The IUCN Red List of Threatened Species™
ISSN 2307-8235 (online)
IUCN 2008: T22732A50664030
Scope: Global
Language: English

Panthera uncia, Snow Leopard

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View on www.iucnredlist.org

Citation: McCarthy, T., Mallon, D., Jackson, R., Zahler, P. & McCarthy, K. 2017. *Panthera uncia. The IUCN Red List of Threatened Species 2017*: e.T22732A50664030. http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T22732A50664030.en

Taxonomy

Kingdom	Phylum	Class	Order	Family
Animalia	Chordata	Mammalia	Carnivora	Felidae

Taxon Name: *Panthera uncia* (Schreber, 1775)

Synonym(s):

- *Felis uncia* Schreber, 1775
- *Uncia uncia* (Schreber, 1775)

Common Name(s):

- English: Snow Leopard, Ounce
- French: Léopard des neiges, Once, Panthère des neiges
- Spanish: Pantera de la Nieves

Taxonomic Notes:

Formerly this species was placed in the genus *Uncia* but it is now assigned to *Panthera* according to genetic analysis (Johnson *et al.* 2006). It is most closely related to the tiger *Panthera tigris*, having diverged over two million years ago (O'Brien and Johnson 2007). Two subspecies have been named based on minor morphological differences (Medvedev 2000) but have not been confirmed by genetic analysis.

Assessment Information

Red List Category & Criteria: Vulnerable C1 ver 3.1

Year Published: 2017

Date Assessed: November 8, 2016

Justification:

The Snow Leopard is assessed as Vulnerable because the global population is estimated to number more than 2,500 but fewer than 10,000 mature individuals, and there is an estimated and projected decline of at least 10% over 22.62 years (3 generations). There have been five attempts to compile national estimates, of varying data quality, to determine global Snow Leopard global population size. Two sets contain estimates largely dating prior to 2003: 4,080-6,500 (McCarthy and Chapron 2003) and 3,920-6,390 (Snow Leopard Working Secretariat 2013). Two sets date from 2008-2010: 4,500-7,500 (Jackson *et al.* 2010) and 4,678 to 8,745 (a compilation of individual population estimates for prime habitat covering about 1/3 of likely extant range developed at an expert mapping workshop in 2008 but not available until 2016: McCarthy *et al.* 2016). The most recent set of national estimates comes from country chapters in the comprehensive book *Snow Leopards*: 7,463 to 7,980 (McCarthy and Mallon 2016, Thinley *et al.* 2016: Table 1 in the Supporting Information). While all these sets of estimates exclude dependent cubs, a population modelling exercise was carried out in 2015 to exclude young adults which may not be capable of breeding (Appendix 2 in the Supporting Information). Model outputs for nine different scenarios were applied to the most conservative possible global population estimate available at the time (4,000), resulting in a number of mature individuals between 2,710 and

3,386. The number of mature individuals would be roughly double if applied to the upper bounds of the more recent estimates published in 2016.

There is virtually no substantiated documentation of population trends over appropriate time scales; Snow Leopard numbers are reportedly stable or modestly increasing in some areas, but are likely to be declining in others, including recent localized extinctions which may have occurred in some areas of the former Soviet Union. A decline of at least 10% over the next 3 generations (22.62 years) is estimated given the growing threat related to increasing livestock numbers in some countries or emerging threats like intensified road construction and mineral extraction. Although poaching appears to have declined since the late 1990s, Nowell *et al.* (2016) estimated that 221-450 Snow Leopards were poached annually since 2008 (based on extrapolation of cases known to over 40 surveyed experts); these were attributed to retaliation for actual or perceived livestock depredation, but this supposition is not substantiated by hard evidence. With the average rate of poaching detection estimated by experts at less than 38%, these numbers could be substantially higher. If these poaching estimates are anywhere near accurate, this suggests that roughly 2-10% of the population could be poached annually. While a direct relationship between offtake and a population decline is not clear, even at the magnitude reported by Nowell *et al.* 2016, it adds to the plausibility of a 10% decline over 3 generations (22.62 years).

Approach to Uncertainty
The IUCN Red List Criteria are designed to incorporate the use of inference, suspicion and projection, to allow taxa to be assessed in the absence of detailed and complete data, which are rarely available across the entire range of a taxon; the absence of high-quality data should not deter attempts at applying the criteria (IUCN Standards and Petitions Subcommittee 2016). Throughout this assessment, we have attempted to show the degree to which we have dealt with uncertainty stemming from the paucity of data for this elusive and secretive species. To ensure this assessment is both “precautionary and credible," as specified by IUCN (2012), a range of values as well as best estimates were considered for the critical parameters, including those used in modelling the number of 'mature individuals' (MI) in the population. Specifically, the model dealt with uncertainty by including a variety of scenarios with cats maturing between 2 to 4 years of age, and then applied the resultant MI percent to the lowest published population estimate which, contrary to convention, included dependent yearlings (Appendix 2 in the Supporting Information). Here, even the very lowest bound of the estimated range of mature individuals did not fall within the threshold for the Endangered category.

It is acknowledged that precise and robust estimates of Snow Leopard density are difficult to obtain, are available for only a limited proportion of the global range, and represent small study sites selected for their suitability for the species. Because extrapolation to larger areas or even range-wide would be tenuous, we have avoided doing so in all cases. Estimates of Snow Leopard population size based on rigorous study design and survey methodology are sparse. The national population estimates cited here are considered to be the best available, following advice in the Red List Guidelines: “**The plausible range may be established using…… the opinion of a single expert, or the consensus view of a group of experts**” (IUCN Standards and Petitions Subcommittee 2016).

There is also a lack of hard data on overall population trends, which hinders estimates of the magnitude of any decline which rely on fragmentary evidence and are therefore largely speculative. Nonetheless, the evidence considered does not suggest that the situation has deteriorated since 2008, which would be needed to justify an Endangered listing under criterion C1.

Reasons for Change in IUCN Red List Status

The previous assessment in 2008 (Endangered C1) was based on <2,500 mature individuals and an estimated decline of 20% over 16 years (two generations). However, in that assessment, effective population size (Ne) was incorrectly used as a surrogate for 'mature individuals' and produces a lower figure (50% of the adult population of 4,080). Therefore, the species should have been listed as Vulnerable in 2008.

Moreover, given the apparent limits to dispersal (Riordan *et al.* 2015), it is questionable whether such a small number of individuals capable of breeding (and therefore fewer actually breeding) is demographically viable over such an extensive range. Recent survey information indicates that Snow Leopard densities in several areas are higher than previously believed, implying that the overall population size is also likely to be larger than the minimum estimates (Jackson *et al.* 2010, SLSS 2014, McCarthy and Mallon 2016). The revised estimate of the number of mature individuals addressed the earlier mistake, in combination with new information, and the change from EN to VU is therefore a non-genuine change.

The estimated 20% decline over 16 years in 2008 included a documented upsurge in poaching for skins and body parts in the countries of Central Asia, following the break-up of the Soviet Union around 1991. While this threat has since subsided, it is unlikely to have completely disappeared. The other traditional threats still exist, alongside emerging potential threats such as mining and other infrastructure development (roads, railroads, hydro-dams, etc.), some of which will have intensified in recent years (summaries in Snow Leopard Network 2014, McCarthy and Mallon 2016).

There have also been very significant investments in conservation measures to reduce threats or to mitigate their effects. These include: establishment of new protected areas in Snow Leopard range; more effective anti-poaching measures; training and capacity-building of range country conservation professionals; a number of independent initiatives to reduce conflict with herders (e.g., strengthening livestock corrals, vaccination, handicrafts and alternative livelihoods, grazing set-asides); community engagement programmes; the illegalization of guns in China since 1989; and education programmes to raise awareness of the Snow Leopard and its habitat (see the *Conservation Measures* section for more details and examples). The Rangewide Priority Setting workshop in Beijing in 2008 (Sanderson *et al.* 2016), the Global Snow Leopard and Ecosystem Protection Program (Snow Leopard Working Secretariat 2013) and the revised version of the Snow Leopard Survival Strategy (Snow Leopard Network 2014) have all enhanced the global strategic framework.

Although the Snow Leopard undoubtedly is still threatened, the measures listed above are collectively considered to have contributed to improving the overall conservation situation for Snow Leopards since 2008. The generation length of 8 years used in 2008 has been revised to 7.54 years following Pacifici *et al.* (2013). There is no current evidence to support a decline of 20% over such a short period of 15.08 years, as needed to support a listing as Endangered, and which would represent a steeper decline and therefore a deterioration in the situation since 2008. However, in view of the existing and emerging threats, a decline of 10% or more over 22.62 years (three generations) is considered plausible (starting in 2014). This change in the estimated rate of decline is the result of conservation actions taken, so potentially could qualify as genuine change and on this basis IUCN's 5-year waiting period would apply, dated from the first draft of this assessment (June 2014). However, since the EN category in 2008 was incorrect, the species should have been listed as VU in 2008, the change in category is therefore non-genuine.

For further information about this species, see Supplementary Material.

Previously Published Red List Assessments

2008 – Endangered (EN)
http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T22732A9381126.en

2002 – Endangered (EN)

1996 – Endangered (EN)

1994 – Endangered (E)

1990 – Endangered (E)

1988 – Endangered (E)

1986 – Endangered (E)

Geographic Range

Range Description:

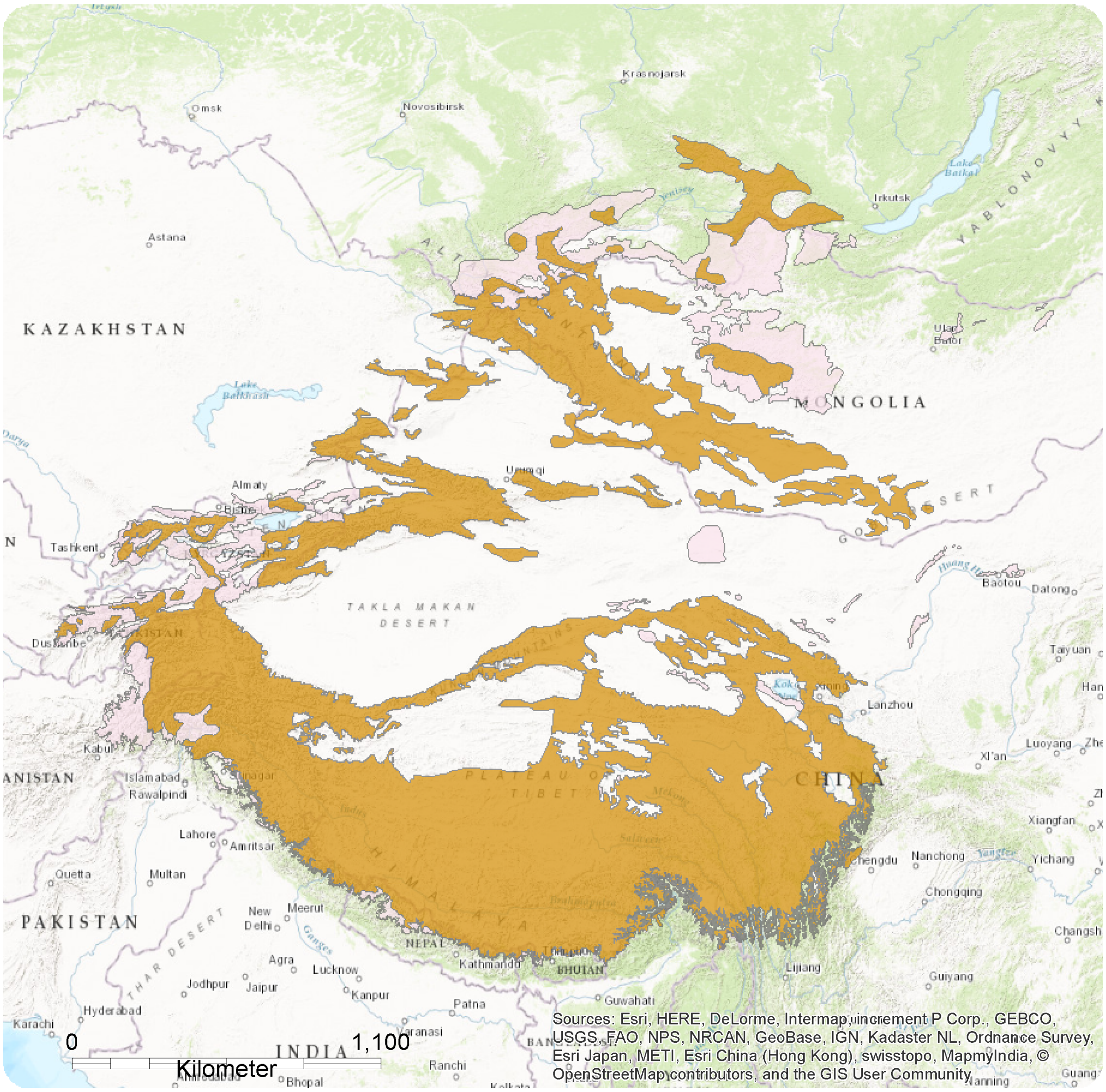
The range of the Snow Leopard extends from the Himalaya in the south, across the Qinghai-Tibet Plateau and the mountains of Central Asia to the mountains of southern Siberia in the north. It occurs in the Altai, Sayan, Tien Shan, Kunlun, Pamir, Hindu Kush, Karakoram, and outer Himalayan ranges and in smaller isolated mountains in the Gobi region. It occurs in 12 countries: Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russia, Tajikistan and Uzbekistan. A small area of potential range occurs in northern Myanmar but recent Snow Leopard presence has not been confirmed. The area of occupied range was recently estimated to be about 2.8 million km^2 (McCarthy *et al.* 2016).

Country Occurrence:

Native: Afghanistan; Bhutan; China (Gansu, Nei Mongol, Qinghai, Sichuan, Tibet [or Xizang], Xinjiang, Yunnan); India (Arunachal Pradesh, Himachal Pradesh, Jammu-Kashmir, Sikkim, Uttaranchal); Kazakhstan; Kyrgyzstan; Mongolia; Nepal; Pakistan; Russian Federation; Tajikistan; Uzbekistan

Distribution Map

Panthera uncia



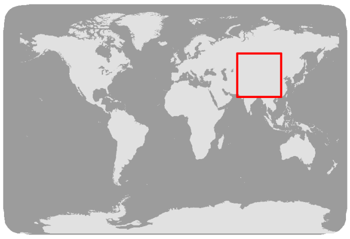
Range

Extant (resident)

Possibly Extant (seasonality uncertain)

Compiled by:

Panthera, Wildlife Conservation Society, Snow Leopard Trust, Snow Leopard Network



The boundaries and names shown and the designations used on this map do not imply any official endorsement, acceptance or opinion by IUCN.

Population

There are no robust estimates of Snow Leopard global population size and the various figures available are best regarded as guesses: 4,080-6,500 (McCarthy and Chapron 2003); 4,500-7,500 (Jackson *et al.* 2010), and 3,920-6,390 (Snow Leopard Working Secretariat 2013). There are several difficulties to overcome in making reliable estimates of Snow Leopard population size (Snow Leopard Network 2014), namely this species' secretive nature, generally low density, sparse (or sporadic) distribution and remote terrain contributing to generally low detection rates and small sample sizes that in turn may make extrapolation problematic. Until recently, most studies were conducted over rather small areas, sometimes smaller than the home range of a single Snow Leopard, rendering the information inadequate to make population and density inferences over larger areas (Appendix 1 in Snow Leopard Network 2014). Furthermore, not all studies report the size of the surveyed area, thus precluding generation of density estimates. These limitations are starting to be addressed, for example through the adoption of more robust methods, such as spatially-explicit recapture models from camera data (e.g., Shrestha *et al.* 2013, Thinley *et al.* 2014, Alexander *et al.* 2015). Additionally, recently published information includes relatively rigorous surveys conducted over larger areas (see below).

Snow Leopards are known to breed at 2 or 3 years of age (Leif Blomqvist, International Snow Leopard Studbook Keeper, Helsinki Zoo, pers. comm., Jay Tetzloff, US Association of Zoos and Aquariums Snow Leopard Species Survival Plan Coordinator, pers. comm., McCarthy and Chapron 2003). Field observations are consistent with Snow Leopards breeding at 2 or 3 years of age. Of two known-age females in a long-term radio-telemetry study of Snow Leopards in Mongolia, one gave birth at the age of 3 years and the other at age 3 or 4 years (O. Johansson, pers. comm. and Panthera/Snow Leopard Trust unpublished data). Since breeding occurs in February/March and birth occurs in May/June, this means that one female definitely bred at age 2 years and the second bred when either 2 or 3 years old. Two other females of estimated age in the same study likely gave birth when 3-4 years old, again indicating successful breeding at 2-3 years old. Sexual maturity and breeding at 2-3 years old appears to be consistent across a range of large wild felids (Berry *et al.* 1997, Hunter 1998, Kelly *et al.* 1998, Balme *et al.* 2012, Hunter *et al.* 2013, Miller 2013, Miller and Funston 2014).

The IUCN Red List guidelines (IUCN Standards and Petitions Subcommittee 2016) define 'mature individuals' as individuals known, estimated or inferred to be capable of reproduction. The guidelines also state that age of first reproduction in the wild may be later than the age at which an individual is biologically capable of breeding. Hence, mature individuals in the Red List context are those capable of breeding, not just those actually breeding in any given year. Snow Leopards are capable of breeding beginning at 2 years of age and thus meet the IUCN definition of mature individuals, even if they do not actually start to breed this young.

Estimating the percent of mature individuals (≥ 2 years of age) in the wild Snow Leopard population has been historically difficult, but with the extensive application of camera trapping new information is available. In 21 camera trapping studies conducted in 6 countries between 2003 and 2014 and comprising more than 29,165 trap-nights, a mean of 82.3% of Snow Leopards captured in photos were independent animals (Appendix 1 in the Supporting Information). Snow Leopards become independent at between 18 and 26 months old, hence, a small percent of independent cats in camera trap photos may not yet have reached the mature age class (2-year olds).

With few exceptions, published felid population estimates do not include dependent cubs. Camera-trapping derived density estimates are an example where exclusion of cubs applies. The global population estimate of 4,080-6,590 Snow Leopards (McCarthy and Chapron 2003) only includes mature individuals. Similarly, the 2008 Red List assessment (Jackson *et al.* 2008) for Snow Leopard states that the population estimate is for adults only and the authors calculate effective population size (2,040) as 50% of the estimated total number of adults (4,080), citing Nowell *et al.* (2007). Hence, for the purposes of estimating the percent of mature individuals, published Snow Leopard population estimates should be considered to be comprised of adults only.

Population modelling can be used to estimate the percent of individuals in each age class. McCarthy *et al.* 2015 (Appendix 2 in supplementary material) employed a stochastic age-structured population model to produce a suite of stable stage population matrices. Vital rate input variables included the age at which Snow Leopards become capable of reproduction (mature), and the percentage of each age class that actually bred. The proportion of yearlings in the population estimate varied in the model from 0% to 50%. The model was run using nine scenarios of various combinations of vital rates and percentages of yearlings in the population. The lowest percentage of mature individuals (MI) was obtained when 2-year old maturity rates were lowest (25%), actual breeding did not begin until age 3, and the proportion of cubs in the population estimate was highest (50%). Yet even in that most precautionary scenario a mean MI of 67.7% (s.d. = 2.07) was obtained. Applying that MI percent to the most conservative global population estimate of 4,000 individuals, yields 2,710 (s.d. = 83) mature individuals. Model outputs for all nine scenarios when applied to this minimum population of 4,000 ranged from 2,710 to 3,386 MI. In no case did MI fall below the threshold required for an Endangered designation for the species.

A population of < 2,500 mature individuals distributed across 1,776,000 km² (taking a relatively conservative estimate of global range size from Snow Leopard Working Secretariat 2013) or a maximum of 3,300,000 km² (Snow Leopard Network 2014) equates to a density of one Snow Leopard capable of reproduction per 710 km² or 1,320 km² respectively. We question how such a scenario would be demographically viable; and in fact, recent best-practice density estimates largely range from 1 to over 3 per 100 km² for areas surveyed to date (see below).

Doubt is also being cast on the lower estimates of the global Snow Leopard population size through the expansion of field surveys in recent years and the application of more sophisticated and reliable survey techniques (such as systematic camera trapping, faecal genotyping and satellite collaring). Recent studies have confirmed the presence of Snow Leopards in new areas or their reappearance in former areas. Snow Leopards returned to the Sagarmatha area, Nepal, in 2002-2003 after an absence of *ca* 25 years (Lovari *et al.* 2009, Ferretti *et al.* 2014). Snow Leopard presence in the Vakhan Range of Tajikistan was confirmed by camera-trapping for the first time in 2011 (Diment *et al.* 2012) and in the Kizilsu area of the Gissar Nature Reserve in Uzbekistan in 2013 (Panthera, unpublished data). In other areas, studies have indicated stable or even circumstantial evidence of increasing populations. In Wakhan District (10,000 km²) in Afghanistan, the National Environmental Protection Agency reports that numbers of Snow Leopards and one of their main prey, argali *Ovis ammon*, have increased in recent years (www.khaama.org 06 August 2015). The Snow Leopard population in Tost Uul, South Gobi, Mongolia, has been the object of the most intensive (and reliable) research to date using satellite collaring and camera trapping and was reported to be stable during the course of four years of study (Sharma *et al.* 2014). This site was completely unprotected until recently.

A review of the majority of camera trap and genetic surveys to date indicate densities in excess of 1.5 adults per 100 km². Densities of 0.87-2.85 and 0.32-1.62 per 100 km² were reported at two sites in the Eastern Pamirs (Kachel 2014). In Bhutan, there is a "bright future for Snow Leopards" (Wangchuk and Tharchen 2016) and density in Wangchuk Centennial Park, Bhutan was estimated at 2.39/100 km² by Shrestha *et al.* (2013). Thinley *et al.* (2014) found even higher densities in Bhutan's Jigme Dorji National Park (6.2/100 km²) and estimated that the protected area could harbour as many as 192 Snow Leopards, which is nearly equal to the high end of the estimate for the entire country (200). At six sites in Ladakh-Spiti, India, densities were 0.45, 0.74, 1.17, 1.66, 1.94, and 3.3 per 100 km² (Suryawanshi *et al*. 2013). Density in Sarychat-Ertash State Reserve, Kyrgyzstan, was 1.38 per 100 km² (Jumabay-uulu *et al.* 2014), which is a reserve that Koshkarev and Vyrypaev (2000) pointed to as having been 'absolutely trapped out', with surveys in 1999 finding no sign of Snow Leopards after the post-Soviet declines earlier that decade.

In China, Snow Leopard presence has been confirmed at numerous locations across all parts of the range, including areas where the species was thought to have disappeared such as Inner Mongolia (Riordan and Shi 2016). The Second National Biodiversity Survey of China being undertaken by the State Forestry Administration suggests that there have been improvements for Snow Leopard and their ecosystems across the country since the first assessment reported in 1995. Snow Leopard populations in the Sanjiangyuan region are believed to have increased in the last 20 years along with those of a major prey species, Blue Sheep (*Pseudois nayaur*) (Liu *et al.* 2016). Camera-trap surveys in Suojia (also in Sanjiangyuan) indicated densities of 3.1/100 km² (Li 2012). Alexander *et al.* (2015), using spatially-explicit recapture models, reported 3.31 Snow Leopards/100 km² in the Qilian Shan range, where surveys in the 1980s suggested densities < 1/100 km². Schaller (2014) resurveyed portions of the Qilian Shan range in Qinghai 29 years after he first surveyed the area and although direct comparisons were not made they saw more Snow Leopard sign and more Blue Sheep in their recent surveys. Qinghai Forestry Department recently increased their estimate for the province to at least 1,000 individuals based on camera trapping surveys (Liu *et al.* 2016). Riordan and Shi (2016) estimate Snow Leopard populations for each province in China, totalling at least 4,500 for the whole country. Since China contains c. 60% of the overall range this figure implies that the global population may possibly reach 7,500, broadly in line with the upper estimates described above. The current situation for Snow Leopard in China is a result of new information emerging as survey effort improves, as well as positive effects of the illegalization of firearms in China in 1989, along with hunting bans in key provinces, and greater awareness of the national importance of Snow Leopards.

Some, but not all, of the recent studies have been in protected areas or locations thought to have good populations of Snow Leopards, so densities might be higher there than elsewhere, and thus these figures are not easily extrapolated to the entire range. However, taken together, and considering the widely spread localities within the overall distribution of Snow Leopards, these figures do seem to suggest that the global population size is closer to the upper end of the estimates cited above, rather than the lower end.

Two sets of global population estimates published in 2015, after the modelling exercise in Appendix 2 (in the Supporting Information) was carried out, also suggest that Snow Leopard numbers are higher than previously estimated in 2003. In 2008, an expert knowledge process was used to map current Snow Leopard range and identify important Snow Leopard Conservation Units (SLCUs) within that range

(McCarthy *et al.* 2016). Experts from all range states and global experts participated and identified 69 SLCUs. Adequate information was available to estimate Snow Leopard population size in 56 SLCUs, placing it at 4,678 to 8,745 adults and large sub-adults within an area of 875,818 km², or about 31.5% of currently occupied range. The population trend was considered to be stable or increasing in 33 (48%) of SLCUs and decreasing in only 15 (22%), while no information on trend was reported by experts in 11 (30%) of the units. Notably, experts indicated that most population and trend estimates they provided came from recent research as opposed to previous 'guesstimates' lacking field-based evidence.

With the recent publication of the first ever comprehensive book on the species (McCarthy and Mallon 2016), additional light has been shed on current Snow Leopard population estimates in most of the 12 range countries. National experts authored individual chapters providing updates on the status of the species in their home countries. With the exception of Bhutan those chapters included current population estimates; taking the high and low values of the population ranges provided (Table 1 in the Supporting Information) a range-wide population of 7,367-7,884 is indicated. If the results of the 2014-2016 Bhutan Snow Leopard census are added in (79-112: Thinley *et al.* 2016), the global population would then be estimated at 7,446 to 7,996. This indicates that Snow Leopards are likely more numerous than historic estimates suggest, perhaps substantially so. It should be noted that this represents better knowledge and not necessarily a population increase.

There is little evidence to indicate that small-scale fragmentation and lack of connectivity are significant issues, despite the typically insular nature of mountain habitat and the species' preference for steep or broken terrain. Most of Snow Leopard range is more or less contiguous and it is difficult to delimit separate subpopulations (Jackson, unpub. data; Janecka, unpub. data); furthermore, other than major rivers along the periphery of Snow Leopard range, some border fences, and short sections of railroads or major highways, there currently appear to be few major barriers to restrict movement. The Mongolia telemetry study has confirmed that Snow Leopards are capable of crossing open habitat (desert plains) in excess of 100 km (Panthera/SLT unpublished data) and Snow Leopards have been encountered attempting to cross the Chinese Gobi Desert in Inner Mongolia on at least three occasions (Riordan *et al.* 2015, Nei Mongol Wildlife Division, pers. comm). Riordan *et al.* (2015) used resistant kernel modelling to assess connectivity and predicted two regional populations, in the north and south of the species range, and identified several potentially important connecting areas. Snow Leopard range in Nepal lies in five "relatively contiguous habitat blocks" (Ale *et al.* 2016); in Pakistan, there is "confirmed presence over large landscapes" (Ud-Din and Nawaz. 2016); the range in Bhutan is virtually contiguous across the whole of the north of the country (Wangchuk and Tharchen 2016); in Sanjiangyuan region, a key Snow Leopard habitat in China, "there are abundant connections between important habitats" (Li 2012, Liu *et al.* 2016).

Current Population Trend:
Snow Leopard numbers are reportedly stable or modestly increasing in some areas, but are likely to be declining in others. Recent localized extinctions may have occurred in some areas of the former Soviet Union (Taubmann *et al.* 2016). Evidence of increased or re-established populations described above may in some cases be a consequence of enhanced survey effort in previously unsurveyed areas, although conservation actions and policies will have no doubt helped. However, there remains a lack of sufficiently longitudinal surveys, except in very few sites, and thus we have virtually no substantiated documentation of population trends over appropriate time scales. This is an information gap that urgently needs to be filled in order to validate this and all future Red List assessments and provide a

reliable basis from which to evaluate conservation actions and measure their impact.

Population Reduction - Past

Population reductions in the Central Asian republics—which represent only 7% of the global occupied range (McCarthy *et al.* 2016)—following the collapse of the Soviet Union are thought to have been as high as 40-75% during the 1990s. There is no evidence to indicate such high rates of decline continued beyond the late 1990s.

Population Reduction - Future

Recent surveys in Pakistan suggest that Snow Leopard numbers in parts of the country may be lower than previously thought (Snow Leopard Foundation, unpublished reports, Nawaz and Hameed 2015) and may experience further decline in the future. Localized extinctions, such as those documented by Taubmann *et al.* (2016) in parts of the Alay region of Kyrgyzstan, may be expected in other isolated sites in Central Asia. There are also growing threats from extractive industries across the species' range and potential impacts from climate change which may influence population trends. Despite positive conditions described previously, a decline of 10% over the next 3 generations (22.62 years) is estimated in light of localized declines given the growing threat related to increasing livestock numbers in some countries or emerging threats like intensified road construction and mineral extraction (see below). However, projecting rural development more than 3-5 years into the future is difficult, even in countries with well-articulated 5-10 year Development Plans, environmental impact laws or robust protocols for forecasting economic growth.

Population Reduction - Ongoing

Current reductions appear to be modest and local, likely driven by a declining natural prey base, localized poaching for skins, and sporadic but apparently increasing human-wildlife conflict resulting from depredation of livestock. Growing flocks of sheep and goats and a thriving meat (e.g., Nepal and Pakistan) and cashmere trade (China and Mongolia) appear to lie at the root of these inter-connected threats (Berger *et al.* 2013). However, where not mitigated, the mix of livestock-wild ungulate competition, associated rangeland degradation, declining natural prey numbers and Snow Leopard predation of livestock would likely accelerate retributive killing by herders, who could also be expected to offset their economic losses by funnelling Snow Leopard body parts into the illegal trade network.

For further information about this species, see Supplementary Material.

Current Population Trend: Decreasing

Habitat and Ecology (see Appendix for additional information)

Snow Leopards inhabit mountainous rangelands at elevations of 3,000 to over 5,000 m in the Himalaya and Tibetan Plateau, but can occur as low as 500 m in the Altai (Snow Leopard Network 2014). Wild caprids are the principal natural prey of Snow Leopards, especially Blue Sheep (*Pseudois nayaur*) and Siberian Ibex (*Capra sibirica*), whose distribution coincides closely with Snow Leopard range. Argali (*Ovis ammon)* and Markhor (*Capra falconeri*) are also important prey in some areas. Primary productivity in Snow Leopard habitat is relatively low due to low temperatures and high aridity, consequently, the density of ungulate prey also tends to be relatively low, with reports ranging from 0.9 to 10.2 animals per km^2 (e.g., Suryawanshi *et al.* 2013, Mallon *et al.* 2016). Wild prey abundance is one of the main determinants of Snow Leopard abundance (Suryawanshi *et al.* 2013).

Snow Leopard diet is dominated by wild caprids, reportedly contributing 45% to 98% of the diet, while livestock may contribute 40-70%, though generally more on the order of 15-30% (Schaller *et al.* 1987, Oli *et al.* 1994, Chundawat and Rawat 1994, Jackson 1996, Bagchi and Mishra 2006, Anwar *et al.* 2011, Shezad *et al.* 2012, Jumabay-Uulu *et al.* 2014, Suryawanshi *et al.* 2013, Mallon *et al.* 2016). Smaller prey reported in Snow Leopard diet (approximately 12–25%) include marmots (*Marmota* spp.), pika (*Ochotona* spp.), hares (*Lepus* spp.), small rodents, and birds. It appears that the contribution of small sized prey in Snow Leopard diet may have been overestimated in earlier studies due to inadvertent inclusion of scats of other carnivores such as foxes (*Vulpes* spp.) in the analyses of Snow Leopard diet. Results of recent studies that have confirmed the identity of scats through faecal DNA (e.g., Anwar *et al.* 2011, Jumabay-Uulu *et al.* 2014, Suryawanshi *et al.* 2013) or examined prey DNA in scats (Shezad *et al.* 2012) report the contribution of small sized prey to be relatively low (2-8%).

Although Snow Leopards may occur in relatively flat or rolling areas such as in parts of Mongolia and the Tibetan Plateau (Schaller 1998, McCarthy 2000), within their habitat, they favour steep, rugged and broken terrain and rocky outcrops (Jackson *et al.* 2010). Mountain ridges, cliff edges, and well-defined drainage lines serve as common travel routes and sites for the deposition of signs, including scrapes, scats, and scent marks (Ahlborn and Jackson 1988).

There is substantial variation in the reported home range sizes of Snow Leopards. An earlier study in Nepal based on ground-based very high frequency (VHF) tracking reported home ranges of five individuals between 12 and 39 km², with substantial overlap between individuals and sexes (Jackson and Ahlborn 1989). However, the home range of a single Snow Leopard radio-collared in 2013 in Nepal using a satellite collar was estimated to be > 400 km² (Rinjan Shreshtha, WWF, pers. comm). McCarthy *et al.* (2005) reported home range size of four Snow Leopards based on VHF tracking in Mongolia to range between 13 and 141 km², while the satellite-monitored home range of one of these individuals in the same study was at least 15 times higher. In the most current and comprehensive study to have been undertaken, home ranges of 18 individuals monitored between 2008 and 2014 using Global Positioning System (GPS) Satellite telemetry in Mongolia ranged from approximately 100 to >1,000 km² (SLT, Panthera and SLCF, unpubl. data).

A four-year camera trapping study in Mongolia reveals considerable underlying dynamics in an otherwise stable population of Snow Leopards, with the adult sex ratio apparently changing from being male-biased to female-biased during the study period (1.67 to 0.38 males per female, Sharma *et al.* 2014). This is the first study to estimate vital rates including probabilities of immigration and emigration. The adult survival probability for the study population was estimated at 0.83 (Sharma *et al.* 2014).

Systems: Terrestrial

Use and Trade

Poaching and illegal trade has been a traditional threat and continues in many parts of the range. Currently, the demand for rugs, luxury décor, and taxidermy, especially from China and Eastern Europe appears on the increase (EIA 2012). In China, that holds the largest Snow Leopard population, trade in Snow Leopard pelt and bones, which was earlier restricted to Snow Leopard range provinces, is reported to also be emerging in the wealthier coastal cities since 2010 (Li and Lu 2014). The extent of illegal trade was reviewed by Maheshwari and Von Meibom (2016).

Threats (see Appendix for additional information)

Appendix 2 of the Snow Leopard Survival Strategy (Snow Leopard Network 2014) provides a global and country-by-country threat assessment based on the GSLEP-supported exercise drawing loosely on the Threats Reduction Assessment (TRA) protocol of Salafsky and Margoluis (1999) and involving select experts from each range country. McCarthy and Mallon (2016) include several chapters exploring well-known and emerging threats including livestock depredation, prey declines, disease, illegal trade, climate change, and resource extraction. There is considerable variation in the type and extent of threat among countries, especially with respect to large countries such as China or Mongolia where suitable habitat is extensive and split across different administrative regions. The main ongoing threats fall into three broad areas: 1) competition with livestock, habitat degradation and declines in prey; 2) depredation by Snow Leopards on livestock and retaliatory killing; 3) illegal trade in furs, bones and other body parts. New threats have been identified since 2003, including climate change, mining, large scale infrastructure and barriers such as roads or fenced railway lines (Wingard *et al.* 2014, Zahler 2016); however, the potential impact of these emerging threats on Snow Leopards or their habitat is as yet difficult to quantify. A further set of threats regarded as less severe at the range-wide level, or at least more localized, include the lack of awareness among local people and policymakers, insufficient institutional capacity and law enforcement, and limited transboundary collaboration.

Specific threats to particular populations are outlined below:

Recently Nowell *et al.* (2016) found that over 90% of annual Snow Leopard poaching is estimated to occur in five range countries: China (103-236 animals poached per year), Mongolia (34-53), Pakistan (23-53), India (21-45) and Tajikistan (20-25). While the highest levels of poaching and illegal trade are in China, which has the largest share of Snow Leopard range, countries with smaller shares of global range were flagged for having disproportionately high levels of estimated poaching (Nepal and Pakistan) and illegal Snow Leopard trade (Afghanistan and Russia). Afghanistan, Bhutan and Kazakhstan had markedly low levels of seizures compared to observations of poaching and illegal trade, suggesting the need for strengthened law enforcement in these countries (Nowell *et al.* 2016).

For further information about this species, see Supplementary Material.

Conservation Actions (see Appendix for additional information)

Very significant investments in conservation have been made. These include: establishment of new protected areas within the Snow Leopard range; anti-poaching measures; training and capacity-building; initiatives to reduce conflict with herders (e.g. strengthening livestock corrals, vaccination, handicrafts and alternative livelihoods, grazing set-asides), community engagement programmes; illegalization and confiscation of firearms across China, and education programmes to raise awareness of the Snow Leopard and its habitat (see Conservation Measures section for more details and examples). The Rangewide Priority Setting workshop in Beijing in 2008 (Sanderson *et al.* 2016), the Global Snow Leopard and Ecosystem Protection Program (Snow Leopard Working Secretariat 2013) and the revised version of the Snow Leopard Survival Strategy (Snow Leopard Network 2014) have all enhanced the global strategic framework for conservation of the species.

Illegal poaching, the main threat to Russia's Snow Leopard population, was recently alleviated, at least in several important areas, by concerted removal of wire-snares and the recruitment of former poachers as protected area rangers (Paltsyn *et al.* 2016). Anti-poaching efforts in Tajikistan, Kyrgyzstan and Kazakhstan have also been strengthened, thus addressing the main underlying threat that led to the drastic decline in numbers in several Central Asia states following the break-up of the Soviet Union 25 years ago.

In terms of protected area establishment and enhancement, the whole of Wakhan District Afghanistan (>10,000 km²) has been declared the country's second national park (Moheb and Paley 2016). Sarychat Ertash State Reserve, a key site in Kyrgyzstan, has recently been enlarged by 150 km² and mining concessions withdrawn (www.snowleopard.org 3 June 2015), and several projects have worked on management planning, training and monitoring and/ or provided substantial amounts of equipment (Hotham *et al.* 2016). Tost Uul, a key site in Mongolia's South Gobi, was declared a local nature reserve in 2010 (www.snowleopard.org, 4 October 2015). Capacity building in Zorkul State Reserve in the Eastern Pamir of Tajikistan includes development of a new management plan, training programmes, and substantial donations of equipment (Mallon and Diment 2013). The role of Buddhist monasteries in providing effective protection around monasteries was highlighted by Li *et al.* (2014). The GSLEP initiative, along with conservation practitioners have been highlighting customary beliefs of Snow Leopards as important totem animals for select traditional communities across this species' range.

A number of transboundary projects provide important conservation benefits to Snow Leopards across their range (Rosen and Zahler 2016). Two transboundary or landscape-level projects are currently operating in Central Asia (Mallon and Kulikov 2015): The Khan Tengri nature conservation park (3,257 km²) has been designated in eastern Kyrgyzstan that will link Naryn Reserve, Sarychat Ertash Reserve, and two others in Kyrgyzstan with Tomur Nature Reserve in China; a transboundary project is currently operating in the northern Tien Shan (Kyrgyzstan and Kazakhstan) with Snow Leopard as a focal species and with the aim of developing cooperation and enhancing protected areas. The UNDP/GEF Altai-Sayan Project (2007-2012) also identified the Snow Leopard as one of its focal species and carried out a series of transboundary projects including camera trapping, and training (WWF 2012).

Many incentive programs have been initiated (reviewed in Mishra *et al.* 2003 and see chapters in McCarthy and Mallon 2016). One oft-cited threat is the killing of Snow Leopards by herders in retaliation for predation on livestock, exacerbated by occasions when many sheep or goats are killed in a single attack by a Snow Leopard gaining entry to poorly constructed or maintained night-time corrals. Remedial measures have involved strengthening corrals to make them predator-proof. To date, over 260 corrals have been strengthened in Afghanistan, India, Pakistan and Tajikistan with the result that no subsequent livestock predation occurred (Mohammad *et al.* 2016, Moheb and Paley 2016). A similar programme in Western Tyva, Russia protected corrals in 46 herder camps, and since 2008 no predation occurred in any of them and annual losses of livestock fell by 50-60% (Paltsyn *et al.* 2016).

Innovative community programmes have been established in Afghanistan and Pakistan, with new governance structures created (over 65 in Pakistan) aimed at local natural resource management, and with over 50 rangers in the Afghan Wakhan and over 100 rangers in Gilgit-Baltistan, Pakistan monitoring wildlife and enforcing local and national regulations against poaching and other resource extraction activities (Zahler and Paley 2016). A programme has been pioneered by the Snow Leopard Trust in Mongolia and Kyrgyzstan to increase local incomes by providing training in the manufacture of handicrafts and access for the finished products to international markets in return for a commitment to prevent poaching of Snow Leopards and their prey and to engage in environmental education and other activities. These programmes have proved successful and have had additional benefits (Bayarjargal *et al.* 2016). In Kyrgyzstan, no Snow Leopards or prey were poached during 2014 in any of the partner communities (www.snowleopard.org 3 June 2015). Incentives related to ecotourism have led to a surge in Snow Leopard sightings in Hemis National Park, Ladakh (India), attributed to a combination of corral predator-proofing and meaningful income generation associated with community-managed homestays first initiated in 2007 (Jackson and Wangchuk 2004, Wangchuk *et al.* 2010, Jackson 2015, Namgail and Dadul 2016). With these local communities now perceiving Snow Leopards positively instead of pests to be killed or chased away, this notoriously elusive big cat is now being regularly observed from distances as close as 50-200 meters, especially during its mating season in winter.

In addition to these programmes, other conservation initiatives include grazing set-asides (village reserves; Mishra *et al.* 2016), livestock vaccination (Nawaz *et al.* 2016), livestock insurance (Kunkel *et al.* 2016) and a range of education and awareness projects (Hillard *et al.* 2016). Conservation initiatives that blend conservation science with traditional knowledge, and which mitigate Snow Leopard-related human-wildlife conflict, improve household incomes for households dependent upon livestock, and that highlight the cultural and ecological importance of Snow Leopards are also most likely to be embraced by local people who likely represent the effective and cost-efficient stewards for this felid's remote mountain landscapes (Jackson and Brewer-Lama 2016).

Credits

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Bibliography

Ahlborn, G.G. and Jackson, R. 1988. Marking in free ranging snow leopards in west Nepal: a preliminary assessment. In: H. Freeman (ed.), Fifth International Snow Leopard Symposium, pp. 25–49. India.

Ale, S., Shah, K. and Jackson, R. 2016. Conservation of snow leopard in Nepal. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 471-479. Elsevier, New York.

Alexander, J.S., Gopalaswamy, A.M., Shi, K. and Riordan, P. 2015. Face value. Towards robust estimates of snow leopard densities. *PLOS One* 10(8): e0134815. doi: 10.1371/jpurnal.pone.0134815.

Anwar, M.B., Jackson, R., Nadeem, M.S., Janečka, J.E., Hussain, S., Beg, M.A., Muhammad, G. and Qayyum, M. 2011. Food habits of the snow leopard *Panthera uncia* (Schreber, 1775) in Baltistan, Northern Pakistan. *European Journal of Wildlife Research* 57: 1077–1083.

Bagchi, S. and Mishra, C. 2006. Living with large carnivores: predation on livestock by the snow leopard (*Uncia uncia*). *Journal of Zoology (London)* 268: 217–224.

Balme, G.A., Batchelor, A. de Woronin Britz, N. Seymour, G., Grover, M., Hes, L., MacDonald, D.W. and Hunter, L.T.B. 2012. Reproductive success of female leopards *Panthera pardus*: the importance of top-down processes. *Mammal Review*.

Bayarjargal, A., Allen, P., Dashzeveg, U., Midgiddorj, Ts. and Snell-Rullman, J. 2016. Snow Leopard Enterprises, Mongolia. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 169-172. Elsevier, New York.

Berger, J., Buveibaatar, B. and Mishra, C. 2013. Globalization of the Cashmere Market and the Decline of Large Mammals in Central Asia. *Conservation Biology* 27: 678-679.

Berry, H., Bush, M., Davidson, B., Forge, O., Fox, B., Grisham, J., Howe, M., Hurlbut, S., Marker-Kraus, L., Martenson, J., Munson, L., Nowell, K., Schumann, M., Shille, T., Stander, P., Venzke, K., Wagener, T., Wildt, D., Ellis, S., and Seal, U. (eds). 1997. *Population and habitat viability assessment for the Namibian cheetah and lion. Workshop report*. IUCN/SSC Conservation Breeding Specialist Group, Minn.

Chapron, G. 2015. Modelling the proportion of Mature Individuals in Snow Leopard populations. Unpublished Report.

Chapron, G., Miquelle, D.G., Lambert, A., Goodrich, J.M., Legendre, S. and Colbert, J. 2008. The impact on tigers of poaching versus prey depletion. *Journal of Applied Ecology* 45(6): 1667-1674.

Chundawat, R.S. and Rawat, G.S. 1994. Food habits of the snow leopard in Ladakh. In: J.L. Fox and D. Jizeng (eds), 7th International Snow Leopard Symposium, pp. 127-132.

Devkota, B.P., Silwa, R. and Kolejka, J. 2013. Prey density and diet of snow leopard (*Uncia uncia*) in Shey Phoksundo National Park, Nepal. *Applied Ecology and Environmental Sciences* 1(4): 55-60.

Diment, A., Mallon, D.P. and Hotham, P. 2012. First biodiversity survey of Zorkul Reserve, Pamir Mountains, Tajikistan. *Oryx* 46: 13-14.

Environmental Investigation Agency. 2012. Briefing on snow leopards in illegal trade – Asia's forgotten cats. Environmental Investigation Agency (EIA).

Ferretti, F., Lovari, S., Minder, I. and Pellizzi, B. 2014. Recovery of snow leopard in Sagarmatha (Mt Everest) National Park: effects on main prey. *European Journal of Wildlife Research* 60: 559-562.

Harris, R.B. 2008. *Wildlife Conservation in China: Preserving the habitat of China's Wild West*. M.E.

Sharpe, London.

Heiner, M., Yunden, B., Kiesecker, J., Davaa, G., Ganbaatar, M., Ichinkhorloo, O., Von Wehrden, H., Reading, R., Olson, K., Jackson, R., Evans, J., McKenney, B., Oakleaf, J., Sochi, K. and Oidov, E. 2013. Identifying conservation priorities in the face of future development: applying development by design in the Mongolian Gobi. The Nature Conservancy, Ulaanbaatar.

Hillard, D., Weddle, M., Padmanabhan, S., Ale, S., Khuukhenduu, T. and Almashev, C. 2016. Environmental education for snow leopard conservation. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 245-255. Elsevier, New York.

Hotham, P., Howard, P., Nyul, H. and Whitten, T. 2016. Corporate business and the conservation of the snow leopard: Worlds that need not collide. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 277-289. Elsevier, New York.

Hunter, L., Henschel, P, and Ray J.C. 2013. *Panthera pardus* Leopard. In: Kingdon J, Hoffmann M (ed.), *Mammals of Africa. Volume V: Carnivores, Pangolins, Equids and Rhinoceroses*, pp. 159-168. Bloomsbury Publishing, London, UK.

Hunter, L.T.B. 1998. The behavioural ecology of reintroduced lions and cheetahs in the Phinda Resource Reserve, Kwazulu-Natal, South Africa. Ph.D. dissertation, University of Pretoria.

IUCN. 2012. *IUCN Red List Categories and Criteria: Version 3.1. Second Edition*. IUCN, Gland, Switzerland and Cambridge, UK.

IUCN. 2017. The IUCN Red List of Threatened Species. Version 2017-2. Available at: www.iucnredlist.org. (Accessed: 14 September 2017).

IUCN Standards and Petitions Subcommittee. 2016. Guidelines for Using the IUCN Red List Categories and Criteria. Version 12. Prepared by the Standards and Petitions Subcommittee. Available at: http://www.iucnredlist.org/documents/RedListGuidelines.pdf.

Jackson, R. and Ahlborn, G. 1989. Snow leopards (*Panthera uncia*) in Nepal - home range and movements. *National Geographic Research* 5: 161-175.

Jackson, R.M. 1996. Home range, movements, and habitat use of snow leopard (*Uncia uncia*) in Nepal. PhD thesis. London.

Jackson, R.M. 2015. HWC Ten Years Later: Successes and Shortcomings of Approaches to Global Snow Leopard Conservation. *Human Dimensions of Wildlife* 20: 310-316.

Jackson, R., Mallon, D., McCarthy, T., Chundawat, R.A. and Habib, B. 2008. *Panthera uncia*. The IUCN Red List of Threatened Species 2008. Available at: http://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T22732A9381126.

Jackson, R.M. and Brewer Lama, W. 2016. The role of mountain communities in snow leopard conservation. In: T. McCarthy & D. Mallon (eds), *Snow Leopards*, pp. 139-149. Elsevier, New Yotk.

Jackson, R.M. and Wangchuk, R. 2004. A community-based approach to mitigating livestock depredation by snow leopards. *Human Dimensions to Wildlife* 9: 307-315.

Jackson, R., Mishra, C., McCarthy, T.M. and Ale, S.B. 2010. Snow leopards, conflict and conservation. In: D.W. Macdonald and A. Loveridge (eds), *Biology and Conservation of Wild Felids*, pp. 417-430. Oxford University Press, Oxford, UK.

Johnson, W.E., Eizirik, E., Pecon-Slattery, J., Murphy, W.J., Antunes, A., Teeling, E. and O'Brien, S.J. 2006. The late Miocene radiation of modern Felidae: A genetic assessment. *Science* 311: 73-77.

Johnson, W. E., Eizirik, E., Pecon-Slattery, J., Murphy, W.J., Antunes, A., Teeling, E. and O'Brien, S.J. 2006. The Late Miocene radiation of modern Felidae: a genetic assessment. *Science* 33: 73-77.

Jumabay-Uulu, K., Wegge, P., Mishra, C. and Sharma, Koustubh. 2014. Large carnivores and low diversity of optimal prey: a comparison of the diets of snow leopards *Panthera uncia* and wolves *Canis lupus* in Sarychat-Ertash Reserve in Kyrgyzstan. *Oryx* 48: 529-535.

Kachel, S.M. 2014. Evaluating the efficacy of wild ungulate trophy hunting as a tool for snow leopard conservation in the Pamir mountains of Tajikistan. University of Delaware. MSc thesis.

Kelley, M.J., Laurenson, M.K., Fitzgibbon, C.D., Collins, D.A., Durant, S.M., Frame, G.W., Bertram, C.R. and Caro, T.M. 1998. Demography of the Serengeti cheetah population: the first 25 years. *Journal of Zoology* 244: 473-488.

Kerley, L. L., Goodrich, J. M., Miquelle, D. G., Quigley, H. B., Hornocker, M. G. and Smirnov, E. N. 2003. Reproductive parameters of wild female Amur (Siberian) tigers (*Panthera tigris altaica*). *Journal of Mammalogy* 84: 288-298.

Koshkarev, E.P. and Vyrypaev, V. 2000. The snow leopard after the break-up of the Soviet Union. *Cat News* 32: 9-11.

Kunkel, K., Hussain, S. and Khatiwada, A. 2016. A review of lessons, successes, and pitfalls of livestock insurance schemes. In: T.M. McCarthy and D.P. Mallon (eds), *Snow Leopards*, Elsevier, New York.

Li, J. 2012. Ecology and conservation strategy of snow leopard (*Panthera uncia*) in Sanjiangyuan area on the Tibetan Plateau. University of Peking. PhD thesis.

Li, J. and Lu, Z. 2014. Snow leopard poaching and trade in China 2000-2013. *Biological Conservation* 176: 207-211.

Li., J., Wang, D., Yin, H., Zhaxi, D., Jiagong, Z., Schaller, G.B., Mishra, C., McCarthy, T.M., Wang, H., Wu, L., Xiao, L., Basang, L., Zhang, Y., Zhou, Y. and Lu, Z. 2014. Role of Tibetan Buddhist monasteries in snow leopard conservation. *Conservation Biology* 28: 87-94.

Liu, Y., Weckworth, B., Li, J., Xiao, L. and Zhao, X. 2016. Conservation status and opportunities of snow leopard in the Sanjiangyuan region of the Tibetan Plateau. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 514-521. Elsevier, New York.

Lovari, S., Boesi, R., Minder, I., Mucci, N., Randi, E., Dematteis, A. and Ale, S.B. 2009. Restoring a keystone predator may endanger a prey species in a human-altered ecossystem: the return of the snow leopard to Sagarmatha National Park . *Animal Conservation* 12: 559-570.

Maheshwari, A. and von Meibom, S. 2016. Monitoring illegal trade in snow leopards (2003-2012). In: T.M. McCarthy and D.P. Mallon (eds), *Snow Leopards*, Elsevier, New York.

Mallon, D. and Diment, A. 2013. Biodiversity survey of Zorkul Nature Reserve, summer 2011. Fauna & Flora International, Cambridge, UK.

Mallon, D. and Kulikov, M. (compilers). 2015. Transboundary snow leopard conservation in Central Asia. Report of the FFI/CMS workshop, 1-2 December 2014. Fauna & Flora International and Convention on Migratory Species, Cambridge UK and Bonn, Germany.

Mallon, D., Harris, R.B. and Wegge, P. 2016. Snow leopard prey and diet. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 43-55. Elsevier, New York.

McCarthy, T. and Mallon, D. (eds). 2016. *Snow Leopards*. Elsevier, New York.

McCarthy, T.M. 2000. Ecology and conservation of snow leopards, Gobi brown bears, and wild Bactrian camels in Mongolia. University of Massachusetts.

McCarthy, T., Mallon, D., Sanderson, E. and Zahler, P. 2016. Biogeography and status overview. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 23-41. Elsevier, New York.

McCarthy, T.M. and Chapron, G. 2003. Snow Leopard Survival Strategy. Snow Leopard Trust and Snow Leopard Network, Seattle.

McCarthy, T., McCarthy, K. and Robinson, H. 2015. Modelling the number of mature individuals in the global snow leopard population: implications for the IUCN Red List status. Panthera, New York.

McCarthy, T.M., Fuller, T.K. and Munkhtsog, B. 2005. Movements and activities of snow leopards in Southwestern Mongolia. *Biological Conservation* 124: 527-537.

Medvedev, D.G. 2000. Morfologichskiye otlichiye isbisa iz yuzhnogo Zabaikalia . *Vestnik Irkutskoi Gosudarstvennoi Selskokhozyaistvennoi Akademii* 20: 20-30 [in Russian].

Miller, S.M. 2013. Population Viability Analysis for the Jaguar (*Panthera onca*) in the Northwestern Range. Unpublished report of the Conservation Breeding Specialist Group (SSC/IUCN) for the U. S. Fish and Wildlife Service.

Miller, S.M. and Funston, P.J. 2014. Rapid growth rates of lion (*Panthera leo*) populations in small, fenced reserves in South Africa: a management dilemma. *South African Journal of Wildlife Research* 44: 43-55.

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

Mishra, C., Bhatnagar, Y.V., Trivedi, P., Timbadia, R., Bijoor, A., Sonam, K., Thinley, S., Namgail, T. and Prins, H.T. 2016. The role of village reserves in revitalizing the natural prey base of the snow leopard. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 184-187. Elsevier, New York.

Mishra, C., Van Wieren, S.E., Ketner, P., Heitkonig, I. M A. and Prins, H.H.T. 2004. Competition between domestic livestock and wild bharal *Pseudois nayaur* in the Indian Trans-Himalaya. *Journal of Applied Ecology* 41: 344-354.

Mohammad, G., Mostafawi, S., Rosen, T. and Dadul, J. 2016. Corral improvements. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 180-183. Elsevier, New York.

Moheb, Z. and Paley, R. 2016. Snow leopard status and conservation in Afghanistan. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 409-417. Elsevier, New York.

Namgail, T. and Dadul, J. 2016. Himalayan homestays; fostering human-snow leopard conservation coexistence. In: T.M. McCarthy and D.P. Mallon (eds), *Snow Leopards*, Elsevier, New York.

Namgail, T., Fox, J.L. and Bhatnagar, Y.V. 2007. Carnivore-caused livestock mortality in Trans-Himalaya. *Environmental Management* 39: 490-496.

Nawaz, M.A. and Hameed, S. 2015. Research Update 2008-2014 Snow Leopard Program, Pakistan. Unpublished report.

Nawaz, M.A., Ud Din, J. and Buzdar, H. 2016. The Ecosystem Health Program: a tool to promote the co-existence of livestock owners and snow leopards . In: T. McCarthy & D. Mallon (eds), *Snow Leopards*, pp. 188-195. Elsevier, New York.

Nowell, K. and Jackson, P. 1996. *Wild Cats. Status Survey and Conservation Action Plan*. IUCN/SSC Cat Specialist Group, Gland, Switzerland and Cambridge, UK.

Nowell, K., Li, J., Paltsyn, M. and Sharma, R.K. 2016. An Ounce of Prevention: Snow Leopard Crime Revisited. *TRAFFIC, Cambridge, UK*.

Nowell, K., Schipper, J. and Hoffmann, M. 2007. Re-evaluation of the Felidae of the 2008 IUCN Red List. *Cat News* 47: 5.

O'Brien, S.J. and Johnson, W.E. 2007. The evolution of cats. *Scientific American* July: 68-75.

Oli, M.K. 1994. Snow leopards and blue sheep in Nepal: densities and predator: prey ratio. *Journal of Mammalogy* 75: 998-1004.

Oli, M.K., Taylor, I.R. and Rogers, R.M. 1994. Snow leopard *Panthera uncia* predation of livestock: An assessment of local perception in the Annapurna Conservation Area, Nepal. *Biological Conservation* 68: 63-68.

Pacifici, M., Santini, L., Di Marco, M., Baisero, D., Francucci, L., Grottolo Marasini, G., Visconti, P. and Rondinini, C. 2013. Generation length for mammals. *Nature Conservation* 5: 87–94.

Paltsyn, M., Poyarkov, A., Spitsyn, S., Kuksin, A., Istomov, S., Gibbs, J.P., Jackson, R.M., Castner, J., Kozlova, S., Karnaukhov, A., Malykh, S., Korablev, M., Zvychainaya, E. and Rozhnov, V. 2016. Snow leopard conservation in Russia. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 501-511. Elsevier, New York.

Riordan, P. and Shi, K. 2016. Current state of snow leopard conservation in China. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 523-531. Elsevier, New York.

Riordan, P., Cushman, S., Hughes, J., Mallon, D. and Shi, K. 2015. Predicting global snow leopard connectivity and targeting conservation action for snow leopard across its range. *Ecography* 38: 1-8.

Robinson, H.S., DeSimone, R., Hartway, C., Gude, J., Thompson, M., Mitchell, M. and Hebblewhite, M. 2014. A Test of the Compensatory Mortality Hypothesis in Mountain Lions: A Management Experiment in West-Central Montana. *Journal of Wildlife Management* 78: 791-807.

Rosen, T. and Zahler, P. 2016. Transboundary initiatives and snow leopard conservation. In: McCarthy, T., Mallon, D. (ed.), *Snow leopards*, pp. 267-276. Elsevier, New York.

Salafsky, N. and Margoulis, R. 1999. Threat reduction assessment: a practical and cost-effective approach to evaluating conservation and development projects. *Conservation Biology* 13(4): 830-841.

Sanderson, E., McCarthy, T., Mallon, D. and Zahler, P. 2016. Global strategies for snow leopard conservation: a synthesis . In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 543-558. Elsevier, New York.

Schaller, G.B. 1998. *Wildlife of the Tibetan Steppe*. Chicago University Press, Chicago.

Schaller, G.B. 2014. Trip report: Qinghai Province, China, June 5-July 12, 2014. Panthera, New York.

Schaller, G.B., Li, H., Ren, J.R., Qiu, M.J. and Wang, H.B. 1987. Status of large mammals in the Taxkorgan Reserve, Xinjiang, China. *Biological Conservation* 42: 53-71.

Sharma, K., Bayrakcismith, R., Tumursukh, L., Johansson, O., Sevger, P., McCarthy, T. and Mishra, C. 2014. Vigorous dynamics underlie a stable population of the Endangered Snow Leopard *Panthera uncia* in Tost Mountains, South Gobi, Mongolia. *Plos One* 9(7): e1011319.

Shezad, W., McCarthy, T.M., Pompanon, F., Purejav, L., Coissac, E., Riaz, T. and Taberlet, P. 2012. Prey preference of snow leopard (*Panthera uncia*) in South Gobi, Mongolia. *Plos One* 7(2): e32104. doi: 10.1371/journal.pone.0032104.

Shrestha, R., Tenzing, Dorji, L., Tashi, N. and Wangdi, G. 2013. A report on snow leopard (*Panthera uncia*) population survey in the Central Range of Wangchuk Centennial Park, Bhutan. WWF-US, Eastern Himalayas Program.

Snow Leopard Network. 2014. *Snow Leopard Survival Strategy. Version 2014.1*. Snow Leopard Network. www.snowleopardnetwork.org.

Snow Leopard Working Secretariat. 2013. *Global Snow Leopard and Ecosystem Protection Program*. Snow Leopard Working Secretariat, Bishkek, Kyrgyzstan.

Suryawanshi, K.R., Bhatnagar, Y.V., Redpath, S. and Mishra, C. 2013. People, predators and perceptions: patterns of livestock depredation by snow leopards and wolves. *Journal of Applied Ecology* 50: 550–560. doi: 10.1111/1365-2664.12061.

Taubmann, J., Sharma, K., Zhumnabai Uulu, K., Hines, J.E. and Mishra, C. 2016. Status assessment of the endangered snow leopard *Panthera uncia* and other large mammals in the kyrgyz Alay, using community knowledge to correct for imperfect detection. *Oryx* 50: 220-230.

Thinley, P., Dagay, Leki, P., Dorji, C., Namgyel, S., Yoenten, Phuntsho and Dorji, T. 2014. Estimating Snow Leopard (*Panthera uncia*) abundance and distribution in Jigme Dorji National Park using camera traps: A technical report. KUENSEL Corporation Ltd., Thimpu, Bhutan.

Thinley, P., Lham, D., Wangchuk, S. and Wangchuk, N. 2016. National snow leopard survey of Bhutan 2014-2016. Department of Forests and Park Services, Thimpu, Bhutan.

Ud Din, J. and Nawaz, A. 2016. The current status of snow leopard conservation in Pakistan. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 486-491. Elsevier, New York.

Wangchuk, R., Jackson, R. and Brewer, W. 2010. Snow leopards and Himalayan Homestays: catalysts for community-based conservation in mountain areas. *Mountain Forum Bulletin* January 2010: 25-28.

Wangchuk, T. and Tharchen, L. 2016. Snow leopard conservation in Bhutan. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 449-456. Elsevier, New York.

Wingard, J., Zahler, P., Victurine, R., Bayasgalan, O. and Buuveibaatar, B. 2014. Guidelines for addressing the impact of linear infrastructure on migratory large mammals in Central Asia. Convention on Migratory Species Technical Report, Bonn, Germany.

WWF. 2012. Altai-Sayan Regional Conservation Strategy. World Wide Fund for Nature. http//:wwf.ru/resources/publ/book/eng/843, Moscow.

Zahler, P. 2016. Linear infrastructure and snow leopard conservation. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 123-126. Elsevier, New York.

Zahler, P. and Paley, R. 2016. Building community governance structures and institutions for snow leopard conservation. In: T. McCarthy and D. Mallon (eds), *Snow Leopards*, pp. 151-162. Elsevier, New York.

Citation

McCarthy, T., Mallon, D., Jackson, R., Zahler, P. & McCarthy, K. 2017. *Panthera uncia. The IUCN Red List of Threatened Species 2017*: e.T22732A50664030. http://dx.doi.org/10.2305/IUCN.UK.2017-2.RLTS.T22732A50664030.en

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External Resources

For Supplementary Material, and for Images and External Links to Additional Information, please see the Red List website.

Appendix

Habitats

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Habitat	Season	Suitability	Major Importance?
1. Forest -> 1.1. Forest - Boreal	Resident	Marginal	-
3. Shrubland -> 3.4. Shrubland - Temperate	Resident	Suitable	Yes
3. Shrubland -> 3.7. Shrubland - Subtropical/Tropical High Altitude	Resident	Suitable	Yes
4. Grassland -> 4.7. Grassland - Subtropical/Tropical High Altitude	Resident	Suitable	Yes
0. Root -> 6. Rocky areas (eg. inland cliffs, mountain peaks)	Resident	Suitable	Yes

Threats

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Threat	Timing	Scope	Severity	Impact Score
1. Residential & commercial development -> 1.1. Housing & urban areas	Ongoing	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.2. Species disturbance		
1. Residential & commercial development -> 1.3. Tourism & recreation areas	Ongoing	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.2. Species disturbance		
11. Climate change & severe weather -> 11.5. Other impacts	Ongoing	Majority (50-90%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 1. Ecosystem stresses -> 1.3. Indirect ecosystem effects		
2. Agriculture & aquaculture -> 2.3. Livestock farming & ranching -> 2.3.1. Nomadic grazing	Ongoing	Minority (50%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.2. Species disturbance 2. Species Stresses -> 2.3. Indirect species effects -> 2.3.2. Competition		
2. Agriculture & aquaculture -> 2.3. Livestock farming & ranching -> 2.3.2. Small-holder grazing, ranching or farming	Ongoing	Majority (50-90%)	Unknown	Unknown
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.2. Species disturbance 2. Species Stresses -> 2.3. Indirect species effects -> 2.3.2. Competition		

3. Energy production & mining -> 3.2. Mining & quarrying	Ongoing	Minority (50%)	Unknown	Unknown	
	Stresses:	1. Ecosystem stresses -> 1.1. Ecosystem conversion 1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.2. Species disturbance			
4. Transportation & service corridors -> 4.1. Roads & railroads	Ongoing	Minority (50%)	Unknown	Unknown	
	Stresses:	1. Ecosystem stresses -> 1.2. Ecosystem degradation 2. Species Stresses -> 2.3. Indirect species effects -> 2.3.8. Other			
5. Biological resource use -> 5.1. Hunting & trapping terrestrial animals -> 5.1.1. Intentional use (species is the target)	Ongoing	Majority (50-90%)	Unknown	Unknown	
	Stresses:	2. Species Stresses -> 2.1. Species mortality			
5. Biological resource use -> 5.1. Hunting & trapping terrestrial animals -> 5.1.2. Unintentional effects (species is not the target)	Ongoing	Majority (50-90%)	Unknown	Unknown	
	Stresses:	1. Ecosystem stresses -> 1.3. Indirect ecosystem effects 2. Species Stresses -> 2.1. Species mortality			
5. Biological resource use -> 5.1. Hunting & trapping terrestrial animals -> 5.1.3. Persecution/control	Ongoing	Majority (50-90%)	Unknown	Unknown	
	Stresses:	2. Species Stresses -> 2.1. Species mortality			
6. Human intrusions & disturbance -> 6.2. War, civil unrest & military exercises	Ongoing	Minority (50%)	Negligible declines	Low impact: 4	
	Stresses:	2. Species Stresses -> 2.2. Species disturbance			
8. Invasive and other problematic species, genes & diseases -> 8.2. Problematic native species/diseases -> 8.2.1. Unspecified species	Ongoing	Unknown	Unknown	Unknown	
	Stresses:	2. Species Stresses -> 2.1. Species mortality			

Conservation Actions in Place
(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Actions in Place
In-Place Research, Monitoring and Planning
Action Recovery plan: Yes
Systematic monitoring scheme: Yes
In-Place Land/Water Protection and Management
Conservation sites identified: Yes, over entire range
Occur in at least one PA: Yes
Invasive species control or prevention: Not Applicable
In-Place Species Management
Harvest management plan: No

Conservation Actions in Place
Successfully reintroduced or introduced beningly: No
Subject to ex-situ conservation: Yes
In-Place Education
Subject to recent education and awareness programmes: Yes
Included in international legislation: Yes
Subject to any international management/trade controls: Yes

Conservation Actions Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Conservation Actions Needed
1. Land/water protection -> 1.1. Site/area protection
1. Land/water protection -> 1.2. Resource & habitat protection
2. Land/water management -> 2.1. Site/area management
2. Land/water management -> 2.3. Habitat & natural process restoration
4. Education & awareness -> 4.1. Formal education
4. Education & awareness -> 4.2. Training
4. Education & awareness -> 4.3. Awareness & communications
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.1. International level
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.2. National level
5. Law & policy -> 5.4. Compliance and enforcement -> 5.4.3. Sub-national level
6. Livelihood, economic & other incentives -> 6.1. Linked enterprises & livelihood alternatives
6. Livelihood, economic & other incentives -> 6.4. Conservation payments

Research Needed

(http://www.iucnredlist.org/technical-documents/classification-schemes)

Research Needed
1. Research -> 1.1. Taxonomy
1. Research -> 1.2. Population size, distribution & trends
1. Research -> 1.3. Life history & ecology
1. Research -> 1.5. Threats
1. Research -> 1.6. Actions

Research Needed
3. Monitoring -> 3.1. Population trends
0. Root -> 4. Other

Additional Data Fields

Distribution
Estimated extent of occurrence (EOO) (km^2): 6786272
Lower elevation limit (m): 500
Upper elevation limit (m): 5800
Population
Number of mature individuals: 2710-3386
Continuing decline of mature individuals: Yes
Extreme fluctuations: No
Population severely fragmented: No
Habitats and Ecology
Generation Length (years): 7.54
Movement patterns: Altitudinal Migrant

The IUCN Red List Partnership

The IUCN Red List of Threatened Species™ is produced and managed by the IUCN Global Species Programme, the IUCN Species Survival Commission (SSC) and The IUCN Red List Partnership.

The IUCN Red List Partners are: Arizona State University; BirdLife International; Botanic Gardens Conservation International; Conservation International; NatureServe; Royal Botanic Gardens, Kew; Sapienza University of Rome; Texas A&M University; and Zoological Society of London.