Draft Terms of Reference – Puma

- **Provide information on the taxonomy of the species**

Kingdom: Animalia
Phylum: Chordata
Class: Mammalia (mammals)
Order: Carnivora (Carnivores)
Suborder: Feliformia (cats, hyaenas, civets, mongooses)
Family: Felidae (cats)
Subfamily: Felinae (small cats)
Genus: *Puma*
Species: *concolor*

Synonym: *Felis concolor*

Common names: Puma; Cougar; Mountain Lion

Alternative common names: The Puma is renowned for the multitude of common names which the species possesses, although most of these are either indigenous names or colloquialisms - e.g. names such as painter, catamount, screamer, devil-cat, mountain devil, etc are used in parts of the USA. The only names which are in common or widespread usage, especially in official circles, are Puma, Cougar, and Mountain Lion. However, the Floridian subspecies *Puma concolor coryi* is commonly referred to as the Florida Panther, even in scientific publications.

Scientific binomen: The Puma was first described by Linnaeus in 1771, under the name *Felis concolor*.[1]

The family Felidae is broadly divided into two subfamilies, Pantherinae (big cats) and Felinae (small cats). The species within the latter subfamily were previously contained almost entirely within the genus *Felis*, with the exception of the Cheetah *Acinonyx jubatus* (formerly in its own subfamily Acinonychinae) and often the lynxes (in *Lynx*). More recent genetic studies have shown that the subfamily is composed of several distinct lineages, and hence the large genus *Felis* has been broken down into multiple genera.[2] The current majority view of Puma taxonomy is that it is in the genus *Puma*, closely related to the Jaguarundi *Herpailurus yagouaroundi* (often also placed in the genus *Puma*) and with a common ancestry to the Cheetah.[3]

Subspecies: Traditionally the Puma has been divided into a large number of subspecies - as many as 32 have been named from throughout its extensive range.[4] A phylogeographical study published in 2000 by Culver *et al* [5] suggested that there were in fact only six distinct subspecies (given as *cabrerae, capricornensis, concolor, costaricensis, couguar,* and *puma*). This was followed by, e.g., Wilson and Reeder (2005)[6] who also accepted a total of six subspecies but replaced *capricornensis* with *anthonyi*. The most recent taxonomic treatment of the Felidae by Kitchener *et al* (2017)[7] lumps them even further, into just two subspecies - *couguar* in North and Central America, and *concolor* in South America - although this decision was based on a 2014 study by Caragiulo *et al* with admitted poor sampling sizes.[8]

The majority of Pumas kept in zoos are treated as being "non-subspecific", probably due to most founder stock being of unknown origin. ZIMS has additional listings of pure subspecies, mostly from within range states, although these are few in comparison to "unknown" animals, and do not necessarily match the most current taxonomic distinctions.[9]

[1] Wilson, D.E., and D.M. Reeder (eds) (2005) "*Mammal Species of the World: a taxonomic and geographic reference*" (3rd edition), John Hopkins University Press
[2] Salles, L. O. (1992). "*Felid phylogenetics: extant taxa and skull morphology (Felidae, Aeluroidea)*" American Museum Novitates, no. 3047
[3] Kitchener A.C., C. Breitenmoser-Würsten, E. Eizirik, A. Gentry, L. Werdelin, A. Wilting, N. Yamaguchi, A.V. Abramov, P. Christiansen, C. Driscoll, J.W. Duckworth, W. Johnson, S.J. Luo, E. Meijaard, P. O'Donoghue, J. Sanderson, K. Seymour, M. Bruford, C. Groves, M. Hoffmann, K. Nowell, Z. Timmons, and S. Tobe (2017) "*A revised taxonomy of the Felidae. The final report of the Cat Classification Task Force of the IUCN/SSC Cat Specialist Group*" Cat News, Special Issue 11
[4] Kitchener *et al* (2017), *op. cit*.
[5] Culver, M., W.E. Johnson, J. Pecon-Slattery, and S.J. O'Brien (2000) "Genomic ancestry of the American puma (*Puma concolor*)" *Journal of Hereditry*, vol. 91 (3), pp. 186-97
[6] Wilson and Reeder (2005), *op. cit.*
[7] Kitchener *et al* (2017), *op. cit*.
[8] Caragiulo, A,. I. Dias-Freedman, J.A. Clark, S. Rabinowitz, and G. Amato (2014) "Mitochondrial DNA sequence variation and phylogeography of Neotropical pumas (*Puma concolor*)" *Mitochondrial DNA*, vol. 25 (4), pp. 304-312
[9] *Species360* Zoo Aquarium Animal Management Software (ZIMS)

- **Provide information on the status of the species under CITES**

CITES Listing: Appendix II, apart for certain subspecies on Appendix I
IUCN Red List Status: LC (Least Concern)

The Puma is listed by CITES on Appendix II apart for specific populations in Florida (*coryi*) and Central America (*costaricensis* and *couguar*) which are listed on Appendix I.[10]

It is listed by the IUCN as LC (Least Concern).[11]

The Puma has a vast distribution, originally covering the entire continental landmass of the Western Hemisphere, from Canada to Argentina, and still being present in most American countries today.[12]

Total population figures are unknown. There is little known about the status of most populations in Central and South America.[13] The IUCN states, however, that the population in North America (Canada and USA) alone was estimated at c.15,000 animals in the early 1990s.[14] Most range countries prohibit hunting of Pumas, with the exceptions of Canada, Mexico, Peru, and the USA.[15]

[10] CITES page for "Puma concolor": https://cites.org/eng/node/24434
[11] IUCN page for "Puma concolor": http://www.iucnredlist.org/details/18868/0
[12] Caragiulo, A,. I. Dias-Freedman, J.A. Clark, S. Rabinowitz, and G. Amato (2014) "Mitochondrial DNA sequence variation and phylogeography of Neotropical pumas (*Puma concolor*)" *Mitochondrial DNA*, vol. 25 (4), pp. 304-312
[13] Caragiulo et al (2014), *op. cit*.

[14] IUCN page for "Puma concolor": http://www.iucnredlist.org/details/18868/0
[15] IUCN page for "Puma concolor": http://www.iucnredlist.org/details/18868/0

- **Provide information about the ecology of the species.**

Like most large cats, Pumas have relatively short lifespans. Almost all studies on wild Pumas have been done in North America, where longevity data variably shows anywhere between 6 and 12 years.[16] One study of the skulls of c.1200 Puma skulls showed that few of these animals (only 51 individuals) had lived past about 9 years of age.[17] It should be noted that numerous websites state, without sources, that the "average" lifespan of wild Pumas is 18 to 20 years. Weigl (2005) gives the captive record for lifespan at 23.8 years.[18]

Pumas have a substantial size range as well as being sexually-dimorphic. Body size in this species has been demonstrated to follow Bergmann's Rule (size correlates to latitude and temperature, with equatorial populations having smaller individuals than those furthest from the equator).[19] The overall body measurements are given by Nowak and Paradiso[20] as being 1050-1959mm head-body length, 660-784mm tail length, and 67-103kg in weight (males); and 966-1517mm head-body length, 534-815mm tail length, and 36-60kg in weight (females). Shoulder height is given as 600-700mm.

Males are 30-50% larger than females in both mass and measurements.[21] This sexual dimorphism remains constant regardless of whether the individual population is equatorial or boreal,[22,23] but it cannot be used to sex wild animals of unknown origin as females from northern latitudes will always be as large or larger than males from equatorial areas, and it also cannot be relied upon for captive animals as founder stock is likely to have been of mixed origins. As in other cat species, males have an external scrotum. However according to Pierce and Bleich[25] the genitalia are not obvious, and mistaken sexing is common with inexperienced wildlife officers (in the USA, with wild Pumas).

Pumas are largely solid in colour, without the spots or striping found in the majority of cat species. Nowak and Paradiso[26] describe the colour range as being in "two variable color phases: one ranges from buff, cinnamon, and tawny to cinnamon rufous and ferrugineous; the other ranges from silvery gray to bluish and slaty gray". The body form is slender, with a relatively small head and long tail. Very superficially they could be considered to resemble a small lioness (female *Panthera leo*) but only someone completely unfamiliar with the two species would make this error. All the other *Panthera* species which are within a similar size-range have prominent body patterning and could not be confused with Pumas. The related Jaguarundi (*Herpailurus* [or *Puma*] *yagouaroundi*) is also solidly-coloured, but is very different in body form, being only about half the size of the Puma and in general resembling a large marten or otter rather than any of the larger cat species.[27,28]

Pumas have the most extensive latitudinal distribution of any land mammal, being found the length of the Americas from the Canadian Yukon in the north to Patagonia in the south. Within this range they occupy habitats including alpine and subalpine areas, grassland, desert, and all types of forest. The only habitat which is not utilised by Pumas in the Americas is the Arctic tundra.[29,30,31]

Prey items depend in part on location (e.g. in North and southern South America deer and other large-bodied ungulates are the dominant prey items, whereas in Central America small mammals are dominant), but also on the presence of Jaguars (*Panthera onca*). Where both species of cat coexist, Jaguars typically take larger prey and Pumas have a subordinate niche, feeding on small- to mid-sized animals, although this is not necessarily the case (e.g. in Rueda *et al* (2013)[32] where both cat species preyed upon the same species to the same extent), and may also be related to habitat use.[33,34,35]

Pumas are, generally speaking, sedentary within territories (non-migratory). As with all Felidae, they do not hibernate or aestivate. However there is a lot of variation across their range in how they respond to seasonal migrations of ungulates where these are their dominant prey items (e.g. deer in North America or camelids in South America). In some areas Pumas do not follow the migrating ungulates but simply switch to other available prey animals for the relevent part of the year, while in other areas Pumas do follow the herds.[36,37]

They are extremely versatile in their habitat requirements, naturally occupying all ecological zones in the Americas except Arctic tundra, with temperatures extremes from below freezing in northern North America and the Andean mountain chain, to the lowland tropics of Central and South America. Recorded altitudes range from sea-level up to 4500 metres.[38]

Pumas have traditionally been considered to be completely solitary. Cubs remain with their mother for up to two years but otherwise it was thought that there was no group structure in Pumas.[39] More recent wild studies have shown that Pumas commonly exist in overlapping territories and interact benignly with one another, both as resident and migratory individuals. [40,41] Male Pumas are more territorial than females, with one male living in the ranges of several unrelated females, and those females interact socially to the extent of even feeding from the same kills.[42]

Pumas are large predators, roughly the size of a small Leopard (*Panthera pardus*) and can inflict serious injuries upon people. They are not normally aggressive in the wild state, but still there are a number of documented attacks on people, some of which have resulted in deaths. Comprehensive data is only available from North America, with about twenty human deaths from Pumas in the c.120-year-span between 1890 and 2011.[43,44] About two-thirds of humans killed were children.

[16] Busch, R.H. (1996) "*The Cougar Almanac: a complete natural history of the mountain lion*" Lyons & Burford
[17] Gay, S.W., and T.L. Best (1996 a) "Age-Related Variation in Skulls of the Puma (*Puma concolor*)" *Journal of Mammalogy*, vol. 77 (1), pp. 191-198
[18] Weigl, R (2005) "*Longevity of Mammals in Captivity; from the living collections of the world*" Kleine Senckenberg-Reihe 48
[19] Gay, S.W., and T.L. Best (1996 b) "Relationships between abiotic variables and geographic variation in skulls of pumas (*Puma concolor*: Mammalia, Felidae) in North and South America" *Zoological Journal of the Linnean Society*, vol. 117 (3), pp. 259-282
[20] Nowak, R.M., and J.L. Paradiso (1999) "*Walker's Mammals of the World*" John Hopkins University Press
[21] Gay, S.W., and T.L. Best (1995) "Geographic variation in sexual dimorphism of the Puma (*Puma concolor*) in North and South America" *The Southwestern Naturalist*, vol. 40, pp. 148-159
[22] Gay and Best (1995), *op. cit*.
[23] Iriarte, J.A., W.L. Franklin, W.E. Johnson, and K.H. Redford (1990) "Biogeographic variation in food habits and body size of the America puma" *Oecologia,* vol. 85, pp. 185–190.
[24] *Anon*. "*Mountain Lion Education and Identification Course*" Colorado Division of Wildlife
[25] Pierce, B.M., and V.C. Bleich (2003) "Mountain Lion" in Feldhamer, G.A., B.C. Thompson, and J.A. Chapman "*Wild Mammals of North America: Biology, Management, and Conservation*" Johns Hopkins University Press, pp. 744-757
[26] Nowak and Paradiso (1999), *op. cit*.
[27] Nowak and Paradiso (1999), *op. cit*.
[28] Sunquist, M., and F. Sunquist (2002) "Wild Cats of the World" University of Chicago Press
[29] Nowak and Paradiso (1999), *op. cit*.

[30] Sunquist and Sunquist (2002), *op. cit*.
[31] Hornocker, M., and S. Negri (2009) "*Cougar: Ecology and Conservation*" University of Chicago Press
[32] Rueda, P., G.D. Mendoza, D. Martinez, and O.C. Rosas-Rosas (2013) "Determination of the jaguar (*Panthera onca*) and puma (*Puma concolor*) diet in a tropical forest in San Luis Potosi, Mexico" *Journal of Applied Animal Research*, vol. 41 (4), pp. 484-489
[33] Haines, A.M. (2006) "Is there competition between sympatric jaguar *Panthera onca* and puma *Puma concolor*" *Acta Zoologica Sinica*, vol. 52 (6), pp. 1142-1147
[34] Scognamillo, D., I.E. Maxit, M. Sunquist, and J. Polisar (2003) "Coexistence of jaguar (*Panthera onca*) and puma (*Puma concolor*) in a mosaic landscape in the Venezuelan llanos " *Journal of Zoology*, vol. 259 (3), pp. 269-279
[35] Hornocker and Negri (2009), *op. cit*.
[36] Pierce, B.M., V.C. Bleich, J.D. Wehausen, and R.T. Bowyer (1999) "Migratory Patterns of Mountain Lions: implications for social regulation and conservation" *Journal of Mammalogy*, vol. 80 (3), pp. 986-992
[37] Gelin, M.L., L.C. Branch, D.H. Thornton, A.J. Navaro, M.J. Gould, and A. Caragiulo (2016) "Response of pumas (*Puma concolor*) to migration of their primary prey in Patagonia" *PLoS One*
[38] Nowak and Paradiso (1999), *op. cit*.
[39] Lopez-Gonzalez, C.A., and A. Gonzalez-Romero (1998) "A Synthesis of Current Literature and Knowledge About the Ecology of the Puma (*Puma concolor* Linnaeus)" *Acta Zoologica Mexicana*, vol. 75, pp. 171-190
[40] Hornocker and Negri (2009), *op. cit*.
[41] Pierce *et al* (1999), *op. cit*.
[42] Elbroch, L.M., M. Levy, M. Lubell, H. Quigley, and A. Caragiulo (2017) "Adaptive social strategies in a solitary carnivore" *Science Advances*, vol. 3 (10)
[43] Beier, P. (1991) "Cougar attacks on humans in the United States and Canada" *Wildlife Society Bulletin, vol.* 19, pp. 403-412
[44] Mattson, D., K. Logan, and L. Seanor (2011) "Factors governing risk of cougar attacks on humans" *Human-Wildlife Interactions*, vol. 5 (1), pp. 135-158

- **Provide information on the reproductive biology of the species**

Pumas attain sexual maturity at between one and three years of age (from 17 to 36 months, with males typically maturing at an older age than females).[45] Typically females become sexually mature between 2 to 2.5 years of age, and males between 2.5 and 3 years of age.[46]

In general breeding in Pumas occurs at any time of year throughout their extensive range,[47] especially when considering the huge distribution of the species. In North America the majority of births occur in the spring, which is thought to be the result of coinciding with the births of ungulates (deer etc).[48]

When breeding, the female Puma dens in an enclosed area, such as a cave or hollow.[49]

The gestation period is 82 to 96 days, and litters consist of up to six cubs, with three or four cubs being normal.[50] Cubs in smaller litters are typically heavier than those in larger litters.[51] They remain with the mother for between one and two years.[52] Males take no part in the rearing of the cubs.[53]

The average time between cubs becoming independent and a new litter being born is three months, while if a litter is lost (not reared successfully) a new litter is born between four and ten months later.[54]

As in all felid species, males and females are distinct sexes (i.e. not hermaphroditic, and parthenogenetic births are not possible), and they cannot change sex.[55]

Pumas have been recorded as hybridising in captivity with Leopards (*Panthera pardus*), which is particularly interesting in that this is an inter-generic hybrid. In the early 1900s Carl Hagenbeck of Hamburg Zoo, Germany, bred at least one such hybrid, and perhaps multiple hybrids (accounts differ). A number of photos exist of these and there is an existing taxidermied specimen at Tring Museum in the UK.[56,57,58]

There is no possibility of Pumas hybridising with native Australian mammals, as there are no felid species native to Australia.[59]

[45] Lopez-Gonzalez, C.A., and A. Gonzalez-Romero (1998) "A Synthesis of Current Literature and Knowledge About the Ecology of the Puma (*Puma concolor* Linnaeus)" *Acta Zoologica Mexicana*, vol. 75, pp. 171-190
[46] Busch, R.H. (1996) "*The Cougar Almanac: a complete natural history of the mountain lion*" Lyons & Burford
[47] Lopez-Gonzalez and Gonzalez-Romero (1998), *op. cit*.
[48] Jansen, B.D., and J.A. Jenks (2012) "Birth Timing for Mountain Lions (*Puma concolor*); Testing the Prey Availability Hypothesis" *PLoS One*, 7 (9)
[49] Sunquist, M., and F. Sunquist (2002) "Wild Cats of the World" University of Chicago Press
[50] Lopez-Gonzalez and Gonzalez-Romero (1998), *op. cit*.
[51] Jansen and Jenks (2012), *op. cit*.
[52] Lopez-Gonzalez and Gonzalez-Romero (1998), *op. cit*.
[53] Sunquist and Sunquist (2002), *op. cit*.
[54] Jansen and Jenks (2012), *op. cit*.
[55] Sunquist and Sunquist (2002), *op. cit*.
[56] Denis, A. (1964) "*Cats of the World*" Houghton Mifflin
[57] Gray, A.P. (1972) "*Mammalian Hybrids: a Check-list with Bibliography*" Commonwealth Bureau of Animal Breeding and Genetics
[58] Hagenbeck, C. (1909) "*Beasts and Men*" Vita Deutsches Verlagshaus
[59] Menkhorst, P., and F. Knight (2010) "*A Field Guide to the Mammals of Australia*" Oxford University Press

- **Provide information on whether the species has established feral populations**

The Puma is not known to have ever established wild breeding populations outside of its natural range, and it has never been deliberately introduced to the wild in countries outside of its natural range.[60]

The only accounts for Puma in *Introduced Mammals of the World* (Long, 2003)[61] are for deliberate re-introductions of wild Pumas to parts of the eastern USA from which they had previously been extirpated by hunting.

The Puma is not generally considered to be a pest but it is persecuted in some parts of its natural range due to predation on livestock, although studies show that wild animals are preferred prey (e.g. IUCN notes that in North America, deer alone account for 60-80% of prey items). The Puma has also been known to attack and kill humans on rare occasions.[62]

[60] Long, J.L. (2003) "*Introduced Mammals of the World*" CSIRO
[61] Long (2003), *op. cit.*
[62] IUCN page for "Puma concolor": http://www.iucnredlist.org/details/18868/0

- **Environmental risk assessments of the species**

The Puma is listed in the Vertebrate Pests Committee's 2007 "List of Exotic Vertebrate Animals in Australia" under the scientific name *Puma concolor* with noted generic synonym *Felis*, and the common names of Cougar, Deer Tiger, Mountain Lion, Puma, and Red Tiger. In this assessment it is given the Category rating of "2/extreme".[63]

The number "2" in the threat rating is used to denote "limited to statutory zoos or endorsed special collections".

The rating of "extreme" is qualified as "These animals should not be allowed to enter, nor be kept in any State or Territory. (Special consideration may be given to scientific institutions on a case by case basis.) Any species that has not been assessed previously should be considered to be in the Extreme Threat Category and should be treated accordingly, until a risk assessment is conducted."

It should be noted that almost every species of exotic mammal listed in the document has been categorised as either "extreme" or "serious".

Quarantine requirements for live exotic Felidae for zoos have been established by Biosecurity Australia, and would cover Pumas if these were to be imported.[64]

[63] Vertebrate Pests Committee "List of Exotic Vertebrate Animals in Australia": https://www.pestsmart.org.au/wp-content/uploads/2010/03/VPCListJuly2007.pdf
[64] Australian Government "Zoo Carnivores: Felidae": http://www.agriculture.gov.au/biosecurity/risk-analysis/animal/zoo-felidae

- **Assess the likelihood that the species could establish a breeding population in Australia**

The likelihood of Pumas establishing a breeding population in Australia outside effective human control is low if based on historical and global data. There are no wild populations of Pumas known to be established outside their natural range, and despite the species being held in zoos throughout the world the only wild-introduced populations are of deliberate re-introductions to their former range in the eastern USA.[65]

Pumas have been held in live-animal collections in Australia since zoos were first established in the country, although currently there is only a single animal left in the country.[66] Despite this long history there are no records of individual Pumas ever escaping, and a wild population has never formed in Australia via escaped or released animals.

Pumas are exclusively carnivorous and predatory. Their preferred prey selection varies across their wild range. In temperate zones they feed predominantly on large-bodied mammals with relatively

few species making up the overall diet, whereas in the tropics they feed on smaller-bodied animals with a greater variety of species. This appears to be a combination of competition with the larger Jaguar (*Panthera onca*) - absent in most of the temperate regions - and to a lesser extent a difference in the abundance of large-bodied prey in temperate versus tropical zones.[67]

In North America (USA and Canada) where they are the largest surviving cat species, the dominant prey is large-bodied ungulates (primarily deer), which make up about 68% of the diet by frequency of occurrence.[68,69,70] Currier (1983) says that in the western USA, Mule Deer (*Odocoileus hemionus*) make up about 60% of the summer diet and 75% of the winter diet of Pumas.[71] In the Neotropics of Central and South America Pumas tend to live sympatrically with the larger Jaguar, and the two cats largely partition their ecology with Jaguars hunting larger prey and Pumas hunting smaller prey, although there is considerable overlap in the species hunted. In these areas, Pumas do hunt peccaries and deer, but a larger part of the diet is composed of small-bodied mammals such as opossums, raccoons, and armadillos. Some studies suggest that Jaguars preferentially hunt peccaries while Pumas preferentially hunt deer.[72,73,74,75] Where Jaguars are absent, such as on Barro Colorado Island, Pumas hunt large prey in proportionally larger quantity than in locations where Jaguars are present.[76] In southern South America, the dominant prey of Pumas are large-bodied animals such as Guanacos (*Lama guanicoe*) [related to Llamas] and Lesser Rheas (*Rhea pennata*) [emu-like ratites], except in areas where these native species have been extirpated by man in which case the dominant prey becomes small-bodied mammals, in particular the introduced European hare (*Lepus europeaus*).[77,78]

Because Pumas take prey in a wide range of body-sizes and from a variety of animals groups (albeit predominantly mammalian), they would find food easily in any part of Australia should a wild population become established.

In their natural range, Pumas occur in almost every habitat in the Americas except Arctic tundra. This includes boreal forest, tropical rainforest, montane forest, alpine environments, grasslands, swamplands, and desert, as well as in farmland (sheep and cattle ranches, plantations, etc). Temperatures across their distribution range from sub-zero in northern winters and in mountains, to the equatorial tropics. They have been recorded from sea-level up to altitudes of 4500 metres. They do not hibernate, and are active year-round. Shelter is normally taken in caves or hollows, or amongst dense vegetation.[79,80]

Wild Pumas have relatively short lifespans and, as apex predators, low reproductive output. They become sexually-mature at between two and three years of age, and females breed about every second year once mature. Litters average three or four cubs, although up to six cubs is possible.[81,82] Wild lifespan is usually less than ten years.[83,84] Based on age of maturity, rate of breeding, and average lifespan, a wild female Puma would normally only produce four or five litters in her life.

Pumas have a very wide range of prey species, so they are not typically limited by resources in this respect. Even where prey species migrate (e.g. deer in North America[85] or camelids in South America[86]) they can switch to alternate prey species for that part of the year; and where preferred native prey species are extirpated by man they can switch permanently to other available prey even if it is an introduced species (e.g. European Hares in Patagonia).[87] All mammal and bird species in Australia fall within the sizes of prey taken by Puma in their native habitats.

Direct competition in the wild comes primarily from Jaguars, the only other large cat in the Americas to survive into the Holocene. The distributional range of the Jaguar falls entirely within that of the Puma and there is much discussion about how sympatry works between the two species, including suggestions that they are active at different periods (night versus day) or focus on different prey items (large versus small).[88,89,90,91] In North America, Pumas coexist with Grey Wolves (*Canis lupus*) and two species of bears (*Ursus spp*), all of which are dominant over Pumas, with wolves in particular stealing Puma kills and even attacking Pumas directly.[92,93] In Australia there are no wild large predators other than the Dingo (*Canis familiaris dingo*).[94]

Pumas in Australia would be legally restricted to licenced holders (i.e. zoos) and thus importation of additional animals past an initial import would likely not result in any increase in risk of the establishment of wild populations via escape or release.

[65] Long, J.L. (2003) "*Introduced Mammals of the World*" CSIRO
[66] Australian zoo census data from Zoo and Aquarium Association (ZAA)
[67] Iriate, J.A., W.L. Franklin, W.E. Johnson, and K.H. Redford (1990) "Biogeographic variation of food habits and body size of the American puma" *Oecologia*, vol 85 (2), pp. 185-190
[68] Iriate *et al* (1990), *op. cit*.
[69] Laundre, J.W. and L. Hernandez (2003) "Winter hunting habitat of Pumas (*Puma concolor*) in northwestern Utah and southern Idaho, USA" *Wildlife Biology*, vol. 9 (1), pp. 123-129
[70] Kortello, A.D., T.E. Hurd, and D.L. Murray (2007) "Interactions between cougars (*Puma concolor*) and gray wolves (*Canis lupus*) in Banff National Park, Alberta" *Ecoscience*, vol. 14 (2), pp. 214-222
[71] Currier, M.J.P. (1983) "Felis concolor" *Mammalian Species* no. 200, The American Society of Mammalologists
[72] Iriate *et al* (1990), *op. cit*.
[73] Rueda, P., G.D. Mendoza, D. Martinez, and O.C. Rosas-Rosas (2013) "Determination of the jaguar (*Panthera onca*) and puma (*Puma concolor*) diet in a tropical forest in San Luis Potosi, Mexico" *Journal of Applied Animal Research*, vol. 41 (4), pp. 484-489
[74] Monroy-Vilchis, O., Y. Gomez, M. Janczur, and V. Urios (2009) "Food niche of Puma (*Puma concolor*) in Central Mexico" *Wildlife Biology*, vol. 15 (1), pp. 97-105
[75] Gutierrez-Gonzalez, C.E. and C.A. Lopez-Gonzalez (2017) "Jaguar interactions with pumas and prey at the northern edge of jaguars' range" *PeerJ* 5
[76] Moreno, R.S., R.W. Kays, and R. Samudio Jr. (2006) "Competitive Release in Diets of Ocelot (*Leopardus pardalis*) and Puma (*Puma concolor*) after Jaguar (*Panthera onca*) Decline" *Journal of Mammalogy*, vol. 87 (4), pp. 808-816
[77] Martinez, J.I.Z., A. Travaini, S. Zapata, and D. Procopio (2012) "The ecological role of native and introduced species in the diet of the puma *Puma concolor* in southern Patagonia" *Oryx*, vol 46 (1), pp. 106-111
[78] Rau, J.R. and J.E. Jimenez (2002) "Diet of Puma (*Puma concolor*, Carnivora: Felidae) in Coastal and Andean Ranges of Southern Chile" *Studies on Neotropical Fauna and Environment*, vol. 37 (3), pp. 201-205
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- **Provide a comprehensive assessment of the potential impact of the species should it become established in Australia**

A. Does the species have similar niche/living requirements to native species?

Pumas are large and generally-solitary predators, roughly the size of small Leopards (*Panthera pardus*), which hunt through ambush. There are no carnivorous mammals of this size and hunting strategy found wild within Australia. The nearest equivalent in size is the Dingo (*Canis familiaris dingo*), which is the size of, and has the general behaviour of, a dog.[95]

B. Is the species susceptible to, or capable of transmitting any pests or diseases?

Pumas can be carriers of external parasites such as ticks and fleas, and internal parasites such as nematodes, all of which can be easily and effectively treated/removed before undergoing quarantine.

There are a number of Zoonoses (protozoal, fungal and bacterial infections) which can be carried by and transferred between Pumas and other cat species (including the domestic cat). Some of these are also transferrable to humans, including Bartonellosis and Toxoplasmosis. A study by Murray *et al* (1999), covering the research of diseases in large carnivores, found 52 diseases, of which 44% were viral, 31% bacterial, and the rest fungal or protozoal.[96] Zoonoses can be tested for, and generally be effectively treated, before undergoing quarantine.

Munson *et al* (2010) list felid-specific viruses and haemoparasites, as well as pathogens which are not specific to felids but can also infect other Carnivores and non-Carnivores.[97]

Biosecurity Australia has existing quarantine regulations for the importation of live exotic Felidae for zoos, which covers disease control.

C. Probable prey/food sources.

Pumas have a very broad prey base which ranges from mammals as large as Moose (*Alces americanus*) down to small rodents, as well as birds including rheas, waterfowl, and gamebirds (pheasants etc), and also reptiles such as small crocodilians and large lizards. All species of mammals and birds, and many reptiles, within Australia would count as probable prey items.[98,99,100,101]

In the wild Pumas occur in almost all habitats, including famland, and have been recorded as killing domestic animals for food, including cattle, goats, sheep, and dogs. In Central and South America it can be difficult to separate predation of livestock by Pumas from that of Jaguars. Studies show that predation is affected partly by stock density and surrounding habitats, but mostly by availability of natural prey (i.e. where natural prey is abundant, livestock predation is minimal; where natural prey is extirpated or reduced by human hunting then predation on livestock increases). Predation on ranched animals (e.g. cattle and sheep) is primarily on young animals rather than adult animals.[102,103,104,105]

D. Impacts on habitat and local environments.

If a wild population should become established there would be no impact on the floral or geological components of the environment as Pumas do not destroy vegetation or dig burrows. As with any mammal, seeds may be spread attached to their fur. As predators they would hunt other wild animals and potentially domestic animals for food.

E. Discuss any control/eradication programs that could be applied in Australia if the species escaped or were released.

Evidence of the presence of wild or free-living Pumas is not difficult to detect for trained persons, albeit via indirect methods (faeces, tracks, prey remains, etc). Capturing Pumas would be relatively difficult, however, due to their solitary nature and secretive habits. In the native range, hunters usually use dogs to track and then chase a Puma into a tree before it is shot.

When wild Pumas need to be captured for scientific studies (e.g. to attach radio collars), this has typically been through the use of trained dogs which "tree" the Puma, which is then shot with a tranquiliser dart. This has a number of dangers attached for both the Puma and the dogs, and deaths or injuries are frequent. A better method has been through the use of foot-snares set at, e.g., Puma kills. Injuries or deaths using foot-snares are uncommon.[106]

F. Behaviours that cause environmental degradation.

Pumas do not have any behaviours or physical attributes which could cause environmental degradation. Based on their known ecology, they do not impact the ground, dig burrows, or damage or pollute waterways.[107,108]

G. Impacts on primary industries.

An established wild population of Pumas would have no impact on plant-based industries such as crops, orchards, or plantations. However they are large predators, and in their native range are known to attack livestock including cattle and sheep. Pumas are the only large cat in the USA and Canada, but in Central and South America they share most of their range with Jaguars (*Panthera onca*) and hence it can be difficult to separate livestock predation between the two species, although the Jaguar tends to take larger prey (e.g. cattle versus calves).

In North America, the numbers of livestock deaths caused by predators (including domestic dogs, Coyotes, Wolves, Pumas, etc) is a tiny percentage of overall deaths. The National Agricultural Statistics Service (NASS) of the United States Department of Agriculture releases irregular records of livestock deaths.

In 2004, 37.3% of sheep deaths in the USA were attributed to animal predators, of which the majority (73.8%) were caused by domestic dogs and Coyotes. Of the total losses to predators, 5.7% were attributed to Pumas.[109]

In 2009, 39% of sheep deaths in the USA were attributed to animal predators, although a breakdown of predator species is not given in the data from NASS (as it was for 2004).[110]

In 2010, only 5.5% of cattle deaths in the USA were attributed to animal predators, of which the majority (63%) were caused by domestic dogs and Coyotes. Of the total losses to predators, 8.6% were attributed to Felidae (including Pumas, Lynxes, and Bobcats).[111]

In Central and South America, studies show that predation is affected partly by stock density and surrounding habitats, but mostly by availability of natural prey (i.e. where natural prey is abundant, livestock predation is minimal; where natural prey is extirpated or reduced by human hunting then predation on livestock increases). Predation on ranched animals (e.g. cattle and sheep) is primarily on young animals rather than adult animals.[112,113,114,115]

H. Damage to property.

Pumas do not cause damage to physical properties.

I. Is the species a social nuisance or danger?

Pumas are not a species which would generally cause a social nuisance, although they can be dangerous to humans (see section J below) and in suburban USA have been known to take domestic cats as prey.[116]

J. Describe any potentially harmful characteristics of the species.

Pumas are large predators, roughly the size of a small Leopard (*Panthera pardus*) and can inflict serious injuries upon people. They are not normally aggressive in the wild state, but still there are a number of documented attacks on people, some of which have resulted in deaths. Comprehensive data is only available from North America, with about twenty human deaths from Pumas in the c.120-year-span between 1890 and 2011.[117,118] About two-thirds of humans killed were children.

In captivity they should be treated with the same safety measures as other large Carnivores.

Pumas can carry and transmit the same felid-to-human diseases as are common in domestic cats, such as Toxoplasmosis. Munson *et al* (2010) list felid-specific viruses and haemoparasites, as well as pathogens which are not specific to felids but can also infect other mammals including humans.[119]

Biosecurity Australia has existing quarantine requirements for the importation of live exotic Felidae for zoos, which covers disease control.

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[110] "Sheep and Goats Death Loss" (NASS, 27 May 2010): http://usda.mannlib.cornell.edu/usda/current/sgdl/sgdl-05-27-2010.pdf
[111] "Cattle Death Loss" (NASS, 12 May 2011): http://usda.mannlib.cornell.edu/usda/current/CattDeath/CattDeath-05-12-2011.pdf
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[119] Munson *et al* (2010), *op. cit*.

- **What conditions or restrictions could be applied to reduce any potential for negative impacts of the species?**

Importation and transfer of Pumas would be limited exclusively to recognised zoological facilities as licensed by their respective states and territories. As a containment species, Pumas would be specifically excluded from import by or transfer to private individuals to keep as private pets.

Measures to prevent breeding such as limiting importation to a single sex or to de-sexed individuals would prevent imported specimens being used to conserve the species in Australian zoos in the future.

- **Summary of proposed activity**

It is intended to import Pumas to:

- Restore the numbers of this species in Australian licensed and registered zoos, by import and controlled breeding, to cater to institutional and industry demand. Pumas have been historically held in Australian zoos in reasonable numbers for many years but, for a variety of reasons, their numbers have now dropped to a level where the population cannot be sustained without imports.

- Act as an ambassador species to promote conservation awareness and action about the plight of medium sized predators.

- Provide an interpretive species to complement learning outcomes for a range of visitation demographics.

It is proposed to initially import 3.3.0 unrelated young animals to be housed at three separate zoos – one pair at each. This will provide a nucleus on which to build a genetically sustainable population in this country.

Further imports will be necessary as the species is re-established in the region's zoos.

All animals to be imported will be eligible for import under Australia's CITES and animal health requirements.

All breeding will be planned, to avoid the production of surplus animals and to ensure genetic diversity of progeny.

Breeding will be to order only - individual specimens will be contracepted to avoid breeding to surplus.

- **Guidelines on how species should be kept**

Pumas are very widely kept throughout the world and their husbandry and management requirements are well documented.

The zoos that are proposed to receive animals from this import are all Animal Welfare Accredited Full Institutional Members of the Zoo and Aquarium Association of Australasia [ZAA].

The ZAA has general guidelines covering the well-being of zoo animals.

Additionally, many Australian States have adopted the NSW Standards for Exhibiting Carnivores in NSW as secondary legislation. These Standards require Puma to be kept in a roofed enclosure with a minimum area of 200 square metres and a mesh roof at least 3 metres high. All zoos receiving Pumas following this application will provide housing in excess of the NSW requirements.

Each enclosure will be of a permitted size to hold a pair of this species but provision will be built in to permit separation of individual specimens as required.

Further to the prescribed spatial Standards, Puma enclosures will be appropriately vegetated and contain a variety of environmental enrichment furniture such as rocks, logs and varying substrate.

Keepers will not be permitted to access the same space as the animals. Access will be via an airlock arrangement into an empty enclosure. A Felidae SOP will outline procedures that keepers must follow for all management and husbandry procedures.

There will be no visitor interaction with this species.

Visitor viewing will be from one side of the enclosure only.

Visitors will be kept a minimum distance of 2 metres back from the enclosure by a 1200 high stand-off fence.

The zoo premises are surrounded by a security fence with locked access gates.

There is 24 hour, live-in, human security presence backed by after-hours guard dogs presence.

Other security measures are classified.

- **State/Territory controls**

Pumas have a long history of being kept and bred in Australia, both in public zoos and in private facilities (circuses, animal training facilities, private licenced collections). All the major Australian zoos have kept, and most have bred, Pumas (e.g. Melbourne, Taronga, Adelaide, Perth), as well as smaller public collections having kept them. Currently there is one elderly Puma left in the country, in a non-public facility.

*The Australian Government's "List of Specimens taken to be Suitable for Live Import" does not currently include Puma.
https://www.legislation.gov.au/Details/F2017C00434

*In Queensland the *Exhibited Animals Act 2015* does not cover the Puma (or any species specifically) but allows a licence holder to "Exhibit and deal with animals listed on this authority in accordance with information assessed and approved in deciding the application and details listed on this authority". Pumas have been kept in Queensland until recently, with two animals which died of old age in 2016 and 2018 respectively.

https://www.legislation.qld.gov.au/view/pdf/2017-07-03/act-2015-005

*In New South Wales the *Non-Indigenous Animals Regulation 2012* lists the Puma as a Category 2 species (under the scientific name *Puma concolor* and the common name of Puma). Species in this Category are restricted to licenced facilities. This regulation allows these species to be kept in zoos with a permit to be issued by the relevant state authority for possession of the species. Pumas have a long history of being kept and bred in zoological institutions in New South Wales, both in public zoos and private licenced facilities. Currently there is one Puma still kept in captivity in New South Wales.

https://www.legislation.nsw.gov.au/regulations/2012-405.pdf

*In Victoria the *Catchment and Land Protection Act 1994* lists the Puma under Schedule 2 as a Controlled Pest Animal (under the scientific name *Puma concolor* and the common names of Cougar, Puma, and Mountain Lion). Species listed in Schedule 2 are allowed to be kept in zoos with a permit to be issued by the relevant state authority for possession of the species. Pumas have a long history of being kept and bred in zoological institutions in Victoria, but there are currently none being kept in this State.

http://www.legislation.vic.gov.au/domino/Web_Notes/LDMS/LTObject_Store/ltobjst10.nsf/DDE300B846EED9C7CA257616000A3571/1B88C214FAD7CE39CA2581F7000236BB/$FILE/94-52aa057%20authorised.pdf

http://www.gazette.vic.gov.au/gazette/Gazettes2010/GG2010S399.pdf

*In South Australia the *Natural Resources Management Act 2004* lists the Puma under Category 1 of Schedule 1 (under the scientific name *Felis concolor* and the common names of Puma and Cougar). Species listed as such are allowed to be kept in zoos with a permit to be issued by the relevant state authority for possession of the species. Pumas have a long history of being kept and bred in zoological institutions in South Australia, but there are currently none being kept in this State.

http://www.pir.sa.gov.au/__data/assets/pdf_file/0003/137460/Declaration_of_Animals_and_Plants_Jan_2015.pdf

*In Western Australia the *Biosecurity and Agricultural Management Act 2007* lists the Puma under Category C1 as a Prohibited Organism, which allows a species to be kept in zoos with a permit to be issued by the relevant state authority for possession of that species. Pumas have been kept in the past at zoological institutions in Western Australia, but there are currently none being kept in this State.

The *Biosecurity and Agricultural Management (Prohibited Organisms) Declaration 2013* is available at the following link (where this species is listed solely under the scientific name *Puma concolor*): https://www.agric.wa.gov.au/sites/gateway/files/BAM%20Decl%20s22%20%28Prohibited%20Organisms%29.pdf

The Western Australian Organism List is searchable online at the following link for the most current results (where this species is listed under the scientific name *Puma concolor* and the common names of Puma, Mountain Lion, and Cougar): https://www.agric.wa.gov.au/organisms

*In Tasmania the Puma has not been risk-assessed for the State. There is no record of Pumas having previously been held in captivity in Tasmania.

https://www.legislation.tas.gov.au/view/html/inforce/current/act-2002-063

List of species which have been risk-assessed for Tasmania: http://dpipwe.tas.gov.au/wildlife-management/management-of-wildlife/wildlife-imports/species-risk-assessments

*In the Northern Territory all non-native wildlife is classed as a "Prohibited Entrant" and applications for keeping these species (which would include the Puma) are assessed on a case-by-case basis. There is no record of Pumas having previously been held in captivity in the Northern Territory.

https://nt.gov.au/environment/animals/wildlife-permits/prohibited-wildlife

*In the Australian Capital Territory there doesn't appear to be any specific legislative status of exotic zoo species. Pumas were held in captivity in this State until 2016 when the last one died of old age.

Biosecurity Australia has an existing comprehensive set of quarantine requirements for the importation of live exotic Felidae for zoos, which would cover Pumas should they be imported.

http://www.agriculture.gov.au/biosecurity/risk-analysis/animal/zoo-felidae

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