biological Conservation, 129:558–565.

Waters CN, Zalasiewicz J, Summerhayes C, Barnosky AD, Poirier C et al. 2016 The Anthropocene is functionally and stratigraphically distinct from the Holocene. Science,351.

Western D 1989 Conservation without parks: Wildlife in the rural landscape In D Western and M Pearl (eds) Conservation for the Twenty-first Century. Oxford University Press, New York.

Western D 1995 Opening address on the national debate on the wildlife-human conflict in Kenya. August 3, 1995. Nairobi.

Western D, Russell S and Cuthill I 2009 The status of Wildlife in protected areas compared to non-protected areas of Kenya. PLOS ONE, 4:6140.

White PCL and Ward AI 2011 Interdisciplinary approaches for the management of existing and emerging human–wildlife conflicts. Wildlife Research, 37: 623–629.

Wijayagunawardane MPB, Short RV, Samarakone TS, Nishany KBM, Harrington H, Perera BVP et al. 2016 The use of audio playback to deter crop-raiding Asian elephants. Wildlife Society Bulletin, 40:375–379.

Williams AC and Johnsingh AJT 1996 Status survey of elephants and their habitats in Garo Hills, north-east India: Gajah, 16:43-60.

Woodroffe R 2000 Predators and people: using human densities to interpret declines of large carnivores. Animal Conservation 3:165-173.

Woodroffe R, Thirgood S and Rabinowitz A 2005 People and wildlife, conflict or coexistence? Cambridge, Cambridge University Press.

Woolhouse MEJ and Gowtage-Sequeira S 2005 Host range and emerging and reemerging pathogens Emerging Infectious Diseases, 11: 1842–1847.

Wright SD 2001 Foot-and-Mouth Disease May Threaten North American Wildlife USGS-NWHC Information Sheet.

WWF 2007 Human-animal conflict. wwf_human_wildlife_conflict_mitigation_annex.pdf

Zedrosser A, Steyaert SMJG, Gossow H and Swenson JE 2011 Brown bear conservation and the ghost of persecution past, Biological Conservation, 144:2163-2170.

Zeppelzauer M, Hensman S and Stoeger AS 2015 Towards an automated acoustic detection system for free ranging elephants. Bioacoustics, 24(1): 13–29.