DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS–R9–ES–2012–0025; 450 003 0115]

RIN 1018–BA29

Endangered and Threatened Wildlife and Plants; Listing Two Lion Subspecies

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Final rule.

SUMMARY: We, the U.S. Fish and Wildlife Service (Service), determine endangered status for the lion subspecies *Panthera leo leo* and threatened status for *P. l. melanochaita* under the Endangered Species Act of 1973, as amended (Act). We are also publishing a concurrent rule under section 4(d) of the Act. This rule provides for conservation measures for *P. l. melanochaita*.

DATES: This rule is effective **[**INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER**]**.

ADDRESSES: This final rule is available on the Internet at *http://www.regulations.gov* and comments and materials received, as well as supporting documentation used in the preparation of this rule, will be available for public inspection, by appointment, during normal business hours at: U.S. Fish and Wildlife Service; 5275 Leesburg Pike; Falls Church, VA 22041.

FOR FURTHER INFORMATION CONTACT: Branch of Foreign Species, Ecological Services, U.S. Fish and Wildlife Service, MS: ES, 5275 Leesburg Pike, Falls Church, VA

22041–3803; telephone, 703–358–2171; facsimile, 703–358–1735. If you use a telecommunications device for the deaf (TDD), call the Federal Information Relay Service (FIRS) at 800–877–8339.

SUPPLEMENTARY INFORMATION:

Executive Summary

I. Purpose of the Regulatory Action

We are listing two subspecies of lion, *Panthera leo leo* and *P. l. melanochaita*, under the Endangered Species Act of 1973, as amended (Act). We are listing the *P. l. leo* subspecies as an endangered species and the *P. l. melanochaita* subspecies as a threatened species under the Act. We are also finalizing a rule under section 4(d) of the Act that will provide for conservation measures for *P. l. melanochaita*.

II. Major Provision of the Regulatory Action

This action revises the taxonomic classification of the Asiatic lion (currently classified as *P. l. persica* and listed as an endangered species under the Act) to *P. l. leo* based on a taxonomic change. The *P. l. leo* subspecies will be listed as an endangered species and the *P. l. melanochaita* subspecies will be listed as a threatened species in the List of Endangered and Threatened Wildlife in title 50 of the Code of Federal Regulations (CFR) at 50 CFR 17.11(h). This action will also add a rule under section 4(d) of the Act for *P. l. melanochaita* which is set forth at 50 CFR 17.40 (r).

Background

The Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 *et seq*.), is a law that was passed to prevent extinction of species by providing measures to help alleviate the loss

of species and their habitats. Before a plant or animal species can receive the protection provided by the Act, it must first be added to the Federal List of Endangered and Threatened Wildlife or the Federal List of Endangered and Threatened Plants in part 17 of title 50 of the Code of Federal Regulations (CFR). Section 4 of the Act and its implementing regulations at 50 CFR part 424 set forth the procedures for adding species to these lists.

Previous Federal Actions

In a final rule published in the **Federal Register** on June 2, 1970 (35 FR 8491), the Asiatic lion (currently listed under the Act as *Panthera leo persica*) was listed under the Act's precursor, the Endangered Species Conservation Act of 1969, as an endangered species and has remained listed as an endangered species under the Act.

On March 1, 2011, we received a petition dated the same day from the International Fund for Animal Welfare, the Humane Society of the United States, Humane Society International, the Born Free Foundation/Born Free USA, Defenders of Wildlife, and the Fund for Animals requesting that the African lion subspecies be listed as endangered under the Act. The petition identified itself as such and included the information as required by 50 CFR 424.14(a). On November 27, 2012, we published a "positive" 90-day finding (77 FR 70727) indicating that we would initiate a status review of the African lion.

On October 29, 2014 (79 FR 64472) we published in the **Federal Register** a finding that listing the African lion subspecies (*Panthera leo leo*) as a threatened species was warranted and

proposed to list the subspecies as a threatened species under the Act. We also proposed a rule under section 4(d) of the Act to provide conservation measures for the African lion.

Summary of Changes from the Proposed Rule

We fully considered comments from the public and the peer reviewers on the proposed rule to determine our final listing status of lion. This final rule incorporates changes to our proposed rule based on the comments we received that are discussed under **Summary of Comments and Responses** and newly available scientific and commercial information that became available after the close of the comment period. We accept the taxonomy as recommended by the International Union for Conservation of Nature (IUCN) Species Survival Commission Cat Classification Task Force: *P. l. leo* (Asia and western, central, and northern Africa) and *P. l. melanochaita* (southern and eastern Africa). Here we evaluate the status of the lion species (*P. leo*), which includes the previously unreviewed population of *P. l. leo* in India (formerly *P. l. persica*). Additionally, we have incorporated new population estimates and population trends for the lion into our **Species Information** section.

Based on comments by peer reviewers and others, we revised the section on trophy hunting, providing additional information on the practices that experts have identified as undermining the sustainability of trophy hunting, recommended best practices and reforms, biological impacts of trophy hunting on lion populations, and corruption in range countries, and expanded our assessment of the level of threat that trophy hunting presents to the species. Additionally, we have incorporated information on infanticide, corruption, traditional use of lion parts and products, disease, and climate change. Under the discussion of the 4(d) rule in the

preamble, we further clarify factors we will consider when making an enhancement finding for importation of sport-hunted trophies of *P. l. melanochaita*.

Based on the information we received and our assessment of that information, we have altered our finding. Some of the information we received indicated threats may be worse than previously indicated. Due to significant differences in the impacts of threats within the species, we found that *P. l. leo* and *P. l. melanochaita* qualify for different statuses under the Act.

Species Information

Taxonomy

The lion (*Panthera leo*) was first described by Linnaeus (1758, in Haas *et al.* 2005, p. 1), who gave it the name *Felis leo*. It was later placed in the genus *Panthera* (Pocock 1930, in Haas *et al.* 2005, p. 1). Although the classification of the modern lion as *P. leo* is accepted within the scientific community, there was a lack of consensus regarding lion intraspecific taxonomy (Mazak 2010, p. 194; Barnett *et al.* 2006b, p. 2120).

Based on morphology, traditional classifications recognize anywhere from zero subspecies (classifying lions as one monotypic species) up to nine subspecies (Mazak 2010, p. 194, citing several sources). The most widely referenced of the morphology-based taxonomies is an eight-subspecies (six extant) classification provided by Hemmer (1974, in Nowell and Jackson 1996, p. 312; Barnett *et al.* 2006a, p. 507; Barnett *et al.* 2006b, p. 2120), which is recognized by the Integrated Taxonomic Information System (ITIS) (ITIS 2013, unpaginated). It divides the lion species into: *Panthera leo persica* (India); *P. l. leo*, commonly referred to as the

Barbary lion (Morocco through Tunisia, extinct); *P. l. senegalensis* (West Africa east to the Central African Republic (CAR)); *P. l. azandica* (northern Zaire); *P. l. bleyenberghi* (southern Zaire and presumably neighboring areas of Zambia and Angola); *P. l. nubica* (East Africa); *P. l. krugeri* (Kalahari region east to the Transvaal and Natal regions of South Africa), and *P. l. melanochaita*, also called the Cape lion (Cape region of South Africa, extinct) (Nowell and Jackson 1996, p. 312).

In 1987, O'Brien (1987a, entire; 1987b, entire) reported the first results of genetic studies conducted on lion samples from some, but not all, regions of the species' range using early genetic techniques. Lions in India differed from lions in Africa, supporting a two-subspecies classification for extant lions: *P. l. leo* and *P. l. persica*, the African and Asiatic lion, respectively (O'Brien *et al.* 1987, Meester and Setzer 1971, Ellerman *et al.* 1953, in Dubach 2005, p. 16). According to Dubach (2005, p. 16), most taxonomic authorities recognize this two-subspecies taxonomy. This taxonomy was also recognized by the International Union for Conservation of Nature (IUCN) (Bauer *et al.* 2012, unpaginated) and, consequently, by several international organizations and governing bodies. As a result, this is the classification on which the conservation of the species is largely based. However, results of recent genetic research call into question this classification.

In recent years, several genetic studies have provided evidence of an evolutionary division within lions in Africa (see Barnett *et al.* 2014, p. 6; Dubach *et al.* 2013, p. 746; Bertola *et al.* 2011 (entire); Antunes *et al.* 2008 (entire); Barnett *et al.* 2006a, pp. 511–512). These studies include analysis of DNA samples from all major regions of the species' range, though

some regions are sparsely represented. A major genetic subdivision among lions occurs in Africa, with lions in southern and eastern Africa being distinct from and more diverse than lions elsewhere (western and central Africa and Asia) (Figure 1). Lions in western and central Africa (as well as now-extinct North African lions) are more closely related to lions in India than to lions in southern and eastern Africa (Barnett *et al.* 2014, pp. 4–8; Dubach *et al.* 2013, pp. 741, 746–747, 750–751; Bertola *et al.* 2011, entire). According to Dubach *et al.* (2013, p. 753), current range collapse and fragmentation is too recent a phenomenon to explain the reduced genetic variability in these regions. Rather, the low genetic diversity in and between western and central African lion populations suggests they have a shorter evolutionary history than the more genetically diverse lions in southern and eastern Africa (Bertola *et al.* 2011, p. 1362). Several authors argue that the origin of these genetically distinct groups may be the result of regional extinctions and recolonizations during major climate (and consequently biome) fluctuations during the Pleistocene Epoch (Barnett *et al.* 2014, pp. 5–8; Bertola *et al.* 2011, pp. 1362–1364).

These findings on lion genetic relationships are based primarily on analysis of mitochondrial DNA (mtDNA), which is inherited only from the mother. Because lions display sex-biased dispersal, in which males leave their natal range and females tend to remain in their natal range, one would expect gene flow in females to be lower than in males, resulting in greater geographic differentiation in females (Mazak 2010, p. 204). Consequently, some authors state that results of mtDNA analyses should be backed up by studies on nuclear DNA (nDNA, inherited from both parents) and morphological traits before assigning taxonomic importance to them (Barnett *et al.* 2014, pp. 1, 8).

Recently, Mazak (2010, entire) examined morphological characteristics of 255 skulls of wild lions and found considerable variation throughout the species' range, with variation being greater within populations than between them. However, according to Dubach *et al.* (2013, p. 742), the genetic distinction of lions in southern and eastern Africa from those elsewhere in the species' range is confirmed by results of studies by Antunes *et al.* (2008, entire) which, in addition to analysis of mtDNA, also included analysis of nDNA sequence and microsatellite variation.

The recent results of genetic research renewed the debate on lion taxonomy among the experts. For this reason, the IUCN Species Survival Commission Cat Specialist Group commissioned a Cat Classification Task Force from among its expert members to reach a consensus on taxonomy for the group. As we explained in our proposed rule, until the results of the IUCN Cat Classification Task Force became available, we concluded that the taxonomy of the species was unresolved, but, as required by the Act, we based our status review in our proposed rule on the best available scientific and commercial information, which was the taxonomy that was most widely recognized by taxonomic experts: *P. leo leo* (African lion) and *P. leo persica* (Asiatic lion) and reviewed the status of the petitioned entity, the African lion.

In June 2015, after the close of the comment period on our proposed rule, IUCN posted an updated Red List Assessment for lion. In this assessment, a new two-subspecies classification is proposed based on the recommendation of the IUCN Cat Classification Task Force: *P. l. leo* of Asia (India) and western, central, and northern Africa, and *P. l. melanochaita* for southern and eastern Africa (Bauer *et al*. 2015a, unpaginated) (Figure 1), which is supported by Barnett *et al.*

(2014, p. 6), Dubach *et al.* (2013, p. 746), Bertola *et al*. (2011, entire), Antunes *et al.* (2008, entire), and Barnett *et al.* (2006a, pp. 511–512).

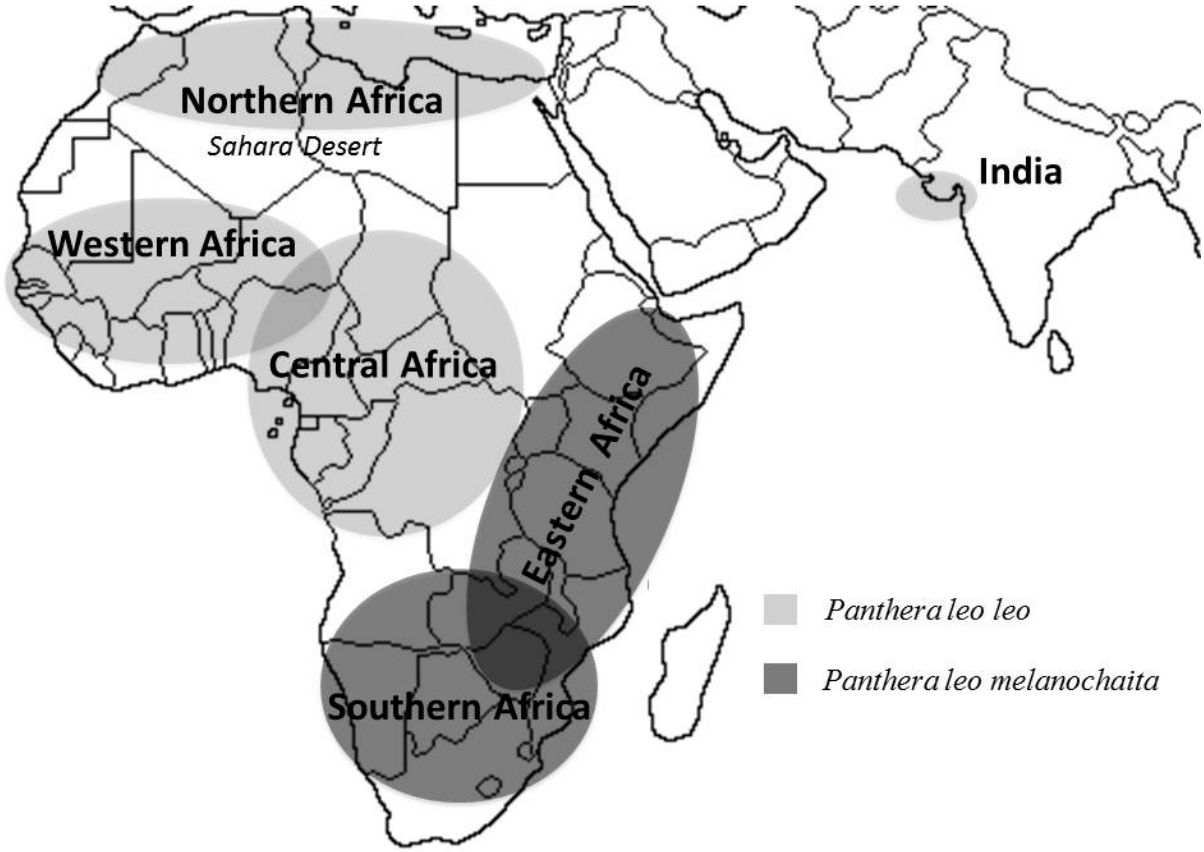

Figure 1. General locations of regions commonly referred to in the literature and in this document. Regions grouped into subspecies based on genetic studies.

As required by the Act, and as explained in our proposed rule, we base our listing determinations on the best available scientific and commercial information. We accept the taxonomy as recommended by the IUCN Cat Classification Task Force, which is supported by

mtDNA analysis, as well as analysis of nDNA sequence and microsatellite variation: *P. l. leo* (Asia and western, central, and northern Africa) and *P. l. melanochaita* (southern and eastern Africa)(Figure 1) as the best available scientific and commercial information. Because this new classification for lion includes subspecies whose ranges span two continents, we assessed the status of the entire lion species (*P. leo*).

Currently, the Asiatic lion (*P. l. persica*) is listed as an endangered species under the Act. Based on the new taxonomic classification for lions, we are revising the List of Endangered and Threatened Wildlife at 50 CFR 17.11(h). In the **Regulation Promulgation** section of this document, we implement a taxonomic change by removing the invalid subspecies *P. l. persica*. This entity is now included in the assessment of the lion species (*P. leo*).

Species Description

The lion is the second-largest extant cat species (second in size only to the tiger) and the largest carnivore in Africa (Ray *et al.* 2005, p. 67). As with other widely distributed large cats, there is considerable morphological variation within the species as a result of sexual selection, regional environmental adaptations, and gene flow (Mazak 2010, p. 194). These include, among others, variation in size, coat color and thickness, mane color and form, and skull characteristics (Mazak 2010, p. 194, citing several sources; Hollister 1917, in Dubach 2005, p. 15). They are described in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Periodic Review of the Status of African Lion Across Its Range (CITES 2014, p. 3) as follows:

> Characteristics include sharp, retractile claws, a short neck, a broad face with prominent whiskers, rounded ears and a muscular body. Lions are typically a tawny color with black on the backs of the ears and white on the abdomen and inner legs. Males usually have a mane around the head, neck and chest. Lions are sexually dimorphic, with males weighing about 20–27 percent more than females. Adult males, on average, weigh about 188 kilograms (kg) (414 pounds (lbs)) with the heaviest male on record weighing 272 kg (600 lbs). Females are smaller, weighing, on average, 126 kg (278 lbs). The male body length, not including the tail, ranges from 1.7 meters (m) to 2.5 m (5.6 feet (ft) to 8.2 ft) with a tail from 0.9 m to 1 m (3 ft to 3.2 ft) (Nowell and Jackson, 1996).

Lions in India tend to be smaller than those in Africa. Adult males weigh between 160–190 kg (353–419 lb), while females weigh between 110–120 kg (243–265 lb) (Chellam *in litt.* in Nowell and Jackson 1996, p. 37). The record total length for a male lion in India, including the tail, is 2.92 m (9.6 ft) (Sinha 1987 in Nowell and Jackson 1996, p. 37). One characteristic unique to lions in India is a longitudinal fold of skin that runs along the belly (O'Brien *et al*. 1987, p. 100). Additionally, male lions in India do not have as large and full a mane as those in Africa, allowing their ears to always be visible, whereas the manes of male lions in Africa completely hide the ears (Nowell and Jackson 1996, p. 37; O'Brien *et al*. 1987, p. 100).

Habitat

Historically, the species occurred in all habitats in Africa, except rainforest and the hyper-arid interior of the Sahara (Ray *et al.* 2005, p. 66). Today they are found primarily in

savannas, although there are some remnant populations in other habitat types (Riggio *et al.* 2013, p. 19). According to Nowell and Jackson (1996, p. 19), optimal habitat appears to be open woodlands and thick bush, scrub, and grass complexes, where sufficient cover is provided for hunting and denning. The highest lion densities are reached in savanna woodlands plains mosaics of southern and eastern Africa (Ray *et al.* 2005, p. 66). The species is intolerant of anthropogenic (human-caused) habitat conversion, such as farming or overgrazing by livestock (Ray *et al.* 2005, p. 66). In India, the lion occurs in dry deciduous forests (Meena *et al*. 2014, p. 121). Moist mixed and mixed forest habitats are critical to lions as they seek moist shady habitats that provide shelter from the heat and cover to hide during peak times of human activities (Jhala *et al*. 2009, p. 3391).

General Biology

Lions are well studied. Much information exists on habits, behavior, and ecology of lions in Africa. CITES (2014, p. 3) provides a general overview as follows:

> Lions are generalist, cooperative hunters, with foraging preferences changing with season and with lion group size. Lions live in groups called "prides," which are "fission-fusion" social units with a stable membership that sometimes divide into small groups throughout the range. Lions have no fixed breeding season. Females give birth every 20 months if they raise their cubs to maturity, but the interval can be as short as 4–6 months if their litter is lost. Gestation lasts 110 days, litter size ranges 1–4 cubs, and sex ratio at birth is 1:1. At about 4 years of age, females will have their first litter and males will become resident in a pride.

> Pride takeovers by male lions and subsequent infanticide of cubs sired by the ousted male lions greatly influences reproductive success. Lionesses defending their cubs from the victorious males are sometimes killed during the takeover. Infanticide accounts for 27 percent of cub mortality. Adult mortality is typically caused by humans, starvation, disease, or attacks from other lions. Injury and death can also occur during hunting attempts on some of their larger prey.

Haas *et al.* (2005, entire) provide a summary of information on lion, including the following:

> "Prides vary in size and structure, but typically contain 5–9 adult females (range, 1–18), their dependent offspring, and a coalition of 2–6 immigrant males (Heinsohn and Packer 1995; Packer *et al.* 1991).…Pride sizes are smallest in arid environments with limited prey species (Elliott and Cowan 1977; Hanby and Bygott 1979; Ruggiero 1991; Schaller 1972; Stander 1992b; Wright 1960)….Males reside in a pride for [approximately] 2 years before being replaced by another group of males (Packer *et al.* 1988).… In the absence of a pride takeover, males generally leave their natal pride when 2–4 years old (Bertram 1975b; Pusey and Packer 1987). Most females are incorporated into their natal prides (Pusey and Packer 1987; Van Orsdol *et al.* 1985)…. A small proportion of lions is nomadic, including young and adult males without a pride. Nomadic lions follow the migrations of prey and hunt and scavenge cooperatively (Bertram 1975a; Bygott *et al.* 1979; Schaller 1968, 1969; Van Orsdol *et al.* 1985).

> …Lion productivity (measured as number of surviving cubs) is limited by food. …Cub mortality is high in lions and is linked to periods of prey scarcity and infanticide by male lions during pride takeovers (Packer and Pusey 1983b; Schaller 1972; Van Orsdol *et al.* 1985; Whitman and Packer 1997).
>
> …Lions are mainly active at night….[They] usually hunt in groups; males hunt less frequently than do females, but males are stronger and can gain access to kills made by females (Bertram 1975a; Scheel and Packer 1991). Prey selection is related to seasonal weather patterns and the migration of large herbivores in some parts of Africa (Hanby *et al.* 1995)…. Lions exhibit individual preferences in prey selection within and between prides in the same area (Rudnai 1973b; Van Orsdol 1984).

Lion prides in India tend to be smaller than those in Africa; most prides in India contain an average of two females, with the largest having five. Coalitions of males will defend home ranges that contain one or more groups of females, but unlike lions in Africa, in India male lions only associate with pride females when mating or on a large kill (Meena 2009, p. 7; Nowell and Jackson 1996, p. 37). Females are approximately 4 years old at first reproduction, males 5–8 years (Banerjee and Jhala 2012, p. 1424; Nowell and Jackson 1996, p. 37). Banerjee and Jhala (2012, p. 1424) found that mating occurred throughout the year, but mostly in winter. Gestation lasts 110 days; births peaked in the summer (April–May). Average litter size is 2.5 cubs, but as many as 5 have been observed (Banerjee and Jhala 2012, pp. 1424, 1427; Nowell and Jackson 1996, p. 37). Lion reproduction in India appears to coincide with the fawning peak of chital deer

(*Axis axis*) between December and January or with the rutting season of chital and peak fawning for sambar deer (*Cervus unicolor*) between May and June. Breeding lionesses may cue into these times of increased availability of food sources to time births for maximum survival of cubs (Banerjee and Jhala 2012, p. 1427). Average interbirth interval is estimated to be 1.37 years; however, if cubs of the previous litter survived to independence, it could be higher. After territorial takeovers and infanticides, females mated within an average 4.8 months (Banerjee and Jhala 2012, p. 1424). Banjeree and Jhala (2012, p. 1424) found that the major cause of cub mortality is infanticide due to territorial takeovers by adult males. Most observed adult mortalities (54.5 percent) were due to natural causes and 43 percent were due to human causes; remaining mortalities were due to unknown causes.

Diet and Prey

Lions are opportunistic hunters and scavengers. As scavengers, lions are dominant and can usually readily displace other predators from their kills (Packer 1986, Schaller 1972, in Haas *et al.* 2005, pp. 4–5). As hunters, they are known to take a variety of prey. However, they are also the largest carnivore in Africa and, as a result, require large prey to survive. Ray *et al.* (2005, pp. 66–67) summarizes lion prey in Africa as follows:

> Lions are generalists and have been recorded to consume virtually every mammal species larger than 1 kg in their range, as well as a wide variety of larger reptiles and birds (Nowell & Jackson 1996; Sunquist & Sunquist 2002). The constraints of large physical size and extended social groups, however, bind them to large-bodied prey, and their diet is dominated by medium-large ungulates. In fact, only

> a few species of large ungulates comprise a majority of their diet wherever they occur (Schaller 1972; Stander 1992; Packer *et al.* 1995), and they are unable to persist in areas without large-bodied prey. The threshold of this requirement is perhaps represented at Etosha National Park, Namibia, where Stander (1992) showed that lions hunting in pairs met their minimum requirements hunting springboks which, at < 50 kg, are the smallest preferred prey species recorded.

In India, the lion's diet is comprised of both small and medium prey, as well as vulnerable livestock (Meena *et al*. 2011, p. 61; Singh and Gibson 2011, p. 1753; Meena 2009, p. 8). The most commonly taken species is chital, which weighs approximately 50 kg (110 lb), and a larger species, the sambar deer (Meena *et al*. 2011, p. 63; Nowell and Jackson 1996, p. 37). The smaller size of the prey available in India may be responsible for the smaller lion group sizes and less interaction between male and female groups (Meena 2009, p. 8; Nowell and Jackson 1996, p. 37). Historically, domestic cattle also constituted a major portion of the lion's diet (Nowell and Jackson 1996, p. 37) and remains a significant portion today (Meena *et al*. 2011, pp. 63, 64; Singh and Gibson 2011, pp. 1753–1754). The proportion of wild prey and domestic livestock in a lion's diet may vary by season and between protected areas and peripheral areas (Meena *et al*. 2011, pp. 64, 65).

Prey availability affects the reproduction, recruitment, and foraging behavior of lions and, as a result, strongly influences lion movements, abundance, and population viability (Winterbach *et al.* 2012, p. 7, citing several sources). Lion densities are directly dependent on prey biomass (Van Orsdol *et al.* 1985, in Packer *et al.* 2013, p. 636; Hayward *et al.* 2007, entire). In Africa,

lion densities range from 8–13 lions per 100 square kilometers (km^2) in Selous Game Reserve and up to 18 per 100 km^2 in protected areas of eastern Africa and South Africa (Creel and Creel 1997, Nowell and Jackson 1996, in Haas *et al.* 2005, p. 4). In India, densities are estimated to be 15 lions per 100 km^2 in Gir Protected Area, 6 per 100 km^2 in Girnar Wildlife Sanctuary, and 2 per 100 km^2 in the surrounding agro-pastoral land (Banerjee and Jhala 2012, p. 1421; Banerjee *et al*. 2010, p. 249). Aside from human-related mortality, prey availability is likely the primary determinant of lion density in Africa (Fuller and Sievert 2001, in Winterbach *et al.* 2012, p. 7). In areas of low natural prey density, or high human contact, lions may prey on livestock (see *Human–Lion Conflict*).

Movements/Home Range

Availability of prey is perhaps the primary factor that determines the ranging behavior of large carnivores (Gittleman & Harvey 1982, Van Orsdol *et al.* 1985, Grant *et al.* 2005, Hayward *et al.* 2009, in Winterbach *et al.* 2012, p. 4). Home-range sizes of lion prides correlate with lean-season prey biomass (Van Orsdol *et al.* 1985, in Haas *et al.* 2005, p. 4) and, therefore, vary widely among habitats. Average range sizes of lion prides in Africa are 26–226 km^2, but can be considerably larger (Stander 1992b; Van Orsdol *et al*. 1985; Viljoen 1993, in Haas *et al.* 2005, p. 4). In areas of low or variable prey biomass, annual range requirements for a single lion pride can exceed 1,000 km^2 (Packer *et al.* 2013, p. 636). Funston (2011, p. 5) found the home ranges of lion prides in the dune-savanna habitat of Kgalagadi Transfrontier Park to range from 1,762 to 4,532 km^2. In India, however, Jhala *et al*. (2009, p. 3391) found the average home range of a breeding group of lionesses to be 33 km^2. Similarly, Meena (2009, pp. 7–8) found home ranges of females and males to be 35 km^2 and 85 km^2, respectively.

Range

The historical range of the lion included most current continental African countries (Chardonnet 2002, pp. 25–28) and extended from Greece through eastern Europe, southwest Asia (the Middle East), and India (Bauer *et al*. 2015a, unpaginated; Nowell and Jackson 1996, p. 38). Lions have undergone dramatic range retraction from this historical distribution (Ray *et al.* 2005, p. 67). Extirpation of lions in Europe occurred almost 2,000 years ago. The species was extirpated from southwest Asia within the last 150 years and northern Africa in the 1940s (Bauer *et al*. 2015a, unpaginated; Black *et al.* 2013, p. 1; Nowell and Jackson 1996, p. 38). Today, lions occur only in Asia and sub-Saharan Africa (Table 1). In Asia, *P. l. leo* only remains in the Gir Forests of India. Within sub-Saharan Africa, *P. l. leo* and *P. l. melanochaita* remain in 34 range countries (35 with South Sudan, which gained its independence as a country in July 2011) and have been recently extirpated from 12 African range countries and potentially extirpated from another 4 (Bauer *et al*. 2015a, unpaginated) (Table 1).

Table 1. Range countries of *P. l. leo* and *P. l. melanochaita*. Information derived from Bauer *et al*. 2015a, unpaginated, IUCN 2006a, IUCN 2006b, and Chardonnet 2002.

Subspecies	Countries
Panthera leo leo	Algeria[1], Benin, Burkina Faso, Cameroon, CAR, Chad, Congo[2], Côte d'Ivoire[2], DRC, Egypt[1], Gabon[2], Gambia[2], Ghana[3], Guinea[3], Guinea-Bissau[2], India, Liberia, Libya[1], Mali[2], Mauritania[2], Morocco[1], Niger, Nigeria, Senegal, Sierra Leone[2], Togo[3], Tunisia[1]
Panthera leo melanochaita	Angola, Botswana, Burundi[2], Djibouti[2], Eritrea[2], Ethiopia, Kenya, Lesotho[2], Malawi, Mozambique, Namibia, Rwanda[3], Somalia, South Africa, Sudan/South Sudan, Swaziland, Tanzania, Uganda, Zambia, Zimbabwe

[1] Lions extirpated.
[2] Lions considered recently extirpated (Bauer *et al*. 2015a).
[3] Lions considered possibly extirpated (Bauer *et al*. 2015a).

The confirmed lion range in western Africa (the total size of protected areas where lions were confirmed) is estimated at 49,000 km^2, or 1.1 percent of the historic range (Henschel *et al*. 2014, p. 5). The most recent estimate of the lion's range throughout Africa comes from Bauer *et al*. (2015a, unpaginated) who estimate the extant lion range (areas reasonably confident that lions persist based on recent records) to be approximately 1.6 million km^2 (617,763 mi^2), or 8 percent of the historical range in Africa. The areas classified by Bauer *et al*. (2015, unpaginted) as possibly extinct total approximately 1.8 million km^2 (694,984 mi^2), which is over half (52 percent) of the range classified as extant by the previous estimate conducted by Riggio *et al*. (2013, p. 26), which was based on estimates of savanna habitat. The lion's range in Asia is estimated to be approximately 10,500 km^2 (4,054 mi^2), which occurs within the Gir National Park and Wildlife Sanctuary (Gir Protected Area), Girnar Wildlife Sanctuary, and surrounding agro-pastoral land (Bauer *et al*. 2015a, unpaginated; Banerjee and Jhala 2012, p. 1421; Jhala *et al*. 2009, pp. 3384, 3385; Nowell and Jackson 1996, p. 38).

Distribution and Abundance

The general distribution of lions in Africa is summarized by Ray *et al.* (2005, p. 67) as follows:

> Currently, lions are restricted mainly to protected areas and surrounding conservancies or 'game management areas,' with the largest populations in East and southern Africa. Where protection is poor, particularly outside protected areas, range loss or population decreases can be significant. Declines have been most severe in West and Central Africa, with only small, isolated populations scattered chiefly through the Sahel. Lions in the region are declining in some

> protected areas and, with the exception of southern Chad and northern Central African Republic, are virtually absent from unprotected areas (Bauer 2003).

Estimates of lion abundance on a large geographical scale are few in number. For a variety of reasons—including low densities, large ranges, cryptic coloration, nocturnal and wary habits—lions are difficult to count (Riggio *et al.* 2013, p. 31; Bauer *et al.* 2005, p. 6). There are large areas of the species' range in which no data are available on lion occurrence or abundance (IUCN 2006b, pp. 12–13). Species experts recognize that estimating the size of the lion population in Africa is an ambitious task, involving many uncertainties (Bauer *et al*. 2012, unpaginated). Estimates, particularly throughout Africa or broad region-wide estimates tend to rely to a considerable extent on expert opinion or inference (Riggio *et al.* 2013, p. 21; Chardonnet 2002, p. 19). Consequently, there is a large degree of uncertainty in these estimates. In addition, to date all efforts to estimate the number of lions in Africa have used different methods; therefore, the results of earlier estimates cannot be directly compared to those of later estimates to determine population trend.

The earliest estimates of lion abundance in Africa were educated guesses made during the latter half of the 20th Century. Bauer *et al.* (2008, unpaginated) summarize the information as follows:

> There have been few efforts in the past to estimate the number of lions in Africa. Myers (1975) wrote, "Since 1950, their [lion] numbers may well have been cut in half, perhaps to as low as 200,000 in all or even less." Later, Myers (1986) wrote, "In light of evidence from all the main countries of its range, the lion has been

> undergoing decline in both range and numbers, often an accelerating decline, during the past two decades." In the early 1990s, IUCN SSC Cat Specialist Group members made educated "guesstimates" of 30,000 to 100,000 for the African Lion population (Nowell and Jackson 1996).

Ferreras and Cousins (1996, entire) provided the first quantitatively derived estimate of lion abundance in Africa using a GIS-based model calibrated with information obtained from lion experts. Ferreras and Cousins predicted lion abundance in Africa in 1980 to be 75,800. Later, four additional efforts—Chardonnet (2002), Bauer and Van Der Merwe (2004), IUCN (2006a, 2006b), and Riggio *et al.* (2013)—estimated lion population sizes ranging from 23,000 to 40,000 (Table 2).

Between 2006 and 2012, Henschel *et al.* (2014, p. 2) conducted field surveys in protected areas within designated Lion Conservation Units (LCUs) of western Africa to confirm lion presence where evidence of occurrence was lacking and to establish population estimates where lions occurred. Lions were absent from protected areas in 5 of the 10 countries in western Africa where lions were considered to be present (Henschel *et al.* 2014, p. 4). Henschel *et al.* (2014, p. 5) estimated only 400 lions remain in the entire western region, with most (about 350, or 88 percent) concentrated in a single population.

Bauer *et al*. (2015a, unpaginated) attempted to correct for outdated sources in Riggio *et al*. (2013) by applying regional trends (discussed below) to 2002 population estimates for central, eastern, and southern Africa from Bauer and Van Der Merwe (2004) and Chardonnet

(2002); estimates for western Africa were taken from Henschel *et al*. (2014) because of the greater precision of their estimate. Applying regional trends to Bauer and Van Der Merwe (2004) lion populations estimates, Bauer *et al*. (2015a, unpaginated; supporting information, Table 7) estimated lions in central Africa to be 590, eastern Africa to be 7,345, and southern Africa to be 10,385 (Table 2). When regional trends were applied to Chardonnet (2002) lion estimates, Bauer *et al*. (2015, unpaginated; supporting information, Table 7) estimated lions in central Africa to be 1,748, eastern Africa to be 13,316, and in southern Africa to be 15,925 (Table 2). In total, Bauer *et al*. (2015, unpaginated) estimate the lion population in Africa to be between 18,841 and 31,394. However, the authors found that the study by Bauer and Van Der Merwe (2004) was more conservative and stricter on data quality; therefore they have a greater confidence in an estimate closer to 20,000 lions in Africa. Additionally, the lion population in India was estimated to be 445 by Bauer *et al*. (2015a, unpaginated). In 2015, the Government of Gujarat completed its latest census, estimating 523 lions in India (BBC 2015, unpaginated) (Table 2).

Table 2. Estimates of lion abundance. Rows may not tally due to rounding.

Source	Western Africa (percent of total)	Central Africa (percent of total)	Eastern Africa (percent of total)	Southern Africa (percent of total)	India	Total
Ferreras & Cousins 1996 (estimate for lion abundance in 1980)	-	-	-	-	-	75,800 (18,600 in protected areas)
Chardonnet 2002	1,163 (3 percent)	2,815 (7 percent)	15,744 (40 percent)	19,651 (50 percent)	-	39,373
Bauer & Van Der Merwe 2004	850	950	11,000	10,000	-	23,000

	(4 percent)	(4 percent)	(48 percent)	(44 percent)		
IUCN 2006[1] (as calculated by Riggio *et al*. 2013)	1,640 (5 percent)	2,410 (7 percent)	17,290 (52 percent)	11,820 (37 percent)	-	33,160
Riggio 2013 (based on estimates of savanna habitat)	480 (1 percent)	2,419 (7 percent)	19,972 (57 percent)	12,036 (34 percent)	-	34,907
Henschel *et al.* 2014	406 (n/a)	-	-	-	-	-
Bauer *et al*. 2015a (trends applied to Bauer and Van Der Merwe 2004)	-	590 (3 percent)	7,345 (39 percent)	10,385 (55 percent)	-	18,726*
Bauer *et al*. 2015a (trends applied to Chardonnet 2002)	-	1,748 (6 percent)	13,316 (42 percent)	15,925 (51 percent)	-	31,394*
Bauer *et al*. 2015a					445	-
Government of Gujarat 2015**					523	

[1] Estimates were made for individual Lion Conservation Units (defined management units), and were given as population size classes rather than specific figures. As calculated by Riggio *et al.* (2013, p. 27).
* Total includes estimate for western Africa taken from Henschel *et al*. (2014).
** As reported in BBC 2015, unpaginated

As previously stated, extant lion populations are limited to protected areas. These populations are largely isolated and many are small. *P. l. leo* (totaling approximately 1,500 lions), is divided into 15 populations in and around protected areas; of these, 14 are remaining populations from a total of 38 historical occurrences in western and central Africa, while one occurs in India (Bauer *et al*. 2015a, unpaginated; Henschel *et al*. 2015b, unpaginated; Brugiére *et al*. 2015, p. 515; Henschel *et al*. 2014, pp. 4–5; Jhala *et al*. 2009, p. 3384). Nearly 90 percent of the lions in western Africa persist in a single population, the W-Arly-Pendjari (WAP) Complex (Henschel *et al*. 2014, p. 5). Based on Bauer *et al*. (2015, unpaginateda; Supporting Information, Table 3) and Bauer and Van Der Merwe (2004, pp. 28–30), most *P. l. melanochaita* occur in

approximately 68 protected areas throughout southern and eastern Africa, with larger populations occurring in Botswana, Kenya, Namibia, South Africa, Tanzania, Zambia, and Zimbabwe.

Population Trends

Based on the best available information, lion range and numbers have clearly declined over the past several decades. However, not all lion populations have declined—some have increased or remained stable, and some have been restored to areas from which they were previously extirpated (Bauer *et al*. 2015a, unpaginated; Packer *et al.* 2013, p. 636; Funston 2011, p. 3; Ferreira and Funston 2010, pp. 201, 203).

Bauer *et al*. (2015a, unpaginated), using a time trend analysis of census data, determined the trend of lion populations from 1993 to 2014. Overall, these lion populations decreased by 43 percent in 21 years (Table 3). However, the authors found significant regional differences. In Asia, the single population increased by 55 percent (Bauer *et al*. 2015a, unpaginated). The population inside the protected area has stabilized and expanded into surrounding agro-pastoral land (Bauer *et al*. 2015b, p. 2; Breitenmoser *et al*. 2008, unpaginated). Additionally, the 2015 census of Gir Sanctuary and surrounding forest areas showed a 27 percent increase from the 2010 census (The Guardian 2015, unpaginated). In southern Africa, the sample populations overall increased by 8 percent (Bauer *et al*. 2015a, unpaginated). However, one of the largest populations, Okavango, and populations of 6 unfenced reserves are declining (Bauer *et al*. 2015a, unpaginated, supporting information Table 3; Bauer *et al*. 2015b, p. 1). Fifteen of the 23 sample populations in southern Africa were fenced; none experienced sharp declines and many small fenced populations are increasing (Bauer *et al*. 2015a, unpaginated, supporting information

Table 3; Bauer *et al*. 2015b, p. 1). South Africa was the only African country with growth in every population. However, these were all fenced populations, and most were reestablished in the past 20 years and quickly reached capacity (Bauer *et al*. 2015b, pp. 1–2). Populations in eastern Africa decreased overall by 59 percent (Bauer *et al*. 2015a, unpaginated). The Serengeti population was the only large population surveyed that did not decrease. Katavi National Park experienced complete loss of lions from an estimated 1,118 in 1993 to zero in 2014 (Bauer *et al*. 2015a, unpaginated, supporting information Table 3; Bauer *et al*. 2015b, p. 1). Western and central Africa (combined) experienced the largest decline at 66 percent (Table 3). All populations are declining, except the population in Pendjari; populations in Comoé and Mole are now likely extinct (Bauer *et al*. 2015a, unpaginated, supporting information Table 3; Bauer *et al*. 2015b, p. 1). Furthermore, almost all lion populations in Africa that historically exceeded 500 individuals, the minimum number estimated to constitute a viable population (according to Riggio *et al*. 2013, p. 32 and Björklund in Riggio *et al.* 2013, p. 32), are declining (Bauer *et al*. 2015b, p. 1).

Although these trends are based on 47 sample populations, they comprise a substantial portion of the total remaining lion populations; therefore, the authors are confident in applying the observed trends to regions and the species as a whole (Bauer *et al*. 2015a, unpaginated).

Table 3. Regional trends for 47 monitored lion populations from 1993-2014 (Bauer *et al*. 2015a, unpaginated; supporting information Table 7).

Region	Estimated lions in sample populations		Percent change
	1993	2014	
Asia	312	485	+55%
Southern Africa	4,887	5,265	+8%
Eastern	3,112	1,266	-59%

Africa			
Western and Central Africa	1,304	439	-66%
Total	9,615	7,455	-22%

Using these rates of change, the authors calculated that the population in 5 countries (Botswana, India, Namibia, South Africa, and Zimbabwe), or 25 percent of the lion's range, increased by 12 percent, while the population in the remaining 75 percent of the range decreased by 60 percent (Bauer *et al*. 2015a, unpaginated), resulting in a 43 percent population decrease of the entire lion species between 1993 and 2014.

The growth rate estimates discussed above are the best available information on global trends for lion populations, although Bauer *et al*. (2015b, p. 2) caution that these numbers are rough estimates. However, it is unlikely that regional declines are a product of differences in methodological shortcomings. Sample populations are all monitored with at least partial protection. Research sites are known to be generally avoided by poachers and encroachers. Therefore, the estimated growth rates may be less optimistic. It is likely that unmonitored, unfenced populations will have suffered greater rates of decline than reported since lack of management generally means a lack of conservation effort (Bauer *et al*. 2015b, p. 3).

The work of Packer *et al.* (2013a, pp. 639–640) predicts future declines within a number of protected areas. Bauer *et al*. (2015b, p. 2) found that if regional trends remain unchanged in the future, lions in western and central Africa would likely lose a third of their population in 5 years and half of their population in 10 years. The population in eastern Africa is likely to decline by a third in 20 years and half in 30 years. The Okavago population, Botswana, will also

likely decline by a third in 20 years (Bauer *et al*. 2015b, p. 2). Many lion populations are expected to disappear within the next few decades such that the intensely managed populations in southern Africa will replace savanna landscapes as sites for the most successful conservation of lions.

Summary of Threats

Today, lions are mainly restricted to protected areas; however, they still face serious threats that stem from inadequate management of those areas and increasing pressure on natural resources to meet the needs of a growing human population. Habitat loss has been extensive throughout the range of the lion, resulting in local and regional lion population extirpations and a dramatically reduced range with isolated lion populations that are increasingly limited to protected areas. As the human population increases, the protected areas where lions occur will be under increased pressure as more land is needed to satisfy the agricultural needs of the human population.

Inadequate management and law enforcement has led to poaching of the lion's prey base in Africa for bushmeat, which has been critically depleted. Additionally, human population growth in Africa has led to human–lion conflict, particularly on the edge of protected areas, when pastoralists invade protected areas to allow their herds to graze or when lions move out of protected areas in search of prey, often preying on domestic livestock. Human–lion conflict leads to indiscriminate killing of lions, primarily as a result of retaliatory or preemptive actions to protect livestock and human lives. The close proximity of lions to humans and domestic livestock throughout their range exposes them to diseases, mainly transmitted through livestock

and domestic dogs, which can impact general fitness, reproduction, and lifespan. These are in addition to diseases that naturally occur in lion populations in Africa. Furthermore, in some areas of Africa improper management has resulted in reduced lion numbers due to excessive lion harvests from trophy hunting. Subsequently, some lion populations are negatively impacted by infanticide following pride takeovers by new males.

Because habitat loss has resulted in small, isolated populations across its range, lions face threats from stochastic events, such as a disease epidemic and inbreeding depression. An emerging threat to lions is trade in bones and other body parts for traditional medicine. These causes of lion population declines are widespread and likely to continue. The impacts of these threats are likely to be exacerbated by climate change. Projected changes indicate negative impacts to available habitat and, therefore, the range of the lion, prey availability, and the number of disease outbreaks as well as susceptibility to those diseases.

Habitat Loss

Habitat destruction and degradation have been extensive throughout the range of the lion, resulting in local and regional lion population extirpations, reduced lion densities, a dramatically reduced range (see *Range*), and small, fragmented, and isolated lion populations that are increasingly limited to protected areas (see *Distribution and Abundance*) (Singh 2007, in Jhala *et al*. 2009, p. 3384; Ray *et al.* 2005, p. 69; Bauer and Van der Merwe 2004, pp. 29–30; Nowell and Jackson 1996, pp. 20–21). In India, habitat loss is partly responsible for the decline of lions to a single population in a protected area. However, due to good protection and management, lions have dispersed to forested areas outside the protected area, extending their range from an initial

1,883 km^2 to 10,500 km^2 (Johningh *et al*. 2007, Singh 2007, and Divyabhanusinh 2005, in Banerjee *et al*. 2010, p. 248; Singh 2007, in Jhala *et al*. 2009, p. 3384). Farming has been encouraged in the area and has flourished. Cultivated areas have created refuge areas and corridors for lion movement (Vijayan and Pati 2001 in Meena *et al*. 2014, p. 124). At this time, no information indicates habitat loss is currently threatening the lion population in India. In Africa, however, despite lions being mainly found in protected areas, habitat loss and degradation continue to be among the main threats to lions (IUCN 2006a, p. 18; Ray *et al.* 2005, pp. 68–69).

The main cause of lion habitat loss and degradation is expansion of human settlements and activities, particularly due to agriculture and intensive livestock grazing (IUCN 2006a, p. 18; IUCN 2006b, p. 23; Ray *et al.* 2005, pp. 68–69; Chardonnet 2002, pp. 103–106). From 1970 to 2000, the human population in sub-Saharan Africa increased by 126 percent (from 282 million to 639 million) (United Nations (UN) 2013, p. 9), while at about the same time (1975 to 2000), agriculture area increased by 57 percent (from just over 200 million ha to almost 340 million ha) and natural vegetation in the region decreased by 21 percent (Brink and Eva 2009, p. 507). In 2009, approximately 1.2 billion ha, or 40 percent, of Africa's land area was in permanent pasture or crops, with the vast majority (31 percent) in pasture (UNEP 2012b, p. 68). Riggio *et al.* (2013, p. 29) estimate the original extent of savanna habitat in Africa to be approximately 13.5 million km^2. Based on an analysis of land-use conversion and human population densities, Riggio *et al.* (2013, p. 29) found current savanna habitat that is suitable for lions to be fragmented and to total about 3.4 million km^2 (or 25 percent of African savanna habitat). This

indicates a substantial decrease in lion habitat over the past 50 years and explains, in part, why lions are limited to protected areas.

Based on a comparison of land-use and human population data, Riggio *et al.* (2013, p. 23) determined that a density of 25 or more people per km^2 served as a proxy for the extent of land-use conversion that would render habitat unsuitable for lions. Woodroffe (2000, p. 167) analyzed the impact of people on predators by relating local carnivore extinctions to past and projected human population densities and estimated 26 people per km^2 as the mean human density at which lions went locally or regionally extinct. In 1960, 11.9 million km^2 of the original 13.5 million km^2 of savanna habitat had fewer than 25 people per km^2; however, in 2000 that number decreased to 9.7 million km^2 (Riggio *et al*. 2013, p. 29).

Expansion of human settlements, agriculture, and/or livestock grazing are reported as occurring in or on the periphery of several areas identified by Riggio *et al.* (2013, suppl. 1) as lion strongholds (viable populations) and potential strongholds (IUCN 2006a, p. 16; IUCN 2006b, pp. 20–22), and are particularly a threat in western, central, and eastern Africa and some parts of southern Africa. Expansion of agriculture and livestock grazing are reported in or around two of the larger populations of *P. l. leo* in Africa, WAP Complex and a Chad-CAR population (Heschel *et al.* 2014, pp. 5–6; Houessou *et al.* 2013, entire; Chardonnet *et al.* 2010, pp. 24–26; IUCN 2008, pp. 8, 28–29); management in portions of both is reported as weak (Heschel *et al.* 2014, pp. 5–6; IUCN 2008, p. 8). Eastern Africa contains approximately 40 percent of all the lions in Africa (Table 2). Seven of the seventeen major *P. l. melanochaita* populations identified by Riggio *et al.* occur in eastern Africa; six of which occur in Tanzania

and Kenya. Between 1990 and 2010, Kenya's human population grew from 23 million (40/km^2) to 41 million (70/km^2), whereas Tanzania's grew from 25 million (27/km^2) to 45 million (48/km^2) (UN 2013, pp. 421, 798). Not unexpectedly, expansion of agriculture and livestock grazing is occurring in these countries (Brink *et al.* 2014, entire; UNEP 2009, p. 91; Mesochina *et al.* 2010a, p. 74), including in or around these major populations (Ogutu *et al.* 2011, entire; Mesochina *et al.* 2010a, pp. 71–74, 76; Packer *et al.* 2010, pp. 8–9; UNEP 2009, pp. 98–99; Newmark 2008, pp. 322–324; IUCN 2006b, pp. 20–22; Ogutu *et al.* 2005, entire). Mesochina *et al.* (2010a, p. 74) state that widespread destruction of wildlife habitat and human encroachment in wildlife corridors are major threats to lion conservation in Tanzania and consider loss of suitable habitat as a top threat to lion survival in the country. The Kenya Wildlife Service indicates that habitat loss due to land-use changes and human encroachment into previously wild areas is having a major impact on lion range size in Kenya (Kenya's National Large Carnivore Task Force 2010, p. 21).

In southern Africa, the extent of current habitat destruction and degradation appears to vary widely. For example, according to the Zambia Wildlife Authority (2009 pp. 4–5), unplanned human settlement and other land-use activities in game management areas are a major threat to the long-term survival of the lion in Zambia. They note that conversion of natural habitat in game management areas for cropping and grazing of livestock has led to habitat destruction and indicate that elimination of tsetse flies and subsequent increase in pastoralist activities in game management areas places the lion under renewed direct conflict with humans. On the other hand, according to Funston (2008, pp. 123–126), in several areas of southern Africa

where lions were recently extirpated, lions are reestablishing as a result of, among other factors, adequate protection of habitat and prey.

Projections of future growth in human populations, areas converted to agriculture, and livestock numbers suggest suitable lion habitat will continue to decrease across its range into the foreseeable future. Between 2015 and 2050, half of the world's population growth is expected to occur in 9 countries, 6 of which are within the lion's range (India, Nigeria, Democratic Republic of the Congo (DRC), Ethiopia, Tanzania, and Uganda (UN 2015, p. 4). Africa has the fastest population growth rate in the world (UN 2015, pp. 3, 9; UNEP 2012a, p. 2), and future population growth in sub-Saharan Africa is projected to be large and rapid (UN 2013, p. 9). By 2100, Angola, Burundi, DRC, Malawi, Mali, Niger, Somalia, Uganda, Tanzania and Zambia are projected to increase by at least five-fold (UN 2015, p. 9).

By 2050, the UN projects the human population of Tanzania to almost triple its 2010 population, reaching a density of 137 people per km^2, whereas Kenya's population is projected to more than double, reaching a density of 167 people per km^2 (Table 4). Human population growth, and resulting pressures exerted on habitat, are also expected to vary widely in the southern region. Population increases from 2010 to 2050 are projected to range from about 23 percent (South Africa) to well over 200 percent (Zambia), with 2050 densities in the region ranging from 5 people per km^2 (Botswana and Namibia) to 432 people per km^2 (Uganda) (Table 4). The human populations of most other current and recent lion range countries are also expected to have very high growth rates (Table 4). The country-wide human population densities provided here (and in Table 4) are not directly comparable to the density thresholds

determined by Riggio *et al.* (discussed above) due to the differences in scale at which they were made. However, country-wide population densities relate the number of humans to land area and, consequently, are indicative of the level of pressure that will exist to convert land to uses that will meet the needs of the human population. This situation is particularly the case given that much of sub-Saharan Africa is rural and locals depend on agriculture for their livelihood.

Table 4. Human population projections in countries containing the 47 sample lion populations used by Bauer *et al*. (2015), except Côte d'Ivoire and Ghana where lions are considered extirpated. Population data is from UN 2013.

		UN Population Estimate, in Thousands (people/km^2)			
Subspecies	**Country**	**1950**	**2010**	**2050**	**2100**
P. l. leo					
	India	376,325 (114)	1,205,625 (367)	1,620,051 (493)	1,546,833 (471)
	Benin	2,255 (20)	9,510 (84)	22,137 (197)	32,944 (293)
	Burkino Faso	4,284 (16)	15,540 (57)	40,932 (149)	75,274 (275)
	Cameroon	4,467 (9)	20,624 (43)	48,599 (102)	82,393 (173)
	Nigeria	37,860 (41)	159,708 (173)	440,355 (477)	913,834 (989)
	Senegal	2,477 (13)	12,951 (66)	32,933 (167)	58,180 (296)
P. l. melanochaita					
	Kenya	6,077 (10)	40,909 (70)	97,173 (167)	160,423 (276)
	Tanzania	7,650 (8)	44,973 (48)	129,417 (137)	275,624 (292)
	Botswana	413 (1)	1,969 (3)	2,780 (5)	3,025 (5)
	Mozambique	6,442 (8)	23,967 (30)	59,929 (75)	112,018 (140)
	Namibia	485 (1)	2,179 (3)	3,744 (5)	4,263 (5)
	South Africa	13,683 (11)	51,452 (42)	63,405 (52)	64,135 (53)
	Uganda	5,158	33,987	104,078	204,596

		(21)	(141)	(432)	(849)
	Zambia	2,372 (3)	13,217 (18)	44,206 (59)	124,302 (165)
	Zimbabwe	2,747 (7)	13,077 (33)	26,254 (67)	32,608 (83)

Although urbanization is increasing in sub-Saharan Africa, the majority of the population is rural (UN 2014, p. 20). About 60–70 percent of the sub-Saharan population relies on agriculture and livestock for their livelihood (UNEP 2006, pp. 82, 100, 106; IAASTD 2009, p. 2). Much of the agriculture and livestock-raising is at subsistence level (IAASTD 2009, pp. 8, 28). As a result, a large portion of the growing population will depend directly on expansion of agriculture and livestock grazing to survive. Between 2010 and 2050, the population of sub-Saharan Africa is projected to more than double to more than 2 billion (from 831 million to 2.1 billion) (UN 2013, p. 9). During about this same time period (2005 to 2050), the area of cultivated land is projected to increase by 51 million ha (approximately 21 percent) (Alexandratos and Bruinsma 2012, p. 107). However, this figure does not include range land, and the majority of agricultural land in Africa is devoted to grazing (UNEP 2012b, p. 68). The number of livestock (cattle, sheep, and goats) in sub-Saharan Africa is projected to increase about 73 percent, from 688 million to 1.2 billion, by 2050 (Alexandratos and Bruinsma 2012, p. 133).

Expansion of human settlements and activities into lion habitat renders the habitat unsuitable for lions primarily because it results in reduced availability of the wild prey that lions depend on for survival (see *Loss of Prey Base*) and increased human–lion conflict resulting in lion mortality (see *Human–Lion Conflict*)—two of the main factors that influence the distribution

and population viability of large carnivores such as lions (Winterbach *et al.* 2014, p. 1; Riggio *et al.* 2013, p. 18). Ray *et al.* (2005, p. 69) note that, although lions have a wide tolerance for habitats, they are generally incompatible with humans and human-caused habitat alteration and loss; they are the least successful large African carnivore outside conservation areas (Woodroffe 2001, in Winterbach *et al.* 2012, p. 6). Further fragmentation and isolation of lion habitat and populations can also impact dispersal and genetic viability (see *Deleterious Effects Due to Small Population Sizes*).

Large carnivores with low potential for cohabitation with humans have a high risk of local extinction. In order to survive, they require larger contiguous habitats with fewer negative human impacts than do more resilient species (Winterbach *et al.* 2012, p. 5). As human populations continue to rise in sub-Saharan Africa, the amount of land required to meet the needs of those populations is constantly increasing (Brink *et al.* 2014, entire; Brink and Eva 2009, entire; Eva *et al.* 2006, p. 4), a problem accentuated by slow rates of technological progress in food production and land degradation from both overuse and natural causes (United Nations Environment Programme (UNEP) 2012a, p. 3; Chardonnet *et al.* 2010a p. 19; International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD) 2009, pp. 3–4, 8; United Nations Economic Commission for Africa 2008, pp. 3–5). The result of this process is accelerated transformation of natural landscapes at the expense of wilderness that sustains species such as lions and their prey (Chardonnet *et al.* 2010a p. 19).

Urbanization is also increasing in India, but like sub-Saharan Africa, the majority of the population is rural (UN 2014, p. 22; Swain *et al*. 2012, p. 1). In the State of Gujarat, 70 percent

of all workers are rural based, with almost 52 percent being cultivators and agricultural laborers (Swain *et al*. 2012, p. 1). Suitable lion habitat within the Gir Protected Area appears to be secure; however, habitat outside this area that is vital for dispersal may experience increasing pressure in the future. Dispersal corridors and resource-rich habitats outside the protected area are important to avoid inbreeding depression and extirpation of the lion population from stochastic events. Due to the population growth of lions in India, there is increased movement, dispersal, and establishment of lion in natural habitats outside the protected area. Twenty-five percent of the lion population is found in Girnar Wildlife Sanctuary, coastal areas, and natural habitats along the Shetrunji River northeast of Gir (Meena 2014, p. 27). Additionally, the size of the Gir Protected Area implies that dispersing lions will inevitably cross the protected area boundaries (Meena 2010, p. 212). When lions move, they must cross heavily populated human settlements and agricultural fields (Meena 2010, p. 209). Traditional land uses are quickly changing in the region due to limestone mine and infrastructure development (Banerjee *et al*. 2010, p. 250). Additionally, tourist activities (safaris to see the lions and religious pilgrimages to visit temples located within and on the border of protected areas) can have detrimental impacts to wildlife if not carefully planned. For example, construction of a road has been proposed to circle the outside of the whole Gir Protected Area System (Meena 2014, p. 28). Altering this habitat would result in land-use changes, promoting rapid development and urbanization and thereby disconnecting corridors for lion movement (Meena 2014, p. 28; Banerjee *et al*. 2010, p. 250). Furthermore, crossing these areas renders lions more vulnerable to disease transmission (See *Disease* below) and conflict with humans (see *Human–Lion Conflict* below). Because lions are social and territorial, they need adequate space to survive. Lack of adequate habitat will have a bearing on the lion's ecology, behavior, and population structure (Meena 2014, p. 28).

Growing human populations have been associated with declines in large carnivore populations all over the world, and high human density is strongly associated with local extirpation of large carnivores (Linnell *et al.* 2001, Woodroffe 2001, in Woodroffe and Frank 2005, p. 91; Woodroffe 2000, entire). Chardonnet *et al.* (2002, p.103) indicate that the distribution maps of lion subpopulations tend to confirm a direct inverse correlation of lion density and numbers with human activity and presence. Further, Packer *et al.* (2013a, entire) found that lions in unfenced reserves are highly sensitive to human population densities in surrounding communities.

Loss of Prey Base

One of the most important requirements for carnivore survival, including lion, is prey availability, as it affects reproduction, recruitment, and foraging behavior and, therefore, also impacts lion movement, abundance, and population viability (Winterbach *et al.* 2012, p. 7, citing several sources). In India, prey abundance does not appear to be a concern for the lion population as conservation initiatives have ensured availability of ample prey (Banerjee *et al*. 2010, p. 249; Khan *et al*. 1996 and Singh and Kamboj 1996 in Meena 2010, p. 209; Jhala *et al*. 2009, p. 3384). The semi-nomadic pastoral communities that inhabit the Gir Forests are primarily vegetarian (Banerjee *et al*. 2013, p. 2); therefore, there is no great demand for bushmeat. However, in most African countries, large carnivores such as lions are under serious threat through decreased prey abundance (Bauer *et al*. 2014, p. 97) due to unsustainable and increasingly commercialized bushmeat hunting in and around protected areas (Bauer *et al*. 2015a, unpaginated; Henschel *et al*. 2015, unpaginated; Henschel *et al*. 2014, p. 5; Lindsey *et al*.

2013b, p. 84; Lindsey and Bento 2012, pp. 1–2, 61; Scholte 2011, p. 7; Bouché *et al*. 2010, pp. 1000, 1001; Cragie *et al*. 2010, p. 2227; Brashares *et al*. 2004, p. 1181; Fischer and Linsenmair 2001, pp. 132, 133).

Humans in Africa rely on protein obtained from bushmeat, resulting in direct competition for prey between humans and lions, and commercial poaching of wildlife is becoming a significant threat to many species, including those that lions rely upon for food. Subsistence hunting was traditionally carried out with the use of spears, which had minimal impact to wildlife populations. Spears have since been replaced by automatic weaponry (Chardonnet *et al*. 2010, p. 27) and snares, which are most commonly used (Lindsey *et al*. 2013b, p. 83). These methods allow for poaching of large numbers of animals for the bushmeat trade, particularly snares, which are cheap, difficult to detect, and unselective as they can kill nontarget animals ranging from rodents to elephants (Lindsey *et al*. 2013b, p. 83).

The human population in a majority of African countries within the range of the lion has quadrupled since the 1960s (Riggio *et al*. 2013, p. 29; IUCN 2009, p. 15), increasing the demand for bushmeat. Bushmeat contributes significantly to food security, and is often the most important source of protein in rural areas (Nasi *et al*. 2008 in Lindsey *et al*. 2013b, p. 82). It comprises between 6 percent (southern Africa) and 55 percent (CAR) of a human's diet within the lion's range in Africa (Chardonnet *et al.* 2005, p. 9; IUCN 2006b, p. 19). In western Africa, bushmeat is a secondary source of protein, with fish being the primary source. However, when widespread loss of jobs and income occurs due to poor fish harvests, bushmeat becomes an

important source of income and sustenance, leading to increased presence of hunters in protected areas and higher than average declines in wildlife (Brashares *et al*. 2004, pp. 1180–1181).

The sale of bushmeat is an important livelihood in Africa (Chardonnet *et al*. 2010, p. 27; Mesochina *et al*. 2010a, p. 38; Abwe and Morgan 2008, p. 26; Bennett *et al*. 2007, p. 885; Fa *et al*. 2006, p. 507). The little meat produced from domestic livestock is unaffordable for common people (Bouché *et al*. 2010, p. 1001). Bushmeat hunting is rarely practiced solely for subsistence. It supplies meat for local consumption and trade, urban markets, and even international markets (Lindsey *et al*. 2013b, pp. 86–87). Outlets for the sale of bushmeat have arisen in some areas, and full-time commercial bushmeat traders occur in most southern and eastern African countries (Lindsey *et al*. 2013b, p. 86). Significant distribution of bushmeat to Europe and the United States, where it is sold at elevated prices, drives increasing commercialization of trade, a greater number of hunters, adoption of more efficient hunting methods, and an unprecedented pressure on wildlife populations (Stiles 2011 and Barnett 2000 in Lindsey *et al*. 2013b, p. 88). Many illegal hunters are poor (Barnett 2000 in Lindsey *et al*. 2013b, p. 88; Lindsey and Bento 2012, p. 37; Scholte 2011, p. 7). Bushmeat trade can provide a quick income to purchase other food and essentials (Lindsey *et al*. 2013b, p. 82; Lindsey and Bento 2012, p. 62). Hunters are wealthier than non-hunters (Knapp 2007 in Lindsey *et al*. 2013b, p. 86) and enjoy elevated social status.

This growing demand and the availability of modern weapons have led to many African wildlife species being hunted at unsustainable levels and the lion prey base becoming depleted in many areas (Hoppe-Dominik *et al.* 2011, p. 452; Chardonnet *et al.* 2010, pp. 6, 13–14, 27;

Packer *et al.* 2010, p. 8; Frank *et al.* 2006, p. 12). Because wildlife has been depleted in non-protected areas, illegal bushmeat hunters are increasingly focusing efforts on protected areas (Lindsey *et al*. 2013b, p. 84). Weak management effectiveness and inadequate law enforcement have facilitated poaching for bushmeat in protected areas and resulted in a widespread decrease in large mammal populations, including lion prey, in these areas (Henschel *et al*. 2015b, unpaginated; Henschel *et al*. 2014, pp. 5, 7; Lindsey *et al*. 2013b, pp. 84, 88; Lindsey and Bento 2012, p. 61; Scholte 2011, p. 7; Bouché *et al*. 2010, pp. 99, 1001; Brashares *et al*. 2004 in Craigie *et al*. 2010, p. 2227; Fischer and Linsenmair 2001, p. 134).

Significant decreases in prey abundance have occurred in protected areas throughout Africa (Lindsey *et* al. 2013b, pp. 84, 85; Scholte 2011, pp. 2, 8; Craigie *et al*. 2010, p. 2225); Botswana (Bauer *et al*. 2014, pp. 101, 103); CAR (Bouché *et al*. 2010, pp. 99, 1000; Roulet 2004 in Bouché *et al*. 2010, p. 1002); Chad (Potgieter *et al*. 2009 in Bouché *et al*. 2010, p. 1002); Côte d'Ivoire (Fischer and Linsenmair 2001, p. 134); DRC (Martin and Hillman-Smith 1999 in Bouché *et al*. 2010, pp. 1001–1002); Ghana (Brashares *et al*. 2004, p. 1182); Kenya (Western *et al*. 2009, pp. 2, 3, 4); Mozambique (Lindsey and Bento 2012, p. 63); Sudan (UNEP 2006 in Bouché *et al*. 2010, p. 1001); Zambia (Simasiku *et al*. 2008 in Lindsey *et al*. 2013b, p. 84); and Zimbabwe (Zimbabwe Parks and Wildlife Management Authority 2015, p. 9). Bouché *et al*. (2010, p. 1001) found that large wilderness areas spanning the boundaries of Chad, CAR, DRC, and Sudan suffered depleted wildlife abundance. Lindsey *et al*. (2013b, p. 84) concluded that the case studies represented only a tiny fraction of the areas in savannas that are severely impacted by bushmeat hunting. Craigie *et al*. (2010, p. 2226) stated their study might underestimate the extent of decline that has occurred in Africa's protected areas because data came from sites with

resources to carry out long-term monitoring programs and increased management may be associated with greater capacity to address threats.

Low lion population densities have been found to correspond with low prey densities (Van Orsdol *et al.* 1985, Hayward *et al.* 2007 in Bauer *et al*. 2015a, unpaginated; Bauer *et al*. 2014, p. 103; Bauer *et al*. 2010, p. 363). Regional trends in lion populations, as discussed above, mirror regional trends in herbivore populations in western, eastern, and southern Africa between 1970 and 2005 (Bauer *et al*. 2015a, unpaginated; Henschel *et al*. 2015, unpaginated). Overall, Craigie *et al.* (2010, p. 2225) found a 59 percent decline in large mammal populations. Regional differences in herbivore population abundance were also detected. While population sizes in southern Africa increased by 24 percent, they declined by 52 percent and 85 percent in eastern and western Africa, respectively (Craigie *et al.* 2010, p. 2225).

Continent-wide decreases in prey abundance in African protected areas are driven by human population growth (Craigie *et al*. 2010, p. 2225), especially along the boundaries of protected areas where human population growth rates are high, encroachment and habitat loss occurs, and people are dependent on bushmeat. Protected areas in Ethiopia, Mozambique, Tanzania, and Zambia are increasingly settled (Lindsey *et al*. 2013b, pp. 87, 88; Lindsey and Bento 2012, p. 64; Scholte 2011, p. 7). Hunting is more prevalent close to borders and near human settlements as the longer the distance, the more time, effort, and cost is needed to find and transport meat; the chances of detection are also increased with distance (Lindsey *et al*. 2013b, pp. 84, 88; Brashares *et al*. 2001, p. 2475). Additionally, communities often retain livestock as assets and rely on bushmeat for daily protein needs (Barnett 2000 in Lindsey *et al*. 2013b, p. 88).

Furthermore, many communities lack the rights over land and in most cases in Botswana, Tanzania, Zambia, and Zimbabwe, the government retains a significant portion of revenue from wildlife; therefore, those that bear the costs of wildlife do not receive benefits, and bushmeat hunting is the only way to benefit from wildlife (Lindsey *et al*. 2013b, p. 88).

Throughout the African range countries, hunting of wildlife is regulated by various laws and regulations and harvests are controlled through permitting systems and quotas (Lindsey *et al*. 2013b, pp. 82–83). In many countries, the use of snares, poison, and automatic weapons, among other methods, is prohibited. Single-shot firearms, muzzle-loading firearms, shot guns, and bows and arrows are legal under certain circumstances when permitted, and in some cases specific calibers and bow strengths are given depending on the species being hunted (Lindsey *et al*. 2013b, p. 82). Hunting laws also specify hunting seasons and prohibit hunting in certain protected areas, hunting certain species, and hunting young or pregnant animals. Therefore, bushmeat hunting is illegal in most situations due to violations of one or more of these restrictions (Lindsey *et al*. 2013b, p. 83). However, penalties for violations are inadequate and do not inhibit illegal bushmeat hunting. Penalties typically comprise warnings, community service, or fines that are often lower than the value of the meat, or the hunter is not penalized at all. Many governments lack the will and most state wildlife agencies lack the resources or expertise to effectively enforce laws (Lindsey *et al*. 2013b, p.88). Some government officials and police are known to purchase bushmeat, despite it coming from an illegal source, which further contributes to ineffective regulation of illegal hunting (Lindsey and Bento 2012, p. 63). Given the widespread and significant decrease in lion prey throughout its range in Africa, it is apparent that enforcement of laws and regulations is not adequate. Additionally, weak

management of protected areas has caused declining prey populations (Henschel *et al*. 2015, unpaginated; Henschel *et al*. 2014, pp. 5–6; Craigie *et al*. 2010, entire).

The human population in the developing world is projected to increase rapidly, suggesting human pressure on protected areas will also increase (Lindsey *et al*. 2013b, p. 84; Brashares *et al*. 2001, p. 2475). Without intervention, wildlife resources will be lost in many areas with severe ecological impacts (Lindsey *et al*. 2013b, p. 84). Because lion densities closely mirror prey densities, we can expect that lion populations will also be lost in Africa.

Human–lion Conflict

The lion population in and around the Gir Protected Area, India, lives among and is surrounded by many pastoral and forest settlements (Banerjee and Jhala 2012, p. 1421; Singh and Gibson 2011 in Banerjee and Jhala 2012, p. 1421; Banerjee *et al*. 2010, p. 249; Singh 2007 in Jhala *et al*. 2009, p. 3385). The lion population of Gir has increased and dispersed into the large agro-pastoral area adjacent to the protected area. Only 10 percent of lions in India occur in the human-free portion of Gir National Park (Banerjee *et al*. 2013, p. 8). Conflict there, like in Africa, arises from predation of livestock and associated threats to security of pastoral livelihoods (Karanth and Chellam in Banerjee *et al*. 2013, p. 1). The lion's diet there includes livestock (Banerjee *et al*. 2013, p. 6; Meena *et al*. 2011, pp. 63–65). Between 2001 and 2010 the number of villages reporting depredation of livestock increased (Meena *et al*. 2014, pp. 122–123). Additionally, Meena (2012, p. 36) found that in all Forest Divisions, except Gir West, annual livestock predation increased more than 100 percent in 5 years. However, despite the lion's close occupation with human settlements and increased predation on livestock, human–

lion conflict and associated retaliatory killing was not found to be a major source of lion mortality (Pathak *et al*. 2002 in Banerjee and Jhala 2012, p. 1427), mainly due to low economic losses via certain husbandry practices and a compensation scheme (Meena *et al*. 2014, pp. 123, 124; Banerjee *et al*. 2013, pp. 6–7, 8), cultural ethics (Raval 1991 in Banerjee *et al*. 2013, p. 2; Banerjee *et al*. 2013, p. 8), and strict legal enforcement (Banerjee *et al*. 2013, p. 8). Although some lions have been killed (Meena 2008 and Meena *et al*. 2007 in Meena 2010, p. 211), the lion population remained stable between 2001 and 2010 (Meena *et al*. 2014, p. 123).

Although human–lion conflict is not currently considered a threat to the lion population in India due to tolerance of lion presence by the pastoralist community (Banerjee *et al*. 2013, pp. 1–2, 8; Pathak *et al*. 2002 in Banerjee and Jhala 2012, p. 1427), human-caused mortality is likely to increase in the future due to increased human–lion conflict and will be a major threat to the persistence of the lion population (Banerjee and Jhala 2012, p. 1428). Similar to the observed transition in the Maasai community in eastern Africa, traditional value systems of pastoralists in India are rapidly changing under the influence of globalization and free markets. The younger generation is becoming less tolerant to even small monetary losses. These changes in attitudes will likely result in less tolerance of livestock loss to lions (Banerjee *et al*. 2013, p. 8). An indefinite increase in humans and livestock within Gir Forests would upset the current balance by altering forest composition or population dynamics of prey species and would be detrimental to conservation (Banerjee *et al*. 2013, p. 8). Furthermore, with an expanding lion population that disperses and uses habitat in agro-pastoral areas densely populated with human villages, there is an increased potential for human–lion conflict (Meena 2010 and Singh 2007 in Meena *et al*. 2014, pp. 120, 121). Due to high human density and demand for land, most human-free

protected areas in India, and elsewhere, are too small to hold viable populations of large carnivores for the long term (Narain *et al*. 2005 and Karanth 2003 in Banerjee *et al*. 2013, p. 8).

Human–lion conflict and associated retaliatory killing of lions has played a major role in the reduction of lion populations throughout Africa (Lion Guardians 2013, p. 1; Lion Guardians 2011, p. 2; Hazzah and Dolrenry 2007, p. 21; Frank *et al*. 2006, p. 1; Patterson *et al.* 2004, p. 508) and is a threat to remaining lion populations (Bauer *et al*. 2010, p. 363; Hazzah *et al.* 2009, p. 2428; Moghari 2009, p. 31; Kissui 2008, p. 422; Frank *et al.* 2006, pp. 1, 3, 10; Ray *et al.* 2005 in Hazzah 2006, p. 2; IUCN 2006b, p. 18). Conflict between humans and wildlife has been linked to population declines, reduction in range, impacts to small population demographics, and even species extinctions (Dickman 2013, p. 377; Sogbohossou *et al*. 2011, p. 61; Begg and Begg 2010, p. 2; Hazzah *et al.* 2009, p. 2428; Moghari 2009, p. 36; Kissui 2008, p. 422; Hazzah 2006, pp. 15, 23, 25).

Human–lion conflict stems from human population growth and the resulting overlap of humans and wildlife habitat, with associated livestock encroachment and decreasing availability of prey (Hoppe-Dominik *et al.* 2011, p. 452; Chardonnet *et al.* 2010, pp. 6, 13–14; Frank *et al.* 2006, p. 12; Hazzah 2006, pp. 14, 15). Lion populations are increasingly restricted to protected areas due to human expansion and associated expansion of livestock husbandry and agricultural activities. Despite being within protected areas, lions, due to their large home range, often range beyond protected area borders where they are exposed to and impacted by people living on adjacent land. Therefore, most conflict occurs at protected area boundaries (Henschel 2015, pers. comm.; Woodroffe and Ginsberg 1998, p. 2126). It is along these borders that villages are

often established and human encroachment occurs due to conversion of natural habitats for agriculture and grazing livestock, which increases the chance of human–lion encounters (Sogbohossou *et al*. 2011, pp. 51, 62; Chardonnet *et al*. 2010, p. 23; Mesochina *et al*. 2010a, p. 39; Mesochina *et al*. 2010b, p. 33; Moghari 2009, p. 14). Furthermore, cattle herders enter the protected areas, and lions move beyond the borders of protected areas in search of food, increasing interactions between humans and lions and the risk of human–lion conflict (Burkina Faso 2014, pp. 19–20, 21; Hazzah *et al.* 2013, p. 1; Republic of Namibia 2013, p. 13; Bauer *et al*. 2010, p. 365; Chardonnet *et al.* 2010, pp. 11–12; Mesochina *et al.* 2010a, p. 39; Mesochina *et al.* 2010b, p. 33; Packer *et al.* 2010, pp. 2, 6; Gebresenbet *et al.* 2009, p. 9; Moghari 2009, pp. 1, 14, 25, 26, 78; Kissui 2008, p. 422; Hazzah 2006, p. 2). Hunting zones are thought to serve as buffers; however, these areas are not adequate as a low density of competitors in these areas may attract wildlife, including lions, which further disperse into villages, causing conflicts (Sogbohossou *et al*. 2011, p. 51). Lion attacks can have various impacts on those communities that coexist with conflict-causing animals, generating resentment towards them. When lions in Africa cause or are perceived to cause damage to livestock, property, or people, the response is generally to kill them (Dickman 2013, pp. 378–379; Moghari 2009, p. 25; Frank *et al.* 2006, p. 1).

Attacks on Livestock in Africa

The most significant cause of human–lion conflict is livestock depredation. In addition to bushmeat trade, the demand for food to meet increasing needs of a growing population has been met by intensified agriculture and livestock practices (Chardonnet *et al*. 2010, p. 19). As natural habitats are converted to agricultural or pastoral land, the lion's natural prey base is further reduced (Chardonnet *et al*. 2010, p. 27; Gebresenbet *et al*. 2009, p. 9). As a result of prey

species becoming depleted in many areas, lions seek out livestock (and in some cases, humans) for food (Zimbabwe Parks and Wildlife Management Authority 2015, p. 9; Burkina Faso 2014, p. 20; Hoppe-Dominik *et al.* 2011, p. 452; Chardonnet *et al.* 2010, pp. 6, 13–14, 27; Gebresenbet *et al*. 2009, p. 9; Moghari 2009, pp. 78, 83; Frank *et al.* 2006, p. 12; Hazzah 2006, pp. 17–18; Patterson *et al.* 2004, pp. 507, 514). Therefore, lion attacks occur at the highest frequency in areas where natural prey abundance is lowest (Packer *et al.* 2010, p. 9; Frank *et al.* 2006, pp. 9, 12; Patterson *et al.* 2004, p. 507).

Pastoralists allow increasing numbers of livestock to graze in and adjacent to protected areas, and villagers farm up to the boundaries of protected areas, subjecting livestock and humans to lions and increasing the risk of predation and the number of livestock lost to predation (Brugiére *et al*. 2015, p. 514; Bauer *et al*. 2014, p. 98; Burkina Faso 2014, pp. 19–22; Hazzah 2013, p. 1; Chardonnet *et al*. 2010, pp. 11-12; Uganda Wildlife Authority 2010, p. 27; Moghari 2009, pp. 1, 90). Additionally, poor husbandry practices and grazing of livestock within or adjacent to protected areas increase exposure of livestock to lions and increase livestock loss (Uganda Wildlife Authority 2010, p. 27; Woodroffe and Frank 2005 in Moghari 2009, p. 35; Hazzah and Dolrenry 2007, pp. 22–23). Furthermore, conversion of rangeland to agricultural use has blocked several migratory routes for Tanzania's wildebeest and zebra populations, which likely forces lions to rely more on livestock (Packer *et al*. 2010, p. 9). Because most protected areas are too small to support a lion's large home range, adjacent dispersal areas are often used for supplementary food, putting them in greater contact with livestock and humans (Kissui 2009, p. 422; Moghari 2009, p. 27). Conditions worsen as livestock numbers and area under cultivation increase, leading to overgrazing, further habitat destruction, and greater depredation

rates (Gebresenbet *et al*. 2009, p. 9; Hazzah 2006, p. 61; Frank *et al*. 2005, Ntiati 2002, Mishra 1997, Meriggi and Lovari 1996, Rao 1996, Mech *et al*. 1988 in Hazzah 2006, p. 18).

The use of fences to subdivide rangeland interferes with traditional wet and dry season grazing schedules for livestock and wildlife (Hazzah 2006, pp. 58–59). Restricting wildlife movement reduces wild prey and, when combined with an increase in livestock numbers, increases the rate of human–lion conflict (Hazzah 2006, pp. 59, 61). Although well-built bomas (a livestock enclosure) can effectively constrain cattle and keep predators out (Frank et al. 2006, p. 8), they are traditionally built to keep livestock confined, but do not offer effective protection from predators (Moghari 2009, p. 35). In the absence of reliable methods for protecting livestock, some amount of depredation can be expected, and some lions can become habitual livestock killers (Frank *et al*. 2006, p. 9).

Rates of livestock depredation vary with regional rainfall that correlate with prey availability, including changes in herding strategies, movement of prey, and movement of lions (Lion Guardians 2011, p. 6; Moghari 2009, p. 32; Hazzah 2006, pp. 17, 18; Patterson *et al.* 2004, p. 514). For example, in some parts of Zimbabwe, Kenya, and Tanzania, livestock losses occur during the dry season. During this time, herders travel farther for forage and water, they use temporary bomas that are typically weak, they are unfamiliar with carnivore movements in these new areas, and livestock are weak due to disease, which makes them more vulnerable to predator attacks by lions (Hazzah 2006, p. 17). Additionally, herders are dependent on resources within protected areas, and livestock may be left to wander for days or weeks during a prolonged drought to find forage, increasing opportunities for attacks on livestock by lions (Sogbohossou *et*

al. 2011, p. 44; Chardonnet *et al.* 2010, p. 24; Frank *et al.* 2006, p. 6). In Benin, other parts of Kenya, the Maasai Steppe region of Tanzania, and Queen Elizabeth National Park, Uganda, livestock losses were greater during or following the rainy season (Sogbohossou *et al*. 2011, p. 49; Moghari 2009, p. 88; Kissui 2008, pp. 427, 428; Frank *et al.* 2006, p. 6; Patterson *et al.* 2004, pp. 510, 514). Weakened prey and readily available carcasses provide easy meals during times of drought, and wild herbivores tend to concentrate near available water sources, making them easier to prey on and leading to fewer livestock attacks. However, when rains return, the abundant grass makes wild prey harder to catch, and lions may turn to livestock. Migratory prey species such as zebra and wildebeest will move to other areas for forage and replenished water sources, leaving lions to turn to livestock as an alternate food source. Migratory prey may also move outside of protected areas. Opportunities for livestock predation on communal land increase when lions follow migratory prey out of protected areas (Sogbohossou *et al*. 2011, p. 50; Packer *et al.* 2010, p. 9; Kissui 2008, p. 427; Patterson *et al.* 2004, p. 514; Frank *et al.* 2006, p. 6).

Traditional livestock husbandry practices are effective at reducing depredation of livestock by lions (Chardonnet *et al.* 2010, p. 35; Moghari 2009, p. 35; Frank *et al.* 2006, p. 2; Hazzah 2006, p. 22). These practices include livestock being closely herded by men and dogs during the day and being brought into bomas at night with people living in huts around them (Frank *et al.* 2006, p. 4). However, traditional practices are being replaced by less diligent husbandry practices, which is increasing conflict (Woodroffe and Frank 2005 in Moghari 2009, p. 35; Frank *et al.* 2006, pp. 2, 10; Hazzah and Dolrenry 2007, p. 23). In Botswana, livestock are often left to wander outside bomas at night (Frank *et al.* 2006, p. 5). In Kenya and Tanzania,

social changes are altering traditional Maasai pastoral livelihoods, reducing dependency on livestock, and reducing traditional livestock care and management, leaving livestock more vulnerable to predation (Chardonnet *et al.* 2010, p. 35; Hazzah and Dolrenry 2007, pp. 22–23). Young Maasai boys traditionally guarded herds at night; however, increased access to schools has left herds unattended to wander into predator areas at night (Chardonnet *et al.* 2010, p. 35).

In the Pendjari area of Benin, traditional enclosures are low with few branches. These structures and the lack of enclosures encourage livestock predation (Butler 2000, Mazzolli *et al*. 2002, and Wang and Macdonald 2006 in Sogbohossou *et al*. 2011, p. 51). Surveillance of a main pasture area south of Waza National Park in Cameroon and improved enclosures around Waza National Park and Pendjari National Park, Benin, led to a significant decrease in depredation (Bauer *et al*. 2010, p. 365). However, people do not invest much into improving enclosures even though they appear to be economically efficient, ecologically effective, and culturally acceptable. Even enclosures that were built as part of a conservation project were not used full time due to lack of labor and, in some cases, the herd being too large for the enclosures (Bauer *et al*. 2010, p. 365).

Attacks on Humans in Africa

Although lions generally avoid people, they will occasionally prey on humans, causing serious injury or death (Dickman 2013, pp. 380, 384; Chardonnet *et al.* 2010, pp. 11, 12, 13; Moghari 2009, pp. 14, 49, 26, 88; Bauer *et al.* 2001 in Moghari 2009, pp. 31, 78, 84; Frank *et al.* 2006, p. 1; Hazzah 2006, pp. 14, 17; Patterson *et al.* 2004, p. 507). Attacks on humans appear to be more frequent in southern and eastern Africa and rare in western and central Africa (Bauer *et al*. 2010, p. 363; Chardonnet *et al.* 2010, pp. 12, 13; Mesochina *et al.* 2010a, pp. 29–30; Frank *et*

al. 2006, pp. 1, 10), although attacks on humans have been reported in Burkina Faso (Burkina Faso 2014, pp. 19, 22). Environmental factors such as vegetative cover, habitat, climate, seasonality, and prey availability may affect the rate of attacks on humans. A certain amount of vegetative cover is crucial for lion's hunting success; however, in some cases, the vegetative cover may make it more difficult to catch prey, leading to more attacks on humans. Additionally, dense cover near settlements allows lions to hide or stalk humans at a close distance (Mesochina *et al.* 2010a, p. 39; Moghari 2009, p. 85; Frank *et al.* 2006, p. 12).

Provoked attacks on humans are usually associated with someone approaching a lion too closely or trying to injure or kill it and stealing a lion's prey for bushmeat (Chardonnet *et al.* 2010, p. 14; Uganda Wildlife Authority 2010, p. 27). Unprovoked attacks are usually associated with old, sick, or injured lions that turn to humans as easy prey. Additionally, there are risks of unprovoked attacks associated with certain human activities. These activities include walking alone at night, sleeping outside, and surprising a lion, particularly if it has cubs (Begg and Begg 2010, pp. 3, 21; Chardonnet *et al.* 2010, pp. 14, 15; Mesochina *et al.* 2010a, pp. 38, 39; Mesochina *et al.* 2010b, p. 32; Uganda Wildlife Authority 2010, p. 27; Moghari 2009, p. 85; Frank *et al.* 2006, pp. 11, 12). The most common context for attacks on humans occurs during harvest, due to prey dispersal during the wet season, bush pig attraction to crops, and because humans are particularly vulnerable in makeshift tents while protecting crops (Frank *et al.* 2006, p. 12).

Retaliatory Killing of Lions in Africa

Livestock provide an economic value to humans, particularly those in extreme poverty who rely solely on livestock for their protein source and livelihood. When lions have no

economic value to local communities and they kill or are perceived to kill livestock, the economic impact can be significant (Bauer *et al*. 2015a, unpaginated; Hazzah *et al*. 2014, p. 852; Chardonnet *et al.* 2010, p. 12; Mesochina *et al.* 2010a, p. 38; Mesochina *et al.* 2010b, p. 33; Gebresenbet *et al.* 2009, p. 9; Moghari 2009, pp. 4, 25, 49; Kissui 2008, pp. 423, 429; Hazzah 2006, p. 24; IUCN 2006a, pp. 23, 24; IUCN 2006b. pp. 18–19; Frank *et al.* 2006, p. 3). Subsequently, those lions that reside on the edge and outside of protected areas, where there is an increased risk of exposure to humans and livestock, are subject to retaliatory killing across Africa. Boundary transgression leads to lions predating on livestock, and in turn, be subject to pre-emptive or retaliatory killing (Bauer *et al*. 2014, pp. 98, 103; Funston 2011, pp. 1, 3, 5, 6–7); however, this type of killing of lions also occurs within protected areas (Henschel *et al*. 2015, unpaginated; Zimbabwe Parks and Wildlife Management Authority 2015, p. 10; Burkina Faso 2014, pp. 19, 21, 22; Tumenta *et al*. 2009 and Henschel *et al*. 2010 in Sogbohossou *et al*. 2011, p. 100; Moghari 2009, p. 49). Furthermore, killing of lions outside of protected areas may disrupt movement of lions to other areas that could contribute to the viability of larger resident populations (White 2015, pers. comm.). This occurrence greatly impacts already-dwindling lion populations. Even if mortality occurs outside of protected areas, population dynamics inside protected areas are negatively impacted. When lions outside of protected areas are removed, either through retaliatory killings or trophy hunting, territorial gaps that are left are filled by lions from closer to the core of the protected area, exposing more lions to human–lion conflict along the borders of the protected area and creating a population sink (Brugiére *et al* 2015, p. 514; Sogbohossou 2014, p. 3; Loveridge *et al*. 2007, pp. 552, 555; Woodroffe and Ginsberg 1998, p. 2162).

The availability of guns and poison makes killing suspected predators cheaper and easier than other control methods, such as reinforcing bomas (Hazzah *et al.* 2009, p. 2429; Moghari 2009, p. 35; Frank *et al.* 2006, p. 14; Hazzah 2006, p. 3). Spearing, shooting, trapping, and poisoning of lions, as either a preventive measure or in retaliation for livestock and human attacks, occurs regularly (Brugiére *et al*. 2015, p. 519; Bauer *et al*. 2015a, unpaginated; Tanzania 2015, p. 13; Republic of Namibia 2013, pp. 12, 13–14; Begg and Begg 2010, p. 15; Chardonnet *et al.* 2010, pp. 41–42; Packer *et al.* 2010, pp. 9–10; Uganda Wildlife Authority 2010, pp. 13, 42; Gebrensenbet *et al.* 2009, p. 7; Hazzah *et al.* 2009, p. 2429; Moghari 2009, pp. 52, 89, 91; Ikanda 2008, pp. 5–6; Hazzah and Dolrenry 2007, p. 21; Frank *et al.* 2006, pp. 2–4, 7; Hazzah 2006, p. 52; IUCN 2006b, p. 15). Retaliatory killings have been reported as a significant threat to lion populations in protected areas of western and central Africa (Tumenta *et al*. 2009 and Henschel *et al*. 2010 in Sogbohossou *et al*. 2011, p. 100), Botswana (Bauer *et al*. 2014, pp. 98, 103), Botswana and South Africa (Kgaladi Transfrontier Park; Funston 2011, p. 1), Cameroon (Delongh *et al*. 2009 and Tumenta *et al*. 2010 in Sogbohossou *et al*. 2011, p. 60), Kenya (Patterson *et al*. 2004, Kolowski and Holekamp 2006, and Hazzah *et al*. 2009 in Sogbohossou *et al*. 2011, p. 60), Tanzania (Tanzania 2015, p. 13; Kissui 2008 in Sogbohossou *et al*. 2011, p. 60), and Zimbabwe (Zimbabwe Parks and Wildlife Management Authority 2015, p. 10).

In areas of high conflict, identifying the responsible animal is often difficult, and a token animal may be killed instead (Hazzah 2006, p. 25), leaving the problem lion to continue to attack and the potential for additional retaliatory killings. In Tanzania, game officers kill numerous lions each year in retaliation for attacks (Frank *et al.* 2006, p. 12). Whereas shooting or spearing target specific problem animals, poisoning is indiscriminate and is known to remove entire prides

at once (Frank *et al.* 2006, pp. 2, 10, Living with Lions no date, unpaginated). In the absence of reliable methods for protecting livestock, rural people often turn to indiscriminant methods, like poisoning, to control livestock depredation. Poisoning is an easy method for lethal control since it is readily available, and reinforcing bomas or more carefully tending livestock requires time and effort. The use of Furadan, a widely available and cheap agricultural pesticide, is particularly lethal to wildlife and is increasingly being used to kill predators in small pastoralist areas of Kenya and Tanzania. Livestock carcasses are doused with the poison, killing predators and scavengers that feed on them (Frank *et al.* 2006, pp. 2, 10, Living with Lions no date, unpaginated). Poisoning of bush pig carcasses to kill lions is not uncommon after attacks on humans. These practices have serious negative impacts on lion populations (Frank *et al.* 2006, p. 9).

Studies have shown that lion populations are declining in areas where pastoralism persists and the presence of mobile pastoralists are a good indicator of lion extinction (Brugiére *et al*. 2015, p. 519; Hazzah *et al.* 2009, p. 2428). Within protected areas, human–wildlife conflict is likely under-reported because cattle herders are within the protected areas illegally and, therefore, unlikely to report it (Chardonnet *et al.* 2010, p. 14; Mesochina *et al.* 2010b, p. 34). For example, Etosha National Park and Caprivi Game Park have the highest rates of lions killed per 100 km^2, yet it may be that just under half of the lions that are killed are reported (Republic of Namibia 2013, p. 14). Although we do not have information on human–lion conflict from all lion range countries, it is reasonable to conclude that lions are being killed as a result of conflict in all major African range countries, due to their depredation on livestock (Frank *et al.* 2006, p. 4).

Factors That Drive Retaliation in Africa

Several anthropogenic factors drive the level of resentment towards lions and the extent of retaliatory killing (Dickman 2013, pp. 379, 385), including the extent of the loss caused by the lions and the wealth and security of the people affected (Dickman 2013, p. 381; Mesochina *et al.* 2010b, p. 54; Moghari 2009, pp. 14, 25; Hazzah 2006, p. 81). Depending on alternative assets or incomes, the economic impact of lions killing livestock can be significant. Domestic livestock can provide manure, milk, and meat, and are the basis of many family incomes, savings, and social standing; losses can amount to a large proportion of a subsistence herder's annual income. These losses are generally uncompensated, reinforcing negative community attitudes toward lions and causing retaliation (Dickman 2013, pp. 380, 381; Chardonnet *et al.* 2010, pp. 11, 12, 18, 29; Hazzah *et al.* 2009, p. 2428; Moghari 2009, pp. 14, 25, 27, 36; Kissui 2008, pp. 422–423). Furthermore, a common perception among local communities is that lions are conserved at the cost of community safety and uncompensated financial losses. When the people who suffer significant costs from wildlife feel that the wildlife's needs are being put before their own needs, their frustration can lead to retaliatory killings (Dickman 2013, p. 382). Additionally, government officials and local tour and hunting operators experience economic gain from lions, whereas the communities bear the costs in livestock losses (Hazzah *et al*. 2014, p. 852). This situation further contributes to negative attitudes toward lion conservation programs (Moghari 2009, p. 37).

Lions are particularly vulnerable to retributive killing because they are often driven by a perceived level of lion predation on livestock rather than actual levels of conflict. In some locations, other predators (e.g., baboons (*Papio ursinus*), spotted hyenas (*Crocuta crocuta*), and

leopards (*Panthera pardus*)) as well as disease are responsible for the majority of livestock losses and human casualties, yet it is lions that are sought and killed more often. In the Pendjari Biosphere Reserve, Sogbohossou *et al*. (2011, p. 74) found that just one case of a nonlethal attack on a human in a decade and mere rumors of attacks in other regions was enough to cause people to perceive lions as a threat. Negative perceptions of lions may be based on an over-estimated number of lions in a community or protected area and an over-estimated number of human–lion conflicts (Dickman 2013, p. 380; Begg and Begg 2010, p. 20; Chardonnet *et al.* 2010, pp. 12, 21–22; Hazzah *et al.* 2009, p. 2436; Maclennan *et al.* 2009 in Hazzah *et al.* 2009, p. 2429; Moghari 2009, pp. 77–78, 107, 150; Holmern *et al.* 2007 in Moghari 2009, p. 34; Butler 2001 in Moghari 2009, p. 34; Kissui 2008, pp. 426, 428, 429; Hazzah 2006, pp. 18–19, 83–85, 96, 98, 107, 111; Patterson *et al.* 2004, pp. 514, 515). One cause for the disproportionate blame put on lions is that the lion is a highly visible species. It is a large-bodied species that lives in groups and has cultural significance. Because of its physical presence, there is often a hyper-awareness of the potential risk for lion attacks and lions may be blamed simply because they have been seen in an area (Dickman 2013, pp. 380–381).

Cultural beliefs and traditions can have a negative impact on lions. Because cattle are of great cultural significance to Maasai, their loss can impose social or cultural costs and incite greater resentment and higher levels of retributive killing (Dickman 2013, p. 384; Kissui 2008, p. 429; Hazzah 2006, p. 99). Cultural beliefs still motivate ritual lion hunts for young Maasai warriors. Despite being outlawed, this practice persists due to community secrecy. However, it is easily disguised as retaliatory killings for livestock predation. The prohibition of ritual lion hunts provides a greater incentive for participating in retaliatory hunts (Hazzah *et al*. 2014, p.

852; Packer *et al*. 2010, p. 10; Moghari 2009, pp. 13–14, 28; Ikanda 2008, pp. 5, 6; Kissui 2008, p. 423; Frank *et al*. 2006, p. 10; Hazzah 2006, p. 99). In some areas of Africa, locals believe in "spirit lions," a lion whose body is overtaken by evil to kill rivals or their livestock (West 2001 in Dickman 2013, pp. 381–382). Because people believe spirit lions are created by their enemies, the number of perceived spirit lions, and killing of these lions, increases during times of social tension (Dickman 2013, p. 382.)

Cultural beliefs can also have a positive impact on lions. An association with a totem is an important component of certain cultures and could explain why retaliatory killing is uncommon in some areas despite negative perceptions. However, the positive impact may not continue as cultural beliefs dwindle due to urbanization and modernization (Sogbohossou *et al*. 2011, pp. 73, 75).

Social tensions within tribes and between local communities and other communities, the government, park officials, or tourists can lead to conflict and retributive killing of lions (Dickman 2013, p. 382; Hazzah 2006, p. 75). Locals often report that wildlife authorities do not react effectively when chronic livestock raiders are reported (Frank *et al.* 2006, p. 9). Significant numbers of lions have been killed when promised benefits were not received or adequate compensation was not provided for livestock and human losses (Dickman 2013, p. 383; Hazzah 2006, p. 45).

Trophy Hunting

Lions are a key species in sport hunting, or trophy hunting, as they are considered one of the "big five" African species (lion, leopard, elephant, rhino, and cape buffalo) touted to be the most challenging to hunt due to their nimbleness, speed, and behavioral unpredictability (Lindsey *et al*. 2012a, p. 2). However, with the documented decline in lion population numbers throughout Africa, sport hunting of lions for trophies has become a highly complex issue.

Trophy hunting is carried out in a number of range countries and is considered an important management tool for conserving land and providing financial resources for lion conservation. However, management programs are not always sufficient to deter unsustainable off takes (harvests), which has occurred in many areas (Lindsey *et al*. 2013a, pp. 8–9; Packer *et al*. 2006 in Bauer *et al*. 2015a, unpaginated). Documented declines in lion populations of Africa are a result, in part, of mismanaged trophy hunting (Rosenblatt *et al*. 2014, entire; Sogbohossou *et al*. 2014, entire; Becker *et al*. 2013, entire; Lindsey *et al*. 2013a, entire; Packer *et al*. 2013, p. 636; Croes *et al*. 2011, entire; Packer *et al*. 2011, entire; Loveridge *et al*. 2007, entire). Depending on how trophy hunting is regulated and managed, trophy hunting can be a tool for conservation, but may also have negative impacts on lions (Bauer *et al*. 2015a, unpaginated; Lindsey *et al*. 2013a, p. 1; Whitman *et al.* 2004, pp. 176–177; Loveridge *et al.* 2007, p. 548).

In response to growing international recognition of reduced population numbers, many countries began implementing moratoriums banning the sport hunting of lions. In this document we use the terms moratorium and ban interchangeably. A ban or moratorium can be permanent, long term, or temporary, and can occur in countries that have hunting quotas in place (e.g., Botswana and Zambia). Having both a moratorium and a quota in place at the same time means

that, although the country may have a hunting quota, the country has halted authorization of trophy hunting pursuant to that quota until some later date or until some further action is taken, as prescribed by that country.

Trophy hunting is currently banned in 12 range countries: Angola, Botswana, Congo, Gabon, Ghana, India, Kenya, Malawi, Mauritania, Niger, Nigeria, and Rwanda (CITES 2014, p. 14; Meena 2014, p. 26; Lindsey *et al*. 2013a, entire; Lindsey 2013, pers. comm.; Jackson 2013, pp. 7–8). In 1977, Kenya banned all sport hunting (Elliot and Mwangi 1998, p. 3). Botswana banned lion hunting between 2001 and 2004, and then again from 2008 to the present (Davison *et al*. 2011, p. 114). Benin imposed a 2-year moratorium, and CAR a 3-year moratorium, in the early 2000s (Lindsey *et al*. 2013a, p. 4). In January of 2013, Zambia placed a moratorium on sport hunting in 19 game management areas. While a few other game management areas and private game ranches in Zambia remain open for sport hunting for other species, the nationwide moratorium on sport hunting of cats remains in place (White 2015, pers. comm.; ABC News 2014, unpaginated; Flocken 2013, unpaginated). Trophy hunting is restricted to problem or dangerous animals in Ethiopia and Uganda (Lindsey 2008, p. 42). In our proposed rule, we had conflicting information regarding whether Cameroon had or has a lion hunting moratorium (CITES 2014, p. 14; Lindsey 2013, pers. comm.; Jackson 2013, p. 8). During the public comment period, a peer reviewer confirmed that Cameroon has not put a moratorium in place for lions, either in the past or present (Bauer 2015, pers. comm.). Additionally, Zimbabwe has suspended trophy hunting in the Gonarezhou area (Conservation Force 2015, pers. comm.).

As of May 2014, approximately 18 countries in Africa allowed legal hunting of lions for trophies: Benin, Burkina Faso, CAR, DRC, Ethiopia, Côte d'Ivoire, Mali, Mozambique, Namibia, Senegal, Somalia, RSA, Sudan, Tanzania, Togo, Uganda, Zambia (nationwide moratorium on sport hunting of cats is currently in place), and Zimbabwe. However, in 2013 lion trophy hunting was documented to occur in only 8 countries, specifically Benin, Burkina Faso, CAR, Mozambique, Namibia, South Africa (RSA), Tanzania, and Zimbabwe (Lindsey 2013, pers. comm.). Four countries, Burundi, Guinea Bissau, Lesotho, and Swaziland, provide no legal protection for lions (CITES 2014, p. 14).

Where trophy hunting occurs, quotas are set by the government for the purpose of limiting the actual number of lions killed (offtake) during a given timeframe. A scientifically based quota is the maximum number of a given species that can be removed from a specific population without damaging the biological integrity and sustainability of that population (World Wildlife Fund (WWF) 1997, p. 9). Two primary concerns have been raised by the scientific and international community with regard to current lion quotas. These are that (1) existing quotas are set above sustainable levels, and (2) the data used for setting quotas is inconsistent and not scientifically based (Hunter *et al*. 2013, unpaginated; Lindsey *et al*. 2006, p. 284) (see *Potential Impacts of Trophy Hunting*). For example, recent quotas do not appear to address safeguards for sustainability nor has a systematic approach been established for setting lion quotas (Hunter *et al*. 2013, p. 2; Lindsey *et al*. 2013b, p. 8). Additionally, it has been noted that previous quotas in Namibia, Mozambique, and Zimbabwe may have been influenced by human–lion conflict, with higher quotas being allocated to locations with reportedly higher levels of human–lion conflict (Lindsey *et al*. 2013b, p. 4).

Generally, the conservation principle behind scientifically based quotas is to limit total offtake of the species to either equal or slightly lower than the growth rate of the target specimens (e.g., males vs. female), such that damage to the integrity and sustainability of that population is prevented. Scientifically based quotas do not apply solely to sport hunting, but set the limits for total offtake for a particular timeframe; other potential offtake includes problem-animal control (to reduce human–wildlife conflict), translocation (to expand conservation), culling (reducing population pressures), and local hunting (for protein/meat or employment) (WWF 1997, pp. 8–10). For quotas to be sustainable, scientists and policy makers must evaluate a multitude of factors including the species' biological factors (i.e., reproductive rate, gender ratios, age, and behavior), as well as community and client objectives (WWF 1997, pp. 14–19).

Creel and Creel (1997, p. 83, executive summary) suggest that, for a quota to be considered sustainable for lions, it should be limited to no more than 5 percent of the population. Distinct from the quota, Packer *et al*. (2011, p. 151) recommend actual lion offtake should not exceed more than 1 lion per 2,000 km^2 (Bauer 2015, pers. comm.; Henschel 2015, pers. comm.; Packer *et al*. 2015, per comm.; Creel and Creel 1997, p. 83, executive summary). However, most range countries have their quotas set well above these recommendations (Bauer 2015, pers. comm.; Henschel 2015, pers. comm.; Packer 2015, pers. comm.). Specifically, Lindsey *et al*. (2013a, p. 8) found that of the nine countries allowing trophy hunting of lions in 2013 (including data from Zambia prior to the moratorium in 2013), eight have quotas set higher than current recommendations by Packer *et al* (2011, p. 151) and five have quotas set to more than double Packer's recommendations. Mozambique is the only country with a lion quota less than the

recommended 1 lion per 2,000 km^2. It should be noted that although quotas are currently set higher than recommended, the actual offtake for each of the countries overall has been consistently lower than the set quota (Table 5). However, in Burkina Faso, Zambia, Namibia, and Zimbabwe, the actual harvests are greater than Packer's recommended offtake (Lindsey *et al*. 2013a, p. 8). For instance, five countries maintain quotas to allow for 5–31 lion trophies to be taken per year: Benin (5), Burkina Faso (20), Cameroon (30), CAR (31), and Namibia (15). Only Mozambique currently has a quota lower than the recommendation of Packer *et al*. (2001, p. 1651). In 2013, the quota was set at 42–60 lions, which translates to 1 lion per 2,400km^2 (or 0.8 lions per 2,000km^2). Between 2011 and 2012, Tanzania maintained the highest quota for lions at 315 (Lindsey *et al*. 2013a, p. 6).

Several countries have begun to reduce their quotas as they have begun implementing recommendations as outlined by Lindsey *et al*. (2013a, pp. 8–9), Hunter *et al*. (2013, unpaginated), and Packer *et al*. (2011, p. 151) (Bauer 2015, pers. comm.; Henschel 2015, pers. comm.; White 2015, pers. comm.; Tanzania 2015, pers. comm. Zimbabwe 2015, pers. comm.). In 2011, Zimbabwe's quota was set at 101 lions; in 2014, it was reduced to 50 lions following the implementation of age restrictions (Henschel 2015, pers. comm.). Following pressure from the European Union to ban lion trophies if their quota remained higher than the 1 lion per 2,000 km^2 recommendation, Burkina Faso proposed to reduce the set quota of 20 lions in the 2014/2015 season to 6 in the 2015/2016 season (Henschel 2015, pers. comm.). South Africa has not set a quota for the take of wild lions since 99 percent of the trophy-hunted lions are reportedly not of wild origin but captive born (Hunter *et al*. 2013, p. 2; RSA 2013, pp. 5, 7) (Table 5).

Table 5. Annual Trophy Quotas and Offtake by Country (Approximate) as of 2013*

Country	**Annual Lion Trophy Quotas**	**Year(s) of Data**	**Annual Offtakes**	**Year(s) of Data**
Panthera leo leo				
Benin	5.0±0	2007–2009	2.0±0.4	2007–2009
Burkina Faso	20.0±0	2006–2009	13.3±1.45	2006–2009
Cameroon	29.2±2	2006-2010	6.9±1.0	2006–2010
CAR	31	2009	13.7±6.9	2008–2011
Panthera leo melanochaita				
Mozambique	42-60	2013	19.2±7.3	2008–2011
Namibia	14.5	2010	14.0±3.2	2008–2011
Tanzania	315	2011–2012	85	2011–2012
Zambia (moratorium)[1]	74(50[2])	2012	47	2012
Zimbabwe	101(50[3])	2011	42.5±7.5	2008–2011

*Source: Lindsey *et al*. 2013a. p.6.
[1]Zambia enacted a moratorium on sport hunting in 19 game management units. Sport hunting remained open in other game management units and on some private game ranches. Sport hunting of all cats is currently banned throughout Zambia (White 2015, pers. comm.).
[2]Approximate average quota for Zambia in the few years prior to the moratorium placed on cat hunting in 2013. (White 2015, pers. comm.).
[3]In 2014, Zimbabwe reduced its quota to 50 due to implementation of age restrictions (Henschel 2015, pers. comm., citing Lindsey pers. comm.)

Potential Benefits of Trophy Hunting

Proponents and most lion experts support trophy hunting as a conservation tool for the lion if it is practiced in a sustainable and scientifically based manner (Henschel 2015, pers. comm.; Hunter 2011, entire; van der Merwe 2013, entire; Hunter *et al*. 2013, entire) because it can provide: (1) Incentives for the conservation of large tracts of prime habitat, and (2) funding for park and reserve management, anti-poaching activities, and security activities.

As habitat loss has been identified as one of the primary threats to lion populations, it is notable that the total amount of land set aside for hunting throughout Africa, although not ameliorating threats to habitat loss, exceeds the total area of the national parks, accounting for approximately half of the amount of viable habitat currently available to lions (Chardonnet *et al*. 2010, p. 34; Packer *et al*. 2006, pp. 9–10). For example, in Tanzania, 25–33 percent of the total area, covering over 247,000 km^2 and encompassing 190 hunting units, has been set aside for sport hunting purposes; this has resulted in an area 5.1 times greater than Tanzania's fully protected and gazetted parks (Jackson 2013, p. 6; Barnett and Patterson 2005, p. 61). Tanzania also has land set aside for sport hunting in the form of safari areas, communal land, and privately owned properties that make up 23.9 percent of the total land base (Barnett and Patterson 2005, pp. 76–77).

In Botswana, despite the current ban on lion hunting, the country currently has over 128,000 km^2 of gazetted wildlife management areas and controlled hunting areas set aside for hunting purposes, which equates to 22.1 percent of the country's total area. This amount is in addition to 111,000 km^2 (or 19.1 percent of the country's total area) set aside as habitat in the form of national parks, game reserves, and forest reserves (Barnett and Patterson 2005, p. 7). In 2000, five countries in southern Africa (Botswana, Namibia, South Africa, Tanzania, and Zimbabwe) set aside a combined 420,000 km^2 of communal land, 188,000 km^2 of commercial land, and 420,089 km^2 of state land totaling over 1,028,000 km^2 for sport hunting purposes (Barnett and Patterson 2005, p. iii).

As a species with a considerable range (up to 1,000 km^2) (Packer *et al*. 2013, p. 636; Haas *et al*. 2005, p. 4), suitable habitat is important to the survival of the species, and the marked decline in suitable habitat is a significant threat to the species (see *Habitat Loss*). The land currently designated in Africa for use in sport hunting has helped to reduce, but not eliminate, the impact of habitat loss on the lion.

If trophy hunting is part of a scientifically based management program, it may provide direct economic benefits to the local communities and may potentially create incentives for local communities to conserve lions, reduce the pressure on lion habitat, and reduce retaliatory killing, primarily because lions are viewed as having value. Conversely, lack of incentives could cause declines in lion populations because lions are viewed as lacking value and they kill livestock, which are of great value to communities (see *Human–lion Conflict*).

Over the last few decades, conservationists and range countries have realized the integral role local communities play in the conservation of lions and their habitat; when communities benefit from a species, they have incentive to protect it. Therefore, using wildlife as a source of income for rural populations has increasingly been employed throughout the lion's range countries in Africa. Many of these countries are classified as "developing" nations; specifically, seven of the ten countries (we include Cameroon here) where trophy hunting is permitted have 27–64 percent of their human populations living in severe poverty (United Nations Development Programme's (UNDP) 2014, unpaginated; Barnett and Patterson 2005, p. iii). These countries often have high population growth, high unemployment, limited industry, and a Gross Domestic Product (GDP) per capita lower than the poverty level (Barnett and Patterson 2005, p. iii). These

combined challenges highlight the need for innovative solutions. Conservationists and range countries recognize the value of the wildlife sector; if managed sustainably, there is potential to contribute to rural economic development while simultaneously protecting the unique ecological habitats and species contained therein (Chardonnet *et al*. 2010, p. 33; Kiss 1990, pp. 1, 5–15).

For species such as the lion to persist, local communities must benefit from or receive a percentage of funds generated from tourism such as wildlife viewing, photography, or trophy hunting (White 2013, p. 21; Martin 2012, p. 57; Kiss [editor] 1990, pp. 1, 5–15). The economic value of a species, such as lion, can encourage range countries to develop management and conservation programs that involve local communities and which would ultimately discourage indiscriminate killings by local communities (Groom 2013, pp. 3, 5; Hazzah *et al*. 2013, p. 1; White 2013, p. 21; Martin 2012, p. 49). If local communities see no benefit of lions being present in their communal areas, sustainable use of lions becomes less competitive with other land-use options, such as grazing and livestock management, and local communities become unwilling and unable to manage their wildlife heritage (Barnett and Patterson 2005, p. iii). When the value of lions in areas outside national parks is diminished, those areas are likely to be converted to forms of land use less suitable for lions, such as agriculture, livestock pastures, or areas of resource extraction, making lions even more vulnerable to expanding human settlement (Van der Merwe 2013, p. 2).

Community conservancies that benefit from trophy hunting have specifically been formed as a way to protect wildlife and habitat. As an example, in Namibia, 160,000 km^2 of community conservancies were established in part due to revenue from trophy hunting. These

conservancies benefit the local communities, which in turn protect lion habitat. In 2012, the Savé Valley Conservancy (Zimbabwe) "provided over $100,000 USD worth of support to adjacent villages or farmers in the resettled areas. Assistance included drilling boreholes, maintaining boreholes, dredging of dams, building clinics and schools, assisting with repairs, maintenance and materials for schools, education initiatives, school field trips, provision of computer equipment in schools, and craft programs" (Groom 2013, p. 5). Connecting conservation to community benefits can provide a value for wildlife, including lions, where there was previously resentment or indifference, helping to instill a sense of importance for lion conservation. Additionally an estimated 125,000 kg of game meat is provided annually to rural communities by trophy hunters in Zambia at an estimated value of $250,000 USD per year, which is considerable for rural locations where severe poverty and malnutrition exists (White 2013, p. 21), further providing a value for wildlife, including lions. As stated above, local communities can benefit from the trophy hunting industry by additional employment opportunities and revenue generated for local microbusinesses.

Many range countries have recognized the need to incorporate incentives and local community benefits into their trophy hunting regulations, land management policies, and lion conservation action plans (Lindsey *et al*. 2013a, pp. 2–3; Zambia Wildlife Authority 2009, p. 10; Windhoek 2008, p. 18; IUCN 2006a, pp. 22, 24; IUCN 2006b, pp. 23, 28; Zimbabwe Parks and Wildlife Management Authority 2006, unpaginated). Of the ten countries where lion trophy hunting currently occurs (we are including Cameroon and South Africa here), seven have developed National Poverty Reduction Strategies in partnership with the International Monetary Fund (for a complete list, see *http://www.imf.org/external/np/prsp/prsp.aspx*). Each of these

countries has incorporated sustainable natural resource development as a priority and discussed benefit distribution and management to rural communities (Benin 2000, unpaginated; Burkina Faso 2000, unpaginated; CAR 2000, p. 45; United Republic of Tanzania 2000, pp. 13, 21; Zambia 2000, unpaginated). Although we acknowledge the steps many countries have taken to address local community incentives, most of the countries are currently not transparent about the benefits provided to local communities, and due to the high revenue potential, are subject to corruption (Packer 2015, pers. comm.; see Potential Impacts of Trophy Hunting).

Many range countries rely heavily on tourism (predominantly ecotourism and safari hunting) to provide funding for wildlife management (IUCN 2006a, p. 24). Additionally, revenue generated from these industries provides jobs, such as game guards, cooks, drivers, and security personnel and often brings in revenue for local microbusinesses that sell art, jewelry, and other crafts. Revenue generated from scientifically based management programs can be used to build and maintain fences, provide security personnel with weapons and vehicles, provide resources for anti-poaching activities, and provides resources for habitat acquisition and management (Chardonnet *et al*. 2010, pp. 33–34; Newmark 2008, p. 321). For example, trophy hunting revenue in the Savé Valley Conservancy in Zimbabwe has enabled $150,000–$250,000 USD to be invested in anti-poaching activities, including the removal of wire-snares (Groom 2013, p. 5). Revenue from trophy hunting can also increase the ability of many African countries to manage wildlife populations both within and adjacent to reserves; many of these hunting areas are geographically linked to national parks and reserves, providing wildlife corridors and buffer zones (Chardonnet *et al*. 2010, p. 34; Newmark 2008, p. 321).

Depending on the country in which a hunter visits, there may be several different fees associated with trophy hunts, including game fees, observer fees, conservation fees, permit fees, trophy handling fees, and government payments in terms of taxes, as well as safari operator fees (Barnett and Patterson 2005, p. 71). In the late 1990s, Tanzania reported annual revenue of $29.9 million USD from all trophy hunting, South Africa $28.4 million USD, Zimbabwe $23.9 million USD, Botswana $12.6 million USD, and Namibia $11.5 million USD; the revenue generated solely from lion hunting was not broken out (Barnett and Patterson 2005, p. iv). According to Groom (2013, p. 4), a 21-day lion hunt in Savé Valley Conservancy, Zimbabwe, may be sold for approximately $2,500 USD per day, with an additional trophy fee of approximately $10,000 USD. Between 2005 and 2011, lion hunting in Savé Valley Conservancy provided an estimated net income (based on 26 lions) of approximately $1,365,000 USD in per-night charges and roughly $260,000 USD in trophy fees (Groom 2013, p. 4). In the past, government and private landowners were the primary beneficiaries of the revenue gained; currently, efforts are being made in many range countries to incorporate incentives at the local level (Barnett and Patterson 2005, p. vi).

In summary, if part of a scientifically based management program (including a scientifically based quota), trophy hunting of lions can provide direct benefits to the species and its habitat, both at the national and local levels. Trophy hunting and the revenue generated from trophy hunting are tools that range countries can use to facilitate maintaining habitat to sustain large ungulates and other lion prey, protecting habitat for lions, supporting the management of lion habitat, and protecting both lions and their prey base through anti-poaching efforts. While

scientifically based trophy hunting alone will not address all of the issues that are contributing to the declined status of the lion, it can provide benefits to the species.

Potential Impacts of Trophy Hunting

An issue critical to the conservation of lions is sustainable management of trophy hunting by lion range countries. Lion experts agree that, if trophy hunting is well regulated and managed, it can be a tool for conservation (Bauer *et al*. 2015a, unpaginated; Lindsey *et al*. 2013a, p. 1; Whitman *et al.* 2004, pp. 176–177; Loveridge *et al.* 2007, p. 548). However, problems with the current management of lion hunting increase the likelihood of negative impacts on the species (note that because 99 percent of hunted lions in South Africa are captive-bred, we exclude them from this discussion) (Hunter *et al*. 2013, p. 2). Lindsey *et al*. (2013a, pp. 8–9) and Hunter *et al*. (2013, p. 2) identified six key practices undermining sustainable management of lions:

- arbitrary establishment of quotas and excessive harvest
- lack of age-restriction implementation
- fixed quotas
- hunting of females
- lack of minimum hunt lengths in some countries
- general problems associated with management of trophy hunting

As discussed above, one of the primary practices experts identify as undermining sustainable trophy hunting is the use of non-scientific information underlying the development of quotas (Lindsey *et al*. 2013a, p. 8). The best available monitoring data should be used to set

quotas if they are to be scientifically based and sustainable. However, monitoring data are often lacking (Barnett and Patterson 2005, p. 102). A limited number of independent, scientific population counts of lions have occurred across their range, especially in hunting concessions (LionAid 2014a, pers. comm.; Packer 2015, pers. comm.; Packer *et al*. 2011, p. 143). While some existing quota allocations have been derived from information provided by hunting concession operators, it has been noted that many hunting concession operators have not allowed independent population studies to take place, possibly as a result of illegal activity and corruption (LionAid 2014a, pers. comm.; Packer 2015, pers. comm.). Lion experts also describe an over-reliance on subjective opinions, including input from concession operators, in the process of developing quotas (Lindsey *et al*. 2013a, p. 8). As a result, information underlying current quotas in much of the species' range has been inconsistent, biased, and/or lacking. It is difficult to predict with accuracy what level of offtake would be appropriate to ensure a quota is sustainable for a given population without accurate information on the size of the resource (LionAid 2014a, pers. comm.; Barnett and Patterson 2005, p. 102). Therefore, quotas not scientifically based are often too high to maintain sustainability and overharvest occurs.

Lions are particularly vulnerable to excessive harvests due to impacts associated with the removal of males (Hunter *et al*. 2013, p. 2). As stated before, except in Mozambique, quotas are higher than the recommended maximum harvest of 1 lion per 2,000 km^2. Additionally, mean actual harvests are higher than the recommended 1 lion per 2,000 km^2 offtake in Burkina Faso, Zambia, Namibia, and Zimbabwe (Lindsey *et al*. 2013, p. 8). Multiple researchers have documented declines in lion populations across the range of the species as a result of mismanaged trophy hunting. Specifically, negative impacts to lions from excessive offtakes

have been documented in Benin (Sogbohossou *et al*. 2014, entire), Cameroon (Croes *et al*. 2011, entire), Tanzania (Packer 2011, entire), Zambia (Rosenblatt *et al*. 2014, p. entire; Becker *et al*. 2013, entire), and Zimbabwe (Groom *et al*. 2014, entire; Davidson *et al*. 2011, entire; Loveridge *et al*. 2007, entire). Additionally, the effects of over-harvesting can extend into adjacent national parks where hunting does not occur (Packer *et al*. 2013, p. 636).

Most experts consider the recommendation by Packer *et al*. (2011, p. 151) to limit offtake to no more than 1 lion per 2,000 km^2 throughout its range (or 1 per 1,000 km^2 in areas with high density of lions) to be the best available science and recommend each country impose a quota cap at those levels to ensure sustainability while other methods are being developed and refined. According to Hunter *et al*. (2013, p. 5), "such caps provide a short-term means of reducing the risk of negative population impacts while more robust methods are being implemented. Areas that are smaller than 1,000 km^2 should be granted the equivalent fraction of 0.5 lions per year: For example, an area of 200 km^2 would be allocated 0.1 lions per year, or one tag every ten years. Such a system would reduce the extent to which hunting in small concessions adjacent to protected areas affects protected populations, as in Zambia and Zimbabwe."

Species experts also recommend, as part of reforming trophy hunting, adoption by range countries of an adaptive quota management system that would allow for quotas to fluctuate annually based on the population trends of the species. An adaptive quota management system would not only prevent over-harvesting of lions, but would also prevent excessively conservative quotas (Hunter *et al*. 2013, p. 5).

Recognizing the inconsistencies in the process of setting a quota and the information on which they are based, range countries and conservationists have been working to establish a set of best practices in order to create a more consistent, scientifically based approach to determining quotas. The recommended best practices include: (1) establishing processes and procedures that are clearly outlined, transparent, and accountable; (2) establishing processes and procedures that are CITES compliant; (3) demonstrating management capacity; (4) standardizing information sources; (5) establishing monitoring systems for critical data; (6) recording and analyzing trophy hunting data; (7) conducting data collection and analysis for each hunting block and concession; and (8) establishing a primary body who will approve quotas (Burnett and Patterson 2005, p. 103).

Each country that allows trophy hunting has some data collection system in place; most countries have a central wildlife authority that requires operators to submit data collection forms or questionnaires providing details of each of their hunts. However, according to the authors, these guidelines have not been followed throughout much of the range countries, which has led to a variety of compliance issues. Some systems have been overly complex and cumbersome. "In 2000, Zimbabwe, for example, had nine different forms, which contain essentially the same information, that had to be completed by safari operators for each client and submitted to different government departments" (Barnett and Patterson 2005, p. 100). Additionally, governmental bodies have sometimes failed to analyze data and provide feedback to operators; experts agree this failure undermines the purpose of the system and encourages noncompliance.

In the absence of reliable population estimates, age restriction on trophy harvests can ensure sustainability (Lindsey *et al*. 2013a, p. 8; Packer *et al*. 2006, pp. 6–8). Whitman *et al*. (2004, pp. 176–177) found that if offtake is restricted to males older than 6 years of age, trophy hunting will likely have minimal impact on the pride's social structure and young. By removing only males 6 years of age or older, younger males remain in residence long enough to rear a cohort of cubs (allowing their genes to enter the gene pool; increasing the overall genetic diversity); recruitment of these cubs ensures lion population growth and therefore, sustainability. Simulations indicate that populations with quotas of more than two male lions of minimum eligible age of 3–4 years were more likely to experience extinction events than populations with hunting restricted to a minimum eligible age of 5–6-year-old males (Whitman *et al*. 2004, p. 176). Additionally, full implementation and enforcement of this age-based strategy could potentially cause the need for quotas to become irrelevant or eliminated entirely. Age restrictions will naturally restrict offtake to a limited number of individuals that meet the age criteria (Loveridge *et al*. 2007, p. 549; Whitman *et al*. 2004, p. 177).

Implementing this approach in the field involves conducting an age assessment of male lions using identification techniques, such as mane development, facial markings, nose pigmentation, and tooth-aging to establish the relative age of the target lion. Tooth wear on incisors, yellowing and chipping of teeth, coupled with scars, head size, mane length and color, and thinning hair on the face, as well as other factors can be an indicator of advanced age in lions (Whitman and Packer 2006, entire).

Whitman *et al*. (2004, p. 176) postulated that "the most reliable index in the Serengeti/Ngorongoro lions is the extent of dark pigmentation in the tip of the nose, which becomes increasingly freckled with age. Individual variation in nose coloration is sufficiently low that age can be estimated up to 8–9 years. The noses of 5-yr-old males are 50 [percent] black so the rule of thumb would be to restrict all trophy hunting to males with noses that are more than half black." Although this varies individually and regionally, recommended best practices could be regionally tailored. Packer *et al*. (2006, p. 7) note that males in South Africa require an additional 1–2 years to become competitive with other males, and suggest a 7-year minimum might be judicious for some regions. Therefore, there is concurrence by species experts that national or regional guidelines should be developed to accompany those produced in Tanzania and Zambia (Lindsey *et al*. 2013a, p. 8; Packer and Whitman 2006, entire).

According to Lindsey *et al*. (2013a, p. 8), some operators were uncertain of their ability to age lions; however, based on research conducted in Niassa National Reserve, Mozambique, hunters can be taught to age lions effectively. While experts agree it may be difficult to determine the exact age of a lion, broader categories based on age have been developed to assist officials. For example, Tanzania officials have "aging sessions" wherein each concession operator is required to bring in the skulls of their trophies for examination. Each skull is then classified as "acceptable" (6+ years old), "accepted with penalties" (4–5 years old), and "not accepted with deterrent penalties" (<4 years) (Tanzania 2015, pp. 23–24). Tanzania reports that this step is required prior to any issuance of a CITES export permit.

Species experts place high emphasis on the requirement for both enforcement and transparency in the strategy. A fully transparent quota allocation system would be one in which a quota allocation system is based on scientific data received from all hunting areas and concession units annually, and would require trophies to be independently evaluated, data on the trophies (e.g. age, sex, origin) be available nationally and internationally, and quotas based upon data obtained from the previous hunting season (Henschel pers. comm. 2015).

Lion experts recommend age-based strategies be incorporated into lion management action plans (Hunter *et al*. 2013, pp. 4–5; Lindsey *et al*. 2013a, p. 8). Although the 6-year method has potential to reduce the rate of infanticide in lion populations used for trophy hunting (Hunter *et al*. 2013, p. 4–5; Lindsey *et al*. 2013a, p. 8), the issue of incorporating this strategy into each country's conservation strategy and/or action plan, and following up with implementation, enforcement, and transparency has yet to be observed in many of the lion's range countries (Henschel 2015, pers. comm.). While several countries, including Benin, Burkina Faso, Mozambique (only in Niassa National Reserve), Tanzania, and Zimbabwe have committed to implementing the age-based strategy (White 2013, p. 14; Davidson *et al*. 2011, p. 114; Whitman *et al*. 2004, p. 176), only two have fully implemented it (Henschel 2015, pers. comm.). Thus far, Mozambique and Zimbabwe have implemented this strategy and shown a reduction in total offtake (Henschel 2015, pers. comm.). They also appear to be transparent in their implementation. Tanzania has implemented age restrictions and shown reductions in offtake; however, there is concern related to transparency (in terms of trophy quality data) and the scientific objectivity of the evaluating body has been questioned. Benin and Burkina Faso committed to implementing age restrictions in 2014; their progress is currently pending. Lastly,

Mozambique, excluding Niassa National Reserve and Cameroon have not yet instituted or committed to the strategy (Henschel 2015, pers. comm.). Lack of implementation of age-based strategies may undermine the successful use of trophy hunting as a sustainable conservation strategy.

Additionally, experts believe that importing countries should have the ability to ascertain that the imported trophies originated from hunting concessions that fully comply with best practices. According to Lindsey *et al*. (2007, p. 3; Lindsey *et al*. 2006, pp. 285, 288), there is a market in the United States for conservation-based hunting. "In a survey of prospective clients 45–99 percent were unwilling to hunt under various scenarios if conservation objectives would be compromised, and 86 percent were more willing to purchase a hunt if local communities would benefit" (Lindsey *et al*. 2007, p. 3). Experts agree that a fully transparent system would allow hunters to choose operators who have demonstrated a commitment to conservation principles; this system could provide incentives for operators to comply with the recommended best practices.

Harvesting of males that are too young can have devastating impacts to the population. If male lions are harvested too young (even as old as 3 years of age), combined with quotas that are too high, the population will be driven to extinction as female populations collapse as they eventually are unable to mate (Whitman *et al*. 2004, p. 176). Additionally, excessive trophy hunting and taking of males under a certain age cause male replacements and increased infanticide rates (when males kill young lion cubs sired by other males) (Whitman *et al*. 2004, p. 175). Packer (2001, p. 829, citing Bertram 1975, Packer and Pusey 1984, and Pusey and Packer

1994) demonstrated that cub mortality increases when a new male joins a pride. Infanticide is a common practice among many species, including lions (Hausfater *et al*. 1984, pp. 31, 145, 173, 487). Removing a younger male lion allows another male of the pride to take over and kill the former patriarch's cubs; offspring younger than 2 years of age are generally unable to defend themselves and may be killed or forced to disperse from the pride prematurely, which also often leads to death (Elliot *et al*. 2014, p. 1054; Packer 2001, p. 829; Pusey and Packer 1984, p. 279). This behavior is believed to be advantageous to the incoming male as it increases and accelerates the opportunity for the new male to sire a cohort of cubs. When females give birth to cubs, the female generally does not return to estrus until the cubs are around 18–24 months old (Pusey and Packer 1984, p. 281). Following the loss of her cubs, however, a female will return to estrus rather quickly; females will resume mating within days or weeks, thus increasing the likelihood that the new male will have the chance to sire the next cohort. Pusey and Packer (1984, p. 279) calculated that infant fatality during male takeovers accounted for 27 percent of all cub fatalities under the age of 12 months.

Further, when an adult male lion in a pride is killed, surviving males who form the pride's coalition are vulnerable to takeover by other male coalitions, and this often results in injury or death of the remaining males (Davidson *et al*. 2011, p. 115).

Recently, Elliot (2014, p. 1054) postulated that the impacts of male takeovers due to trophy hunting may be more severe than previously recognized. Specifically, when a pride male is removed and a new male takes over, subadults may be forced to disperse from the pride. These males are then at a disadvantage as they are often inexperienced and physically smaller

which may prevent them from being able to compete with older males for territory. In the study, Elliot found 100 percent fatality for all males who dispersed earlier than 31 months old. The study concluded that dispersal of subadults is highly related to the presence of incoming males, resulting in a type of delayed infanticide, as many of the subadults do not survive the dispersal. This effect may be amplified in populations that have a high offtake rate. Therefore, the author concluded that age restriction and reducing offtake could reduce takeover rates by new males, allowing subadults a longer period to mature prior to dispersal and thus, reducing the number of subadult deaths (Elliot *et al*. 2014, p. 1055).

A lack of mature males dispersing reduces the genetic viability of populations and may contribute to local population extinctions (See *Deleterious Effects Due to Small Population Sizes*). Selective offtake of large males may also modify the genetic evolution of lions. Allendorf and Hard (2009, p. 9987) and Loveridge *et al*. (2007, p. 553) consider the genetic and evolutionary role of selective hunting on wildlife populations. As individuals who display certain characteristics (such as largest size) are more likely to be harvested, this type of selective removal will bring about genetic change in future generations. Specifically, removing the males with the most desirable traits from a population ultimately affects upcoming generations as those individuals are no longer contributing to the gene pool. "For example, the frequency of elephants (*Loxodonta africana*) without tusks increased from 10 percent to 38 percent in South Luangwa National Park, Zambia, apparently brought about by poaching of elephants for their ivory" (Jachmann *et al*. 1995 in Allendorf and Hard 2009, p. 9987). This comparison relates to lion as the removal of the largest males consequentially results in females breeding with less desirable males and thus, perpetuating the production of less desirable individuals. Selective offtake based

on gender also has the potential to skew sex ratios and impact breeding success, as has been the case for lions (Allendorf and Hard 2009, p. 9991; Loveridge *et al*. 2007, p. 553). The authors state that in order to maintain the highest yield and viability of the most desirable males, one option is to be less selective (Allendorf and Hard 2009, p. 9991). Specifically as related to lions, this would mean implementing age restrictions so that the more desirable males are not harvested prior to successful reproduction.

Whitman *et al.* (2004, pp. 175–177) found that if offtake is restricted to males 6 years of age or older, the impacts of trophy hunting are likely to be minimal on the prides social structure and reproduction. Therefore, experts recommend that a 6-year age restriction should be implemented for all hunting concessions throughout the lion's range.

Species experts have suggested an additional mechanism that could help reduce infanticide. In concessions where operators can distinguish between resident and solitary individuals, removal of the nomadic males may reduce the likelihood of a possible conflict and take-over (Packer *et al*. 2006, p. 7; Whitman 2004, p. 177). If concession operators selectively remove males in a manner that promotes healthy population growth, the lion population could yield more males in the long term (Davidson *et al*. 2011, p. 114; Packer *et al*. 2006, p. 7; Whitman *et al*. 2004, p. 176).

Hunter *et al*. (2013, pp. 2, 5) and Lindsey *et al*. (2013a, p. 9) identified hunting of female lions to be another aspect of trophy hunting that is harmful to lion populations. Specifically, females are the most productive portion of a population; if females are removed from a pride,

there is inherent risk that dependent cubs will die and the overall breeding success of the pride will be reduced. Packer *et al*. (2001 in Packer *et al*. 2006, pp. 5, 7) report that "large prides out-compete smaller prides and per capita reproduction is lowest in prides of only 1–2 females." Lindsey *et al*. (2013a, pp. 2, 4, 9) indicate that a loss of a female increases a pride's vulnerability to territory loss. As a result, removing females has injurious effects on the overall success of the population and, ultimately, the number of harvestable males.

Lindsey *et al*. (2013a, pp. 2, 4, 9) indicate that quotas are currently available for female lions in some locations within Namibia, and between 1990 and 2011, in Zimbabwe (Packer *et al*. 2006, p. 4). Between 1998 and 2004, Zimbabwe maintained a mean quota of $0.3 \pm 0.1/100$ km^2 for female lions; during the same period, actual offtake was lower at $0.08 \pm 0.1/100$ km^2, or a mean of 30.6 percent of the quota actually harvested (Loveridge *et a*l. 2007, p. 551). Zimbabwe discontinued issuing quotas for females in 2011. Female hunting is not allowed elsewhere within the range of the species (Lindsey *et al*. 2013a, p. 2). Species experts recommend that the trophy hunting of females be prohibited, unless the management plan is specifically to control the size of the lion population (Hunter *et al*. 2013, p. 5; Lindsey *et al*. 2013a, p. 9).

Another deficiency in current trophy hunting management is the use of fixed quotas. There are two primary types of quotas, "fixed" and "optional." Trophy fees for fixed quotas require the payment of a portion (40–100 percent) of the lion trophy fee, regardless of whether the hunt is successful, whereas optional quotas are paid by operators only when the lion is shot. Until 1999, male lions were typically on fixed quotas, whereas female lions were under optional quotas. According to Lindsey *et al*. (2013a, pp. 2–3), Mozambique, Benin, Burkino Faso, and

Cameroon all have optional quotas in place, thereby, hunters only pay for animals hunted. Other range countries continue to have fixed quotas in place and charge a percentage of the quota regardless of success (CAR charges 50 percent; Namibia 100 percent; Tanzania 40 percent; Zambia 60 percent; Zimbabwe 30 percent). This approach facilitates harvesting of trophies even if a sufficiently old lion is not found (Hunter *et al*. 2013, p. 6). Therefore, harvested lions are often of lower quality, younger, and less desirable male lions, as operators and hunters, who had already paid the trophy fee, had no incentive to be selective. Abolishing fixed-quota fees and only allowing optional quotas will encourage and reward operators who are selective and follow age restrictions (Lindsey *et al*. 2013a, p. 9; Packer *et al*. 2006, pp. 5, 9).

To ensure hunters have adequate time to be selective in trophies harvested, and to ensure the revenue earning potential is maximized, experts recommend that a minimum stipulated hunt length be set at 21 days. However, many countries either have no limits on length of hunting safaris or have too short a minimum length (Lindsey *et al*. 2013a, p. 9). Currently, there are no set lengths for hunting safaris in Mozambique, Namibia, Zambia, and Zimbabwe. Burkino Faso has a minimum requirement of 12 days, and Benin and Cameroon require 12 to 14 days. Tanzania has a minimum length of 21 days while CAR varies from 12 to 21 days (Lindsey *et al*. 2013a, pp. 2–3).

Several other problems with current management of lion trophy hunting are likely to worsen negative impacts associated with hunting of lions and undermine conservation incentives. Corruption, allocation of hunting concessions, and lack of benefits and recognition of the role communities play in conservation have been identified (Lindsey *et al*. 2013a, pp. 2–3, 9).

Corruption is widespread within the range of the lion (Transparency International 2014, unpaginated). All but one lion range country (Botswana) scored below 50 (out of 100) on Transparency International's 2014 Corruption Perception Index (CPI), which measures perceived levels of public sector corruption based on expert opinion and is based on a scale of 0 (highly corrupt) to 100 (very clean). Approximately half of the current lion range countries—including Tanzania and Kenya, where more than half of all wild lions occur—are among the most corrupt countries in the world, ranking in the lower 30 percent of 174 countries assessed (Transparency International 2014, unpaginated).

Corruption is particularly prevalent in areas with extreme poverty (Transparency International 2014, unpaginated; Michler 2013, pp. 1–3; Kimati 2012, p. 1; Garnett *et al.* 2011, p. 1; IUCN 2009, p. 89; Leader-Williams *et al.* 2009, pp. 296–298; Kideghesho 2008, pp. 16–17). Certain circumstances tend to promote corruption, such as opportunity for financial gain, weak rule of law, abnormal concentrations of power in one individual or institution, no counter-balancing mechanisms in place among different government agencies, and reliance on discretionary powers for allocation of permits, licenses, or activities (Smith *et al*. 2015, p. 953; Nelson 2009, unpaginated; Luo 2005 in Smith *et al.* 2015, p. 953).

Corruption manifests itself in several ways, such as embezzling of public funds, fraud, demanding or accepting bribes to overlook illegal activities, interference in decisions to implement conservation measures, and offering patronage, nepotism, and political influence (Vargas-Hernandez 2013 in Smith *et al.* 2015, p. 953; Garnett *et al.* 2011, p. 1; Leader-Williams

et al. 2009, p. 301; Kaufmann 1997 in Leader-Williams *et al*. 2009, p. 297). With respect to lion management, it may include, for example: infringement of hunting regulations in the field; acceptance of bribes to overlook illegal activities such as poaching; interference or mismanagement in monitoring and setting of hunting quotas and in issuing of licenses; misappropriation of hunting fees; allocation of hunting blocks based on patronage and nepotism or to persons presumably considered to be of financial or other strategic importance; and allocation of hunting blocks at less than competitive prices (see Leader-Williams *et al.* 2009, pp. 301–305; Nelson 2009, unpaginated).

Peh and Dori (2010, pp. 336–337) show that global indices of corruption and governance are highly correlated with those of environmental performance—countries with high levels of corruption have lower levels of environmental performance. Further, Smith *et al.* (2003, entire) found strong associations between changes (declines) in elephant and rhinoceros numbers and governance scores. Governance scores, which were based largely on Transparency International's CPI, explained observed changes in numbers of elephants and rhinoceroses better than per capita GDP, Human Development Index scores, and human population density. These results suggest that political corruption may play a significant role in determining the success of national strategies to conserve these species (Smith *et al.* 2003, p. 69). Corruption can reduce the effectiveness of conservation programs by reducing the funding, law enforcement, and political support available for conservation, and also by acting as an incentive for the overexploitation of resources (Garnett *et al.* 2011, p. 1, citing several sources; Smith and Walpole 2005, p. 252). Given the financial gains to be made from lion trophy hunting, and the high level of corruption in many lion range countries (Packer 2015, pers. comm.; Transparency International 2014,

unpaginated), it is reasonable to conclude that corruption and the inability to control it are having negative impacts on decisions made about lion management in many areas of the species' range and on lion populations, and undermine steps to reform hunting of lions. The impacts highlight the importance of transparency within the hunting industry and independent verification of processes such as quota setting, trophy monitoring, and concession allocation (Lindsey *et al.* 2013a, p. 9).

In recent years, leadership in several African lion range countries has taken steps to address corruption, or activities that facilitate corruption, associated with wildlife management. For example, in 2013, the Tourism Minister of Zambia banned hunting in 19 game management areas for 1 year due to allegations of corruption and malpractice among the hunting companies and various government departments. Some game management areas and privately owned game ranches were not included in the ban, but lion hunting appears to be prohibited throughout the country (Michler 2013, pp. 1–3). Whether recent reforms taken by various lion range countries will reduce the effect of corruption on lion management and, therefore, lion populations is as yet unknown.

Most concessions in the African range of the lion use a closed-tender process for land management. A closed-tender system is the process of selling a product by inviting a specific group of potential buyers to provide a written offer by a specified date. In the case of a hunting concession, the owner of the property thus sells a lease on a property for a given length of time. Countries that use this process for state-owned lands include Benin (lease is for 5 years); Burkina Faso (20 years); Cameroon (10 years, renewable); CAR (10 years (renewable); Mozambique

(10+ years); Tanzania (5 years); and Zambia (10–15 years based on status of wildlife). In Namibia, state concessions lease land by public auctions for 3-year periods, while community conservancies lease for a 5-year period via a closed-tender process. Zimbabwe holds a public auction for state safari areas, with the option to extend 5 years based on performance. Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) areas are leased on 3–10 year-period using a closed-tender process (Lindsey *et al*. 2013a, pp. 2–3).

The chief complaint regarding this system is that concession areas are leased to operators without regard for the operators' track record in conservation. Zimbabwe is the only country that renews based on operator performance (Lindsey *et al*. 2013a, pp. 2, 9). Lindsey *et al*. (2007, p. 2) found that various countries have problems with their allocation process, "with the effect that they are sometimes sold too cheaply, allocated for periods too short to promote responsible custodianship, and occasionally given to unlicensed operators…. In several countries large citizen quotas are provided to urban residents at low prices, reducing revenues from trophy hunting and reducing incentives for communities to conserve wildlife." Experts believe that basing the ability to renew a concession lease on operators' past performance records could be an incentive for operators to comply with best practices. Thus, experts recommend concession allocation should base concession lease renewals on operator performance in regard to best practices compliance.

As discussed under *Human–lion Conflict*, the risk of retaliatory killing is elevated in many cases due to the fact that communities living in close proximity to lion populations often bear the cost of that proximity (e.g., loss of valuable livestock due to lion depredation), but

receive little of the benefits generated by the presence of lion in the trophy hunting and ecotourism industries (Lindsey *et al*. 2013a, p. 9). Trophy hunting can generate millions of dollars in annual revenue (see *Potential Benefits of Trophy Hunting*).

In the past, government and private land owners were the primary beneficiaries of the revenue gained; currently efforts are being made in many range countries to incorporate incentives at the local level (Barnett and Patterson 2005, p. vi). Many range countries are now recognizing the need to incorporate incentives and local community benefits into their trophy hunting regulations, land management policies, and lion conservation action plans. Most countries that allow lion trophy hunting have developed National Poverty Reduction Strategies and discussed benefit distribution and management to rural communities (see *Potential Benefits of Trophy Hunting*). Although positive steps are being taken to address local community incentives, most of the countries are currently not transparent about the benefits provided to local communities, and due to the high revenue potential are subject to corruption.

Captive Lions

In analyzing threats to a species, we focus our analysis on threats acting upon wild specimens within the native range of the species, because the goal of the Act is survival and recovery of the species within its native ecosystem. We do not separately analyze "threats" to captive-held specimens because the statutory five factors under section 4 (16 U.S.C. 1533) are not well-suited to consideration of specimens in captivity, and captive-held specimens are not eligible for separate consideration for listing. However, we do consider the extent to which specimens held in captivity create, contribute to, reduce, or remove threats to the species.

In 2009, approximately 3,600 captive-held lions were managed for trophy hunting across 174 breeding facilities in South Africa ((Lindsey *et al.* 2012, p. 18, citing Taijaard 2009; Barnett *et al*. 2006a, p. 513). The captive-breeding industry often publicizes captive breeding and reintroduction of captive-born species into the wild as a potential solution to the decrease in wild lion populations. However, lions raised in captivity often develop a variety of issues that make them unsuitable for reintroduction. Captive lions in general are not suitable for reintroduction due to their uncertain genetic origins (Barnett *et al*. 2006a, p. 513; Hunter *et al*. 2012, p. 3), potential maladaptive behaviors, and higher failure risk compared to translocated individuals (Hunter *et al*. 2012, pp. 2–3). Research has indicated that restoration efforts using wild-caught individuals have a much higher rate of success than those using captive-raised individuals for a large variety of species (Hunter *et al*. 2012, p. 21). Currently, reintroduction efforts of captive-raised lions have not been shown to address the underlying causes of populations' declines throughout the species range.

We note that while the captive-lion industry may not be contributing to the conservation of the species in the wild via reintroduction, the captive-lion industry in South Africa may reduce the pressures of trophy hunting on the wild populations in South Africa (Hargreaves 2010b in Lindsey *et al*. 2012, p. 12; Lindsey *et al*. 2012, p. 19), which is evidenced by the fact that 99 percent of lion trophies from South Africa are of captive origin. Lindsey *et al*. (2012, p. 21) warn that future efforts to control hunting of captive-bred lions could potentially increase the demand for wild lion trophies and result in excessive harvests. However, we also note that trade in bones of captive lions could stimulate harvest of wild lions to supply a growing bone trade (Lindsey *et al*. 2012, p. 20). Hunting of captive lions could also potentially undermine the price

of wild hunts and reduce incentives for conservation of wild lions in other African countries (Lindsey *et al*. 2012, p. 12).

Limited research has been conducted on the use of captive-raised lions for reintroduction purposes. Existing research has generally found that captive-raised lions are not as able to successfully adapt to conditions out of captivity and therefore, the success rate is much reduced compared to the use of wild-caught lions. Although some potential exists that the captive-lion industry in South Africa may benefit some local wild populations, additional research would be needed to verify this claim. As a result, we do not believe that the captive-lion industry currently contributes to, reduces, or removes threats to the species.

Summary of Trophy Hunting

If trophy hunting of lions is part of a scientifically based management program, it can provide considerable benefits to the species by reducing or removing incentives to kill lions in retaliation for livestock losses, and by reducing the conversion of lion habitat to agriculture. Trophy hunting, if managed well and with local communities in mind, can bring in needed revenue, jobs, and a much-needed protein source to impoverished local communities, demonstrating the value of lions (Groom 2013, pp. 1–3; Lindsey *et al*. 2006, pp. 283, 289). In addition, the amount of habitat that has been set aside by range countries specifically for trophy hunting has greatly increased the range and habitat of lions and their prey base, which contrasts the overall ongoing rate of habitat destruction occurring in Africa. The total amount of land set aside for trophy hunting throughout Africa exceeds the total area of the national parks, providing

half the amount of viable lion habitat (Chardonnet *et al*. 2010, p. 34; Packer *et al*. 2006, pp. 9–10).

The main problem with mismanaged trophy hunting stems from excessive harvests and impacts associated with removal of males (Hunter *et al*. 2013, p. 2). Researchers have documented declines in populations across the range of the species that were a direct result of mismanaged trophy hunting (Rosenblatt *et al*. 2014, p. entire; Sogbohossou *et al*. 2014, entire; Becker *et al*. 2013, entire; Lindsey *et al*. 2013, entire; Croes *et al*. 2011, entire; Packer 2011, entire; Loveridge *et al*. 2007, entire). Six management weaknesses have been identified in the current management of lion hunting. These weaknesses include: (1) A lack of scientifically based quota that results in excessive harvests; (2) a lack of enforcement in age restrictions, which leads to unsustainable harvests, increased rates of infanticide, and population declines; (3) hunting of female lions in Namibia, which decreases reproduction success, thereby decreasing males available for trophy hunting; (4) the use of fixed quotas, which encourages hunters to be unselective in their take of a trophy (i.e., they will kill younger, less desirable males); (5) a lack of minimum hunt lengths or minimum lengths that are too short to allow hunters the time needed to be more selective in their take of trophies; and (6) general problems associated with management of trophy hunting, including corruption, allocation of concessions, and lack of benefits to communities and recognition of the important role they play in conservation.

Most *P. l. leo* populations are extremely small, isolated, and rapidly declining. Of the 18 countries documented to allow lion trophy hunting, 8 are in the range of *P. l. leo*. However, we note that due to the lack of lions in some of these countries, it is unlikely that all of these

countries could conduct lion trophy hunts. A study found that quotas in Benin and Burkina Faso are too high for sustainability, although Burkina Faso has proposed to reduce their quota in the 2015–2016 season (Henschel 2015, pers. comm.; Lindsey *et al*. 2013a, p. 6). Actual harvests in Burkina Faso were also found to be higher than the level recommended by Packer *et al*. (2011, p. 151). Additionally, Benin and Burkina Faso have committed to implementing an age-based strategy, but have yet to implement it. As a result, species experts agree that there is no level of offtake that would be sustainable for *P. l. leo* populations in their current condition (Bauer 2015, pers. comm.; Henschel *et al*. 2014, entire; Henschel *et al*. 2010, entire).

Of the 18 countries documented to allow lion trophy hunting, 10 are in the range of *P. l. melanochaita*. However, we note that, like the situation with *P. l. leo*, due to a lack of lion populations in some of these countries, it is likely that fewer countries could conduct lion trophy hunts. A study found that Namibia, Tanzania, Zambia, and Zimbabwe all had quotas higher that the recommended level for sustainability; however, Zimbabwe has reduced their quota. Mozambique (Niassa National Reserve) is the only location found to have a quota below the recommended level. Age-based strategies have been implemented and shown to reduce offtakes in Mozambique (only in Niassa National Reserve, excludes the rest of the country), Tanzania, and Zimbabwe. Furthermore, Zimbabwe and Niassa National Reserve are the only two locations that have fully implemented an age-based strategy with transparency, an element experts say is critical to a quota allocation system. Several other countries have made commitments to implement the age-restrictions strategy but their progress is pending. In South Africa, 99 percent of the lion trophies are captive bred, and, therefore, were not the result of removing lions from the wild.

Unless reforms are made to the current management of trophy hunting, we expect the declines specifically documented from excessive offtakes in Benin, Cameroon, Tanzania, Zambia, and Zimbabwe to continue. Furthermore, we expect excessive harvests to further contribute to declines in the species across its African range.

Import/Export of Lion Trophies

The lion species (*Panthera leo*) is listed in Appendix II of CITES; however, the former Asiatic lion (*P. l. persica*) is listed in Appendix I. CITES is an international agreement through which member countries work together to protect against over-exploitation of animal and plant species found in international trade. Parties regulate and monitor international trade in CITES-listed species—that is, their import, export, and reexport, and introduction from the sea—through a system of permits and certificates. CITES lists species in one of three appendices—Appendix I, II, or III.

An Appendix-I listing includes species threatened with extinction whose trade is permitted only under exceptional circumstances, which generally precludes commercial trade. The import of specimens (both live and dead, as well as parts and products) of an Appendix-I species generally requires the issuance of both an import and export permit under CITES. Import permits are issued only if findings are made that the import would be for purposes that are not detrimental to the survival of the species in the wild and that the specimen will not be used for primarily commercial purposes. For live specimens, a finding must also be made that the recipient is suitably equipped to house and care for the specimens (CITES Article III(3)).

Export permits are issued only if findings are made that the specimen was legally acquired and the export is not detrimental to the survival of the species in the wild, and that a living specimen will be so prepared and shipped as to minimize the risk of injury, damage to health, or cruel treatment, and that the CITES Management Authority of the exporting country is satisfied that an import permit has been granted for the specimen (CITES Article III(2)).

CITES Appendix II includes species that are less vulnerable to extinction than species listed in Appendix I, and "although not necessarily now threatened with extinction, may become so unless trade in specimens of such species is subject to strict regulation in order to avoid utilization incompatible with their survival." Species listed in Appendix II of CITES may be commercially traded, subject to several restrictions.

Although each country has its own method of regulating trophy hunting, international trade of lion trophies must adhere to CITES. International trade of lion parts and products (including trophies) are reported by both the exporting and importing countries and tracked by the United Nations Environment Programme World Conservation Monitoring Centre (UNEP–WCMC).

According to the UNEP–WCMC CITES Trade Database, between 2005 and 2012, exports of lion trophies demonstrated a decreasing trend, if exports of captive-born lions from South Africa are excluded (UNEP-WCMC 2014, unpaginated). UNEP–WCMC indicates that 521 lion trophies were exported (excluding South Africa) in 2005 and 303 were reported (excluding South Africa) in 2012.

It should be noted that there are limitations to interpreting the above reported information. The 2004 guide to using the CITES Trade Database indicates that the outputs produced by the CITES Trade Database can be easily misinterpreted if one is not familiar with it (CITES 2004b, p. 5). The number of "trophies" reported does not necessarily equate to the number of lions hunted. Additionally, the number of trophies reported for a given year in the trade report does not equate directly to the number of animals hunted in that given year (CITES export permits are generally valid for 6 months, and a trophy could in theory be exported the year after it was hunted). The second limitation to interpreting this information is that, although many permits may indicate that an animal is of wild origin (source code "W"), these permits may be incorrectly coded. This is true for South Africa, where during the period of 2000 to 2009, animals that were captive born and released into private reserve systems were assigned an incorrect source code of "W." South Africa has since requested their provincial authorities to use the correct source code for "captive bred" in order to correctly reflect the source of sport-hunted lion trophies; however, some provinces are not complying (RSA 2013, pp. 8–9). Based on South African trade data, the bulk of lion exports and their parts and products (including trophies) are from captive-born lions (RSA 2013, p. 7).

Tanzania, with one of the largest lion populations (Hamunyela *et al*. 2013, pp. 29, 283; Riggio *et al*. 2013, p. 32; Ikanda 2008, p. 4; Baldus 2004, pp. 5, 6), was the largest exporter of wild-origin lion trophies, but their exports have decreased significantly since 2008. In 2008, approximately 138 trophies were exported from Tanzania; in 2010, 128 were exported; in 2011, 55 were exported; in 2012, 62 were exported (it should be noted that in 2012 Tanzania

established an annual quota to limit trophy hunting to no more than 50 animals (Jackson 2013, p. 7); and in 2013, 11 were exported (UNEP-WCMC 2014, unpaginated). Again, it should be noted that there may be discrepancies between the annual quota and the actual number of trophies exported in a given year (see *http://www.cites.org/common/resources/TradeDatabaseGuide.pdf* for additional information). Regardless, the numbers of lion trophies exported by Tanzania according to the UNEP–WCMC CITES Trade Database suggest a decreasing trend.

Additionally, some trophies are exported from source countries under the "skins" category. According to the most recent data available, the United States imported skins of wild origin from four African countries in 2013; 9 from Mozambique, 5 from Tanzania, 2 from South Africa, and 22 from Zimbabwe. The purpose code for these imports was "Trophy Hunt," except for the two skins from South Africa which were coded as "Commercial."

For 2013, the most recent year for which complete CITES trade data are available, U.S. CITES Annual Report trade data indicate that the United States allowed the direct import of lion trophies from seven African countries, as follows:

Botswana = 1 trophy (originated from Mozambique)

Burkino Faso = 3 trophies

Mozambique = 5 trophies

Namibia = 9 trophies

South Africa = 545 trophies (the majority of which are reported to be of captive-born origin; additionally 2 captive trophies originated in South Africa, imported to Canada, and then imported into the United States)
Tanzania = 3 trophies
Zambia = 17 trophies
Zimbabwe = 44 trophies

Based on CITES trade data, lion trophy exports have decreased throughout most of the lion's range, including Tanzania, which has one of the largest lion populations. South Africa is the only country where exports have increased because most of these trophies are of captive origin.

Traditional Use of Lion Parts and Products

Lion parts and products are used in many African countries as medicine, nutrition, talismans, and decorations, and in traditional ceremonies and rituals (CITES 2014, p. 7; Burton *et al.* 2010, p. 4). CITES (2014, p. 8) reports that many African countries, including Somalia, Nigeria, Burkina Faso, Kenya, and Cameroon, maintain local markets in lion products. Parts used include skin, teeth, claws, fat, whiskers, bone, bile, testicles, meat, and tails. In addition, lion bone is also used in Asia as a substitute for tiger bone in traditional Asian medicine (Williams *et al.* 2015, pp. 2, 62).

While quantitative data is lacking, according to a peer reviewer (Bauer 2015, pers. comm.), trade in lion parts and products is very common within western and central Africa.

Responses to the CITES periodic review consultation process support this claim: Trade in lion skins and partial skins is described as "frequent" in street markets in Abidjan, Côte d'Ivoire; lion skins and canines are described as "easily found" in the markets of Dakar, Senegal; and the scale of domestic trade in illegal lion products is described as "massive" in Nigeria (CITES 2014, pp. 5–6). Further, in the central African country of Cameroon, the estimated value of a single lion carcass exceeds the trophy fee, and at a lion conservation conference the Government of Cameroon identified trade in lion skins as a major cause of the decline in lion populations in western and central Africa (LAGA pers. comm., in CITES 2014, p. 12). According to Henschel (in CITES 2014, p. 12), the trade in lion skins is most likely one of the biggest threats to lion survival in western Africa due to the rarity of lions in the region, the extent of the trade, and the high price of lion skins.

In southern and eastern Africa, trade in lion parts, particularly lion bone, to Asia is generally considered a severe potential threat to the species (Bauer 2015, pers. comm.). According to CITES (2014, p. 14), there is "clear scope for the international trade in lion body parts for [traditional Chinese medicine and traditional African medicine] to grow uncontrollably, as it has done for other big cats."

Lion bones are used as a substitute for tiger (*Panthera tigris*) bone in traditional Asian medicine and in Asian luxury products (Williams *et al.* 2015, pp. 2–3, 5; Graham–Rowe 2011, pp. s101–s102). Lion bones are difficult to distinguish from tiger bones (Williams *et al.* 2015, pp. 8, 102; Wildlife Protection Society of India 2007, unpaginated), and are sold into Asian markets as tiger bone fakes (Williams *et al.* 2015, pp. 2–3, 62, citing several sources). Tiger

bone is highly valued in Asia, primarily in China and Vietnam, and there is considerable demand for it (Williams *et al.* 2015, p. 1; Gratwicke *et al.* 2008, pp. 2–5; Graham-Rowe 2011, pp. s101–s102). Consequently, tiger bones are one of the most lucrative products on the illegal wildlife market (Haken 2011, in Williams *et al.* 2015, p. 1)—the retail price of raw tiger bone can reach $1,250–3,750 USD per kilogram (Nowell and Ling 2007, p. 23).

Tigers are categorized by IUCN as endangered (Goodrich 2015, p. 2). Globally, the tiger population has declined from what is believed to have been 100,000 at the turn of the 19th century (Jackson 1993, in Nijman and Shepherd 2015, p. 1) to an estimated 5,000–7,000 in 1998, to 3,159 tigers in 2014 (Goodrich 2015, p. 7; Seidensticker *et al.* 1999, in Goodrich *et al.* 2015, p. 7). Poaching for the illegal trade in tiger parts, especially bone has become a major driver in the species' decline (Goodrich *et al.* 2015, p. 9; Williams *et al.* 2015, p. 1; Nowell and Ling 2007, p. v). While wild tiger populations are declining, the demand for tiger parts in Asia is increasing (Williams *et al.* 2015, p. 5; United Nations Office on Drugs and Crime 2013, p. 81; United Nations Office on Drugs and Crime 2010, pp. 10, 17; Nowell and Ling 2007, p. 4). This increasing demand for tiger parts has led to the rise of tiger farms, where live captive bred tigers appear to be utilized to supply the bone trade within China (Denyer 2015, unpaginated). With tigers difficult to obtain, lion bone may be increasingly used as a replacement for tiger bone. Thus, the lion bone trade could potentially follow the same course as the tiger bone trade: become lucrative, spur considerable demand from suppliers of the black market, result in extensive poaching of wild individuals, and have significant impacts to wild populations.

Certain aspects of the current lion bone trade suggest that the potential for the trade to impact wild lion populations may be high. For example, evidence suggests that demand from Asia for lion bone is increasing rapidly. Based on Williams (2015, pp. ix–x, 46), during 1982–2000, only nine lion skeletons were exported from worldwide sources, destined primarily to Europe. CITES permit records show only three exported from South Africa prior to 2008, destined for Denmark. In 2008, South Africa began issuing CITES permits for the export of skeletons of captive-bred lions to Asia. These exports currently appear to come primarily from South Africa's captive-bred lion hunting industry as a byproduct of trophy hunting. The number of lion skeletons for which South Africa issued permits for export to Asia (China, Viet Nam, Thailand and Lao PDR) increased tenfold from 2008 to 2011, from about 50 to about 573 skeletons, respectively, representing a total of 1,160 skeletons or about 10.8 metric tons (11.9 US tons) of lion bone in 4 years (Williams 2015, pp. ix–x, 46). Further, according to the Government of Kenya (2015, p. 3), the declared exports of bones, skulls, and skeletons derived from wild lions also show an increasing trend through the period 2003–2012, with total declared specimens in 2012 more than ten times those in 2003. With respect to meeting demand for lion bone, Lindsey *et al.* (2012, p. 20) state that there are likely to be large numbers of lion bones available for export from game farms, from lionesses and non-trophy males, and as byproducts from animals shot as trophies. In addition, Williams *et al.* (2015, p. 41) report that there may be between 1,400 and 6,200 lion skeletons from past trophy hunts on South African game farms that could potentially be used to supply demand for lion bone. However, considering the sharp and continuing increases in demand from Asia for lion bone, there is potential for demand to surpass the availability of legally obtained lion bone and, consequently, result in poaching of wild lions to meet demand.

In addition, recent evidence strongly suggests live lions are being used to supply the lion bone trade (Williams *et al*. 2015, pp. ix, 2–3, 42–44). In August 2006 a live Asiatic lion was observed in a market in Mong La, Myanmar (Oswell, 2010, p. 12). The town, known for incidents of wildlife trafficking, is less than 2km from the Chinese border. Up to 2006/2007, Williams *et al*. (2015, p. x, Table 11, Figure 24) noted:

> "The combined quantity of live lions and lion parts and derivatives exported to East–Southeast Asia from South Africa was minimal in the broader global trade. From 2008, however, the quantities exported increased almost six-fold from the previous year. Not only did the number of live lions exported to East–Southeast Asia reach record levels from this time, but also the first permits to export lion skeletons were issued. The demand for lion parts and derivatives appears to have coincided with the strengthened conservation measures adopted in 2006–2007 to protect tigers and Asian big cats. Accordingly, tiger parts were increasingly substituted with lion parts obtained from Africa. The trade in lion parts and derivatives to Lao PDR dominates the exports. Since 1998, but especially after 2007, China, Viet Nam, Lao PDR, Myanmar and Thailand have imported increasing amounts of live lions, lion bodies and bones from South Africa."

Evidence also indicates "well established" links between South Africa's legal lion bone trade and the Xaysavang Network, an international wildlife trafficking syndicate that is also involved in the illicit rhino horn trade in South Africa (Williams *et al.* 2015, pp. 7–10, 59; Environmental Investigative Agency 2014, p. 13; U.S. Department of State 2013, unpaginated).

The U.S. Department of State has issued a $1 million reward for information leading to the dismantling of this network. According to the U.S. Department of State, the Xaysavang Network facilitates the killing of endangered species in Africa and elsewhere and smuggles them to Laos for export to other Asian countries (U.S. Department of State 2013, unpaginated). During 2008–2011, the vast majority (85%) of the permits issued by South Africa to export lion skeletons or carcasses were issued for exports to Laos (Williams *et al.* 2015, pp. x, 46) and, for the only 2 years for which data were available (2009 and 2010), over half of the consignments destined for Laos were listed as imported by Vixay Keosavang, believed by the U.S. Department of State to be the leader of the Xaysavang network (U.S. Department of State 2013, unpaginated; Williams *et al.* 2015, pp.8–10). The involvement of the Xaysavang Network in South Africa's lion bone trade indicates there are well-established avenues for laundering of illegally obtained lion bones, such as those obtained from poached wild lions, into the legal trade.

Lastly, evidence suggests incentive to poach wild lions for the bone trade may currently exist. According to Williams *et al.* (2015, p. x), the 2013 price paid to South African game farmers and landowners for lion bones was $1,260–2,100 USD per skeleton. In many lion range states this exceeds per capita GDP (gross domestic product) (World Bank 2015, unpaginated). Thus, the current price paid for lion bone appears to provide incentive in some countries to poach wild lions.

While the lion bone trade appears to currently be based primarily in South Africa's captive-bred lion hunting industry, the trade appears to be having little or no impact on wild lion populations in South Africa at this time—lion populations in South Africa are stable or

increasing and there is little poaching of wild lions in the country (Funston and Levendal 2014, pp. 1, 26; Williams *et al.* 2015, pp. 79–80). However, the impact of the lion bone trade on lion populations outside South Africa is unknown, and most wild lions occur outside South Africa (see *Distribution and Abundance*). Based on the effect of the tiger bone trade on tiger populations, if current conditions—for example, rapidly increasing demand and involvement of an international crime syndicate—continue unchanged, then there is considerable potential for extensive poaching of wild lions to occur in order to meet demand.

Disease

Wild lions are known to be infected with various pathogens (Hunter *et al.* 2012, p. 2; Craft 2008, p. 6; Michel *et al.* 2006, p. 92; Hofmann-Lehmann *et al.* 1996, pp. 559–561). However, information on the extent of infections and impacts of diseases on lion populations is limited. We found one study documenting disease in a single wild lion in India that died from trypanosomiasis in 2007; analysis of tissue samples also detected peste des petits ruminants virus (PPRV), which is not known to cause disease in carnivores (LionAid 2013, unpaginated; Balamurugan *et al*. 2012, pp. 203, 205). Information on the presence of disease and impacts to lions come from a few long-term studies that have been conducted in Africa, including Serengeti National Park, Ngorongoro Crater, and Kruger National Park.

As a result of human population expansion into lion habitat, lions are increasingly exposed to diseases from domestic animals (IUCN 2006b, p. 26). Because lions are a top predator, they are at a particularly high risk of exposure to pathogens (Keet *et al.* 2009, p. 11). Some pathogens are endemic, meaning they are constantly present, but often do not cause

disease. Others are epidemic and cause a sudden severe outbreak with the potential to cause high mortality (Craft 2008, pp. 5, 6). The association between disease, age, nutritional health and other factors that could predispose a lion to morbidity and, eventually, mortality is complex. It is often difficult to determine whether mortality was due to a single factor or a combination. Lions could be infected with and become debilitated by a disease, but the actual cause of death could be other factors, such as fighting with other lions or large predators (LionAid 2014a, p. 4).

Feline calicivirus, feline herpesvirus, feline parvovirus, feline coronavirus, and feline leukemia virus are endemic viruses known to occur in lions of Serengeti National Park, Ngorongoro Crater, Lake Manyara National Park, Kruger National Park, and Etosha National Park (but not all viruses are known in all parks). However, these diseases are not known to affect lion survival (Hunter *et al.* 2012, p. 2; Craft 2008, p. 6; Hofmann-Lehmann 1996, pp. 559, 561).

Lions within Kruger National Park and Hluhluwe-iMfolozi Park, South Africa, and Serengeti National Park, Tanzania, are known to be infected with *Mycobacterium bovis*, a pathogen that causes bovine tuberculosis (bTB). This pathogen is not endemic to African wildlife and was likely introduced from cattle imported from Europe. *M. bovis* is transmitted to ungulates, such as African buffalo (*Syncerus caffer*) and wildebeest (*Connochaetes taurinus*), from domestic cattle located on the periphery of the parks (Maas *et al.* 2012, p. 4206; Keet *et al.* 2009, pp. 4, 11; Renwick *et al*. 2007, p. 532; Michel *et al.* 2006, pp. 92, 93; Cleaveland *et al.* 2005, pp. 446, 449, 450). Spillover of the disease from buffalo to other lion prey species, such as kudu (*Tragelaphus strepsiceros*) and warthog (*Phacochoerus africanus*), has also been

documented (Keet *et al.* 2009, pp. 4, 11; Renwick *et al.* 2007, p. 535; Cleaveland *et al.* 2005, p. 450). Because the lion's primary prey are infected with bTB, they are frequently exposed to large amounts of infected tissue and are at risk of infection (Keet *et al.* 2009, pp. 4, 6; Renwick *et al.* 2007, pp. 532, 536; Michel *et al.* 2006, p. 93; Cleaveland *et al.* 2005, pp. 450, 451). Furthermore, predators prey on weak animals and scavenge on carcasses, increasing their likelihood of being exposed to *M. bovis* (Renwick *et al.* 2007, p. 536; Michel *et al.* 2006, p. 93). Transmission may also occur among lions via scratching and biting (Keet *et al.* 2009, p. 7; Renwick *et al.* 2007, pp. 532–533). *M. bovis* is a pathogen that causes the infected animal to remain infectious and, therefore, a source of infection, until it dies (Renwick *et al.* 2007, p. 531). Miller *et al*. (2014, pp. 495, 496) found respiratory shedding of viable *M. bovis* in living lions, meaning that lions could transmit bTB and serve as maintenance hosts.

The social behavior of buffalo and lions allows *M. bovis* to spread to larger areas and facilitates the transmission within and between prides. Drought conditions may also encourage the spread of this pathogen as herds must move into new areas in search of forage, potentially putting them in contact with new, uninfected herds (Keet *et al.* 2009, pp. 4, 6; Renwick *et al.* 2007, p. 533; Michel *et al.* 2006, p. 93). In Kruger National Park, bTB was introduced in the southeastern corner of the park between 1950 and 1960. It gradually made a northern progress and reached the park's northern boundary in 2006. In 2009, the disease was found in buffalo across the river boundary in Zimbabwe (Keet *et al.* 2009, pp. 6, 11; Renwick *et al.* 2007, pp. 532, 533; Michel *et al.* 2006, pp. 92, 96, 98). A study from Kruger National Park indicated that bTB spreads quickly through lion populations; in an area with high herd prevalence of *M.* bovis, 90 percent of lions became infected (Cleaveland *et al.* 2005, p. 451). In time it will likely spread to

Mozambique (Keet *et al.* 2009, p. 6). In Serengeti National Park, infection may be widespread due to the large, migratory wildebeest population that ranges throughout the Serengeti ecosystem, including Maasai Mara National Reserve (Cleaveland *et al.* 2005, p. 450). Although an eradication program has been implemented for cattle in South Africa, once an infection is established in a free-ranging maintenance host, like buffalo, it is unlikely to be eradicated (Keet *et al.* 2009, p. 11; Renwick *et al.* 2007, pp. 537, 538; Michel *et al.* 2006, p. 96). In fact, modeling has predicted that prevalence could reach as high as 90 percent over the next 25 years, with similar consequences for predators (Renwick *et al.* 2007, p. 535).

Clinical signs of bTB in lions include emaciation, respiratory complications, swollen lymph nodes, draining sinuses, ataxia, and lameness (Keet *et al.* 2009, p. 13; Renwick *et al.* 2007, pp. 533, 534; Cleaveland *et al.* 2005, p. 450), although some lions may be subclinically infected but remain asymptomatic until they experience another bTB infection, suffer from poor nutrition or advancing age, or become super-infected with other diseases that may exacerbate the infection (Renwick *et al.* 2007, p. 533). The impact of bTB on lions is largely unknown. Researchers suggest that bTB may lower breeding success, reduce resiliency, and be a mortality factor based on data that indicate survival is shortened in infected lions, with death ranging between 2 and 5 years after infection (Maas *et al.* 2012, p. 4212; Renwick *et al*. 2007, p. 536; Keet, unpublished data in Michel *et al.* 2006, p. 93; Cleaveland *et al.* 2005, pp. 450, 451). In addition to clinical effects of bTB that may lead to mortality, this disease has also led to social changes with lower lion survival and breeding success with more frequent male coalition turnover and, consequently, higher infanticide (Keet, unpublished data in Michel *et al*. 2006, p. 93). Research has shown adverse effects to lion individuals and subpopulations, but effects at

the species population level are developing slowly (Michel *et al*. 2006, p. 97). Studies have shown that impacts of bTB on lion numbers vary between populations. For example, 30 percent of the inbred populations in Hluhluwe-iMfolozi Park died due to a combination of bTB and malnutrition (Hunter *et al.* 2012, p. 3). However, despite bTB infection and a high prevalence in prey species, the lion population in Kruger National Park has remained stable (Ferreira and Funston 2010, p. 201).

Epidemics of canine distemper virus (CDV) are known to have occurred in the Serengeti-Mara Ecosystem, an area that encompasses the Serengeti National Park, Ngorongoro Conservation Area, and Maasai Mara National Reserve (Craft 2008, pp. 13–14; Cleaveland *et al.* 2007, pp. 613, 616, 618). CDV is a common pathogen in the large population of domestic dogs (*Canis lupus familiaris*) around the Serengeti-Mara Ecosystem, which are believed to be the source of CDV in lions (Cleaveland *et al.* 2007, pp. 613, 617). CDV is assumed to be transferred to lions by the sharing of food sources with spotted hyenas (*Crocuta crocuta*) or jackals (*Canis* spp.) that become infected by consuming the infected carcasses of domestic dogs (Craft *et al*. 2009, p. 1783; Craft 2008, p. 13). Viana *et al*. (2015, pp. 1466, 1467) recently discovered that domestic dogs are not the sole source of CDV in the Serengeti, but rather there is likely a larger, multihost community of wildlife that contribute to outbreaks. Lions may also transmit CDV among themselves via sharing food, fights, and mating (Craft *et al.* 2009, pp. 1778, 1783; Craft 2008, pp. 13, 18, 71).

CDV generally lacks clinical signs or measurable mortality in lions, and most CDV events have been harmless. However, in 1994 and 2001, CDV epidemics in the Serengeti

National Park/Maasai Mara National Reserve and Ngorongoro Crater, respectively, resulted in unusually high mortality rates (Hunter *et al.* 2012, p. 2; Craft 2008, p. 14; Munson *et al.* 2008, pp. 1, 2; Cleaveland *et al.* 2007, pp. 613, 618; Roelke-Parker *et al.* 1996, pp. 441, 443). These outbreaks coincided with climate extremes that resulted in a higher number of *Babesia*, a tick-borne parasite, infections (Munson *et al.* 2008, pp. 2, 5). *Babesia* is common in lions, but typically at low levels with no measurable impacts on their health (Craft 2008, p. 14; Munson *et al.* 2008, p. 3). However, droughts in 1993 and 2000 in Serengeti National Park/Maasai Mara National Reserve and Ngorongoro Crater, respectively, led to large-scale starvation and widespread die-offs of buffalo. This situation combined with resumption of rains and fire suppression in Ngorongoro Crater favored propagation of ticks, vectors of *Babesia*, leading to unusually high tick burdens. The compromised health of buffalo allowed lions to feed on an inordinate number of tick-infested prey (Craft 2008, p. 14; Munson *et al.* 2008, pp. 2, 4, 5).

Exposure to either CDV or *Babesia* singly is not typically associated with a compromise in health or an increase in mortality (Craft 2008, p. 14; Munson *et al.* 2008, pp. 1, 2, 3). However, the *Babesia* infections were exacerbated by the immunosuppressive effects of CDV and led to the unusually high mortality rates (Craft 2008, p. 14; Munson *et al.* 2008, p. 5). The Serengeti National Park/Maasai Mara National Reserve lion population lost 30 percent of its population (approximately 1,000 lions), but has recovered to its pre-epidemic population levels (Craft 2008, pp. v, 14, 41; Munson *et al.* 2008, p. 1; Cleaveland *et al.* 2007, pp. 613, 617; Roelke-Parker *et al.* 1996, p. 444). Thirty-four percent of the Ngorongoro Crater lion population was killed, but frequent outbreaks of disease have prevented this population from recovering back to its carrying capacity (Craft 2008, p. 14; Munson *et al.* 2008, pp. 1, 2; Cleaveland *et al.*

2007, p. 617). The difference in recovery is likely due to the highly inbred nature of the Ngorongoro Crater lion population, compared to the Serengeti population, and its greater susceptibility to parasitic and viral infections (Hunter *et al.* 2012, p. 2; Munson *et al.* 2008, p. 5; Brown *et al.* 1994, pp. 5953–5954).

Feline immunodeficiency virus (FIV) is an endemic pathogen in many lion populations of southern and eastern Africa (Maas *et al.* 2012, p. 4206; Adams *et al.* 2011, p. 173; Pecon-Slattery *et al.* 2008, p. 2; Hofmann-Lehmann *et al.* 1996, pp. 555, 558; Brown *et al.* 1994, p. 5966). FIV is believed to have been present in lions since the late Pliocene (O'Brien *et al.* 2012, p. 243; Troyer *et al.* 2011, p. 2; Roelke *et al.* 2009, p. 3; Pecon-Slattery *et al.* 2008, p. 8). There are 6 subtypes of FIV, A through F, each with a distinct geographic area of endemnicity (Adams *et al.* 2011, p. 174; Troyer *et al.* 2011, p. 2; Roelke *et al.* 2009, p. 3; Pecon-Slattery *et al.* 2008, p. 4; O'Brien *et al.* 2006, p. 262) and differing levels of virulency (LionAid 2014b, unpaginated). The social nature of lions allows for viral transmission within and between prides through saliva when biting (Maas *et al.* 2012, p. 4210; Pecon-Slattery *et al.* 2008, p. 5; Brown *et al.* 1994, p. 5953). Prevalence of FIV often approaches 100 percent of adults in infected lion populations, including the few remaining populations in Botswana, South Africa, and Tanzania, (LionAid 2014b, unpaginated; O'Brien *et al.* 2012, p. 243; Troyer *et al.* 2011, p. 2; Roelke *et al.* 2009, p. 3; O'Brien *et al.* 2006, p. 262; Hofmann-Lehmann *et al.* 1996, p. 559).

FIV causes immune deficiencies that allow for opportunistic infections in the host (Roelke *et al.* 2009, p. 1; Brown *et al.* 1994, p. 5,953). With an impaired immune system, lions may not have an appropriate and effective immune response to various pathogens to which they

are consistently exposed (LionAid 2014a, p. 6). There may also be unrecognized immunological consequences (Roelke *et al.* 2006, p. 234) and adverse clinical and pathological outcomes (Roelke *et al.* 2009, p. 1). Chronic effects of FIV are important to long-term survival and differ according to subtype (Troyer *et al.* 2011, p. 6). Studies have indicated that lions may exhibit signs of opportunistic infection associated with AIDS, such as swollen lymph nodes, gingivitis, tongue papillomas, dehydration, poor coat condition, and abnormal red blood cell parameters, and in some cases death (Troyer *et al.* 2011, p. 2; Roelke *et al.* 2009, pp. 2, 3–6). Lions in Botswana and Tanzania have demonstrated multiple clinical features of chronic immune depletion similar to HIV and domestic cat AIDS (Troyer *et al.* 2011, pp. 2–3). However, there is no evidence that FIV itself poses a threat to wild populations (Frank *et al.* 2006, p. 1); FIV does not appear to be impacting lions in Kruger National Park (Maas *et al.* 2012, p. 4212), and no evidence of AIDS-like illnesses or decreased lifespan has been found in FIV lion populations in the Serengeti (O'Brien *et al.* 2006, p. 263).

The role of disease in determining survival and reproductive potential in lions is almost completely unknown. It is often difficult to determine whether mortality was due to a single or combination of factors. Lions could be infected with and become debilitated by a disease, but the cause of death could ultimately be due to other factors (LionAid 2014a, pp. 4–5). Available studies do not indicate that infection with a single disease is causing detrimental impacts to lions at the species level, although general body condition, health, and lifespan may be compromised and result in negative impacts at the individual or population level.

Co-infections, however, could have synergistic effects that lead to greater impacts on lions than a single infection. Lions impacted by the 1994 CDV outbreak in Serengeti National Park/Maasai Mara National Reserve may have been more susceptible to CDV due to depleted immunity caused by FIV (O'Brien *et al.* 2006, p. 263). Troyer *et al.* (2011, pp. 5–6) found that survival during the CDV/*Babesia* outbreak in Serengeti National Park/Maasai Mara National Reserve was significantly less for lions infected with FIV A and/or C than FIV B. This finding suggests that FIV A and C may predispose carriers to CDV pathogenesis and may increase the risk of mortality (O'Brien *et al.* 2012, p. 243). Impacts of co-infections of FIV with FCV, FPV, FHV, and FCoV on individual lions are negligible and do not endanger the lion population, at least in the absence of other aggravating cofactors (Hofmann-Lehmann *et al.* 1996, p. 561).

Pathogen–pathogen interactions may become more important when lions are under additional stress (e.g., increased parasite load or low prey density) (Maas *et al.* 2012, p. 4212). Certain environmental conditions may exacerbate the effects of an otherwise innocuous infection. For example, as discussed above, CDV and *Babesia* infections generally have no measurable impacts on lion health, but climatic conditions increased exposure of lions to *Babesia* infections, which were exacerbated by the immunosuppressive effects of CDV and led to unusually high mortality rates (Craft 2008, p. 14; Munson *et al.* 2008, p. 5). Some lions infected with bTB may remain asymptomatic until conditions change and they suffer from poor nutrition due to low prey density, advancing age, or become super-infected with other diseases that may exacerbate the infection (Renwick *et al.* 2007, p. 533).

Species with reduced genetic variation may be less able to mount an effective immune response against an emerging pathogen (O'Brien *et al.* 2006, p. 255). For example, the inbred populations in Hluhluwe-iMfolozi Park lost 30 percent of lions due to a combination of bTB and malnutrition (Hunter *et al.* 2012, p. 3). The Ngorongoro Crater lions have not recovered to pre-outbreak numbers due to their inbred nature and greater susceptibility to parasitic and viral infections (Hunter *et al.* 2012, p. 2; Munson *et al.* 2008, p. 5; Brown *et al.* 1994, pp. 5953–5954). Additionally, disease outbreaks can lead to extirpation in small, isolated populations (Gilpin and Soule 1986 and Paul-Murphy *et al*. 1994 in Harvell *et al*. 2002). Although we found no information indicating presence of disease in the Indian population, the small, isolated nature makes the population more vulnerable to disease outbreaks and could have a detrimental impact on the population (Banerjee and Jhala 2012, p. 1427; Meena 2010, p. 209; Johnsingh *et al*. 2007, p. 93). This principle also applies to the small, isolated populations throughout Africa.

Although disease is known in several populations, the impacts are known in only a few populations where disease has been frequently studied. Precise estimates of lions lost to disease are lacking, due to the difficulty in detection. However, disease appears to be a secondary factor influencing the decline of lions when co-infections occur or when disease is combined with other factors, including environmental changes, reduced prey density, and inbreeding depression. Diseases weaken individuals and allow them to succumb to other diseases or factors. Although disease does not appear to be a major driver in the status of the lion, populations can suffer significant losses; some may recover to pre-outbreak levels, others may not. Given the small and declining lion populations that remain, any loss of individuals from the populations could be detrimental.

The risk of disease may increase with time due to loss of genetic variation associated with continued fragmentation of populations, whether by habitat loss or fencing of habitat, and increased proximity to humans and domestic livestock that may expose lions to new diseases (IUCN 2006b, pp. 19, 26). Additionally, changes in climate may increase disease outbreaks in prey species, as well as lions (See *Climate Change*). Climate change could potentially increase the likelihood of lethal co-infections (The Heinz Center 2012, p. 12), similar to the co-infections of CDV and *Babesia* in Serengeti National Park/Maasai Mara National Reserve and Ngorongoro Crater lions following drought events.

Deleterious Effects Due to Small Population Sizes

The risk of extinction is related to the moment when a declining population becomes a small population and is often estimated using minimum viable population (MVP) sizes (Traill *et al.* 2010, p. 28). The viability of a lion population is complex, but it partly depends on the number of prides and ability of males to disperse and interact with other prides, which affects exchange of genetic material (Björklund 2003, p. 518). Without genetic exchange, or variation, individual fitness is reduced and species are less able to adapt to environmental changes and stress, increasing the risk of extinction (Bijlsma and Loeschcke 2012, pp. 117, 119; Segelbacher *et al.* 2010, p. 2; Traill *et al.* 2010, p. 31; Björklund 2003, p. 515).

Björklund (2003, p. 520) found that the most important determining factors for the level of inbreeding in lions is the number of prides and male dispersal. The MVP for lions has not been formally established and agreed upon by species experts (Riggio *et al.* 2011, p. 5; CITES

2004a, p. 2; Björklund 2003, p. 521); however, it has been suggested that to conserve genetic diversity, populations of at least 50 prides, but preferably 100 prides (250 to 500 individuals), with no limits to dispersal, are necessary (Bauer *et al.* 2008 in Riggio *et al.* 2013, p. 32; Björklund 2003, pp. 515, 518). Björklund (2003, p. 518) found that inbreeding decreased rapidly with the number of prides. For example, if there are less than 10 prides the likelihood of genetic effects due to inbreeding increased from 0 in the beginning to 26–45 percent after 30 generations, whereas if 100 prides are present, the likelihood is only 5 percent assuming no migration into the population (Björklund 2003, p. 515). Additionally, it appears that inbreeding rapidly increases when the number of prides falls below 50 (Björklund 2003, p. 518, Figure 2). Riggio *et al*. (2013, pp. 20, 22) used the threshold described by Björklund (2003) to define, in part, lion strongholds. Stronghold populations of lions were considered to be those that meet the necessary requirements for long-term viability and were defined, in part, as containing at least 500 individuals (100 prides). Potential strongholds were described, broadly, as areas where immediate interventions might create a viable population and were defined, in part, as populations that contained at least 250 lions. However, the threshold described by Björklund (2003) and used by Riggio *et al.* (2013) may be smaller for *P. l. leo* as pride sizes are generally smaller than those for *P. l. melanochaita* (Riggio *et al*. 2013, p. 32; Meena 2009, p. 7; Nowell and Jackson 1996, p. 37).

Male dispersal also plays an important role in determining the level of inbreeding in lion populations. Even if only a fraction of males do not disperse, inbreeding rapidly increases with each generation (approximately 5 years) (Björklund 2003, pp. 518, 520). Even when migration rates of males is as high as 95 or 99 percent, the likelihood of inbreeding is clearly higher than if

100 percent of males disperse. Using a 95 percent dispersal rate, the probability of inbreeding reached 57 percent and 20 percent for 10 and 100 prides within 30 generations (150 years) (Björklund 2003, pp. 518–519). One example is the lion population in Ngorongoro Crater. New males rarely migrate into the population due to physical barriers, and inbreeding has been shown to occur (Packer *et al*. 1991b in Björklund 2003, p. 521). The fewer number of males present to contribute genes to the next generation, the more inbred the population will be (Riggio *et al*. 2013, p. 32). Therefore, not only does dispersal impact inbreeding, so does the loss of male lions due to excessive trophy hunting and infanticide (see *Trophy Hunting*).

Because the number of prides and male dispersal are the most important factors for maintaining viability, sufficient areas are needed to support at least 50 prides, but preferably 100 prides, and allow unrestricted male dispersal (Björklund 2003, p. 521). Unfortunately, few lion populations meet these criteria as almost all lion populations in Africa that historically exceeded 500 individuals are declining, and few protected areas are large enough to support viable populations (Bauer *et al*. 2015a, unpaginated; Bauer *et al*. 2015b, p. 1; Bauer *et al.* 2008, unpaginated; Riggio 2011, p. 5; Hazzah 2006, p. 2; Bauer and Van Der Merwe 2004, pp. 28–30; Björklund 2003, p. 521). Even within large areas, inbreeding will increase if dispersal is limited, (Björklund 2003, pp. 521–522). Furthermore, research indicates that there is a general lack of gene flow in most lion conservation units (Dubach *et al.* 2013, pp. 749, 750; Bertola *et al.* 2011, p. 1364; Chardonnet *et al.* 2009, p. 54).

Small populations (e.g., fewer than 50 lions) can persist in the wild for some time; however, the lack of dispersal and genetic variation can negatively impact the reproductive

fitness of lions in these populations and local extirpation is likely (Traill *et al.* 2010, p. 30; O'Brien 1994, p. 5748). Loss of fecundity leads to a decrease in population size, fewer prides in a population, and increased inbreeding which contributes to a decline in the population and increases the risk of extinction (Björklund 2003, p. 521). Additionally, lack of genetic variation can impact the ability of lions to withstand stochastic events. For example, the inbred populations in Hluhluwe-iMfolozi Park were unable to mount an effective immune response and lost 30 percent of lions due to a combination of bTB and malnutrition (Hunter *et al.* 2012, p. 3). Additionally, the lions of Ngorongoro Crater never recovered to pre-outbreak numbers due its inbred nature and greater susceptibility to parasitic and viral infections (Hunter *et al.* 2012, p. 2; Munson *et al.* 2008, p. 5; Brown *et al.* 1994, pp. 5953–5954). Reductions in genetic variations may also limit the lion's ability to evolve responses to climate change (The Heinz Center 2012, p. 12).

The lion population in India is one of the few populations that are increasing (Bauer *et al*. 2015a, unpaginated; BBC 2015, unpaginated; The Guardian 2015, unpaginated; Banerjee and Jhala 2012, p. 1427) and could be considered a stronghold according to the criteria set by Riggio *et al*. (2013, p. 22). Despite being genetically less diverse, Banerjee and Jhala (2012, pp. 1424–1425) found no evidence of depressed demographic parameters in the lions of India. However, intense management, including healthcare interventions, may interfere with natural selection processes by ensuring the survival of unfit lions which facilitates the propagation of deleterious genes in the population (Banerjee and Jahala 2012, p. 1427). This population is also running out of area to expand. Being a small, isolated population and less genetically diverse, it is more vulnerable to the loss of any individuals due to environmental and stochastic events, and more

prone to local extinction events (Banerjee and Jhala 2012, p. 1428; Meena 2010, p. 209; Johnsingh *et al*. 2007, p. 93; Thuiller *et al*. 2006, pp. 434–435).

The establishment of another free-ranging population geographically separate from Gir would reduce the risk of extinction of this population due to stochastic events (e.g., disease outbreaks or floods). In the early 1990s, a second population was proposed at Kuno Wildlife Sanctuary in Madhya Pradesh State (Johnsingh *et al*. 2007, p. 93). However, the Government of Gujarat has refused to allow any lions from Gir to be transferred to the Kuno Wildlife Sanctuary, despite a ruling by India's Supreme Court (The Economic Times 2015, unpaginated; Duerr 2014, unpaginated; Meena 2014, p. 29).

Regulatory Mechanisms

Regulatory mechanisms in place to provide protections to African lions vary substantially throughout Africa. The lion species (*Panthera leo*) is listed in Appendix II of CITES; however, the former Asiatic lion (*P. l. persica*) is listed in Appendix I. With the exception of South Sudan, all of the lion range states are Parties to CITES. According to the draft CITES Periodic Review of the Status of African Lions (CITES 2014, pp. 14–15) outside of CITES, lions have no legal protections in four countries: Burundi, Guinea Bissau, Lesotho, and Swaziland. However, CITES 2014 (p. 15) states that most of the southern and eastern lion range states have regulatory mechanisms in place to protect lions. We found that most of the range states have national environmental legislation to establish national parks and conservation areas, and to conserve and regulate the take, hunting, and trade of wildlife, including parts and products, but could find no

legislation specific to lions, or to the main threats affecting lions: habitat loss, human–lion conflict, and loss of prey base (Ecolex[1] information last accessed November 6, 2015).

National and international conservation strategies rely on protected areas to protect natural resources from negative impacts of human populations (Craigie *et al*. 2010, p. 2221). The lion is largely limited to protected areas; therefore, effective management is crucial to the survival of the species. However, weak management of protected areas has been documented across its range, especially in western Africa where most protected areas are experiencing severe management deficiencies (Henschel *et al*. 2015, unpaginated; Henschel *et al*. 2014, pp. 5, 7; Brugiére 2012 in Henschel *et al*. 2014, p. 7; Craigie *et al*. 2010, entire). The WAP complex in western Africa had received high scores for management effectiveness (Henschel *et al*. 2015, p. 7).

Effective management requires adequate funding, resources, and staff. Packer *et al*. (2013a, pp. 638–639) found that lion densities were highest in protected areas with the highest management budgets. Cost estimates for maintaining lion populations in protected areas range from an annual budget of $500 USD per km^2 in smaller fenced reserves to $2,000 USD per km^2 for unfenced reserves (Packer *et al*. 2013, p. 640). This includes but is not limited to costs associated with permanent and temporary staff, fencing installation and maintenance (fences can

[1] ECOLEX is a comprehensive database on environmental law, maintained by the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme (UNEP), and the Food and Agriculture Organization of the United Nations (FAO). Our search terms used with respect to wildlife laws were "African lion," "Asiatic lion," "*Panthera leo leo*," "*Panthera leo persica*," and "country," e.g., "Angola," "Benin," etc. Information accessed at http://ecolex.org

cost $3,000 USD per km to install), infrastructure maintenance, anti-poaching activities such as surveillance and snare/trap removal, wildlife restocking fees (both for lions killed by illegal poaching/snares as well as other trophy species killed by lions on the reserves), community outreach, and compensation for loss of livestock in surrounding communities. However, many management areas lack adequate funding (Packer *et al*. 2013, p. 640; Groom 2013, pp. 4–5; Barnett and Patterson 2005, p. 82).

Of 12 protected areas assessed in western Africa, 6 had no budget for management activities or the budget was too low to conserve lion populations; nine reported having either no law enforcement activity or major deficiencies in staff and resources to conduct patrols. In Comoé National Park, the staff was found to be too small for the size of the park (Henschel *et al*. 2014, p. 7). Protected areas in Guinea are essentially parks on paper only. They have no staff, management plan, or operating budget (Brugiére 2012 in Henschel *et al*. 2014, p. 7). Although the WAP complex has received high scores for management effectiveness, the presence of 50,000 head of cattle inside W National Park indicates weak management. Livestock are rare in Arly-Pendjari, and lion density is higher; a higher management budget allocation is suspected to be the cause of the observed differences (Henschel *et al*. 2014, pp. 5–6). Across the lion's range, Africa's protected areas have generally failed to mitigate threats to large mammal populations, including the lion and its prey (Craigie *et al*. 2010, entire).

Poor management leads to many of the threats that lions face, including encroachment by pastoralists, increased poaching pressure, collapse of prey populations, and persecution by pastoralists (Brugiére *et al*. 2015, pp. 519–520; Henschel *et al*. 2015, unpaginated; Henschel *et*

al. 2014, pp. 5, 7; Henschel *et al*. 2010, p. 38). Therefore, it can be said that management of protected areas that still harbor lions is inadequate to address the threats impacting lions, especially those in western Africa (Henschel 2015, unpaginated). Overall, investment in conservation activities is extremely low in western Africa, compared to central, eastern, and southern Africa. Countries in the former or current western Africa lion range are among the 50 poorest countries in the world, and six are classified as least developed countries. These countries will likely be unable to generate the resources required to secure their remaining lion populations (Henschel *et al*. 2014, pp. 7–8). Investment from the international community is needed to increase management effectiveness of these protected areas (Henschel *et al*. 2015, unpaginated).

In India, most lions occur within five designated protected areas: Gir National Park and Gir Wildlife Sanctuary (Gir Protected Area) and Pania, Mitiyala, and Girnar sanctuaries (Bauer *et al*. 2015a, unpaginated; Banerjee and Jhala 2012, p. 1421; Singh and Gibson 2011, p. 1754; Jhala *et al*. 2009, pp. 3384, 3385; Nowell and Jackson 1996, p. 38). Under India's Wild Life Protection Act of 1972 (Act No. 53 of 1972; Chapter IV, sections 27, 28, 33, 35), entry into protected areas is regulated and certain activities are controlled and managed, including security of wild animals and grazing of livestock. In 2012, India's Ministry of Environment and Forests (2012, p. 22) declared the area 5 km from the boundary of Girnar Wildlife Sanctuary an Eco-sensitive Zone for the long-term protection and conservation of the lion. This designation prohibits certain activities within the designated zone, such as mining, unregulated tourism, polluting industries, and unregulated felling of trees.

Because of the protections afforded by the Government of Gujarat, threats that contributed to the decline of this population have been ameliorated and most threats faced by lions are not an immediate threat. Protections ensure food security, water availability, habitat suitability, and safety for these lions (Meena 2014, p. 26). However, because this population is small and isolated, it is vulnerable to extinction from stochastic events. Although a second location has been proposed to establish another free-ranging population geographically separate from Gir to reduce the risk of extinction of this population, translocation of lions from Gujarat are still pending (see *Deleterious Effects Due to Small Population Sizes*).

Climate Change

Consideration of ongoing and projected climate change is a component of our analysis under the Act. The term "climate change" refers to a change in the mean, variability, or seasonality of climate variables over time periods of decades or hundreds of years (Intergovernmental Panel on Climate Change (IPCC) 2013, p. 1255). Climate change models, like all other scientific models, produce projections that have some uncertainty because of the assumptions used, the data available, and the specific model features. The science supporting climate model projections as well as models assessing their impacts on species and habitats will continue to be refined as more information becomes available.

Temperature and Precipitation Trends

Within the past 50–100 years, the surface temperature in Africa and Asia has increased (Hijioka *et al*. 2014a, p. 1333; Niang *et al*. 2014, p. 1206). Across Africa, surface temperature has increased by 0.5°C over the past century (Niang *et al*. 2014, p. 1206), although there are regional differences. For example, decadal warming rates in South Africa have ranged from 0.1

°C to 0.3 °C (Chidumayo *et al*. 2011, p. 18) and 0.23 °C in Tanzania (Carr *et al*. 2013, p. 16). The mean annual temperature in Burundi has increased by 0.7–0.9 °C since the 1930s, while the mean annual temperature in Uganda has increased by 1.3 °C since 1960 (Carr *et al*. 2013, p. 16). In India, annual mean temperatures increased by 0.56 °C during the 20th century (Hijioka *et al*. 2014a, p. 133; Hijioka *et al*. 2014b, p. SM24–2).

Across Africa, trends in annual precipitation indicate a small but statistically significant decline in rainfall (Niang *et al*. 2014, p. 1209; Chidumayo *et al*. 2011, p. 20). Eastern Africa has experienced an increase in extreme precipitation changes, with increasingly frequent droughts followed by increasingly intense heavy rainfall, for the last 30 to 60 years; however, overall levels of precipitation have been declining. The intense rainfall events have caused more frequent flooding and soil erosion and degradation (Niang *et al*. 2014, pp. 1209, 1211; Carr *et al*. 2013, p.16). Attri and Tyagi (2010 in Hijioka *et al*. 2014b, p. SM24–3) report no significant national trends in precipitation for India, although there has been a decrease in the number of monsoon depressions and an increase in the number of monsoon break days, which is consistent with an overall decrease in seasonal mean rainfall (Hijioka *et al*. 2014a, p. 1333). Throughout the 20th century, droughts were frequent in the Gir area. However, in the last two decades average rainfall has increased due to increased western monsoons (Singh and Gibson 2011, p. 1756).

Overall, projections indicate temperatures will continue to increase in Africa and Asia and rainfall will continue to decrease in Africa but increase in India, although regional variations exist (Hijioka *et al*. 2014a, p. 1334; Peterson *et al*. 2014, p. 562; Gosling *et al*. 2011, pp. 64–65).

Warming in Africa is expected to be greater than the global annual mean warming throughout the continent and all seasons (Chidumayo *et al*. 2011, p. 22). Future projections expect the average temperature in Africa to be higher by 1.5–3 °C by 2050 (Niang *et al*. 2014, p. 1206; Carr *et al*. 2013, p. 16; UENP 2007, p. 2), while temperatures in Gujarat are expected to increase between 3.0 and 3.5 °C by 2100 (Gosling *et al*. 2011, pp. 64–65).

Annual precipitation shows greater regional variations, although predictions of precipitation contain high levels of uncertainty. Generally speaking, both Africa and Asia are expected to experience harsher drought and stronger floods during the wet season (Hijioka *et al*. 2014a, p. 1334; Carr *et al*. 2013, p. 12). Precipitation has been projected to decline in western, central, and southern Africa. The areas of southern Africa expected to experience a decline in precipitation is projected to expand during the second half of the 21st century (Niang *et al*. 2014, p. 1210; Hijioka *et al*. 2014a, p. 1333; Carr *et al*. 2013, pp. 12, 14; The Heinz Center 2012, p. 13).

In contrast, eastern Africa and northern India are expected to experience an increase in mean annual precipitation (Niang *et al*. 2010, p. 1210; Hijioka *et al*. 2014a, p. 1334; Carr *et al*. 2013, pp. 12, 14; Gosling *et al*. 2011, p. 65). Some General Circulation Models predict that, by the end of the 21st century, eastern Africa will have a wetter climate with more, intense wet seasons and less severe droughts from October to December and March through May, a reverse in observed trends described above. Other models suggest drying in most parts of Uganda, Kenya, and South Sudan in August and September by the end of the 21st century (Niang *et al*. 2014, p. 1210). Carr *et al*. (2013, p. 15) state that levels of increased precipitation predicted for

the Albertine Rift, located mainly within the eastern African region, are not predicted to be sufficient to counter the effects of warming temperatures; therefore, an overall drying effect is likely to occur, which will be more pronounced between February and May. They also state that November and December will experience the largest increases in precipitation.

In South Asia, including India, future declines in the number of rainy days and increases in extreme precipitation events related to monsoons are very likely (Hijioka et al. 2014a, p. 1334; Gosling *et al*. 2011, pp. 123–124). Increases in precipitation are expected by the 2030s and all regions of India are expected to experience between 10 and 30 percent increases in magnitude of pluvial flooding (flooding derived directly from heavy rainfall and results in overland flow) and an average across India of approximately 50 percent greater risk of fluvial flooding (floods as a result of river flows exceeding river channel capacity, breaking through riverbanks, and inundating the floodplain) (Gosling *et al*. 2011, pp. 122, 123, 126, 130). Gosling *et al*. (2011, pp. 65–66) predict increases in average annual rainfall of up to 20 percent in Gujarat by 2100.

Impacts of Climate Change

Climate change is likely to become a main driver of change in large mammal populations in the future (Scholte 2011, p. 7). In the mid-Holocene, mammals responded rapidly to climate change with a series of local extinctions and near-extinctions, driving a decrease in species richness, and a dramatic increase in xerophytic taxa (Grayson 2000 and Graham 1992 in Thuiller *et al*. 2006, p. 425). It is likely that many species and ecosystems will endure similar impacts in response to predicted climate change in the 21st century, which will act synergistically with the predicted increase in anthropogenic pressures (Fischlin *et al*. 2007, in Carr *et al*. 2013, p. 10; Thuiller *et al*. 2006, p. 425). For lion, impacts described above from existing and predicted

anthropogenic pressures on the species and its habitat are likely to be exacerbated by climate change. The general warming and drying trend projected for Africa could further reduce lion range, numbers, and prey base. Lions may also have to travel greater distances to find food or shift their diet to livestock, increasing conflict with humans and the risk of retaliatory killings (Peterson *et* al. 2014, pp. 562–563; Tuqa *et al*. 2014, p. 8; Tumenta *et al*. 2013, p. 240). Additionally, changes in climate may increase the number and intensity of disease outbreaks in lions and its prey (Peterson *et* al. 2014, pp. 562–563; The Heinz Center 2012, p. 12; Baylis 2006, p. 4).

Peterson *et al*. (2014, pp. 555, 561–562) evaluated the magnitude of potential changes in lion distribution in Africa under different climate change scenarios between the years 2040 and 2070. They found little optimism for the future of lions. No broad new areas will become suitable for lion. Southern Africa, where the broadest areas of suitable conditions occur, is projected to become less suitable because of climate change. Specifically, park areas, including the "Etosha Pan, Lake Opnono, Cuvelai Drainage, Kalahari Gemsbok, and Kgalagadi Transfrontier Park areas" are projected to decline substantially in suitability for lions. A broad swath of potential distributional area in western Africa is projected to become "distinctly less suitable or even uninhabitable." A decrease in the lion's range could mean that stochastic events impact a larger portion of the whole species, especially when the species and its habitat are fragmented (Thuiller *et al*. 2006, p. 434). Additionally, reductions in populations and geographic range may limit the lion's ability to respond to climate change (The Heinz Center 2012, p. 12). However, climate change effects on potential lion distribution are projected to be more neutral in

eastern Africa than across the entire range. Reserves in this region are more likely to sustain lion populations under climate change scenarios (Peterson *et al*. 2014, pp. 555, 561–562).

In India, an increase in average rainfall in the past two decades has resulted in the conversion of dry savanna to forestland (Hijioka *et al*. 2014a, p. 1333; Singh and Gibson 2011, p. 1756). However, the lion population in India has shown to be able to use both forestlands and savannas (Singh and Gibson 2010, p. 1753). Therefore, this type of habitat conversion due to changes in climate may not be as detrimental to lions in India population. However, increased risks of flooding could pose problems for lions. Following a recent flood in Gujarat, nine lions drowned in a stream that flows alongside Gir Wildlife Santuary. Additionally, lions could face serious threats following flood events, such as an outbreak of a disease epidemic (The Economic Times 2015, unpaginated). This population of lions is small, isolated, and less genetically diverse; therefore, it is more vulnerable to stochastic events such as disease outbreaks and flooding and more prone to local extinction events (Banerjee and Jhala 2012, p. 1428; Meena 2010, p. 209; Johnsingh *et al*. 2007, p. 93).

Current lion habitat and suitable habitat predicted to remain under climate change scenarios will be under increasing pressure due to land conversions to meet the needs of the growing human population. As stated earlier, and supported by Carr *et al*. (2013, p. 20), demand for agricultural land is likely to increase to meet the needs of the growing human population, putting pressure on natural landscapes. Projected changes in Africa's climate will increase this pressure as land becomes more arid and food security concerns are exacerbated (Carr *et al*. 2013, p. 20). Impacts to the socio-economic and physical well-being of humans will cause adaptive

responses, eliciting changes in the way much of the land is used, including further encroachment of urban environments and agricultural land into existing natural habitats (Carr *et al*. 2013, pp. 10, 19), including protected areas where lions occur. Additionally, land conversion restructures the landscape and may disrupt prey migrations that are induced by climate change (Thuiller *et al*. 2006, p. 425), decreasing or altering prey available to the lion.

Although lions occur in a variety of temperature and precipitation regimes, suggesting the species may be tolerant of some climatic changes (The Heinz Center 2012, p. 13), lions appear to thrive under specific climate parameters (Leighton-Jones 2004 in Celesia *et al*. 2009, p. 63) and abundance is significantly determined by temperature and rainfall (Celesia *et al*. 2009, pp. 67, 68). Large felids, including lions, occur in biomes with an average annual temperature of 13 °C or higher; lion demography is best when mean annual temperatures are 16–18 °C (Celesia *et al*. 2009, p. 68). Lion density is influenced by multiple natural ecological factors including herbivore biomass, annual mean rainfall, soil nutrients, annual mean temperature, and interactive effects between rainfall and soil nutrients (Celesia *et al*. 2009, pp. 67, 69). These factors explain regional variations in lion densities, where low densities are found in desert or semi-desert ecosystems and higher densities in moist savannas (Celesia *et al*. 2009, p. 67). Lion densities decrease with increasing mean temperature and decreasing rainfall. Therefore, lion density, or carrying capacity of protected areas, in sub-Saharan Africa is likely to decline with climate warming and drying (Chidumayo *et al*. 2011, p. 144).

Lion demography is also influenced by environmental factors. Many variables are associated with aspects of demography, but the strongest associations are with rainfall,

temperature, and landscape features (e.g., elevation, slope, direction of slope, and compound topographic index) (Celesia *et al*. 2009, pp. 63, 68). Impacts to lion demography have been noted with the longer dry spells occurring. For example, when prey become scarce at the end of the dry season, subadult females may be forced out of prides. Furthermore, older lions and cubs may die of starvation (Celesia *et al*. 2009, p. 68). Additionally, Van Vuuren *et al*. (2005 in Celesia *et al*. 2009, p. 68) found in a study of Kgalagadi Transfrontier Park that adult and cub mortality reached 70 to 90 percent in poor years (defined as years in which average annual rainfall in the previous 2 years was less than 165 mm). Mortality decreased to 10 to 40 percent in good years (years in which average annual rainfall in the previous 2 years was greater than or equal to 237 mm). These impacts on demography result in reduced numbers of lions and pride sizes (Celesia *et al*. 2009, p. 68). Given the predicted warming and drying trend for the 21st century, additional lions could be lost and pride sizes reduced. Furthermore, loss of these lions reduces reproductive potential and recruitment, further contributing to the decline of existing populations. The loss of lions could also mean the loss of genetic variation. Combined with declining populations, the risk of inbreeding and associated complications could increase.

Drought conditions can also contribute to reduced prey availability by altering the timing of migration (Peterson *et al*. 2014, p. 562). For migratory species such as the wildebeest or zebra, an earlier and more frequent onset of the dry season may lead to the species undertaking more migrations, which can lead to increases in mortality and disruption of seasonal hunting patterns of lion (The Heinz Center 2012, p. 42). Climate change may already be having an impact on the wildebeest as Dobson (2009, as cited in Chidumayo *et al*. 2011, p. 144) found that, due to the wet season slowly getting drier and the dry season getting wetter, the species is

migrating 2 months earlier than usual, throwing off timing of migrations and conception times that are set by lunar cycles. If the wet season rains are diminishing there will be a reduction in high-quality forage needed to support lactation. This reduction has a detrimental effect not only on the survival of the calf but also for the population as a whole (Dobson 2009, as cited in Chidumayo *et al*. 2011, pp. 144–145).

Climate conditions also influence prey abundance. In Kruger Park, South Africa, almost all ungulate species are extremely sensitive to lack of rainfall during the dry season, which is predicted to increase in the future. This factor may be important to retain green forage during a period when the risk of malnutrition is higher (Thuiller *et al*. 2006, p. 432). Similarly, reproduction in Cape buffalo is strongly related to season. Changes in the timing, frequency, or intensity of seasonal rains could negatively affect reproduction. This species is also sensitive to rainfall due to its high water consumption rate (up to 30–40 liters per animal per day) (Du Troit 2005, as cited in The Heinz Center 2012, p. 15; Whyte *et al*. 1995, pp. 84–85). Variation in the buffalo population then is tied to rainfall conditions year-to-year. Funston and Mills (2006, p. 20) observed that the buffalo population increases only during periods of average to above-average rainfall, which means that climate projections for a drier Africa will have detrimental impacts on the buffalo population. Lions are opportunistic predators that feed on a variety of prey. This flexibility in prey may aid lions in exhibiting some resiliency to changes in prey populations (The Heinz Center 2012, p. 12). However, as discussed under *Loss of Prey Base* and *Human–Lion Conflict*, the loss of prey species can result in lions shifting their diet towards livestock which may increase retaliatory killings by humans (Bauer and Kari 2001, as cited in Tumenta *et al*. 2013, p. 241; Whyte *et al*. 1995, p. 85).

Variation in lion home ranges may have an impact on the frequency of human–lion conflict especially in situations where lion home ranges expand into areas inhabited by humans (Peterson *et al*. 2014, p. 562). The interplay between the types of climate, the density of prey, and seasonal variation in temperature and precipitation all affect lion home range. Areas with a more arid climate and small prey density are associated with larger home ranges, while temperate or tropical regions with higher prey density are associated with smaller home ranges. In addition, prey living in an arid climate tend to disperse, while prey in a wetter climate are more concentrated, leading to a larger and smaller home range, respectively (Tuqa *et al*. 2014, p. 2; Celesia *et al*. 2010, pp. 63, 67; Sogbohossou 2011, p. 17; Loveridge *et al*. 2009, p. 953). In southern Africa, where most of the lion populations are enclosed (fenced), variation in the species' home range may be more limited. Lion home ranges are also influenced by the season with ranges being smaller during the dry season and larger during the wet season. During the dry season, prey congregate around the few remaining water sources, concentrating prey species in a smaller area, shrinking the home range needed by the lion to find food. Conversely, home ranges expand during the wet season due to prey dispersal (Tuqa *et al*. 2014, p. 8).

Climate projections point toward a drier climate for western, central, and southern Africa (Niang *et al*. 2014, p. 1209; Hijioka *et al*. 2014a, p. 1333; Carr *et al*. 2013, p. 14; Chidumayo *et al*. 2011, p. 21). Drought in the western and central African regions is expected to increase by a rate of 5–8 percent by 2080 (UNEP 2007, p. 2). Although drier conditions might initially lead to the lion home range shrinking as prey congregate around remaining water sources (Sogbohoussou 2011, p. 133), Tuqa *et al*. (2014, p. 8) found that lion home ranges expand in the

time after a drought. The reason for this expansion may be that, as prey populations around water sources are depleted, the lion has to travel greater distances to find prey. In addition, researchers found that lions move beyond reserve boundaries and into communal ranches where there will be greater conflict with humans (Tuqa *et al*. 2014, p. 9). It is likely that lions prey on livestock, which will intensify human–lion conflict. To compound the issue, pastoralists in sub-Saharan Africa will often lead their herds into protected areas where lions occur during a drought in search of water, which increases the risk of lion predation (Tumenta *et al*. 2013, p. 240).

When lion prey on livestock, they primarily focus on cattle (Patterson *et al*. 2004, p. 510). Out of all livestock that are domesticated in Africa, cattle have the highest monetary value, which means the loss of cattle to lion predation will have the most adverse effect on pastoralists (Tumenta *et al*. 2013, p. 240). Additionally, droughts affect the survival of livestock (Peterson *et al*. 2014, p. 562). A study of the drought that occurred in Kenya in 2008–2009 found that mortality rates among the cattle population varied between 57 and 64 percent in six districts (Dolrenry 2013, p. 47; Zwaagstra *et al*. 2010, p. 21). Such high mortality may make pastoralists less tolerant of lion predation and may increase the frequency of retaliatory killings (Peterson *et al*. 2014, p. 562).

Climate change may increase the number and intensity of disease outbreaks in lion prey species, as well as lions (The Heinz Center 2012, p. 12; Baylis 2006, p. 4). Diseases can be directly and indirectly affected by climate change by impacting distribution, the timing of outbreaks, and the intensity of outbreaks (Baylis 2006, p. 4). Higher temperatures may increase the rates of development of pathogens and parasites, shorten generation times, and increase the

number of generations per year, increasing the population (Baylis 2006, p. 8; Thuiller *et al*. 2006, p. 435). Temperatures can have impacts on vectors (e.g., ticks and mosquitoes) and hosts that may further influence the spread of diseases (Baylis 2006, pp. 9, 11) and increase risks of extinctions (Thuiller *et al*. 2006, p. 435). Additionally, rainfall conditions also affect the susceptibility of animals to disease outbreaks (Thuiller *et al*. 2006, p. 435). Munson *et al*. (2008) concluded that severe climate change could synchronize temporal and spatial convergence of multiple infectious agents, triggering epidemics with greater mortality than infections from a single pathogen.

Conservation Measures in Place to Protect Lions

There has been awareness for several years that conservation strategies need to be implemented for the lion due to the apparent decrease in its population numbers (Hamunyela *et al.* 2013, p. 1; Henschel *et al.* 2010, p. 34; Gebresenbet *et al.* 2009, p. 5; IUCN 2006a, b, entire). Prior to 2006, institutional inconsistencies throughout the lion's African range resulted in poor lion conservation policies and little to no enforcement of existing laws (IUCN 2006b, p. 18). As mentioned, in 2005 and 2006, nongovernmental organizations (NGOs) and several governments at various levels organized two regional lion conservation workshops. Species specialists, wildlife managers, and government officials attended these regional workshops in order to provide range country governments with frameworks for developing their own national action plans for the conservation of lions. Over 50 lion specialists, representing all lion range countries, participated in these workshops (Henschel *et al.* 2010, p. 34). During the workshops, lion experts collectively assessed what they believed to be the then-current status of African lions based on a variety of information, and subsequently identified 86 African LCUs. This

information was then used as a framework to identify lion areas, strongholds, and potential strongholds by Riggio *et al*. (2013, p. 32).

Many African countries with very small lion populations have developed or updated their conservation plans for the lion. Some of these include Benin, Cameroon, Uganda, and Malawi. Some range countries participate in transboundary conservation projects and are collaborating on transboundary lion conservation initiatives for shared lion populations. Most range countries have a national lion action plan or strategies in place, particularly if there are economic incentives for them to have viable lion populations (Groom 2013, p. 4; Namibia 2013, pp. 11–12; Zambia Wildlife Authority 2012, p.3; LionAid 2011, pp. 1–2; Mesochina *et al.* 2010a, pp. 40–49; Mesochina *et al.* 2010b, pp. 33–38; Government of Tanzania 2010, pp. 3–17; Begg and Begg 2010, entire). Range states have also implemented a number of conservation strategies designed to conserve habitat, reduce human–lion conflict, and preserve the lion's prey-base.

Conservation Measures to Stem Habitat Loss

Habitat loss represents one of the main threats facing lions in Africa (Bauer *et al.* 2008, unpaginated). Attempts by range countries to address this decline in habitat are manifested in a number of ways, such as the creation of protected areas and the establishment of wildlife corridors to connect fragmented habitats.

Two conservation tools used by African range countries for lions include the establishment of protected areas and the enforcement of protections in these areas (Mesochina *et al.* 2010a and b; Treves *et al.* 2009, pp. 60, 64). However, several problems have emerged. For

example, certain land-tenure systems do not recognize community ownership of land and wildlife and undermine the extent to which benefits are converted into incentives for conservation. Protected-area "boundaries" are not always visible. Additionally, law enforcement in protected areas can be sporadic, and parks are often understaffed (Pfeifer *et al.* 2012, pp. 1, 7). More recent evidence suggests that some protected areas are being more commonly encroached upon as human populations expand and search for resources.

Despite encroachment, protected areas are somewhat effective at protecting wildlife and habitat as rates of habitat loss tend to be lower in protected areas than outside them (Green *et al.* 2013, p. 70; Pfeifer *et al.* 2012, p. 2). African countries are realizing the benefits of managing their wildlife populations and parks for tourism; however, conservation of vast areas of land for megafauna such as the lion is not only complex, but also expensive. As an example, the 28-km (17-mi) elephant corridor, completed in 2011 in Kenya, cost $1 million USD (The Nature Conservancy 2013, unpaginated). Additionally, the overall costs of anti-poaching and compensation is expected to increase in range states concurrently with growing human populations, declining purchasing power of external funds, and corruption (Garnett *et al.* 2011, pp. 1–2; Wittemyer *et al.* 2008, pp. 123, 125).

Another mechanism for protecting habitat is to reconnect fragmented habitat across national boundaries. Corridors are being restored, fences are being removed, and protected areas are being connected. Restoration of these corridors allows wildlife to travel between areas of suitable habitat (Jones *et al.* 2012, pp. 469–470). In some areas, fences have been constructed to protect grazing resources for domestic livestock as well as to provide barriers to disease (Gadd

2012, pp. 153, 176). One aspect of these fences is that they separate lions from their prey. In southern Africa, fences are being taken down to increase the size of connected habitat and link it to reserves and national parks (IUCN 2009, p. 101; IUCN 2008, various). The Limpopo Transfrontier Park is another example of where this practice is being implemented (Newmark 2008, p. 327). Boundary fences along national borders that separate many reserves are being removed to form a 35,000-km² park. Limpopo National Park (formerly known as Coutada 16) in Mozambique, Kruger National Park in South Africa, and Gonarezhou National Park, Manjinji Pan Sanctuary, and Malipati Safari Area in Zimbabwe will all be connected, as will be the area between Kruger and Gonarezhou, and the Sengwe communal land in Zimbabwe and the Makuleke region in South Africa (Newmark 2008, p. 327). However, in some locations, areas that have previously been designated as corridors have been encroached upon by human settlements and agriculture (Estes *et al.* 2012, pp. 258–261; Jones *et al.* 2012, p. 469).

Tanzania is an example of a country attempting to reconnect habitat. As of 2002, the Tanzanian Government, with donor and NGO support, was reconnecting the nine largest blocks of forest in the East Usambara Mountains using wildlife corridors (Newmark 2002, various). Additionally, the 2009 Wildlife Act of Tanzania allows the Minister, in consultation with relevant local authorities, to designate wildlife corridors, dispersal areas, buffer zones, and migratory routes. The 2010–2015 National Elephant Management Plan of Tanzania indicates that corridors are the primary objective of the plan, and although primarily designed for elephants, these corridors allow for continuity of populations of other large mammal species such as lions (Jones *et al.* 2012, p. 470).

In 2011, Kenya (which neighbors Tanzania to the North), completed a 28-km corridor through an area that had been heavily impacted by human–wildlife conflict. The purpose of the corridor was primarily to reduce human–elephant conflict and appears to have been successful (Mount Kenya Trust 2011, p. 1). The corridor also allows other wildlife such as lions to disperse through habitat that otherwise would have been unfavorable for wildlife to travel through (Mount Kenya Trust 2011, p. 1). It was an expensive project, but the effort appears to have served its purpose: Elephants are using the corridor on a regular basis (particularly an underpass under a highway), and humans are reporting less human–wildlife conflict (Mount Kenya Trust 2011, p. 1).

However, connectivity alone does not ensure the dispersal of animals (Roever *et al.* 2013, pp. 19–21). The Tanzania Wildlife Research Institute (TAWIRI) is an organization under Tanzania's Ministry of Natural Resources and Tourism, and is responsible for conducting and coordinating wildlife research activities in Tanzania. In this role, TAWIRI has been actively involved in promoting the development of and monitoring the use of wildlife corridors in Tanzania. Surveys conducted in 2009 and 2010 suggest that the Nyanganje Corridor in Tanzania is no longer being used by elephants and other wildlife. This corridor is at a narrow passage in the Kilombero Valley and is the shortest distance for animals to cross between the Udzungwa and Selous ecosystems. Despite efforts in place, much of the corridor is being encroached upon by conversion of land to rice farming and cattle grazing (Jones *et al.* 2012, p. 469). Because these activities often deter wildlife from passing through, the corridor is ineffective (Jones *et al.* 2012, p. 469).

In the latter half of the 20th century, lions in India were on the verge of extinction. However, conservation measures were put in place to protect lion habitat. In 1965, Gir Wildlife Sanctuary was created and became the first protected area in Gujarat. In 1972, the Gir Lion Sanctuary Project began. Two-thirds of the pastoral families living in the Sanctuary, and their livestock, were relocated outside Gir forests (Singh and Gibson 2011, p. 1754). The area of Gir Wildlife Sanctuary was expanded and the core area designated as Gir National Park in 1975.

Following these actions, habitat began to recover, the wild ungulate population increased, and, subsequently, lion numbers increased (Singh and Gibson 2011, pp. 1754, 1755). Habitat adjacent to Gir was also declared a Sanctuary (Pania Sanctuary) in 1989. This area and surrounding community lands were declared protected forests to serve as a buffer area to the Gir Forests (Singh and Gibson 2011, p. 1754). As the lion population began to increase, lion dispersed into satellite forest patches. These reclaimed patches of habitat were protected and the Mitiyala Sanctuary was created in 2002, and the Girnar Sanctuary, in 2007 (Singh and Gibson 2011, p. 1754).

After 40 years, the protected areas of India have experienced habitat recovery, a 10-fold increase in ungulates, and an increase in lion numbers (Singh and Gibson 2011, pp. 1754, 1756). Since 1968, India's Forest Department has conducted wildlife censuses every 5 years (Singh and Gibson 2011, p. 1754), documenting a steady increase in the lion population. Community pride and love of lions, the media, and political pressure has ensured efforts are made to protect these lions. When problems arise, they are quickly assessed and a solution found. For example, when

6 lions were hit and killed by trains, immediate action was taken to rectify the problem (Meena 2014, p. 26). Because of these actions, lions in India now number 523 (BBC 2015, unpaginated).

Conservation Measures in Place to Stem the Loss of Prey Base

Lions, like most large carnivores, prey upon a variety of species including buffalo, plains zebra, wildebeest, giraffe, gemsbok, kob, and warthog (Kenya Wildlife Service 2013, p. 13; Beg and Beg 2011, p. 4; Nowell and Jackson 1996, p. 18). Depletion of these prey species due to competition with humans represents a threat to the lion (Chardonnet *et al.* 2005, pp. 8–9). As noted, the increase in the human population in Africa is a major contributor to the increase in demand for bushmeat, which in turn increases human encroachment into wildlife territory (Lindsey *et al.* 2012b, p. 36). In addition to the increase in the human population, lack of an alternative livelihood, lack of alternate food sources, and lack of clear rights over land or wildlife are contributing factors toward the increase in demand for bushmeat (Lindsey *et al.* 2012b, pp. 36–41). The advent of automatic weapons in the bushmeat trade impacts the lion's prey base, which is being hunted at unsustainable levels.

Reconnecting fragmented habitat has the additive effects of not only conserving the biodiversity of the lion's habitat, but also that of its prey base (Lindsey *et al.* 2012b, p. 43). These types of restoration practices enhance the health of species by allowing genetic interchange to occur and, thus, conserve the genetic diversity of all wildlife. Wildlife management entities are linking many of the major protected areas by removing boundary fences along national borders that separate many reserves in addition to creating or improving corridors to link good-quality habitat for wildlife (Gadd 2012, p. 179; Newmark 2008, pp. 323–324).

To address the increasing consumption of bushmeat, host countries have employed a variety of different strategies, including the development of alternative industries for communities. Helping local communities develop alternate industries represents one of the ways range countries can reduce their dependence on bushmeat. Throughout Africa, several ideas have been attempted with varying levels of success. For example, the Anne Kent Taylor Fund (AKTF) helps local Maasai women to buy beads and other supplies to produce traditional items for the local tourist industry (AKTF 2012, p. 7; Lindsey *et al.* 2012b, p. 45; van Vliet 2011, p. 17). In addition, AKTF helps organize local men into anti-poaching and de-snaring teams (AKTF 2012, p. 5; van Vliet 2011, p. 17). By creating programs targeting both men and women, AKTF creates an environment that provides communities with financial stability as well as direct community interest in protecting local wildlife. With 13 years assisting local communities, the AKTF represents one of the more successful attempts to encourage locals to shift away from relying on bushmeat.

Studies compiled by Hazzah (2013 pp. 1, 8) have shown that local communities who live near protected areas with more lenient policies have a more positive attitude and relationship with both the manager and the protected area as a whole. This open approach to protected area management reflects a trend in recent years to bring in local communities to assist in the management of protected areas (Lindsey *et al.* 2012b, p. 53). Wildlife management programs run by local communities are defined by two goals: conserving wildlife and providing economic aids to the community (Bandyopadhyay *et al.* 2010, p. 5). With regard to discouraging the consumption of bushmeat, this new approach is seen in the creation of community-based wildlife

management programs (van Vliet 2011, p. 26). The purpose of these programs is to give the local community a direct stake in the management of wildlife areas. One use for these areas is to turn them into game ranches. These areas are used both for legal bushmeat production as well as trophy hunting and ecotourism.

Namibia has had great success in setting up community-run conservancies. After gaining independence in 1990, Namibia began to turn over ownership of wildlife areas to local communities (van Vliet 2011, p. 29; Bandyopadhyay *et al.* 2010, p. 6). By 2011, Namibia had 64 communities that covered 17 percent of the country total area (van Vliet 2011, p. 29; Connif 2011, unpaginated; NASCO 2011, p. 4). The majority of the incomes from these conservancies come from ecotourism, followed by trophy hunting (NASCO 2011, p. 22). These incomes are then used to support infrastructure improvement in the community. In addition, legal bushmeat acquired within conservancy lands is distributed to local families (NASCO 2011, p. 25). The success of the program in Namibia has been attributed to Namibia's unique characteristics, including low population density and favorable seasonal rain, which helps prey species recover (van Vliet 2011, p. 30). Despite the successes in Namibia, the country's unique characteristics mean that adapting Namibia's success to other, more densely populated countries will be difficult.

Conservation Measures to Stem Human–Lion Conflict

As the human population expands, the potential for conflict with wildlife increases. In Africa, conflict between villagers and lions, who prey upon livestock, represent a threat to the species (Chardonnet *et al.* 2010, p. 12; Moghari 2009, p. 14; IUCN 2006a, p. 23). In addition,

habitat loss due to conversion of land increases the chance of villagers coming into direct contact with lions (Chardonnet *et al.* 2010, p. 24). In an attempt to address these problems, range countries have employed a variety of different strategies to help the lion. Such strategies involve education, an effective conservation plan, and interacting with the local community.

Historically, range countries seek to mitigate human–lion conflict through controlling rather than conserving the predator population. In countries such as Malawi, for example, the Department of Game, Fish and Tsetse Control would shoot large carnivores that preyed upon livestock. Because of this policy, more than 560 predators (which include lions) were killed in the country between 1948 and 1961, (Mesochina *et al.* 2010b, p. 35). While this department was disbanded in 1963 and jurisdiction shifted to the new Department of Forestry, crop and livestock protection still remains an important part of its function. Despite the department focusing on protecting crops and livestock, the number of lions killed in the country has declined. Between 1977 and 1982, eight lions were killed, whereas six lions were killed between 1998 and 2007 (Mesochina *et al.* 2010b, p. 35). While fewer lions are being killed than in the previous decades, problems remain, including lack of resources, lack of manpower, and corruption within the range countries.

Current governmental management of lions in countries such as Malawi, Tanzania, and Zambia are managed by the Problem Animal Control units (Mesochina *et al.* 2010a, p. 41; Mesochina *et al.* 2010b, p. 36). When lion attack incidents occur, Problem Animal Control dispatches officials to investigate the problems. If the problem lion is located, it is either removed or eliminated. When properly funded, this program has helped in reducing not only

conflicts between lions and humans but also has driven down the numbers of lions killed. Between 2005 and 2009, there were 116 reported cases of lions killed, with the number of lions killed being less than 50 per year in Tanzania (Mesochina *et al.* 2010a, p. 41). However, limitations of resources (including both manpower and funds) have hampered the effectiveness of these officials in responding to these incidents. In addition, many Problem Animal Control interventions resulted in the death of the lion (Mesochina *et al.* 2010a, p. 41; Chardonnet *et al.* 2009, p. 36). Even in cases of translocation, the lions that were being transported often end up injured or continue to pose problems to the community (Bauer *et al.* 2007, p. 91).

NGOs are also assisting in protecting lions. Intervention by NGOs often takes the form of interacting with the local community (Winterbach *et al.* 2010, p. 98). Lion Guardians, which operates in Kenya and Tanzania, recruits and educates local young men to monitor and track lion movement and warn herders of lion presence in the area, recover lost livestock, reinforce protective fencing, and intervene to stop lion hunting parties, thereby mitigating or preventing possible human–lion conflict (Hazzah *et al.* 2014, p. 853; Lion Guardians 2013, p. 7; Lion Guardians 2012, p. 3). From 2010 to 2013, Lion Guardians maintained a recovery rate of lost livestock of more than 85, totaling over $1.5 million USD; in 2014 alone, more than 20,000 livestock (93 percent) were recovered (Lion Guardians 2014, p. 7; Lion Guardians 2013, p. 6). Since 2010, 1,700 bomas have been reinforced to reduce depredation of livestock. End-of-year sampling shows that more than 90 percent of reinforced bomas sampled did not experience further depredation (Lion Guardians 2014, p. 7; Lion Guardians 2013, p. 6). Additionally, 103 lion hunts were stopped or prevented between 2010 and 2014 (Lion Guardians 2014, p. 6; Lion Guardians 2013, p. 5). Lastly, in the years of Lion Guardians operations, lion kills have

decreased by 95 percent and the number of lions has steadily increased; a total of 286 lions have been documented in the Amboseli-Tsavo ecosystem (Lion Guardians 2014, p. 6; Lion Guardians 2013, p. 5).

In addition, Lion Guardians work with tribal elders to dissuade young men from killing lions for ceremonial purposes. Historically, the killing of lions through ritualized lion hunts called *ilmurran* is rewarded with gifting of cows and other rewards (Lion Guardians 2012, p. 5; Goldman *et al.* 2010, p. 334). After introducing village elders to the Lion Guardians program first hand, many return home to their village and give their blessings to the project. This education led to significant results; on August 11, 2013, two Lion Guardians stopped a group of hunters who were planning to hunt a lion in retaliation for the lion preying on their livestock. The local village elders fined the potential hunters two cattle each for going on a lion hunt, marking a gradual but significant shift in the cultural attitudes regarding the lion (Hazzah *et al.* 2014, p. 858; Lion Guardians 2013, p. 20). Between 2007 and 2014, only five lions had been killed in territories where Lion Guardians operates, in contrast to more than 100 lions killed in adjacent areas (Lion Guardians 2013, p. 5). Furthermore, reduced lion mortality was sustained across multiple years, resulting in the reserve having one of the highest lion densities in Africa (Hazzah *et al.* 2014, p. 857; Schuette *et al*. 2013, p. 149). Despite the success of this program, retaliatory as well as ceremonial killings of lions outside the program areas remain a threat to the species.

We found that many of the lion range states are trying to address lion conservation through the establishment of protected areas, wildlife management areas, wildlife corridors, and

reconnecting habitat. In some areas, creating incentives for lion conservation is occurring through community conservation programs in range countries. In other cases, participatory strategies have been implemented to enhance local tolerance for large carnivores in Africa. An increasing number of programs encourage local communities to solve problems that arise from human–lion conflict without killing lions. However, the effectiveness of these measures still ranges from successful to unsuccessful, due in part to lack of resources, political will, and infighting. It is imperative that range countries continue to recognize and support the role that local communities play in lion conservation. Greater support by countries to address the needs of local communities, and thereby address the needs of lions, may be the single-most important role these countries can play in changing the trajectory of lion declines.

Finding

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR part 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be an endangered species or a threatened species based on any of the following five factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

(E) Other natural or manmade factors affecting its continued existence.

A species is “endangered” for purposes of the Act if it is in danger of extinction throughout all or a significant portion of its range and is “threatened” if it is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. The “foreseeable future” is the period of time over which events or effects reasonably can or should be anticipated, or trends extrapolated.

As required by the Act, we conducted a review of the status of the species and considered the five factors in assessing whether the lion is in danger of extinction throughout all or a significant portion of its range or likely to become endangered within the foreseeable future throughout all or a significant portion of its range. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the lion. We reviewed the petition, information available in our files, other available published and unpublished information, and comments received from peer reviewers and the general public.

When considering what factors might constitute threats to a species, we must look beyond the mere exposure of the species to a factor to evaluate whether the species may respond to the factor in a way that causes actual impacts to the species. If there is exposure to a factor and the species responds negatively, the factor may be a threat and we attempt to determine how significant a threat it is. The threat is significant if it drives, or contributes to, the risk of extinction of the species such that the species may warrant listing as endangered or threatened as those terms are defined in the Act.

Overall, the lion population has declined and is expected to continue to decline. Across its range, the lion is facing threats stemming from human population growth. We find a number of factors are currently impacting the species and will impact the species in the future. In general, these factors include: habitat fragmentation, degradation, and loss (Factor A); excessive mortality due to trophy hunting and trade in lion bone (Factor B); disease (Factor C); loss of prey base, retaliatory killing due to human–lion conflict, deleterious effects due to small populations, and climate change (Factor E); and inadequate regulatory mechanisms and weak management of protected areas (Factor D).

Overall, the lion population has decreased by 43 percent over the last 21 years. Regional variations indicate an 8 percent increase in southern Africa and a 55 percent increase in India; however, the eastern region and western and central region (combined) decreased by 59 and 66 percent, respectively, in the past 21 years. Furthermore, almost all lion populations in Africa that historically exceeded 500 individuals, the minimum number estimated to constitute a viable population, are declining.

Human population growth has led to a substantial decrease in lion habitat over the past 50 years. Current savanna habitat that is suitable for lions is fragmented and totals only 25 percent of African savanna habitat. This loss of habitat has resulted in local and regional lion population extirpations, reduced lion densities, and a dramatically reduced range; this decrease in habitat also partially explains why lions are now largely limited to protected areas. Due to good protection and management, lions in India have dispersed to additional forested habitat outside

the protected area, extending their range. Lion habitat in Africa, however, continues to be threatened by expansion of human settlements, despite occurring within protected areas.

Expansion of human settlements, agriculture, and/or livestock grazing are reported as occurring in or on the periphery of several areas identified by Riggio *et al.* (2013, suppl. 1) as lion strongholds (viable populations) and potential strongholds, and are particularly a threat in western, central, and eastern Africa and some parts of southern Africa. Lions are generally incompatible with humans and human-caused habitat alteration and loss; they are the least successful large African carnivore outside conservation areas. In order to survive, they require larger contiguous habitats with fewer negative human impacts than other more resilient species. Expansion of human settlements and activities into lion habitat renders it unsuitable for lions, primarily because human expansion results in reduced availability of wild prey and lion mortality due to increases in human–lion conflict. Both of these factors influence the distribution and population viability of lions. Furthermore, fragmentation and isolation of lion habitat and populations can also impact dispersal and genetic viability.

Prey availability is essential to lion survival as it affects reproduction, recruitment, and foraging behavior and, therefore, also impacts lion movement, abundance, and population viability. Prey abundance does not appear to be a concern for lion populations in India. Conservation initiatives have ensured that ample prey is available, and the pastoral communities that cohabitate with lions are primarily vegetarian; therefore, there is no competition for food and no demand for bushmeat. In Africa, lions are under serious threat due to decreased prey

abundance. Widespread decreases in prey species have been driven by human population growth and unsustainable, increasingly commercialized bushmeat hunting in and around protected areas.

Bushmeat is an important source of protein and livelihood in Africa. The growing human population increases the demand for bushmeat, fueling trade, urban markets, and international markets. Bushmeat sold at elevated prices increases commercialization and the number of hunters. These hunters, who are often poor, are enticed by the quick income to find more efficient hunting methods, putting unprecedented pressure on wildlife. Bushmeat contributes significantly to food security, and is often the most important source of protein in rural areas. It comprises between 6 percent (southern Africa) and 55 percent (CAR) of a human's diet within the lion's African range. In western Africa, bushmeat is a secondary source of protein, with fish being the primary source. However, when widespread loss of jobs and income occurs due to poor fish harvests, bushmeat becomes an important source of income and sustenance, leading to increased presence of hunters in protected areas and higher than average declines in wildlife.

Due to growing demand and availability of modern weapons, many wildlife species, including the lion's prey base, have become depleted in many areas. Hunters are increasingly focusing on protected areas since wildlife has been depleted in non-protected areas. Bushmeat hunting is illegal, yet weak management and inadequate law enforcement have facilitated poaching of bushmeat in protected areas. Significant decreases in large mammal populations, including lion prey species, have occurred in protected areas throughout Africa. Overall, the large mammal population has declined 59 percent. Regional differences in herbivore population

abundance were also detected. Because prey availability is an important factor for lions, decreases in prey densities result in decreases in lion density.

Expansion of human settlements and agricultural and pastoral activities into protected areas not only decreases prey availability, it increases exposure of livestock and humans to lions, thus resulting in human–lion conflict. Most conflict occurs at protected area boundaries where villages are established and human encroachment occurs, which increases the chance of human–lion encounters. Furthermore, cattle herders enter protected areas, and lions move beyond the borders of protected areas in search of food, increasing interactions between humans and lions and the risk of human–lion conflict.

The most significant cause of human–lion conflict is livestock depredation and, to a lesser extent, attacks on humans. As a result of prey species becoming depleted in many areas, lions will seek out livestock. Additionally, when pastoralists graze increasing numbers of livestock in and adjacent to protected areas and cultivate land up to and within the boundaries of protected areas, humans and livestock are subjected to lions, and the risk of predation and the number of livestock lost to predation increases. Conversion of rangeland to agricultural land has blocked migratory prey routes, forcing lions to rely more on livestock. Additionally, because most protected areas are too small to support a lion's large home range, adjacent dispersal areas are often used by lions in search of prey, putting them into greater contact with livestock and humans. Conditions worsen as livestock numbers and areas under cultivation increase, leading to overgrazing, further habitat destruction, and greater depredation rates. Attacks on humans appear to be more frequent in southern and eastern Africa and rare in western and central Africa.

Livestock provide an economic value to humans, particularly those in extreme poverty. When lions have no economic value to local communities and they kill or are perceived to kill livestock, the economic impact to local communities can be significant. Impacts on victims of lion attacks create resentment towards lions and lion conservation, and a greater likelihood of retaliation. The most common solution to lion attacks is retaliatory killing. Spearing, shooting, trapping, and poisoning of lions occur regularly. Retaliatory killings have been reported as a significant threat to lion populations in protected areas of western and central Africa, Botswana, South Africa, Cameroon, Kenya, Tanzania, and Zimbabwe. Despite close occupation of India's lion population with human settlements, increased predation on livestock, and some retaliatory killing of lions, human–lion conflict and associated retaliatory killing is not a major source of lion mortality for that population.

Every year, human–lion conflicts intensify due to habitat loss, poor livestock management, and decreased availability of wild prey. Because most human–lion conflict occurs at the borders of protected areas, only those prides that occur near the borders are subjected to human–lion conflict. However, when these lions are removed via retaliatory killing, territorial gaps are then filled with lions that may have occurred closer to the core of protected areas, causing these border areas to serve as population sinks and exposing more lions to human–lion conflict and retaliation. Retaliatory killing of lions continues in many areas, and this practice impacts the viability of lion populations across their range. The killing of lions due to human–lion conflict is enough to result in the local extirpation of lion populations.

Lions are a key species in sport hunting, or trophy hunting, which is carried out in a number of range countries. If managed correctly, trophy hunting can be an important management tool for conserving land and providing financial resources for lion conservation. However, management programs are not always sufficient to deter unsustainable offtakes, which has resulted in declines in lion populations in many areas. The main problem with mismanaged trophy hunting stems from excessive harvests because of impacts associated with removal of males.

Six management weaknesses have been identified in the current management of lion hunting. These weaknesses include: (1) A lack of scientifically based quotas, which results in excessive harvests; (2) a lack of enforcement in age restrictions, which leads to unsustainable harvests, increased rates of infanticide, and population declines; (3) hunting of female lion in Namibia, which decreases reproduction success, thereby decreasing males available for trophy hunting; (4) the use of fixed quotas that, which encourages hunters to be unselective in their take of a trophy (i.e., they will kill younger, less desirable males); (5) a lack of minimum hunt lengths or minimum lengths that are too short to allow hunter the time needed to be more selective in their take of trophies; and (6) general problems associated with management of trophy hunting, including corruption, allocation of concessions, and lack of benefits to communities and recognition of the important role they play in conservation.

Documented declines in lion populations of Africa are a result, in part, of mismanaged trophy hunting. Multiple researchers have documented declines in lion populations across the range of the species as a result of mismanaged trophy hunting. Specifically, negative impacts to

lions from excessive offtakes have been documented in Benin, Cameroon, Tanzania, Zambia, and Zimbabwe. Additionally, the effects of over-harvesting can extend into adjacent national parks where hunting is prohibited.

Except in Mozambique, trophy hunting quotas are higher than the recommended maximum harvest of 1 lion per 2,000 km^2. Additionally, the mean actual harvests in Burkina Faso, Zambia, Namibia, and Zimbabwe are higher than the recommended 1 lion per 2,000 km^2 offtake.

In the absence of reliable population estimates, age restriction on trophy harvests can ensure sustainability. If offtake is restricted to males older than 6 years of age, trophy hunting will likely have minimal impact on the pride's social structure and young. By removing only males 6 years of age or older, younger males remain in residence long enough to rear a cohort of cubs (allowing their genes to enter the gene pool; increasing the overall genetic diversity); recruitment of these cubs ensures lion population growth and, therefore, sustainability. However, harvesting males that are too young causes male replacements, which results in increased infanticide rates and death of the surviving male coalition. Additionally, a study found a 100 percent fatality rate for males that are prematurely forced to disperse due to a new male takeover. A lack of mature males dispersing, whether it's due to trophy hunting or retaliatory killing, reduces the genetic viability of populations and may contribute to local population extinctions.

Lion experts recommend age-based strategies be incorporated into lion management action plans. Although the 6-year method has the potential to reduce the rate of infanticide in lion populations subject to trophy hunting, the issue of incorporating this strategy into each country's conservation strategy and/or action plan, and following up with implementation, enforcement, and transparency, has yet to be observed in many of the lion's range countries. Lack of implementation of age-based strategies may undermine the successful use of trophy hunting as a sustainable conservation strategy.

Trade in lion parts and products are common in western and central Africa. Lion populations in these regions are small and declining and, therefore, the common use of lions in these regions for their parts and products is likely unsustainable. Further, there seems to be a burgeoning trade in lion bone to supplement or replace tiger bone. There is potential that the current legal trade in lion bone will eventually not be enough to supply demand, resulting in poaching of lions in the future for the Asian medicinal trade.

As a result of human population expansion into lion habitat, lions are increasingly exposed to diseases from domestic animals. Because lions are a top predator, they are at a particularly high risk of exposure to pathogens. Available studies do not indicate that infection with a single disease is causing detrimental impacts to lions at the species level, although general body condition, health, and lifespan may be compromised and result in negative impacts at the individual or population level. Co-infections, however, could have synergistic effects that lead to greater impacts on lions than a single infection.

Disease appears to be a secondary factor influencing the decline of lions when co-infections occur or when disease is combined with other factors, including environmental changes, reduced prey density, and inbreeding depression. Diseases weaken individuals and allow them to succumb to other diseases or factors. Although disease does not appear to be a major driver in the status of the lion, populations can suffer significant losses; some may recover to pre-outbreak levels, others may not. Given the small and declining lion populations that remain, any loss of individuals from the populations could be highly detrimental.

The viability of a lion population partly depends on the number of prides and ability of males to disperse and interact with other prides, which affects exchange of genetic material. Without genetic exchange, or variation, individual fitness is reduced and species are less able to adapt to environmental changes and stress, increasing the risk of extinction.

Male dispersal plays an important role in determining the level of inbreeding in lion populations. The fewer number of males present to contribute genes to the next generation, the more inbred the population will be. Therefore, not only does dispersal impact inbreeding, so does the loss of male lions due to excessive trophy hunting and infanticide. Because the number of prides and male dispersal are the most important factors for maintaining viability, sufficient areas are needed to support at least 50 prides, but preferably 100 prides, and allow unrestricted male dispersal. Unfortunately, few lion populations meet these criteria as almost all lion populations in Africa that historically exceeded 500 individuals are declining, and few protected areas are large enough to support viable populations. Furthermore, research indicates that there is a general lack of gene flow in most lion conservation units.

Lack of dispersal and genetic variation can negatively impact the reproductive fitness of lions in these populations and local extirpation is likely. Loss of fecundity leads to a decrease in population size, fewer prides in a population, and increased inbreeding which contributes to a decline in the population and increases the risk of extinction. Additionally, lack of genetic variation can impact the ability of lions to withstand stochastic events or limit the lion's ability to evolve responses to climate change.

India's lion population is isolated and genetically less diverse. Currently, there is no evidence of depressed demographic parameters. However, intense management may interfere with natural selection by ensuring survival of unfit lions, which facilitates the propagation of deleterious genes in the population. Being a small, isolated population and less genetically diverse, therefore, it is more vulnerable to the loss of any individuals due to environmental and stochastic events, and more prone to local extinction events. The establishment of another geographically separated, free-ranging population would reduce the risk of extinction. Establishment of a new population at Kuno Wildlife Sanctuary in Madhya Pradesh State has been proposed. However, the Government of Gujarat has refused to allow any lions from Gir to be transferred.

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As human populations continue to rise in sub-Saharan Africa, the amount of land required to meet the expanding human population's needs is constantly increasing. Lions are increasingly limited to protected areas, and human population growth rates around protected areas in Africa tend to be higher than the average rural growth rate. Considering the majority of

the human population in sub-Saharan Africa is rural, and land supports the livelihood of most of the population, loss and degradation of lion habitat, loss of prey base, and increased human–lion conflict can reasonably be expected to accompany the rapid growth in sub-Saharan Africa's human population into the foreseeable future.

Impacts described above from existing and predicted anthropogenic pressures on the species and its habitat are likely to be exacerbated by climate change. The general warming and drying trend projected for Africa could further reduce lion range, numbers, and prey base. Lions may also have to travel greater distances to find food or shift their diet to livestock, increasing conflict with humans and the risk of retaliatory killings. Additionally, changes in climate may increase the number and intensity of disease outbreaks in lions and their prey.

Under different climate change scenarios between the years 2040 and 2070, no broad new areas will become suitable for lion. Southern Africa, where the broadest areas of suitable conditions occur, is projected to become less suitable because of climate change. A broad swath of potential distributional area in western Africa is projected to become "distinctly less suitable or even uninhabitable." A decrease in the lion's range could mean that stochastic events impact a larger portion of the whole species, especially if it occurs where the species and its habitat occur. Additionally, reductions in populations and geographic range may limit the lion's ability to respond to climate change. Conversely, climate change effects on potential lion distribution are projected to be more neutral in eastern Africa than across the entire range. Reserves in this region are more likely to sustain lion populations under climate change scenarios in the medium-term.

Increases in average rainfall in the past 20 years have resulted in the conversion of dry savanna to forestland in India; however, these lions have used both habitats. Therefore, habitat conversion due to climate change may not be as detrimental to lions in India. However, increased risks of flooding could pose a problem for lions. Additionally, lions could face threats following flood events, such as an outbreak of disease. Because this population is small, isolated, and less genetically diverse, it is more vulnerable to stochastic events and more prone to local extinction events.

Current lion habitat and suitable habitat predicted to remain under climate change scenarios will be under increasing pressure due to land conversions to meet the needs of the growing human population. Projected changes in Africa's climate will increase this pressure as land becomes more arid and food security concerns are exacerbated. Adaptive responses may result in further encroachment into natural habitats. Land conversion will restructure the landscape, disrupt prey migration, and decrease prey available to lion. Lion densities decrease with increasing mean temperature and decreasing rainfall. Therefore, lion density, or carrying capacity of protected areas, in sub-Saharan Africa is likely to decline with climate warming and drying.

The loss of lions could also mean the loss of genetic variation. Combined with declining populations, the risk of inbreeding and associated complications could increase. Drought conditions can also contribute to reduced prey availability by altering the timing of migration.

Climate conditions also influence prey abundance, and the loss of prey species can result in lions shifting their diet towards livestock, which may increase retaliatory killings by humans.

Diseases can be directly and indirectly affected by climate change by impacting distribution, the timing of outbreaks, and the intensity of outbreaks. Severe climate change could synchronize temporal and spatial convergence of multiple infectious agents, triggering epidemics with greater mortality than infections from a single pathogen.

National and international conservation strategies rely on protected areas to protect natural resources from negative impacts of human populations. The lion is largely limited to protected areas; therefore, effective management is crucial to the survival of the species. However, weak management of protected areas has been documented across its range, especially in western Africa where most protected areas are experiencing severe management deficiencies.

Based on the best scientific and commercial information, we find that several factors are negatively impacting the lion and contributing to the risk of extinction. However, we find there is a substantial difference in the magnitude of these threats to the risk of extinction between the subspecies *P. l. leo* and *P. l. melanochaita*. Based on current population estimates, projected population trends, and the threats described herein, we find that the subspecies *P. l. leo* and *P. l. melanochaita* qualify for different statuses under the Act.

Finding for Panthera leo leo

The range of *P. l. leo* includes the western and central African regions and India. This subspecies has experienced a reduction in range, a reduction in total number of populations, and a reduction in number of lions. There are approximately 1,500 lions distributed among 15 populations; 14 in Africa and 1 in India. The population in western and central Africa has declined by 66 percent since 1993. The current population estimate for this portion of its range is approximately 915 lions. None of the lion populations in these regions meet the MVP, although we do note that the WAP complex qualifies as a potential stronghold where a viable population could occur if immediate interventions are implemented. Between 1993 and 2014, the Indian population increased by 55 percent. A census conducted in 2015 indicates the population has increased by 27 percent since 2010, with lions now numbering 523. Although this population is found within a protected area, its single, small population of 523 animals continues to be highly vulnerable to disease and other stochastic events. Due to weak management in Africa and small populations throughout its range, this subspecies continues to face threats.

Remaining African populations are particularly threatened by expansion of human settlements, agriculture, and/or livestock grazing. Expansion of agriculture and livestock grazing are reported in or around two of the larger African populations of *P. l. leo*, WAP Complex and a Chad–CAR population; management in portions of both protected areas is reported as weak, raising concern for the persistence of lions and their habitat. Expansion of human settlements and activities into lion habitat renders it unsuitable for lions, primarily because human expansion results in reduced availability of wild prey and lion mortality due to increases in human–lion conflict. Both of these factors influence the distribution and population viability of lions.

Significant decreases in prey abundance have occurred in protected areas throughout Africa. In western Africa, specifically, herbivore populations have decreased by 85 percent. As a result of prey species becoming depleted in many areas, lions seek out livestock for food; attacks on livestock occur at the highest frequency in areas where natural prey abundance is lowest. Traditional livestock husbandry practices can reduce depredation rates, but these traditional practices are being replaced with less diligent practices. For example, in the Pendjari area of Benin, traditional enclosures are low with few branches. These structures and the lack of enclosures encourage livestock predation. People do not invest much into improving enclosures even though they appear to be economically efficient, ecologically effective, and culturally acceptable. Even enclosures that were built as part of a conservation project were not used full time due to lack of labor and, in some cases, the herd being too large for the enclosures. When lions in Africa cause or are perceived to cause damage to livestock, property, or people, the response is generally to kill them. Retaliatory killings are reported to be a significant threat to lion populations in western and central Africa.

Some countries in the African range of this subspecies allow hunting of *P. l. leo*. Management programs do not appear to be sufficient to deter unsustainable offtakes, which has resulted in declines in lion populations in many areas. Specifically, negative impacts to lions from excessive offtakes have been documented in Benin and Cameroon. Additionally, hunting quotas in Benin and Burkina Faso are too high for sustainability, although Burkina Faso has proposed to reduce their quota in the 2015–2016 season. Actual harvests in Burkina Faso were also found to be higher than recommended levels. Although experts recommend age-based

strategies be incorporated into lion management plans to reduce excessive harvests and reduce the rate of infanticide, Benin and Burkina Faso have yet to implement an age-based strategy. As a result, species experts agree that there is no level of offtake that would be sustainable for *P. l. leo* populations in their current condition.

Trade in lion parts and products is very common in western and central Africa. Many African countries, including Nigeria, Burkina Faso, and Cameroon, maintain local markets in lion products. Trade in lion skins and partial skins is described as "frequent" in street markets in Abidjan, Côte d'Ivoire, and the scale of domestic trade in illegal lion products is described as "massive" in Nigeria. In the central African country of Cameroon, the estimated value of a single lion carcass exceeds the trophy fee, and at a lion conservation conference, the Government of Cameroon identified trade in lion skins as a major cause of the decline in lion populations in western and central Africa. Trade in lion skins is most likely one of the biggest threats to lion survival in western Africa due to the rarity of lions in the region, the extent of the trade, and the high price of lion skins. Lion populations in western and central Africa are small and declining and, therefore, the common use of lions in these regions for their parts and products is likely unsustainable.

The viability of a lion population partly depends on the number of prides and the ability of males to disperse and interact with other prides, which affects exchange of genetic material. Without genetic exchange, or variation, the more inbred the population will be, individual fitness is reduced, reproductive fitness is reduced, and species are less able to adapt to environmental changes and stress or stochastic events. Loss of fecundity leads to a decrease in population size, fewer prides in a population, and increased inbreeding which contributes to a decline in the

population and may result in local extirpation. The entire *P. l. leo* subspecies comprises small, isolated populations. Research indicates that there is a general lack of gene flow in most lion conservation units. Furthermore, the suggested minimum number of lions estimated to constitute a viable population is at least 250 lions, but preferably 500 lions, or 50–100 prides. This threshold may be smaller for *P. l. leo* as pride sizes are generally smaller than those for *P. l. melanochaita*. However, given the size of the remaining populations, few could be considered potentially viable. Additionally, few protected areas are large enough to support viable populations.

Although there are laws meant to protect wildlife, including lions and their prey species, the drastic and continuing decline of the species and its prey indicate these regulatory mechanisms are not adequate to ameliorate threats to *P. l. leo*. Furthermore, national and international conservation strategies rely on protected areas to protect natural resources from negative impacts of human populations. However, weak management of protected areas has been documented across the lion's range, especially in western Africa where most protected areas are experiencing severe management deficiencies, including the lack of a budget or a budget insufficient to carry out management activities.

The lion population in India is one population of *P. l. leo* that is increasing and could potentially be considered a viable population based on the number of lions. However, intense management, including healthcare interventions, may interfere with natural selection processes by ensuring the survival of unfit lions, which facilitates the propagation of deleterious genes in the population. This population is also running out of area to expand. Being a small, isolated

population and less genetically diverse, it is more vulnerable to the loss of any individuals due to environmental and stochastic events, and more prone to local extinction events.

As previously stated, threats to the lion are expected to continue or increase in conjunction with predicted human population growth. The human population, and thus negative impacts to lions, as well as decreases in lion populations, associated with human population growth, is expected to increase substantially by 2050. If regional trends continue at their current rate, western and central Africa will likely lose a third of its population in 5 years and half the population in 10 years. Lion bone may be increasingly used as a replacement for tiger bone in traditional Asian medicine and in Asian luxury products. Therefore, trade in lion bone could become lucrative, spur considerable demand from suppliers of the black market, result in extensive poaching of wild lions, and have significant impacts to lion populations. Additionally, future development in India could alter habitat vital for dispersal. Tolerance to loss of livestock may also wane as traditional beliefs and traditional value systems are rapidly changing under the influence of globalization. Furthermore, effects of climate change on lion habitat are projected to manifest as early as 2040. Under climate change scenarios, a broad swath of potential distributional area in western Africa is projected to become distinctly less suitable or even uninhabitable. Increases in rainfall predicted for India may not have detrimental impacts on lion habitat; however, increased risks of flooding could result in increased mortality, and post-flooding conditions could be conducive to disease outbreaks and are a serious concern to the persistence of the lion population as this population is more vulnerable to stochastic events and local extinction.

Threats acting on *P. l. leo* have contributed to large reductions in the subspecies' range and suitable habitat, abundance, and number and connectivity of populations. The subspecies has reached critically low numbers of individuals and potentially viable populations. Furthermore, while one small population may be increasing, we are not aware of any information indicating that the overall trend of large declines in the subspecies range, abundance, and connectivity, will reverse course.

Threats continue to act on this subspecies. Due to small population size and lack of connectivity between populations, most populations are not able to recover from the loss of suitable habitat or individuals. Furthermore, because all populations are small and isolated, the subspecies lacks resiliency to recover from stochastic or catastrophic events and is thus highly vulnerable to extirpation. Threats are currently affecting the subspecies and the impacts on the subspecies are expected to continue or even intensify over time as the human population increases and as climate change progresses, negatively impacting availability of suitable habitat, lion distribution, and lion numbers. Based on the current distribution and size of *P. l. leo* populations, the current threats acting on this subspecies, the impacts of those threats, and the impacts of future threats and climate change on lion distribution, lion numbers, habitat, prey availability, susceptibility to disease, loss of lions via human–lion conflict and trophy hunting, and resiliency to stochastic and catastrophic events, we find that the viability of this subspecies is compromised and will not be resistant or resilient to ongoing and future threats. Therefore, we find that *P. l. leo* is in danger of extinction throughout its range and list the subspecies as endangered.

Finding for Panthera leo melanochaita

The range of *P. l. melanochaita* includes the southern and eastern African regions. Although this subspecies has experienced range reduction, a decline in the number of populations, and a decline in the number of lions, it remains relatively widespread. Currently, there are approximately 17,730 *P. l. melanochaita* lions distributed among 68 protected areas, with larger populations in Botswana, Kenya, Namibia, South Africa, Tanzania, Zambia, and Zimbabwe. Between 1993 and 2014, the lion population in eastern Africa declined by 59 percent. In southern Africa the lion population increased by 8 percent during the same time period. Most of the increasing populations contributing to this trend are small, fenced reserves. However, one of the largest populations in southern Africa, Okavango, and populations in 6 unfenced reserves in Botswana, Namibia, and Zimbabwe declined. Although there are larger populations of *P. l. melanochaita* that may meet the suggested MVP, almost all lion populations in Africa that historically exceeded 500 individuals, are declining.

Expansion of human settlements, agriculture, and/or livestock grazing is occurring in or on the major populations and is particularly a threat in eastern Africa and some parts of southern Africa. In particular, expansion of agriculture and livestock grazing is occurring in or around major populations in Kenya, Tanzania, and Zambia and both are major threats to lion survival in these countries. Expansion of human settlements and activities into lion habitat renders it unsuitable for lions, primarily because human expansion results in reduced availability of wild prey and lion mortality due to increases in human–lion conflict. Both of these factors influence the distribution and population viability of lions. However, in some parts of southern Africa,

lions are repopulating areas where lions were recently extirpated due to adequate protection of habitat and prey.

Significant decreases in prey abundance have occurred in protected areas throughout Africa, including Botswana, Kenya, Mozambique, Sudan, Zambia, and Zimbabwe. Herbivore populations have decreased by 52 percent in eastern Africa, although they have increased by 24 percent in southern Africa. Protected areas in Ethiopia, Mozambique, Tanzania, and Zambia are increasingly settled; decreases in prey abundance in African protected areas are driven by human population growth, especially along the boundaries of protected areas where human population growth rates are high, encroachment and habitat loss occurs, and people are dependent on bushmeat. Additionally, many communities lack the rights over land and in most cases in Botswana, Tanzania, Zambia, and Zimbabwe, the government retains a significant portion of revenue from wildlife; therefore, those that bear the costs of wildlife do not receive benefits, and bushmeat hunting is the only way to benefit from wildlife. Furthermore, conversion of rangeland to agricultural use has blocked several migratory routes for Tanzania's wildebeest and zebra populations, which likely forces lions to rely more on livestock

As a result of prey species becoming depleted in many areas, lions seek out livestock for food; attacks on livestock occur at the highest frequency in areas where natural prey abundance is lowest. Additionally, traditional livestock husbandry practices can reduce depredation rates, but these traditional practices are being replaced with less diligent practices. In Kenya and Tanzania, social changes are altering traditional Maasai pastoral livelihoods, reducing dependency on livestock, and reducing traditional livestock care and management, leaving

livestock more vulnerable to predation. Although lions generally avoid people, they will occasionally prey on humans, causing serious injury or death. Attacks on humans appear to be more frequent in the range of *P. l. melanochaita* than *P. l. leo*. When lions cause or are perceived to cause damage to livestock, property, or people, the response is generally to kill them. Retaliatory killings are reported to be a significant threat to lion populations in Botswana, South Africa, Kenya, Tanzania, and Zimbabwe.

Some *P. l. melanochaita* range countries allow hunting of lions. Although some management programs appear to follow recommended practices for sustainability, most do not appear to be sufficient to deter unsustainable offtakes, which has resulted in declines in lion populations in many areas. Specifically, negative impacts to lions from excessive offtakes have been documented in Tanzania, Zambia, and Zimbabwe. Additionally, hunting quotas in most countries are higher than the recommended offtake for sustainability. Actual harvests in Namibia, Zambia, and Zimbabwe were also found to be higher than recommended levels. Experts recommend age-based strategies be incorporated into lion management plans to reduce excessive harvests and reduce the rate of infanticide and several countries, including Mozambique (only Niassa National Reserve), Tanzania, and Zimbabwe have committed to implementing an age-based strategy. Of these, only Niassa National Reserve and Zimbabwe have fully implemented age restrictions and shown reductions in offtake. Tanzania has implemented age restrictions and shown reductions in offtake; however, transparency (in terms of trophy quality data) and the scientific objectivity of the evaluating body has been questioned. Lack of implementation of age-based strategies may undermine the successful use of trophy hunting as a sustainable conservation strategy.

The captive-breeding industry has publicized captive breeding and reintroduction of captive-born species into the wild as a potential solution to the decrease in wild lion populations. However, lions raised in captivity often develop a variety of issues that make them unsuitable for reintroduction, and reintroduction efforts have not been shown to address the underlying causes of population declines throughout the species' range. Existing research has generally found that captive-raised lions are not as able to adapt successfully to conditions out of captivity and, therefore, the success rate is much reduced compared to the use of wild-caught lions.

While it is argued that South Africa's captive-bred lion industry may reduce pressures of trophy hunting on wild South African populations, there is no substantial or peer-reviewed science to support such a claim. Likewise, there is no record or evidence to support claims that the captive-bred lion industry is supporting reintroduction into the wild in any significant way. However, future efforts to control hunting of captive-bred lions could potentially increase the demand for wild lion trophies and result in excessive harvests. Additionally, trade in bones of captive lions could stimulate harvest of wild lions to supply a growing bone trade. Hunting of captive lions could also potentially undermine the price of wild hunts and reduce incentives for conservation of wild lions in other African countries.

Lion parts and products are used in many African countries as medicine, nutrition, talismans, and decorations, and in traditional ceremonies and rituals. Kenya and Somalia maintain local markets in lion products. Lion skins and canines are also described as "easily found" in the markets of Dakar, Senegal. In southern and eastern Africa, trade in lion parts,

particularly lion bone, to Asia is generally considered a severe potential threat to the species. According to CITES, there is "clear scope for the international trade in lion body parts for [traditional Chinese medicine and traditional African medicine] to grow uncontrollably, as it has done for other big cats." According to Kenya, the declared exports of bones, skulls, and skeletons derived from wild lions also show an increasing trend through the period 2003–2012, with total declared specimens in 2012 more than ten times those in 2003. Evidence suggests incentive to poach wild lions for the bone trade may currently exist as prices paid to South African game farmers and landowners for lion bones exceeded the per capita GDP (gross domestic product) in many lion range states. Thus, the current price paid for lion bone appears to provide incentive in some countries to poach wild lions.

The viability of a lion population partly depends on the number of prides and ability of males to disperse and interact with other prides, which affects the exchange of genetic material. Without genetic exchange, or variation, the more inbred the population will be, individual fitness is reduced, reproductive fitness is reduced, and species are less able to adapt to environmental changes and stress or stochastic events. Loss of fecundity leads to a decrease in population size, fewer prides in a population, and increased inbreeding, which contributes to a decline in the population and local extirpation. Research indicates that there is a general lack of gene flow in most lion conservation units. Furthermore, the suggested minimum number of lions estimated to constitute a viable population is at least 250 lions, but preferably 500 lions, or 50–100 prides. Almost all lion populations in Africa that historically exceeded 500 individuals are declining, and few protected areas are large enough to support viable populations.

While the lion bone trade appears to currently be based primarily in South Africa's captive-bred lion hunting industry, the trade appears to be having little or no impact on wild lion populations in South Africa at this time—lion populations in South Africa are stable or increasing and there is little poaching of wild lions in the country (Funston and Levendal 2014, pp. 1, 26; Williams *et al.* 2015, pp. 79–80). However, the impact of the lion bone trade on lion populations outside South Africa is unknown and most wild lions occur outside South Africa (see *Distribution and Abundance*). While wild tiger populations are declining, the demand for tiger parts in Asia is increasing. With tigers difficult to obtain, lion bone may be increasingly used as a replacement for tiger bone. Considering the sharp and continuing increases in demand from Asia for lion bone and the effect of the tiger bone trade on tiger populations, there is potential for demand to surpass the availability of legally obtained lion bone. Therefore, trade in lion bone could become lucrative, spur considerable demand from suppliers of the black market, result in extensive poaching and unsustainable harvest of wild lions to meet demand, and have significant impacts to lion populations.

Although there are laws in place in lion range countries that are meant to protect wildlife, including lions and their prey species, the drastic and continuing decline of the species and its prey in some parts of its range indicate these regulatory mechanisms are not adequate to ameliorate threats to the *P. l. melanochaita* throughout its range. Furthermore, national and international conservation strategies rely on protected areas to protect natural resources from negative impacts of human populations. However, weak management of protected areas has been documented across the lion's range.

As indicated above, *P. l. melanochaita* remains relatively widespread and some remaining populations are large enough to be considered viable. Therefore, due to the size of some populations, the number of remaining populations, and the stability or increasing status of some populations, we find that *P. l. melanochaita* is not currently in danger of extinction. However, the overall population of the subspecies continues to decline and threats to the lion are expected to continue or increase in the future in conjunction with predicted human population growth. If regional trends in lion populations continue at the current rate, eastern Africa will lose a third of its lion population in 20 years and half the population in 30 years. Effects of climate change on lion habitat are projected to manifest as early as 2040. Although climate change effects on potential lion distribution are projected to be more neutral in eastern Africa than across the entire range, southern Africa, where the broadest areas of suitable conditions occur, is projected to become less suitable because of climate change. Specifically, park areas, including the "Etosha Pan, Lake Opnono, Cuvelai Drainage, Kalahari Gemsbok, and Kgalagadi Transfrontier Park areas" are projected to decline substantially in suitability for lions. In addition, reforms to trophy hunting have been made to ensure sustainability of trophy hunting, but these reforms have been implemented in only a few places. Furthermore, demand for lion bone is expected to increase in the future and high prices for lion bone provide incentive to poach wild lions. As a result of the likely impacts of these threats, it is reasonable to conclude that the population of *P. l. melanochaita* is likely to be drastically reduced and fragmented in the foreseeable future, limiting the ability of the subspecies to recover from stochastic and catastrophic events. Therefore, we find that this subspecies is likely to become an endangered species within the foreseeable future and we are listing *P. l. melanochaita* as a threatened species.

Significant Portion of its Range

Under the Act and our implementing regulations, a species may warrant listing if it is endangered or threatened throughout all or a significant portion of its range. The term "species" includes "any subspecies of fish or wildlife or plants, and any distinct population segment [DPS] of any species of vertebrate fish or wildlife which interbreeds when mature." We published a final policy interpreting the phrase "Significant Portion of its Range" (SPR) (79 FR 37578, July 1, 2014). The final policy states that (1) if a species is found to be endangered or threatened throughout a significant portion of its range, the entire species is listed as endangered or threatened, respectively, and the Act's protections apply to all individuals of the species wherever found; (2) a portion of the range of a species is "significant" if the species is not currently endangered or threatened throughout all of its range, but the portion's contribution to the viability of the species is so important that, without the members in that portion, the species would be in danger of extinction, or likely to become so in the foreseeable future, throughout all of its range; (3) the range of a species is considered to be the general geographical area within which that species can be found at the time the Service or the National Marine Fisheries Service makes any particular status determination; and (4) if a vertebrate species is endangered or threatened throughout an SPR, and the population in that significant portion is a valid DPS, we will list the DPS rather than the entire taxonomic species or subspecies.

We found the lion subspecies *P. l. leo* to be in danger of extinction throughout its range, and the subspecies *P. l. melanochaita* likely to become endangered within the foreseeable future throughout its range. Therefore, no portions of the species' range are "significant" as defined in our SPR policy, and no additional SPR analysis is required.

4(d) Rule for *Panthera leo melanochaita*

The purposes of the ESA are to provide a means whereby the ecosystems upon which endangered species and threatened species depend may be conserved, to provide a program for the conservation of such endangered species and threatened species, and to take such steps as may be appropriate to achieve the purposes of the treaties and conventions set forth in the ESA. When a species is listed as endangered, certain actions are prohibited under section 9 of the ESA and are implemented through our regulations in 50 CFR 17.21. These include, among others, prohibitions on take within the United States, within the territorial seas of the United States, or upon the high seas; import; export; and shipment in interstate or foreign commerce in the course of a commercial activity. Exceptions to the prohibitions for endangered species may be granted in accordance with section 10 of the ESA and our regulations at 50 CFR 17.22.

The ESA does not specify particular prohibitions and exceptions to those prohibitions for threatened species. Instead, under section 4(d) of the ESA, the Secretary, as well as the Secretary of Commerce depending on the species, was given the discretion to issue such regulations as deemed necessary and advisable to provide for the conservation of such species. The Secretary also has the discretion to prohibit by regulation with respect to any threatened species any act prohibited under section 9(a)(1) of the ESA. Exercising this discretion, the Service has developed general prohibitions in the ESA regulations (50 CFR 17.31) and exceptions to those prohibitions (50 CFR 17.32) that apply to most threatened species. Under 50 CFR 17.32, permits may be issued to allow persons to engage in otherwise prohibited acts for certain purposes.

Under section 4(d) of the ESA, the Secretary, who has delegated this authority to the Service, may also develop specific prohibitions and exceptions tailored to the particular conservation needs of a threatened species. In such cases, the Service issues a 4(d) rule that may include some or all of the prohibitions and authorizations set out in 50 CFR 17.31 and 17.32, but which also may be more or less restrictive than the general provisions at 50 CFR 17.31 and 17.32. For *P. l. melanochaita,* the Service has determined that a 4(d) rule is necessary and advisable.

We are adding a 4(d) (special) rule for *P. l. melanochaita* at 50 CFR 17.40(r). This 4(d) rule maintains all of the prohibitions and exceptions codified in 50 CFR 17.31 and 17.32 with regard to this subspecies and supersedes the import exemption found in 50 CFR 17.8 for threatened wildlife listed in Appendix II of CITES, such that a threatened species import permit under 50 CFR 17.32 is now required for the importation of all *P. l. melanochaita* specimens. Therefore, through the promulgation of this 4(d) rule, the presumption of legality provided under section 9(c)(2) of the Act for the otherwise lawful importation of wildlife listed in Appendix II of CITES that is not an endangered species listed pursuant to section 4 of the Act does not apply to this subspecies. Thus, under this 4(d) rule, all otherwise prohibited activities, including all imports of *P. l. melanochaita* specimens, require prior authorization or permits under the Act. Under our regulations at 50 CFR 17.32, permits or authorization to carry out an otherwise prohibited activity could be issued for scientific purposes, the enhancement of propagation or survival of the species, economic hardship, zoological exhibitions, educational purposes, or special purposes consistent with the purposes of the Act. Applications for these activities are

available from either *http://www.fws.gov/forms/3-200-20.pdf* or *http://www.fws.gov/forms/3-200-37.pdf*.

The intent of this 4(d) rule is to provide for the conservation of *P. l. melanochaita* consistent with the purposes of the Act. Under this 4(d) rule, the prohibitions, in part, make it illegal for any person subject to the jurisdiction of the United States to "take" (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or to attempt any of these) within the United States or upon the high seas; import or export; deliver, receive, carry, transport, or ship in interstate or foreign commerce, by any means whatsoever, in the course of commercial activity; or sell or offer for sale in interstate or foreign commerce any *P. l. melanochaita* specimens. It would also be illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken in violation of the Act. We find that these protections, including the requirement for a permit for the import, export, interstate and foreign commerce and take for all *P. l. melanochaita* specimens, will support and encourage conservation actions for *P. l. melanochaita* and require that permitted activities involving this subspecies are carried out in a manner that is consistent with the purposes of the Act and our implementing regulations.

In connection with this 4(d) rule, the Service notes that *P. l. melanochaita* is listed in Appendix II of CITES and, without this 4(d) rule, could be imported into the United States pursuant to section 9(c)(2) of the Act upon the presentation of a proper CITES export permit from the country of export, if such importation is not made in the course of a commercial activity. Section 9(c)(2) of the Act provides that the otherwise lawful importation of wildlife that is not an endangered species listed pursuant to section 4 of the Act, but that is listed in Appendix

II of CITES, shall be presumed to be in compliance with provisions of the Act and implementing regulations if the importation is not made in the course of a commercial activity. While there has been question as to whether this provision of the Act might automatically require allowing the importation of a species that is both listed as threatened and in Appendix II, and preclude the issuance of more restrictive 4(d) rules covering importation, the Service has concluded that such 4(d) rules may be issued to provide for the conservation of the involved species. Section 9(c)(2) does not expressly refer to threatened species or prevent the issuance of appropriate 4(d) rules and could not logically have been intended to allow the addition of a species to an appendix of an international convention to override the needs of U.S. law, where there is reliable evidence to affect the presumption of validity. Finally, the term "presumed" implies that the established presumption is rebuttable under certain circumstances, including through the promulgation of a protective regulation pursuant to section 4(d) of the Act.

In the case of the *P. l. melanochaita*, there are substantive grounds on which to challenge the presumption. For the import of sport-hunted trophies, while there is evidence that some range countries are implementing lion management programs, the best available information indicates that not all lion hunting programs are well managed or provide enhancement to survival of the subspecies (see *Trophy Hunting* section), Namely, mismanaged trophy hunting is reported to contribute to documented declines in lion populations of Africa (Rosenblatt *et al*. 2014, entire; Sogbohossou *et al*. 2014, entire; Becker *et al*. 2013, entire; Lindsey *et al*. 2013a, entire; Packer *et al*. 2013, p. 636; Croes *et al*. 2011, entire; Packer *et al*. 2011, entire; Loveridge *et al*. 2007, entire). Depending on how trophy hunting is regulated and managed, trophy hunting can be a tool for conservation, but may also have negative impacts on lions (Bauer *et al*. 2015a,

unpaginated; Lindsey *et al*. 2013a, p. 1; Whitman *et al.* 2004, pp. 176–177; Loveridge *et al.* 2007, p. 548). We want to encourage and support efforts by range countries to develop programs that are based on sound scientific information. As noted, the 4(d) rule for *P. l. melanochaita* would provide for the importation into the United States of trophies taken legally in range countries upon the issuance of a threatened species import permit. While the Service cannot control hunting of foreign species such as *P. l. melanochaita*, we can regulate their importation and thereby require that U.S. imports of sport-hunted *P. l. melanochaita* trophy specimens are obtained in a manner that is consistent with the purposes of the Act and the conservation of the subspecies in the wild, by allowing importation from range countries that have scientifically sound management programs that address the threats that are facing lions and are enhancing the survival of the species in the wild within that country (see further discussion below on enhancement of propagation or survival with regard to authorizing the import of sport-hunted trophies of *P. l. melanochaita*). Further, for the import of parts or products, there is evidence that trade in lion parts, particularly bones, is fast becoming a substitute for tiger bones in traditional Asian medicine and Asian luxury products (see *Traditional Use of Lion Parts and Products* section). While the primary source of the current bone trade appears to be from captive-bred lions from South Africa, considering the sharp and continuing increases in demand from Asia for lion bone, there is potential for demand to surpass the availability of legally obtained lion bone and, consequently, result in poaching and unsustainable harvest of wild lions to meet demand. Based on the effect of the tiger bone trade on tiger populations, if current conditions continue unchanged, there is considerable potential for extensive poaching of wild lions to occur in order to meet demand. Given the current threats to the subspecies, unsustainable harvest to supply a trade in parts could contribute to the further decline of the subspecies.

Finally, due to our concerns about the increasing trade in lion bones and evidence that live lions are being exported to Asia, presumably for the bone trade, we find that unregulated trade and the taking of live lions could further contribute to the lion bone trade. Further, the noncommercial imports of live lions could be a cover for the establishment of lion bone trade within the United States. As with captive tigers and the use of live animals for the bone trade, the Service finds that the unregulated movement of lions within the United States, as well as the import or export of these animals is reasonably likely to be used as a loophole for the bone trade and serve as cover for the establishment of lion bone trade within the United States. By requiring permits for all otherwise prohibited activities under the Act, such as import, export, interstate and foreign commerce and take, including noncommercial imports of live lions, we can ensure that live lions are not used to supplement the trade in lion bones.

Therefore, we find that regulation of the importation of all *P. l. melanochaita* parts and products, including live animals and sport-hunted trophies, will ensure that imported specimens are obtained in a manner that is consistent with the purposes of the Act and the conservation of the subspecies in the wild.

Our threatened species permitting regulations at 50 CFR 17.32 provide issuance criteria for threatened species permits (50 CFR 17.32(a)(2)), but do not specify what would constitute the enhancement of propagation or survival with regard to authorizing the import of parts or products of *P. l. melanochaita*, including sport-hunted trophies. Therefore, when making a determination of whether an otherwise prohibited activity enhances the propagation or survival

of *P. l. melanochaita*, the Service will examine the overall conservation and management of the subspecies in the country where the specimen originated and whether that management of the subspecies addresses the threats to the subspecies (i.e., that it is based on sound scientific principles and that the management program is actively addressing the current and longer term threats to the subspecies). In that review, we will evaluate whether the import contributes to the overall conservation of the species by considering whether the biological, social, and economic aspects of a program from which the specimen was obtained provide a net benefit to the subspecies and its ecosystem.

The Service will evaluate any application received that involves *P. l. melanochaita* in the context of enhancement of propagation or survival permitting in accordance with our threatened species permitting regulations at 50 CFR 17.32 and issuance criteria for threatened species permits (50 CFR 17.32(a)(2)). These include, in addition to the general permitting criteria in 50 CFR 13.21(b):

> (i) Whether the purpose for which the permit is required is adequate to justify removing from the wild or otherwise changing the status of the wildlife sought to be covered by the permit;
>
> (ii) The probable direct and indirect effect that issuing the permit would have on the wild populations of the wildlife sought to be covered by the permit;
>
> (iii) Whether the permit, if issued, would in any way, directly or indirectly, conflict with any known program intended to enhance the survival probabilities of the population from which the wildlife sought to be covered by the permit was or would be removed;

(iv) Whether the purpose for which the permit is required would be likely to reduce the threat of extinction facing the species of wildlife sought to be covered by the permit;

(v) The opinions or views of scientists or other persons or organizations having expertise concerning the wildlife or other matters germane to the application; and

(vi) Whether the expertise, facilities, or other resources available to the applicant appear adequate to successfully accomplish the objectives stated in the application.

In addition to these factors, particularly in relation to sport hunting, we find the IUCN Species Survival Commission (SSC) Guiding Principles on Trophy Hunting as a Tool for Creating Conservation Incentives, Ver. 1.0 (IUCN SSC 2012), to provide useful principles, which, considered in conjunction with our threatened species issuance criteria, will aid the Service when making an enhancement finding for importation of sport-hunted trophies of *P. l. melanochaita*. This document sets out guidance from experts in the field on the use of trophy hunting as a tool for "creating incentives for the conservation of species and their habitats and for the equitable sharing of the benefits of use of natural resources" (IUCN SSC 2012, p. 2) and recognizes that recreational hunting, particularly trophy hunting, can contribute to biodiversity conservation and more specifically, the conservation of the hunted species.

The SSC document lays out five guiding principles that, considered in conjunction with our threatened species issuance criteria, will aid the Service when making an enhancement finding for importation of sport-hunted trophies of *P. l. melanochaita*:

a) Biological sustainability: The hunting program cannot contribute to the long-term decline of the hunted species. It should not alter natural selection and ecological

function of the hunted species or any other species that share the habitat. The program should not inadvertently facilitate poaching or illegal trade in wildlife by acting as a cover for such illegal activities. The hunting program should also not manipulate the ecosystem or its component elements in a way that alters the native biodiversity.

b) Net Conservation Benefit: The biologically sustainable hunting program should be based on laws, regulations, and scientifically based quotas, established with local input, that are transparent and periodically reviewed. The program should produce income, employment, and other benefits to create incentives for reducing the pressure on the target species. The program should create benefits for local residents to co-exist with the target species and other species. It is also imperative that the program is part of a legally recognized governance system that supports conservation.

c) Socio-Economic-Cultural Benefit: A well-managed hunting program can serve as a conservation tool when it respects the local cultural values and practices. It should be accepted by most members of the community, involving and benefiting local residents in an equitable manner. The program should also adopt business practices that promote long-term economic sustainability.

d) Adaptive Management: Planning, Monitoring, and Reporting: Hunting can enhance the species when it is based on appropriate resource assessments and monitoring (e.g., population counts, trend data), upon which specific science-based quotas and hunting programs can be established. Resource assessments should be objective, well documented, and use the best science available. Adaptive management of quotas and programs based on the results of resource assessments and monitoring is essential.

The program should monitor hunting activities to ensure that quotas and sex/age restrictions of harvested animals are met. The program should also generate reliable documentation of its biological sustainability and conservation benefits.

e) Accountable and Effective Governance: A biologically sustainable trophy-hunting program should be subject to a governance structure that clearly allocates management responsibilities. The program should account for revenues in a transparent manner and distribute net revenues to conservation and community beneficiaries according to properly agreed decisions. All necessary steps to eliminate corruption should be taken and to ensure compliance with all relevant national and international requirements and regulations by relevant bodies such as administrators, regulators and hunters.

The Service's approach to enhancement findings for the importation of sport-hunted trophies of *P. l. melanochaita* is consistent with the purpose and intent of the Endangered Species Act. Before we will authorize the importation of a sport-hunted trophy, we must determine that the trophy hunting program is managed to ensure the long-term survival of the species. In many parts of the world, wildlife exists outside of protected areas and must share the same habitat and compete with humans living in these areas for space and resources. If communities that share these resources with wildlife do not perceive any benefits from the presence of wildlife, they may be less willing to tolerate the wildlife. However, under certain circumstances, trophy hunting can address this problem by making wildlife more valuable to the local communities and encourage community support for managing and conserving the hunted species, as well as other species.

When evaluating whether the importation of a trophy of *P. l. melanochaita* would be authorized pursuant to 50 CFR 17.32, in accordance with our threatened species issuance criteria, we will examine how a country's management program for lions addresses the three main threats that have led to the decline of the subspecies: habitat loss, loss of prey base, and human–lion conflict. When examining a management program and whether trophies taken as part of that program meet the issuance criteria, we would study a number of factors. Some of the factors we would consider include whether the program is based on sound scientific information and identifies mechanisms that would arrest the loss of habitat or increase available habitat (i.e., by establishing protected areas and ensuring adequate protection from human encroachment). We would consider whether the management program actively address the loss of the lion's prey base by addressing poaching or unsustainable offtake within the country. A component of a management plan from which trophy imports would meet the issuance criteria would be whether there are government incentives in place that encourage habitat protection by private landowners and communities and incentives to local communities to reduce the incursion of livestock into protected areas or to actively manage livestock to reduce conflicts with lions. We would examine if the hunting component of the management program supports all of these efforts by looking at whether hunting concessions/tracts are managed to ensure the long-term survival of the lion, its prey base, and habitat. As stated previously, hunting can generate significant economic benefits if properly conducted. In looking at whether we would be able to authorize the import of a trophy under the issuance criteria of 50 CFR 17.32, we would examine if the trophy hunting provides financial assistance to the wildlife department to carry out elements of the management program and if there is a compensation scheme or other incentives to benefit

local communities that may be impacted by lion predation. We would also consider how a U.S. hunter's participation in the hunting program contributes to the overall management of lions within a country.

Management programs for *P. l. melanochaita* would be expected to address, but are not limited to, evaluating population levels and trends; the biological needs of the species; quotas; management practices; legal protection; local community involvement; and use of hunting fees for conservation. In evaluating these factors, we will work closely with the range countries and interested parties to obtain the information. By allowing entry into the United States of *P. l. melanochaita* trophies from range countries that have science-based management programs, we anticipate that other range countries would be encouraged to adopt and financially support the sustainable management of lions that benefits both the species and local communities. In addition to addressing the biological needs of the subspecies, a scientifically based management program would provide economic incentives for local communities to protect and expand *P. l. melanochaita* habitat.

As stated, under this 4(d) rule any person wishing to conduct an otherwise prohibited activity, including all imports of *P. l. melanochaita* specimens, must first obtain a permit under 50 CFR 17.32. As with all permit applications submitted under 50 CFR 17.32, the individual requesting authorization to import a sport-hunted trophy of *P. l. melanochaita* bears the burden of providing information in their application showing that the activity meets the requirements for issuance criteria under 50 CFR 17.32. In some cases for imports, such as sport-hunted trophies, it is not always possible for the applicant to provide all of the necessary information needed by

the Service to make a positive determination under the Act to authorize the activity. For the import of sport-hunted trophies of *P. l. melanochaita,* the Service will typically consult with the range country to the extent practicable and other interested parties to obtain necessary information. The Service has the discretion to make the required findings on sport-hunted trophy imports of *P. l. melanochaita* on a country-wide basis, although individual import permits will be evaluated and issued or denied for each applicant. While the Service may make enhancement findings for sport-hunted trophy imports of *P. l. melanochaita* on a country-wide basis, the Service encourages the submission of information from individual applicants. We would rely on the information available to the Service and may rely on information from sources other than the applicant when making a permitting decision.

Effects of this Rule

This action revises the taxonomic classification of the Asiatic lion (currently classified as *P. l. persica* and listed as an endangered species under the Act) to *P. l. leo* based on a taxonomic change. This rule revises 50 CFR 17.11(h) to add *P. l. leo* subspecies and the *P. l. melanochaita* subspecies to the List of Endangered and Threatened Wildlife as an endangered species and a threatened species, respectively. This rule establishes a 4(d) rule for *P. l. melanochaita,* which implements all of the prohibitions and exceptions under 50 CFR 17.31 and 17.32 and requires a threatened species import permit under 50 CFR 17.32 for the importation of all *P. l. melanochaita* specimens. Under the 4(d) rule, the import exemption found in 50 CFR 17.8 for threatened wildlife listed in Appendix II of CITES does not apply to this subspecies. Therefore, through the promulgation of this 4(d) rule, the presumption of legality provided under section 9(c)(2) of the Act for the otherwise lawful importation of wildlife listed in Appendix II of CITES

that is not an endangered species listed pursuant to section 4 of the Act does not apply to this subspecies (See: **4(d) Rule for *Panthera leo melanochaita***).

Available Conservation Measures

Conservation measures provided to species listed as endangered or threatened under the Act include recognition of conservation status, requirements for Federal protection, and prohibitions against certain practices. Recognition through listing encourages and results in public awareness and conservation actions by Federal and State governments in the United States, foreign governments, private agencies and groups, and individuals.

Section 7(a) of the Act, as amended, and as implemented by regulations at 50 CFR part 402, requires Federal agencies to evaluate their actions that are to be conducted within the United States or upon the high seas, with respect to any species that is proposed to be listed or is listed as endangered or threatened. Because *P. l. leo* and *P. l. melanochaita* are not native to the United States, no critical habitat is being proposed for designation with this rule. Regulations implementing the interagency cooperation provision of the Act are codified at 50 CFR part 402. Section 7(a)(2) of the Act requires Federal agencies to ensure that activities they authorize, fund, or carry out are not likely to jeopardize the continued existence of a listed species or to destroy or adversely modify its critical habitat. If a proposed Federal action may adversely affect a listed species, the responsible Federal agency must enter into formal consultation with the Service. Currently, with respect to the lion, no Federal activities are known that would require consultation.

Section 8(a) of the Act authorizes the provision of limited financial assistance for the

development and management of programs that the Secretary of the Interior determines to be necessary or useful for the conservation of endangered or threatened species in foreign countries. Sections 8(b) and 8(c) of the Act authorize the Secretary to encourage conservation programs for foreign listed species, and to provide assistance for such programs, in the form of personnel and the training of personnel.

Section 9 of the Act and our implementing regulations at 50 CFR 17.21 and 50 CFR 17.31 set forth a series of general prohibitions that apply to all endangered and threatened wildlife, respectively, except where a 4(d) rule applies to threatened wildlife, in which case the 4(d) rule contains all the applicable prohibitions and exceptions. Under the 4(d) rule for *P. l. melanochaita*, all of the prohibitions under 50 CFR 17.31 apply to *P. l. melanochaita* specimens. These prohibitions, at 50 CFR 17.21 and 17.31, in part, make it illegal for any person subject to the jurisdiction of the United States to "take" (includes harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or to attempt any of these) within the United States or upon the high seas; import or export; deliver, receive, carry, transport, or ship in interstate or foreign commerce, by any means whatsoever, in the course of commercial activity; or sell or offer for sale in interstate or foreign commerce any lion specimens. It also is illegal to possess, sell, deliver, carry, transport, or ship any such wildlife that has been taken in violation of the Act. Permits may be issued to carry out otherwise prohibited activities involving endangered and threatened wildlife species under certain circumstances. Regulations governing permits for endangered species, such as *P. l. leo*, are codified at 50 CFR 17.22. Regulations governing permits for threatened species, such as *P. l. melanochaita*, are codified at 50 CFR 17.32. Certain exceptions apply to agents of the Service and State conservation agencies.

Summary of Comments and Recommendations

We based this action on a review of the best scientific and commercial information available, including all information received during the public comment period. In the October 2014 proposed rule, we requested that all interested parties submit information that might contribute to development of a final rule. We also contacted appropriate scientific experts and organizations and invited them to comment on the proposed listing. We received tens of thousands of comments.

We reviewed all comments we received from the public for substantive issues and new information regarding the proposed listing of this species, and we address those comments below. Overall, most commenters supported the proposed listing, but did not provide additional scientific or commercial data for consideration. We have not included responses to comments that supported the listing decision but did not provide specific information for consideration. Most of the commenters that did not support the proposed listing were affiliated with the trophy hunting industry and opposed the rule due to potential impacts on importing trophies. These comments are addressed below.

Peer Review

In accordance with our policy published on July 1, 1994 (59 FR 34270), we solicited expert opinions from ten individuals with scientific expertise that included familiarity with the species, the geographic region in which wild members of the species occur, and conservation biology principles. We received responses from five of the peer reviewers from whom we requested comments. The peer reviewers generally supported our rule; however, they provided

updated information on taxonomy, current population estimates, and population trends. They also found our analysis of some of the threats to be inaccurate. Specifically, they provided comments and additional information on loss of prey base, trophy hunting, infanticide, corruption, and trade in lion bones. In some cases, a correction is indicated in the citations by "personal communication" (pers. comm.), which could indicate either an email or telephone conversation; in other cases, the research citation is provided.

Peer Reviewer Comments

(1) Comment: Several peer reviewers commented on our section of the proposed rule regarding the taxonomic classification of lion. These peer reviewers confirmed that the IUCN Cat Specialist Group recommended a two-subspecies classification: *Panthera leo leo* for lions of India and western and central Africa, and *P. l. melanochaita* for lions in eastern and southern Africa.

Our Response: We have reviewed the 2015 IUCN Red List Assessment for the lion, which proposes the new classification as recommended by the IUCN Cat Specialist Group, and the genetic studies supporting this classification. We found this information to be the best available scientific and commercial information; therefore, we have accepted this taxonomic change and incorporated this decision into this document under the *Taxonomy* section of this document. As a result, our assessment is of the status of the lion species (both *P. l. leo* and *P. l. melanochaita*), including the lion population in India.

(2) Comment: Several peer reviewers provided updated information on population estimates and trends. Based on a time trend analysis of scientific census data for 46 well-monitored populations, an overall 43 percent decline in lion populations across Africa was inferred. Furthermore, regional trends emerged, showing that, while populations in southern African increased by 22 percent, populations in eastern and western and central Africa combined decreased by 57 percent and 66 percent, respectively. The peer reviewers also indicated that the actual number of lions in Africa is much lower than previous estimates. Application of regional trends to lion estimates made in 2002 resulted in an estimate of fewer than 20,000 lions, a significant difference from the previous estimate of 32,000.

Our Response: We considered this information and note that this information was also included in the IUCN Red List Assessment for the lion. Information on population estimates and trends was incorporated into the **Species Information** section of this document. Assessment of this information led us, in part, to conclude that the status of the lion is more serious than previously indicated, especially in the western and central regions of Africa (*P. l. leo*).

(3) Comment: One peer reviewer commented that the section on prey loss does not address the issue of prey loss in protected areas where most lions occur.

Our Response: The peer reviewer provided a list of literature on the patterns and trends of prey loss in protected areas that were recently or are currently occupied by lions. We have reviewed these articles and have incorporated the findings in this document (under *Loss of Prey Base*). This information did not change our determination, but rather further supported our

determination that prey loss has occurred throughout the African range countries and is one of the major threats to lion.

(4) Comment: One peer reviewer stated that although most lions in Africa persist inside protected areas, the majority of the protected areas should be uninhabited by humans; therefore, only prides located at the edge of these protected areas should come into conflict with humans. Because the proportion of lions subjected to conflict with humans is small, it is wrong to state that the greatest threat to lions in Africa is human–lion conflict.

Our Response: We have considered the peer reviewer's comments and have altered our discussion of threats to lions from human–lion conflict by clarifying that it is the lions that persist at the boundary, or just outside, of protected areas that are most subjected to this threat. This information did not change our determination; human–lion conflict remains a threat to lion persistence.

(5) Comment: Three peer reviewers indicated that our assessment of corruption within lion range countries was not realistic; that corruption in most of Africa is extensive and worsening. They pointed out oversights and errors pertaining to this subject in our proposed rule and provided additional citations on the topic.

Our Response: We reexamined the information available to us during the drafting of the proposed rule and reviewed information in additional citations, and agree that our section on

corruption did not accurately reflect corruption in lion range countries. Based on peer reviewer comments and available information, we have revised this section accordingly.

(6) Comment: Two peer reviewers and three NGO stakeholders indicated concern that trade in lion parts, particularly lion bone, from Africa to Asia may pose a potential threat to the species.

Our Response: We agree and have revised this rule to include information on the lion bone trade.

(7) Comment: A peer reviewer identified inaccuracies in our review of information on traditional use of lion parts and products in west and central Africa, and also indicated that trade in lion parts and products is very common in these regions.

Our Response: We appreciate the peer reviewer's input. We reviewed the available information and revised the section of this rule pertaining to traditional use of lion parts and products in west and central Africa accordingly.

(8) Comment: One peer reviewer questioned whether "any lion specimen" referred to in the 4(d) rule would include Asiatic lion and/or scientific samples.

Our Response: The 4(d) rule applies only to the threatened subspecies, *P. l. melanochaita*. Scientific samples of *P. l. melanochaita* will require permits pursuant to 50 CFR

17.32. The former Asiatic lion (*Panthera leo persica*) is now classified as *Panthera leo leo* which is now listed as endangered under the Act. Scientific samples of *P. l. leo* will require permits pursuant to 50 CFR 17.22.

(9) Comment: Several peer reviewers commented that the information provided in the proposed rule regarding quotas and offtake trends was incorrect; specifically, several peer reviewers noted several publications pertinent to quotas that should be re-examined and more thoroughly discussed.

Our Response: We reexamined the information available to us during the drafting of the proposed rule and reviewed the citations provided during the public comment period. We consider these publications to be the best available science regarding quota setting in the interim while other strategies are more fully developed (i.e. age-based strategies, adaptive management systems, etc.). We have revised this section to include more discussion accordingly.

(10) Comment: Several peer reviewers provided additional information on country-specific management trends; specifically, information was provided on the progress of the commitment to and implementation of the age-based strategy.

Our Response: We appreciate the peer reviewers input and have incorporated this information into the section of the rule accordingly.

(11) Comment: One peer reviewer commented that, although species experts do generally support trophy hunting as a management tool, additional discussion was needed regarding the recommended reforms species experts submitted during the drafting of the proposed rule.

Our Response: We reexamined the recommendations as provided by species experts and agree that additional discussion was needed. We have incorporated the additional discussion in the section as appropriate.

(12) Comment: Four of the peer reviewers commented that although species experts support trophy hunting as a management tool, it needs to be conducted in a sustainable manner that would require reforms to the current practices. Peer reviewers stated that the quotas set throughout most range states are above sustainable levels (Packer *et al.* 2011) and that quotas should be science-based and sustainable.

Our Response: We agree that current quotas are currently set higher than those recommended by Packer *et al*. (2011). Species experts recommend the implementation of an adaptive management quota system that would ensure quotas would be based on the best available science. We have revised this section accordingly.

(13) Comment: Several peer reviewers commented that the information provided in the proposed rule regarding quotas and offtake trends was incorrect; several of the peer reviewers provided additional information (and citations) on country-specific quota trends, current quotas,

and offtake trends. One peer reviewer noted that clarification was needed regarding the difference between quotas and offtake rates. Additionally, two peer reviewers provided additional information on moratoriums in two of the range countries.

Our Response: We reexamined the information available to us during the drafting of the proposed rule and reviewed information in additional citations provided during the public comment period. We agree that clarification was needed, and, based upon peer review comments and additional information, we have revised this section accordingly.

(14) Comment: One peer reviewer commented that lion trophy hunting could remain as an additive threat if hunting reforms are not implemented and suggested that "USFWS and equivalent bodies in the EU and elsewhere could mediate such reforms by imposing reduced quotas, best practices and the adherence to age restrictions on countries wishing to export trophies."

Our Response: It is not appropriate to establish specific criteria, such as a set quota number, in this final rule because this may not allow for the countries to implement an adaptive management strategy based on the current status of the species within the country. During the public comment period we received new information regarding infanticide and the effects of hunting younger male lions on pride structure. Therefore, we agree with the peer reviewer that the Service is in a position to proactively engage with countries to assure exported trophies fulfill minimum age requirements, and we will consider these factors in making our enhancement findings.

(15) Comment: Two peer reviewers stated that populations in West and Central Africa are small and isolated, and, as a result, sustainable offtake was not possible. Several peer reviewers also provided additional information and citations on documented lion population declines resulting from excessive lion quotas and poor management of trophy hunting.

Our Response: We reexamined the information available to us during the drafting of the proposed rule and reviewed the citations provided during the public comment period. We have incorporated the new information accordingly.

(16) Comment: One peer reviewer commented that our review of infanticide as a result of trophy hunting was incomplete and provided additional literature and citation on the subject for our consideration.

Our Response: We agree that additional discussion was appropriate regarding the impacts of infanticide, including a review of the new studies provided on evolutionary adaptions and impacts of subadult early dispersal on the species. We agree that infanticide and associated factors relating to trophy hunting of males may have additive impacts on the decline of certain populations. Therefore, we have incorporated this information into our final rule.

Public Comments

(17) Comment: One commenter noted that there are very few reliable or scientifically credible lion population surveys in Africa and as a result, quotas are not scientifically derived.

Additionally, the commenter noted that quota allocations are largely based upon concession operators' opinions.

Our Response: We consider Packer *et al*. (2011) to be the best available science regarding quota setting in the interim while other strategies are more fully developed (i.e., age-based strategies, adaptive management systems, etc.). We have re-examined information provided during the development of the proposed rule and reviewed new information provided during the public comment period on quotas, scientific quota development, and adaptive quota management systems. As a result, we have incorporated this information into our rule accordingly.

(18) Comment: One commenter noted that the proposed rule addressed only CITES Trade Data exports under the "trophy" category and that many are exported under the "skins" category.

Our Response: We have reviewed the U.S. imports of "skins" for 2013 and have incorporated this information into our rule.

(19) Comment: One commenter states that lion trophies exported are almost exclusively males and subadult males, and as such, are targeted by hunters at unsustainable levels. Additionally, the commenters note that the situation of harvesting males from neighboring protected areas would not be expected to occur if the males were being harvested at sustainable levels.

Our Response: We agree that if hunting concessions maintained sustainable levels of harvest, the situation of harvesting males from neighboring protected areas would not be expected to occur. Species experts have recommended best practices for sustainable development of quotas and offtake (Packer et al 2011, p. 151) while other methods are developed (adaptive quota management based upon scientific data with an enforceable monitoring program, (Lindsey et al (2013a, pp. 8–9) and Hunter *et al*. (2013, unpaginated)); these recommended reforms have been incorporated as appropriate. Additionally, based on information provided during the public comment period, there currently is no level of offtake that would be sustainable in West and Central Africa at this time. We have incorporated this information into our rule. For *Panthera leo melanochaita*, we have developed a 4(d) rule and clarified factors we will consider when making an enhancement finding for importation of sport-hunted trophies of *P. l. melanochaita* (see **4(d) Rule for *Panthera leo melanochaita***, above).

(20) Comment: Several commenters stated that populations in West and Central Africa are small and isolated and as a result, sustainable offtake was not possible. Several commenters also provided additional information and citations on documented lion population declines resulting from excessive lion quotas and poor management of trophy hunting.

Our Response: We reexamined the information available to us during the drafting of the proposed rule and reviewed the citations provided during the public comment period. With the new population estimates, in combination with the literature and citations provided during the public comment period, we agree that given the current state of the populations in West and Central Africa (*Panthera leo leo*), sustainable offtake is not possible. As a result, we have found that, in their current condition, sustainable offtake for *Panthera leo leo* is not possible. Therefore,

we find that trophy hunting does rise to a level of threat for *Panthera leo leo*. We have incorporated the new information accordingly.

(21) Comment: Several range countries provided additional information on their progress in implementing the best recommended practices and reforms as outlined by species experts.

Our Response: We appreciate the information provided by the range countries. We have incorporated relevant portions of this information into our rule accordingly. It should be noted, however, that, with this finding, *Panthera leo leo* meets our definition of an endangered species and, therefore, will be subject to the provisions and regulations of the Act for endangered species. Import of sport-hunted trophies of *Panthera leo melanochaita* will require issuance of a threatened species import permit under 50 CFR 17.32, which will require an enhancement finding (see **4(d) Rule for *Panthera leo melanochaita***, above).

(22) Comment: One commenter noted that, although the proposed rule offers concrete examples of the role of trophy hunting in lion conservation, the proposal offers only limited support of trophy hunting benefits. Additionally, one commenter notes that the hunting community has been a leader in lion conservation in terms of habitat conservation and states that the success of certain populations is largely in part to contributions from the hunting community.

Our Response: Based on information received during the formation of the proposed rule and based on additional information received during the public comment period, we agree that trophy hunting, if managed in a sustainable and scientific manner, can provide benefits to both

local communities as well as to lion conservation. We also agree that trophy hunting has conserved a considerable portion of lion habitat. However, species experts have identified several areas across the range of the species where hunting has contributed to the decline of lion populations. Species experts have outlined these flaws and have developed and introduced several recommended reforms to assure that offtake is sustainable and scientific. We have incorporated these key issues and the recommended reforms into this rule as appropriate. Although we acknowledge the role trophy hunting has played in lion conservation, we also have reviewed additional literature provided that documents the decline of lion populations as a result of mismanaged trophy hunting. At this time, based on information received during the public comment period, based on the current trends of lion populations in West and Central Africa (*Panthera leo leo*), experts suggest that there is no level of offtake that is considered sustainable in these regions. Regardless, import of sport-hunted trophies of *Panthera leo leo* will require issuance of an endangered species import permit under 50 CFR 17.22, which will require an enhancement finding. Import of sport-hunted trophies of *Panthera leo melanochaita* will require issuance of a threatened species import permit under 50 CFR 17.32, which will require an enhancement finding (see **4(d) Rule for *Panthera leo melanochaita***, above).

(23) Comment: Several commenters noted that excessive lion quotas and offtake was the primary driver for declines in lion abundance.

Our Response: We reviewed the new literature provided and agree that the excessive offtake contributed to the decline of some lion populations throughout their range. We have incorporated this information into our rule and addressed the recommended reforms as provided by Hunter *et al*. (2013, entire) and Lindsey (2013a, pp. 8–9).

(24) Comment: Several commenters noted that current practices, unless reformed according to best recommendations, should be considered a potential threat to lion. Species experts recommend a maximum science-based offtake of no more than <1 lion / 2,000 km^2 of hunting block until age restrictions are enforced.

Our Response: We have reexamined information provided during the formation of the proposed rule and have reviewed new literature submitted during the public comment period regarding the best scientific information available regarding quota setting for lions. We agree and have incorporated this information in our rule as appropriate.

(25) Comment: Three commenters provided additional information on the biological impacts of trophy hunting. New information was provided regarding (1) the evolutionary impacts of selective removal of specimens displaying key traits; (2) biological and genetic results of infanticide as it relates to subadult dispersal and survival; and (3) the role of adult male range and dispersal requirements in genetic variation and isolated populations.

Our Response: We reexamined the information available to us during the drafting of the proposed rule and reviewed the citations and peer review input provided during the public comment period. We agree that additional discussion was required regarding the impacts of infanticide, including a review of the studies the commenters submitted. We agree that infanticide and associated factors relating to trophy hunting of males may have additive impacts

on the decline of certain populations. Therefore, we have incorporated this information into our final rule.

(26) Comment: Several commenters noted that many range countries are in the process of reforming their lion hunting regulations. Other commenters note that these reforms have only been fully implemented in some countries and additional reforms are needed throughout the range. An additional commenter noted that the information presented in the proposed rule on range countries implementation of best practices is overly optimistic with regard to what has actually been achieved.

Our Response: Several commenters provided updates regarding the progress of range countries' reforms to hunting regulations. Although multiple countries have begun to implement the reforms as outlined in this document, only two locations (Mozambique, in Niassa Reserve, and Zimbabwe) have fully implemented the process and are completely transparent. However, many countries are still in the earliest stages of implementation, and their progress is still pending. After a review of this information, we concur that most range countries have multiple barriers (e.g. corruption and poverty) that will have to be addressed concurrently with the establishment of a transparent and scientific-based, adaptive management system. This information has been incorporated into the rule. Import of sport-hunted trophies of *Panthera leo melanochaita*, will require issuance of a threatened species import permit under 50 CFR 17.32, which will require an enhancement finding (see **4(d) Rule for *Panthera leo melanochaita***, above).

(27) Comment: One commenter noted that recent scientific knowledge has established that hunting males aged five and older does not affect lion population dynamics

Our Response: We have reviewed the literature provided and have incorporated the recommended strategy into our rule. Whitman *et al.* (2004, pp. 175-177) found that if offtake is restricted to males older than 6 years of age, then trophy hunting will likely have minimal impact on the pride's social structure and young. Restricting offtake to males over 6 years of age will decrease the frequency of male-takeovers, and reduce the potential for infanticide and delayed infanticide by allowing younger males a chance to sire and raise a cohort of young, and by allowing the subadults to stay within their pride longer (thus allowing them to mature prior to dispersal) (Elliot 2014, p. 1054; Packer *et al.* 2006, p. 6).

(28) Comment: One commenter stated that the validity of the so-called 6-year age approach has been questioned.

Our Response: The 6-year approach is a relatively new development based on research conducted by Whitman (2004, p. 175–177). Like all new concepts, technical issues will arise during the implementation phase. Species experts have been working through these issues by providing research and outreach materials detailing the most current aging techniques, and by providing training to concession operators and communities (Begg and Begg 2010, pp. 8, 14; Packer and Whitman 2006, entire). We anticipate additional research will emerge as this strategy is implemented across the species range.

(29) Comment: Several commenters noted that the existing age limit for 'old males' is not enforced.

Our Response: Enforcement of wildlife crime continues to be an issue for many countries in Africa as evidenced by the rising rate of poaching epidemics and corruption across the African continent. Enforcement of trophy hunting regulations across the range of the species is a critical issue. Currently, only two places within the African continent have completely implemented the recommendations as set forth in this rule. Several other countries have committed to implementing this strategy, but their progress is currently pending. We must note here that enforcement is complex; it is only one component of a multi-tiered regulatory system. Successful enforcement will rely on a variety of other factors related to management. Countries will have to address corruption in order to ensure their monitoring and management systems are transparent.

(30) Comment: During the public comment period, several commenters expressed concern that local communities do not actually benefit from the revenue derived from trophy hunting. Specifically, comments were focused on three issues (see Potential Impacts of Trophy Hunting): (1) corruption of concession operators and corrupt practices surrounding concession allocation prevent local communities from benefitting from trophy derived revenue; (2) financial contributions to local communities from trophy hunting is often exaggerated and bears little connection to conservation of the species (local communities receive only 3–5 percent of revenues); and (3) that benefits have never been independently evaluated and communities

involved in hunting concessions have not been adequately surveyed as to their satisfaction of land use for trophy hunting.

Our Response: Corruption occurs throughout the range of the species, and it likely has an impact on the actual benefits received by local communities. Although many countries have incorporated incentives into their trophy hunting policies, land management policies, and national lion action strategies, most countries are still in the earliest stages of implementing the strategies discussed in the rule. Therefore, we have incorporated this information into our final rule.

(31) Comment: One commenter stated that there is no evidence to support that trophy hunting might provide sufficient money to motivate communities in hunting regions to protect lions against other threats such as retaliatory killings for livestock losses.

Our Response: Although there is limited data on the motivations of individuals who kill lions (see Hazzah 2013), we recognize that human–lion conflict resulting in retaliatory killing is a major threat. Although not the only mechanism for increasing tolerance, incentives are an important aspect of changing individuals' perceptions of lions, especially for communities who live close to lion populations. According to Packer *et al.* (2011, p. 152, citing e.g., Baker 1997, Hurt and Ravn 2000, Child 2004, Lindsey *et al.* 2006, and Dickson *et al*. 2009), "trophy hunting has been considered essential for providing economic incentives to conserve large carnivores." For example, Kenya banned trophy hunting in 1977 due to questionable ethics and poor management. Since then, "wildlife populations outside of parks have declined by at least 60%,

due partly to the inability of local people to benefit from wildlife" (Lindsey *et al.* 2006, citing Child, 2000, 2005).

Recently, Hazzah *et al.* (2014, entire) conducted research in Kenya in the Amboseli ecosystem, where it was estimated that 55 percent of lion killings were retaliatory in nature. In this area, two programs are used to provide incentives to locals to prevent these types of killing. First, there is a Predator Compensation Fund (PCF) wherein local people are compensated for depredated livestock and the system is carefully designed with a system of verification processes, payments, and violation penalties (2014, p. 852). Second, the Lion Guardians (LG) program uses traditional techniques to incorporate community value and belief systems to improve local perceptions. According to Hazzah *et al.* (2014, pp. 857–858), compensation alone showed a 73 percent reduction in lion killing. Combining this with the LG program (in 2007) further reduced the decline by 91 percent (less than one killed per year). Hazzah *et al*. estimated that the PFC program cost an estimated $250,000 USD annually and employed 30 community members. The LG program was estimated to have cost $140,000 USD annually and employed 38 community members. It is important to note, however, that the authors are uncertain regarding the sustainability of long-term payments and questioned what would happen if the compensation stopped. In other countries within the range of lion, systems like these are not necessarily in place. Experts believe the revenue from trophy hunting, if well managed in a transparent way, could potentially fund similar programs throughout the species' range, thus reducing retaliatory killings and benefitting the local population simultaneously.

(32) Comment: One commenter suggested non-consumptive uses such as eco-tourism could provide the promise of sustainable enterprise.

Our Response: We agree in part, but ecotourism and the trophy hunting community need to come together to support the African countries in lion conservation. Non-consumptive uses of wildlife such as eco-tourism have been practiced in many regions throughout Africa. Lindsey *et al.* (2007, entire) studied viewing preferences among visitors in protected areas in South Africa. Most tourists, especially first-time and foreign visitors, were generally focused on charismatic mega-species that are generally confined to protected areas; African visitors had more interest in bird and plant diversity, scenery, and other rare species. Lindsey *et al*. (2007) acknowledge that ecotourism may align with conservation objectives and provide incentives for the development of tour operations geared away from the 'big five.' However, ecotourism as a replacement to trophy hunting will have to be researched further. Information provided by Hunter *et al*. (2013, unpaginated citing Norton-Griffiths 2007) indicates that "a significant portion of the land where trophy hunting occurs is unlikely to be viable for alternate wildlife-based land uses such as photo- or ecotourism due to remoteness, lack of infrastructure including integration in established tourism circuits, lack of spectacular scenery or lack of high densities of viewable wildlife." Additionally, according to Hunter *et al*. (2013, unpaginated citing Packer *et al.* 2007; Groom 2013, pp. 2–3) ecotourism is highly dependent on political stability. As a result, ecotourism is unlikely to be able to provide the revenue potential that is currently associated with trophy hunting, although we agree there is potential for growth in this industry.

(33) Comment: Several commenters state that hunting is able to generate revenues for a larger proportion of areas that are unsuitable for ecotourism (e.g., remote areas lacking

infrastructure, attractive scenery, or high densities of viewable wildlife). Additionally, the commenters state that trophy hunting revenue provides a means of preserving natural habitat despite strong pressure to convert habitat into agriculture or rangelands.

Our Response: We agree that trophy hunting revenue provides conservation value at many levels, especially in terms of lion habitat, conservation programs, anti-poaching programs, equipment, and poaching patrols. However, lion experts have documented the decline of many populations of lion resulting from mismanagement of trophy hunting (Rosenblatt *et al*. 2014, p. entire; Sogbohossou *et al*. 2014, entire; Becker *et al*. 2013, entire; Lindsey *et al*. 2013, entire; Croes *et al*. 2011, entire; Packer 2011, entire; Loveridge *et al*. 2007, entire). Additionally, the high revenue potential associated with trophy hunting makes it a target for corruption. As a result, we have reviewed the recommended best practices as provided by species experts to encourage countries to establish a transparent, science-based, adaptive quota management system. Import of sport-hunted trophies of *Panthera leo leo* will require issuance of an endangered species import permit under 50 CFR 17.22, which will require an enhancement finding. Import of sport-hunted trophies of *Panthera leo melanochaita* will require issuance of a threatened species import permit under 50 CFR 17.32, which will require an enhancement finding (see **4(d) Rule for *Panthera leo melanochaita***, above).

(34) Comment: One commenter noted that that the estimates of revenue from trophy hunting presented in the proposed rule were not believed to be the best scientific information available. Specifically, they questioned the objectivity of one source (Jackson 2013) and provided additional information analyzing Lindsey *et al*. (2012a).

Our Response: The new literature provided by the commenter (Campbell 2012, entire) identifies some analysis and data flaws in Lindsey (2012a). We have reviewed the information presented and updated this rule using the best available scientific information. We have removed information we used from Jackson (2013) and Lindsey *et al*. (2012) and rely upon information from Groom (2013) and Barnett and Patterson (2005), which was also presented in the proposed rule.

(35) Comment: One commenter noted that the discussion as presented in the proposed rule was biased toward the hunting industry and did not discuss the body of research documenting the potential negative impacts of trophy hunting. A peer reviewer requested a more thorough discussion be included to address (1) the major flaws in current management practices, and (2) recommendations for how these issues can be addressed to account for sustainability.

Our Response: We reexamined the information available to us during the drafting of the proposed rule and reviewed the citations and peer review input provided during the public comment period. As a result, we have incorporated this information into the rule.

(36) Comment: Three range countries provided information on the occurrence of human–lion conflict. All three countries indicated that human lion–conflict is a serious problem.

Our Response: We incorporated this information into our discussion of human–lion conflict. The information further supported our conclusion that human–lion conflict constitutes a threat to lion persistence.

(37) Comment: One commenter agrees that human–lion conflict is a threat to remaining lion populations, but asserts that it does not constitute a level of threat in eastern and southern Africa to warrant a listing under the Act. The commenter further asserts that the lion has been secured from the negative impacts of human–lion conflict where 90 percent of its population exists and that human–lion conflict can be controlled and reduced.

Our Response: We agree that there are populations of lions where adequate management has reduced the occurrence and impacts of human–lion conflict. However, the best available information indicates that retaliatory killing is a rangewide occurrence, and given the limited number of lions remaining, any loss of lions to retaliatory killing, or other actions, can have a detrimental impact on the species.

(38) Comment: One commenter disagreed with our conclusion that disease was not a significant threat to the lion and provided additional information on FIV, bTB, and CDV and discussed difficulties in determining the role of disease in lion mortality. The commenter requested that we reconsider our determination based on consequences of diseases to the immune system.

Our Response: As mentioned in their comment, the role of disease in lion mortality and reproductive potential is almost completely unknown in lion populations. Except for a few populations that have been studied, there are no estimates of the number of lions lost to diseases. Some populations were able to recover to pre-outbreak levels, but for others, factors such as an

inbred population prevented populations from recovering to pre-outbreak levels. We found no information indicating the loss of lions to disease is a significant driver of the status to the species. However, we acknowledge that diseases can debilitate rather than cause mortality, but debilitation may cause an individual to succumb to other factors. Furthermore, due to the prevalence of some diseases in lion populations and current stressors on lions, it is likely that disease contributes to lion mortality. The information provided by the commenter did not alter our finding that disease is not a significant threat to the species; however, we have altered the discussion of disease to clarify that disease is a secondary factor that is exacerbated by other threats the lion faces.

(39) Comment: Several commenters stated that climate change has a detrimental impact on the species and that the Service did not incorporate recent climate trend data into our analysis.

Our Response: We have incorporated climate change data and its effect on the species into our analysis.

(40) Comment: One commenter specifically commented that the 4(d) rule is appropriate and needed for the conservation of the species. A second commenter applauded the Service for recognizing the importance of regulated hunting and the conservation of the African lion and the need for a system that allows U.S. hunters to import trophies.

Our Response: The Service agrees that the 4(d) rule is necessary and advisable for the conservation of the subspecies *P. l. melanochaita*. The Service has recognized that a well-

managed, scientifically based hunting program can provide for the conservation of a species and benefit local communities. By establishing the 4(d) rule that encourages range countries to effectively manage their lion populations, U.S. hunters can continue to contribute to the long-term conservation of the subspecies.

(41) Comment: Four commenters stated that the Service lacks the authority to rebut the Act's section 9(c)(2) with a blanket finding applicable to lions throughout Africa, for an indefinite time period. Section 9(c)(2) states that any importation shall "be presumed to be an importation not in violation" of any provision of the Act or implementing regulation for species not listed as endangered but listed on Appendix II of CITES. The commenters stated that African lions, because they are currently listed in CITES Appendix II, would be covered by the presumption provided by section 9(c)(2) if they are listed as threatened. One of the commenters noted a disparity between the 4(d) rule for lions and a 4(d) rule for another species that was commonly hunted. This commenter felt that because both species are listed in Appendix II of CITES that their treatment under the Act should be similar.

Our Response: While there has been question as to whether section 9(c)(2) of the Act might automatically require allowing the importation of a species that is both listed as threatened and in Appendix II, and preclude the issuance of more restrictive 4(d) rules covering importation, the Service has concluded that such 4(d) rules may be issued to provide for the conservation of the involved species. Section 9(c)(2) does not expressly refer to threatened species or prevent the issuance of appropriate 4(d) rules and could not logically have been intended to allow for an international convention to override U.S. law, where there is reliable evidence to affect the

presumption of validity. Finally, the term "presumed" implies that the established presumption is rebuttable under certain circumstances, including through the promulgation of a protective regulation pursuant to section 4(d) of the Act.

(42) Comment: Two commenters stated that, even if the Service had the authority to promulgate a regulation that establishes the manner in which African lions are imported, it cannot use the regulation to essentially shift to the hunter/importer the burden of proving enhancement or survival of the species criteria.

Our Response: The burden of showing that an "otherwise prohibited activity" meets the issuance criteria under 50 CFR 17.32 is on the applicant. In some cases for imports, such as sport-hunted trophies, it is not always possible for the applicant to provide all of the necessary information needed by the Service to make a positive determination under the Act to authorize the activity. For the import of sport-hunted trophies of *P. l. melanochaita*, the Service will typically consult with the range country to the extent practicable and other interested parties to obtain necessary information. The Service has the discretion to make the required findings on sport-hunted trophy imports of *P. l. melanochaita* on a country-wide basis, although individual import permits will be evaluated and issued or denied for each applicant. While the Service may make enhancement findings for sport-hunted trophy imports of *P. l. melanochaita* on a country-wide basis, the Service encourages the submission of information from individual applicants. We would rely on the information available to the Service and may rely on information from sources other than the applicant when making a permitting decision.

(43) Comment: Two commenters stated the Service has offered nothing to demonstrate why limitations on the importation of sport-hunted African lions from throughout the subspecies' range is necessary and advisable to provide for the conservation of the subspecies or sufficient to overcome the Congressional conclusion that such imports would normally (i.e., presumptively) benefit the conservation of the species. Further, these commenters did not feel that the Service's proposed rule for African lion supported a conclusion that a 4(d) rule requiring import permits for trophies was necessary and advisable for the conservation of the subspecies.

Our Response: For the import of sport-hunted trophies, while there is evidence that many of the range countries have lion management plans, we have little information indicating that the plans are being implemented, and we received new information during the public comment period indicating that some hunting programs are not scientifically based or providing adequate conservation benefits to the species. We want to encourage U.S. hunters to take advantage of one of the conservation tools available, well-regulated hunting programs, to improve the long-term survival of the subspecies. The 4(d) rule will support implementing well-managed plans by encouraging countries that have insufficient lion management plans to develop plans that are based on sound scientific information that would generate revenue in support of communities and conservation. As noted, the proposed 4(d) rule for African lion would provide for the importation into the United States of trophies taken legally in range countries upon the issuance of a threatened species import permit. While the Service cannot control hunting of foreign species such as African lion, we can regulate their importation and thereby require that U.S. imports of sport-hunted African lion trophy specimens are obtained in a manner that is consistent with the purposes of the Act and the conservation of the subspecies in the wild, by allowing

importation from range countries that have management plans that are based on scientifically sound data and are being implemented to address the threats that are facing lions within that country.

(44) Comment: Three commenters, a peer reviewer and comments from a consortium of seven range countries felt that the proposed 4(d) rule did not adequately explain the criteria used by the Service to determine whether the importation of any sport-hunted lion would enhance the survival of the species. The commenter expressed concern that because the Service has not adequately explained the criteria for enhancement or made an enhancement finding for lions in Africa, U.S. hunters will be barred from importing their lion trophy. The peer reviewer expressed a need for the Service to elaborate concrete requirements to which countries must adhere as a minimum standard in order for imports of sport-hunted lion trophies from a country to qualify for the export of lion trophies, including quotas of less than one male per 2000 km^2 with a minimum age requirement.

Our Response: We recognize that the preambular language of the proposed 4(d) rule was general, and we have addressed this issue in this final rule. However, we did not find that it was appropriate to establish specific criteria, such as a set quota number, in this final rule because this may not allow for the countries to implement an adaptive management strategy based on the current status of the species within the country. During the public comment period we received new information regarding infanticide and the effects of hunting younger male lions on pride structure. Therefore, we agree with the peer reviewer that the Service is in a position to

proactively engage with countries to ensure exported trophies fulfill minimum age requirements and we will consider these factors in making our enhancement findings.

(45) Comment: Two commenters recommended that the Service should not adopt a 4(d) rule until it makes specific enhancement-of-survival findings for each of the countries for which lions can be hunted, or delay the implementation of the 4(d) rule for 1 year. These two commenters, as well as a third commenter, stated that implementing the 4(d) rule at this time would impact hunters who had already booked trophy hunts months or even years in advance, resulting in the loss of money invested that could not be recovered "in the event of a sudden change in the rules governing the importation of sport-hunted trophies."

Our Response: In the proposed rule, the Service found that hunting, if well managed, may provide a benefit to the subspecies. However, the best available information, obtained by the Service during the public comment period, indicates that not all hunting programs are well managed or provide enhancement to survival of the subspecies. Delaying the implementation of a 4(d) rule may result in U.S. hunters participating in poorly managed hunting programs, which would be counter to the purposes of the Act. We do not agree that such a delay would be appropriate for the conservation of the subspecies. Regarding the potential loss of deposits for previously booked trophy hunts, hunters were notified of a potential regulatory change when the proposed rule with a 4(d) rule was published on October 29, 2014 (79 FR 64472). The availability of the proposed rule would have given hunters the opportunity to use that information to minimize financial losses.

(46) Comment: One commenter urged the Service to adjust the rule to ensure that imports are not stopped, and that the benefits generated by U.S. hunters in foreign countries continue while the Service is making determinations regarding the countries' lion management program. This commenter suggested that the Service issue U.S. import permits for all lion trophies until such time as the Service deems that the import from a particular country would not enhance the survival of the subspecies. It is the commenter's belief that there are beneficial aspects of hunting (benefits to local communities, dollars coming into the country, etc.) that should not be interrupted while the Service is making its determinations. The commenter expressed concern that the Service has insufficient resources to make timely country-by-country determinations.

Our Response: Import of sport-hunted trophies of *Panthera leo leo* will require issuance of an endangered species import permit under 50 CFR 17.22, which will require an enhancement finding. Import of sport-hunted trophies of *Panthera leo melanochaita* will require issuance of a threatened species import permit under 50 CFR 17.32, which will require an enhancement finding (see **4(d) Rule for *Panthera leo melanochaita***, above). We would be unable to issue import permits until we made such determinations. The Service recognizes that making these findings may be time consuming given our current resources. We appreciate the commenter's willingness to use their own resources to obtain information on the range countries' management and assist the Service in making timely findings. We encourage the commenter and others to work with us by submitting any information they may have to make these determinations.

(47) Comment: One commenter stated that the Service should only apply a permitting requirement on lions taken after the listing and 4(d) rule go into effect.

Our Response: For lions held in captivity or a controlled environment on the date of the listing under the Act, no import permit will be required, if the lion meets all the requirements to be considered "pre-Act" (Section 9(b)(1) of the Act). Accordingly, lions hunted after the listing would require permits, and those hunters who have booked hunts, but have not yet hunted a lion, would require a U.S. import permit prior to importation.

(48) Comment: Two commenters stated their belief that most of the lion range countries do not have national lion conservation plans in place, or have plans with quotas in place that are based on inaccurate population numbers. One commenter spoke of lion conservation conferences in 2005 and 2006 that established conference resolutions, very few of which have been adequately addressed by the lion range states. This commenter felt there is an urgent need to conduct independent and scientifically valid lion population assessments throughout the range of the lion. This commenter urged the Service to impose an import moratorium until these population assessments have been conducted. The second commenter recommended that prior to the import of trophies, there needs to be evidence of recovery and stability, as well as clearly identified governmental reforms and their implementation in some of the range states.

Our Response: New information received during the public comment period raises questions about whether some of the range countries have adequate management programs in place, and this information has been incorporated in this final rule. The Service is not imposing a moratorium; however, permits will be required for all imports. Import of sport-hunted trophies of *Panthera leo leo* will require issuance of an endangered species import permit under 50 CFR

17.22, which will require an enhancement finding. Import of sport-hunted trophies of *Panthera leo melanochaita* will require issuance of a threatened species import permit under 50 CFR 17.32, which will require an enhancement finding (see **4(d) Rule for *Panthera leo melanochaita***, above). The import of lions hunted in countries that do not meet the criteria for enhancement will not be permitted.

(49) Comment: Several lion range countries as well as two commenters expressed that successful conservation of African lion relies upon a thoughtful strategy that includes sustainable use. There was concern that the inability to import lions into the United States would result in the increase of threats we identified in the proposed rule (e.g., human–lion conflict and habitat loss). The countries expressed that if U.S. hunters are unable to import sport-hunted trophies, the economic value of lions within the country would be reduced or eliminated, resulting in retaliatory killing of lions by local communities because of real or perceived perceptions that lions kill people and livestock. In addition, two countries noted that, without an economic value, safari companies would not support lions in hunting concessions because lions prey upon other valued trophy species, such as hartebeest and buffalo. One country noted that if hunting companies were unable to export to the United States, they would abandon their hunting areas to agro-pastoral uses, resulting in "unavoidable extinction of wildlife and collapse of ecosystem services." These countries expressed that hunting zones often provide a buffer to protected areas as well as provide ecological corridors between protected areas. They expressed that the removal of lions from these hunting zones would decrease the range of the subspecies and result in overall lion population declines. Further, the loss of legal income from lion hunting, which supports anti-poaching efforts, will negatively affect lion conservation and increase poaching.

Our Response: The Service recognizes the benefits that a well-managed trophy hunting program can provide by increasing revenue for local communities, providing jobs, and supporting local microbusinesses. Revenue is often used to build and maintain fences, pay for security personnel, and provide resources for anti-poaching activities, habitat acquisition, and wildlife management.

Our 4(d) rule for *P. l. melanochaita* will support and encourage conservation actions for this subspecies and ensure that U.S. imports of sport-hunted lion trophy specimens are obtained in a manner that is consistent with the purposes of the Act and the conservation of the *P. l. melanochaita* in the wild. By ensuring that imports of lions occur only from range countries that have management plans based on scientifically sound data which are being implemented to address the threats facing lions within that country, U.S. hunters will continue to support the good efforts of the range countries, while encouraging those countries that have not fully implemented a lion management plan to do so in order to receive business from U.S. hunters.

(50) Comment: Several countries and one commenter provided a combined comment expressing concern that the Service's 4(d) rule surpasses the regulatory requirements they are already following under CITES, and that such restrictions undermine CITES and increase the regulatory burden to lion range states by adding additional reporting requirements. These countries noted that under CITES exports of trophies must not be detrimental to the survival of the species and expressed that proving their management programs enhance the survival of the subspecies is an added administrative burden on their wildlife management authorities that are

already limited on staff, resources, and time. Further, they felt the 4(d) rule would penalize countries that are already working hard to achieve success in wildlife management.

Our Response: As these countries noted in their comments, CITES allows for stricter domestic measures, such as the Act and our 4(d) rule for *P. l. melanochaita* promulgated under the Act. The Service recognizes that the 4(d) rule for *P. l. melanochaita* has stricter requirements than CITES Appendix-II requirements. We find that our 4(d) rule for *P. l. melanochaita* will support and encourage countries to carry out strong conservation programs for *P. l. melanochaita* and ensure that U.S. imports of sport-hunted lion trophy specimens are obtained in a manner that is consistent with the purposes of the Act and the conservation of the *P. l. melanochaita* in the wild. We do not anticipate a significant burden on the lion range countries to provide documentation that should already exist for well-managed lion programs, and we will work with the countries in order to make our determinations under the Act in a timely manner. The 4(d) rule is in place to support countries that have achieved success in managing their lions.

(51) Comment: Several countries and one commenter disagreed with how trade in captive-bred lions would be subject to the prohibitions under the Act. These countries expressed that trade in captive-bred lion does not have an adverse effect on wild lion populations. They felt that the Act's treatment of captive lions in the same manner as wild lions is inconsistent with CITES regulations and that the 4(d) rule should exempt captive-bred lions.

Our Response: In analyzing threats to the species, we focused our analysis on threats acting upon wild specimens within the native range of the species, because the goal of the Act is survival and recovery of the species within its native ecosystem. We did not separately analyze "threats" to captive-held specimens because the statutory five factors under section 4 (16 U.S.C. 1533) are not well-suited to consideration of specimens in captivity and captive-held specimens are not eligible for separate consideration for listing. However, we did consider the extent to which specimens held in captivity create, contribute to, reduce, or remove threats to the species. See the Captive Lions and *Traditional Use of Lion Parts and Products* sections above. Under CITES, captive specimens are still listed the same as their wild counterparts; however, the Convention does allow for different treatment of captive-bred specimens in regard to permitting. As stated earlier, CITES also provides for stricter domestic measures, and the protections afforded to all specimens of the subspecies through listing under the ESA and the 4(d) rule would constitute such a measure.

(52) Comment: A joint comment from the petitioners asked us to scrutinize applications for the import of lion trophies or parts to ensure that they were obtained within a scientifically based management program that promotes the conservation of the subspecies and provided suggestions for criteria to consider when making an enhancement finding. The comment included a number of suggestions for establishing a formal internal guidance on how we would evaluate each application. Finally, the petitioners called on the Service to publish the receipt of threatened species permit applications in the Federal Register and allow for a 30-day comment period. Another commenter questioned establishing findings on a country-wide basis instead of specific regions/hunting programs within a country.

Our Response: We appreciate the input regarding publishing the receipt of threatened species applications, establishing formal internal guidance on how we will evaluate each application, and consideration of making enhancement findings on a specific region/hunting program scale. We will consider these suggestions; however, this issue is outside the scope of this rulemaking process. In regard to the suggested criteria for making enhancement findings, we have expanded the discussion of enhancement within this final rule, and many of the suggestions have been addressed in the preambular language of the 4(d) rule.

(53) Comment: The petitioners also asserted that we should not authorize imports of lions from western Africa, Tanzania or Zimbabwe; imports of trophies from females or males under 6 years of age; or trophies obtained from captive-hunting facilities, or authorize imports, interstate commerce or foreign commerce in lion parts.

Our Response: While the comments are outside the scope of this rulemaking, the Service must make a finding that an "otherwise prohibited activity," such as import, export, interstate and foreign commerce, must meet the issuance criteria under 50 CFR 17.32. We cannot make any determination of whether a particular permit application can be approved or denied until the application is reviewed.

(54) Comment: One commenter called on the Service to specifically prohibit the importation of sport-hunted lions in the 4(d) rule, citing that there is no documented evidence

that trophy hunting supports conservation of the subspecies. In addition, the commenter felt that allowing for legal trade of sport-hunted lions would support the illegal harvest of the subspecies.

Our Response: We found no evidence that allowing legal import of lion trophies would stimulate illegal trade into the United States. In evaluating the best available scientific and commercial information, we concluded that a well-managed, scientifically based lion management program can provide a benefit to the species. While we obtained new information indicating that some hunting programs are not scientifically based or providing adequate conservation benefits to the species, this 4(d) rule will support implementing well-managed plans by encouraging countries that have insufficient lion management plans to develop plans that are based on sound scientific information that would generate revenue in support of communities and conservation. Therefore, we are not prohibiting the import of sport-hunted trophies. Import of sport-hunted trophies of *Panthera leo melanochaita* will require issuance of a threatened species import permit under 50 CFR 17.32, which will require an enhancement finding (see **4(d) Rule for *Panthera leo melanochaita***, above). The import of lions hunted in countries that do not meet the criteria for enhancement will not be permitted.

(55) Comment: One commenter stated that the Service has failed to comply with the National Environmental Policy Act (NEPA) in regard to promulgating the 4(d) rule.

Our Response: We have determined that we do not need to prepare an environmental assessment, as defined under the authority of the National Environmental Policy Act of 1969, in connection with regulations adopted under section 4(a) of the Act. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR

49244). Furthermore, under our 1983 policy, we determined that we do not need to prepare an environmental assessment in connection with regulations adopted under section 4(a) of the Act, including 4(d) rules that accompany listings of threatened species.

Because we are listing *P. l. melanochaita* as threatened and are finalizing this 4(d) rule simultaneously with our final listing determination, we consider this 4(d) rule to be part of the listing determination for the purposes of National Environmental Policy Act compliance.

(56) Comment: One commenter stated that lions do not lend themselves to population surveying due to the boom and bust nature and high fecundity of lion populations. The commenter felt that population surveys have long been considered impractical, and as such, quotas can never be set scientifically and, therefore questioned how the Service can make this a criteria for determining enhancement. Finally, the commenter was concerned that having countries have an understanding of lion population numbers and developing lion management plans would be cost prohibitive to many of the range countries.

Our Response: We are not requiring an exact count of the lions within each country before being able to make a determination of whether imports could occur. However, we need to consider what methods countries are using to establish quotas, such as population trend data, in order to determine if the offtake by U.S. hunters is sustainable and meets the criteria under 50 CFR 17.32.

(57) Comment: One commenter stated that lions have an extraordinary high fecundity, which contributes to its boom or bust population characteristic and helps ensure its long-term existence, making it far less vulnerable to endangerment.

Our Response: We agree that lions have high fecundity and in absence of stressors populations can rapidly increase. However, across most of its range, the lion is not without stressors, and given the threats the lion is currently facing, natural fecundity is reduced. One of the greater stressors on lions, excessive harvests of lions for trophies, can negatively impact the reproduction of a lion such that it causes local extirpations. Harvesting males that are too young causes male replacements, which results in increased infanticide rates, death of the surviving male coalition, and a 100 percent fatality rate for males that are prematurely forced to disperse. Furthermore, the population will be driven to extinction as female populations collapse as they eventually are unable to mate. The species is largely not able to rapidly recover from population declines. This is evidenced by long-term population trends that indicate an overall 43 percent decline in lions over 21 years and higher regional rates of decline in western and eastern Africa.

(58) Comment: One commenter stated that the Service should use its power to list Distinct Population Segments (DPSs), rather than the entire African lion subspecies in light of the recent ruling in *Humane Society of the United States* v. *Jewell*, No. CV 13-186 (BAH), 2014 WL 7237702 (D.D.C. Dec. 19, 2014)..

Our Response: We disagree with this conclusion. Pursuant to 50 CFR 17.11(g), all populations are included in the listing.

Required Determinations

National Environmental Policy Act (42 U.S.C. 4321 et seq.)

We have determined that we do not need to prepare an environmental assessment, as defined under the authority of the National Environmental Policy Act of 1969, in connection with regulations adopted under section 4(a) of the Act for the listing, delisting, or reclassification of species. We published a notice outlining our reasons for this determination in the **Federal Register** on October 25, 1983 (48 FR 49244).

References Cited

A list of all references cited in this document is available at *http://www.regulations.gov* at Docket No. FWS–R9–ES–2012–0025, or upon request from the U.S. Fish and Wildlife Service, Endangered Species Program, Branch of Foreign Species (see **FOR FURTHER INFORMATION CONTACT**).

Authors

The primary authors of this rule are staff of the Branch of Foreign Species, Ecological Services, U.S. Fish and Wildlife Service.

List of Subjects in 50 CFR Part 17

Endangered and threatened species, Exports, Imports, Reporting and recordkeeping requirements, Transportation.

Regulation Promulgation

Accordingly, we amend part 17, subchapter B of chapter I, title 50 of the Code of Federal Regulations, as set forth below:

Part 17—[AMENDED]

1. The authority citation for part 17 continues to read as follows:

Authority: 16 U.S.C. 1361–1407; 1531–1544; and 4201–4245; unless otherwise noted.

2. Amend § 17.11(h), the List of Endangered and Threatened Wildlife, by:

a. Removing the entry for "Lion, Asiatic *(Panthera leo persica)*"; and

b. Adding entries for "Lion (*Panthera leo leo*)" and "Lion (*Panthera leo melanochaita*)" in alphabetic order under MAMMALS to read as set forth below:

§ 17.11 Endangered and threatened wildlife.

* * * * *

(h) * * *

Species		Historic range	Vertebrate population where endangered or threatened	Status	When listed	Critical habitat	Special rules
Common name	**Scientific name**						
Mammals							
* * * * * * *							
Lion	*Panthera leo leo*	Africa, Asia	Entire	E	862	NA	NA
Lion	*Panthera leo melanochaita*	Africa	Entire	T	862	NA	17.40(r)
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3. Amend § 17.40 by adding paragraph (r) to read as follows:

§ 17.40 Special rules—mammals.

* * * * *

(r) Lion (*Panthera leo melanochaita*).

(1) *General requirements*. All prohibitions and provisions of §§ 17.31 and 17.32 apply to this subspecies.

(2) The import exemption found in § 17.8 for threatened wildlife listed in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) does not apply to this subspecies. A threatened species import permit under § 17.32 is required for the importation of all specimens of *Panthera leo melanochaita*.

(3) All applicable provisions of 50 CFR parts 13, 14, 17, and 23 must be met.

Dated: December 10, 2015.

Daniel M. Ashe,

Director, Fish and Wildlife Service.

BILLING CODE 4333-15-P