

# The Need to Rationalize and Prioritize Threatening Processes Used to Determine Threat Status in the IUCN Red List

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**Abstract:** *Thorough evaluation has made the International Union for Conservation of Nature (IUCN) Red List the most widely used and accepted authority on the conservation status of biodiversity. Although the system used to determine risk of extinction is rigorously and objectively applied, the list of threatening processes affecting a species is far more subjectively determined and has not had adequate review. I reviewed the threats listed in the IUCN Red List for randomly selected groups within the three most threatened orders of mammals: Artiodactyla, Carnivora, and Primates. These groups are taxonomically related and often ecologically similar, so I expected they would suffer relatively similar threats. Hominoid primates and all other terrestrial fauna faced similar threats, except for bovine artiodactyls and large, predatory carnivores, which faced significantly different threats. Although the status of bovines and hominoids and the number of threats affecting them were correlated, this was not the case for large carnivores. Most notable, however, was the great variation in the threats affecting individual members of each group. For example, the endangered European bison (*Bison bonasus*) has no threatening processes listed for it, and the lion (*Panthera leo*) is the only large predator listed as threatened with extinction by civil war. Some threatening processes appear spurious for the conservation of the species, whereas other seemingly important factors are not recorded as threats. The subjective nature of listing threatening processes, via expert opinion, results in substantial biases that may be allayed by independent peer review, use of technical manuals, consensus among multiple assessors, incorporation of probability modeling via decision-tree analysis, and adequate coordination among evaluators. The primary focus should be on species-level threats rather than population-level threats because the IUCN Red List is a global assessment and smaller-scale threats are more appropriate for national status assessments. Until conservationists agree on the threats affecting species and their relative importance, conservation action and success will be hampered by scattering scarce resources too widely and often by implementing conflicting strategies.*

**Keywords:** carnivora, competition, conservation status, threatening processes

La Necesidad de Racionalizar y Priorizar los Procesos Amenazantes Utilizados para Determinar el Estatus de Amenaza en la Lista Roja de la UICN

**Resumen:** *La evaluación exhaustiva ha hecho que la Lista Roja de la Unión Internacional para la Conservación de la Naturaleza (UICN) sea la autoridad más aceptada y ampliamente utilizada respecto al estatus de conservación de la biodiversidad. Aunque el sistema utilizado para determinar el riesgo de extinción es aplicado rigurosa y objetivamente, la lista de procesos amenazantes que afectan a las especies es determinado muy subjetivamente y no es revisado adecuadamente. Revisé las amenazas consideradas en la Lista Roja UICN para grupos seleccionados aleatoriamente en los tres órdenes de mamíferos más amenazados: Artiodactyla, Carnivora y Primates. Estos grupos están relacionados taxonómicamente y a menudo son ecológicamente similares, así que esperaba que tuvieran amenazas relativamente similares. Los primates homínidos y toda la demás fauna terrestre enfrentan amenazas similares, excepto por los bovinos artiodáctilos y los carnívoros*

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*depredadores mayores, que enfrentan amenazas significativamente diferentes. Aunque el estatus de los bovinos y homínidos y el número de amenazas que los afectan estuvieron correlacionados, este no fue el caso para los carnívoros mayores. Sin embargo, lo más notable fue la gran variación en las amenazas que afectan a miembros individuales de cada grupo. Por ejemplo, no hay procesos amenazantes enlistados para el bisonte europeo (Bison bonasus), y el león (Panthera leo) es el único depredador mayor enlistado como amenazado de extinción por la guerra civil. Algunos procesos amenazantes parecen espurios para la conservación de las especies, mientras que otros factores aparentemente importantes no están registrados como amenazas. La naturaleza subjetiva de los procesos de enlistado, por medio de la opinión de expertos, resulta en sesgos sustanciales que pueden disiparse por la revisión independiente por pares, el uso de manuales técnicos, el consenso de múltiples asesores, la incorporación del modelado probabilístico mediante análisis de árboles de decisión y la adecuada coordinación entre evaluadores. El enfoque principal debería ser sobre amenazas a nivel de especies en lugar de amenazas a nivel de poblaciones porque la Lista Roja UICN es una evaluación global y las amenazas a menor escala son más apropiadas para evaluaciones nacionales de estatus. Hasta que los conservacionistas estén de acuerdo sobre las amenazas que afectan a las especies y su importancia relativa, las acciones de conservación y su éxito estarán obstaculizados por la dispersión demasiado amplia de recursos limitados y a menudo por la implementación de estrategias contrapuestas.*

**Palabras Clave:** carnívora, competencia, estatus de conservación, procesos amenazantes

## Introduction

The International Union for Conservation of Nature (IUCN) Red List is the most widely used and accepted authority on the conservation status of biodiversity (Rodrigues et al. 2006). Since the early 1990s, there has been a great deal of theoretical work done to ensure that the red-list categories and criteria are objective and explicit (Mace & Lande 1991; Mace et al. 1992). They have been further refined and assessed since (e.g., Akcakaya et al. 2000; Akcakaya et al. 2006; Jetz et al. 2008), and the result is a highly robust and repeatable system of placing species in appropriate risk categories (Rodrigues et al. 2006; Mace et al. 2008).

The red list prioritizes conservation actions by identifying species of high extinction risk (Collar 1996; Miller et al. 2007; Hoffmann et al. 2008). Conversely, there is still no measure in the red list of the relative importance of the threatening processes that drive species to extinction. Listing and ranking threatening processes is critical because conservation managers aiming to improve the status of biodiversity are likely to do this by addressing the threats in the IUCN Red List—as evidenced by the association of threats with conservation actions (IUCN-CMP 2006). If these threats are inaccurate or imprecise, valuable and scarce conservation funds will be misdirected and wasted.

Most conservation managers undertake multiple actions to conserve threatened species; however, when faced with restricted funding, they are forced to eliminate some projects. There are excellent mathematical models of how to do this (McBride et al. 2007; Murdoch et al. 2007). If, however, the extinction risk arising from a particular threat is exaggerated, then these models will fail to identify the conservation action of most value, and, ultimately, the threatened species will be no better off.

The red-list assessment process can be conducted by anyone, although the majority of assessments are performed by the IUCN Species Survival Commission's Specialist Groups or participants of Global Biodiversity Assessment workshops (IUCN 2008). These assessments are peer reviewed, but the focus is on the status of species rather than the threats that affect status. The listing of threatening processes lacks the theoretical and mathematical rigor of the conservation-status listing process and relies on the perspectives of workshop attendees. Thus, it is a subjective, rather than objective, process.

The orders Artiodactyla, Carnivora, and Primates are threatened at a greater rate than other taxa (IUCN 2007), so I analyzed randomly selected subgroups of these orders. These subgroups were all taxonomically related, which meant my comparative methods would face fewer phylogenetic problems (Ortolani & Caro 1996) and thus likely to be threatened to similar degrees (Cardillo et al. 2008). Artiodactyls investigated were the large-bodied grazers of the subfamily Bovinae, primates studied were the hominoidea (excluding humans), and carnivores were the large, terrestrial predators. I hypothesized that occupying similar niches results in similar patterns of threats. The identities of the studied species were largely irrelevant because I sought to highlight anomalies within the threat-listing process rather than to highlight anomalies among particular species.

I reviewed the IUCN Red List database (IUCN 2007) and compared the threats affecting groups of ecologically similar species with all mammals with the aim of identifying biases in the listing of threatening processes. Unlike previous researchers who assessed biases in determination of the status of listed species, I focused on the causes of decline. Ultimately, this focus will allow identification of ways to rationalize and prioritize the threats listed as driving species toward extinction.

## Methods

I collected data from the 2004 IUCN Red List (IUCN 2007). The major threat categories used by the IUCN are habitat loss or degradation (human induced), invasive alien species (directly affecting the species), harvesting (hunting for or gathering food, fuel, or medicine), accidental mortality (through bycatch or collision), human persecution through pest or predator control, pollution (affecting habitat or species), natural disasters, changes in native species dynamics (competitors, predators, prey food base, hybridizers, pathogens and parasites, mutualisms), intrinsic factors, and human disturbance (recreation, research, war, transport, fire).

The ecologically similar bovine artiodactyls, large carnivores, and hominoid primates I examined are presented in Table 1. The large carnivores studied were predatory terrestrial mammals over 20 kg, which occupy a distinct ecological niche as predators of prey larger than 24 kg (Carbone et al. 1999). Among the carnivores, bears (*Ursidae*) and the maned wolf (*Chrysocyon brachyurus*) were excluded because they are largely omnivorous, and I excluded the carnivorous polar bear (*Ursus maritimus*) because it relies on the marine realm for food. I excluded lynxes because they were below the 20-kg mean adult body mass criteria and the brown (*Hyaena brunnea*) and striped (*H. hyaena*) hyaena because they are predominately scavengers.

I used chi-square tests to investigate whether the three study taxa were affected by threatening processes at the same frequency as all other terrestrial mammals. I used Spearman's nonparametric rank-order correlation to test whether a categorical factor of threat status (1, critically endangered; 2, endangered; 3, vulnerable; 4, near threatened; 5, lower risk [conservation dependent]; 6, least concern) correlated with the number of threats affecting species within each study group and overall. The Kruskal-Wallis test was used to compare the number of threats affecting each group and each status category. All analyses were conducted in Statistica (StatSoft, Tulsa, Oklahoma).

## Results

Respectively, habitat loss and harvesting were considered the first and second greatest threats to the existence of all mammals (Fig. 1). All other major threatening processes were reported to affect <100 species. This distribution of threats was similar to those listed as affecting hominoid primates ( $\chi^2 = 14.48$ ,  $df = 9$ ,  $p = 0.106$ ), although a larger proportion of primates were listed as threatened by harvesting and none were listed as affected by persecution, invasive species, pollution, or accidental mortality (Fig. 1). The distribution of threats to all assessed mammals

differed significantly from that of large predators ( $\chi^2 = 70.41$ ,  $df = 9$ ,  $p < 0.001$ ) and bovines ( $\chi^2 = 25.94$ ,  $df = 9$ ,  $p = 0.002$ ). Persecution was deemed the biggest threat to large predators and was followed by habitat loss, harvesting, and changes in native species dynamics. No large predators were considered threatened by pollution, intrinsic factors, or natural disasters (Fig. 1). Bovines were mostly considered threatened by habitat loss, degradation, and harvesting, and a high proportion were considered threatened by changes in native species dynamics (parasites and pathogens) (Fig. 1).

For mammals overall (Spearman's  $R = -0.462$ ,  $n = 52$ ,  $p < 0.001$ ), bovines ( $R = -0.670$ ,  $n = 22$ ,  $p < 0.001$ ), and hominoids ( $R = -0.614$ ,  $n = 17$ ,  $p < 0.005$ ), the more threatened a species was, the more threatening processes were listed for that species. The status of large predators and the number of threats listed as affecting them were not related ( $R = -0.378$ ,  $n = 13$ ,  $p > 0.05$ ).

The number of threats reportedly affecting each group differed significantly (Kruskal-Wallis  $H_{2,52} = 6.364$ ,  $p = 0.042$ ). Primates had a median of one threat, bovines two, and large carnivores three. Nevertheless, the median status of the three groups did not differ (Kruskal-Wallis  $H_{2,52} = 3.557$ ,  $p = 0.169$ ). The number of threats affecting each status category, however, differed significantly (Kruskal-Wallis  $H_{5,56} = 13.428$ ,  $p = 0.020$ ). Critically endangered and endangered species faced three threats (median), and vulnerable species faced two threats. Confusingly, species listed as being of least concern faced a median of two threats, which was one more than near-threatened and conservation-dependent species.

No threats were listed as affecting the endangered European bison, the conservation-dependent American bison and nyala, or the near-threatened giant eland (Fig. 1). (Scientific names are provided in Table 1.) That threats to the vulnerable capped gibbon exist was acknowledged, but the threats were listed as unknown (IUCN 2007). The water buffalo was the only species recorded as being threatened by natural disasters (storms and flooding). The lion, chimpanzee, bonobo, and Sumatran orangutan were the only species listed as threatened by war.

Among the threatened bovines, only the bisons, nyala, giant eland, and greater kudu were considered threatened by habitat loss, and they, the chousingha, and eland were not considered threatened by harvesting (Fig. 2a). It was considered that changes to parasite and pathogen dynamics affect all bovines listed as threatened by changes to native-species dynamics, and the yak and banteng were also considered threatened by hybridization. Human disturbance, by way of fire, was listed as a threat to Mindoro dwarf buffalo, and disturbance from transportation was listed as affecting saolo.

Among the large predators, only the snow and clouded leopards reportedly avoid persecution, whereas only the snow leopard, puma, and red wolf were not considered threatened by habitat loss (Fig. 2b). Most predators were

Table 1. The status and number of threats affecting the species assessed in this analysis.

Taxon	Common name	Scientific name	Status*	No. of threats*
Artiodactyla				
Bovinae	American bison	<i>Bison bison</i>	conservation dependent	0
	European bison	<i>B. bonasus</i>	endangered	0
	gaur	<i>Bos frontalis</i>	vulnerable	3
	yak	<i>Bo. grunniens</i>	vulnerable	4
	banteng	<i>Bo. javanicus</i>	endangered	4
	kouprey	<i>Bo. sauveli</i>	critically endangered	3
	nilgai	<i>Boselaphus tragocamelus</i>	least concern	2
	water buffalo	<i>Bubalus bubalis</i>	endangered	4
	anoa	<i>Bub. depressicornis</i>	endangered	2
	Mindoro dwarf buffalo	<i>Bub. mindorensis</i>	critically endangered	4
	mountain anoa	<i>Bub. quarlesi</i>	endangered	2
	saola	<i>Pseudoryx ngbetinbensis</i>	critically endangered	4
	chousingha	<i>Tetracerus quadricornis</i>	vulnerable	1
	nyala	<i>Tragelaphus angasii</i>	conservation dependent	0
	mountain nyala	<i>T. buxtoni</i>	endangered	3
	giant eland	<i>T. derbianus</i>	near threatened	0
	bongo	<i>T. eurycerus</i>	near threatened	2
	lesser kudu	<i>T. imberbis</i>	conservation dependent	2
	eland	<i>T. oryx</i>	conservation dependent	1
	bushbuck	<i>T. scriptus</i>	least concern	0
	sitatunga	<i>T. spekii</i>	near threatened	2
	greater kudu	<i>T. strepsiceros</i>	conservation dependent	0
Carnivora (>20 kg)				
Canidae	African wild dog	<i>Lycaon pictus</i>	endangered	4
	dhole	<i>Cuon alpinus</i>	endangered	4
	gray wolf	<i>Canis lupus</i>	least concern	0
	red wolf	<i>C. rufus</i>	critically endangered	3
Felidae	cheetah	<i>Acinonyx jubatus</i>	vulnerable	3
	clouded leopard	<i>Neofelis nebulosa</i>	vulnerable	2
	jaguar	<i>Panthera onca</i>	near threatened	2
	leopard	<i>P. pardus</i>	least concern	0
	lion	<i>P. leo</i>	vulnerable	4
	snow leopard	<i>P. uncia</i>	endangered	2
	tiger	<i>P. tigris</i>	endangered	4
	puma	<i>Puma concolor</i>	near threatened	1
Hyaenidae	spotted hyaena	<i>Crocuta crocuta</i>	conservation dependent	3
Hominoidea	great apes			
Hominidae	mountain gorilla	<i>Gorilla beringei</i>	endangered	2
	lowland gorilla	<i>G. gorilla</i>	critically endangered	3
	bonobo	<i>Pan paniscus</i>	endangered	3
	chimpanzee	<i>Pa. troglodytes</i>	endangered	3
	Sumatran orangutan	<i>Pongo abelii</i>	critically endangered	5
	Bornean orangutan	<i>Pon. pygmaeus</i>	endangered	4
	hoolock gibbon	<i>Bunopithecus hoolock</i>	endangered	1
	agile gibbon	<i>Hylobates agilis</i>	near threatened	1
	dwarf gibbon	<i>H. klossii</i>	vulnerable	1
	common gibbon	<i>H. lar</i>	near threatened	1
	Javan gibbon	<i>H. moloch</i>	critically endangered	1
	Bornean gibbon	<i>H. muelleri</i>	near threatened	0
	capped gibbon	<i>H. pileatus</i>	vulnerable	0
	black gibbon	<i>Nomascus concolor</i>	endangered	1
	buff-cheeked gibbon	<i>N. gabriellae</i>	vulnerable	1
	eastern black gibbon	<i>N. nasutus</i>	critically endangered	2
	siamang	<i>Symphalangus syndactylus</i>	near threatened	1

\*As listed in the 2004 IUCN Red List.

listed as persecuted as pests (eight species), and medicinal uses, pelts, cultural significance, scientific study, and recreational use were listed as the causes of persecution for three species (Fig. 2b). Eight large predators were

considered threatened by changes in native-species dynamics (Fig. 2b). Changes to prey or food base reportedly affect six of these, and the African wild dog and red wolf were listed as not being affected by prey but rather by

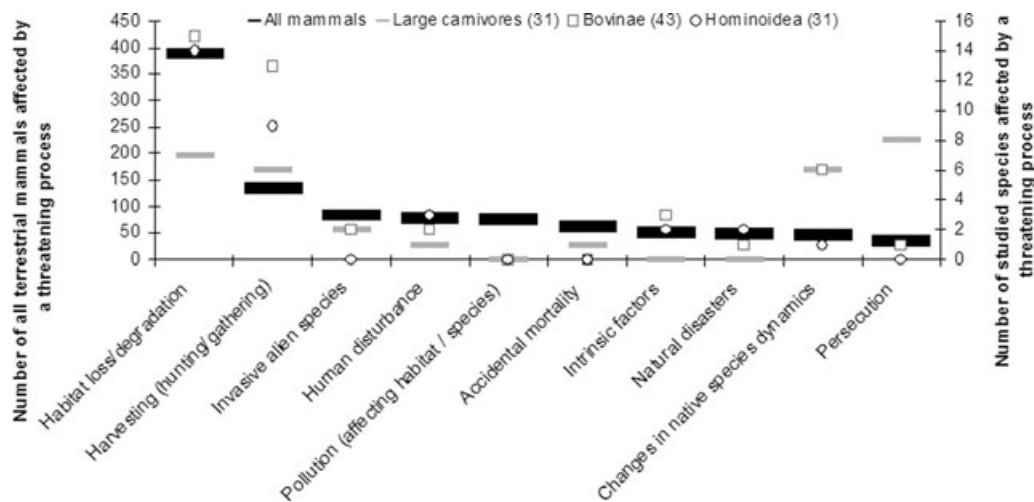


Figure 1. Number of species of all assessed terrestrial mammals and of bovine artiodactyls, large carnivores, and nonhuman hominoid primates affected by each major threatening process considered in the IUCN Red List.

competitors and hybridizers, respectively. The spotted hyaena, jaguar, and puma were listed as unaffected by changes in prey dynamics.

Despite being the most threatened group studied, hominoid primates had the fewest threats listed for them (31; Table 1). All hominoid primates were listed as threatened by habitat loss and degradation, except the Bornean, capped, buff-cheeked, and white-cheeked gibbons (Fig. 2c). All the hominids were listed as affected by harvesting. Nevertheless, only buff-cheeked, white-cheeked, and eastern black gibbons were among the species of the Hylobatidae threatened by harvesting (Fig. 2c). The western gorilla was listed as threatened by changes to native pathogen-parasite dynamics, and orangutans were listed as threatened by fire.

## Discussion

It is the anomalies rather than the commonalities of my analysis that are of importance. Why are there no threats listed for the endangered European bison? The species has a tiny, highly fragmented population and it hybridizes with American bison and cattle (Baranov & Zakharov 1997). On this basis, changes in native species dynamics (hybridization), habitat loss and degradation and intrinsic factors could all be potential threats. The water buffalo occurs over >20,000 km<sup>2</sup> throughout several countries in Southeast Asia (IUCN 2007). It is hard to envisage floods in numerous catchments throughout this range occurring almost simultaneously and thus driving this species to extinction.

Why is the endangered snow leopard only listed as having two threats—changes to prey base and harvest-

ing? Illegal trade in skins has had a massive impact on snow leopard populations (Nowell & Jackson 1996), but given that none of the disjunct and often isolated remnant populations supports more than 250 individuals of the remaining 2500 snow leopards (IUCN 2007), surely genetic factors within a probable metapopulation are threats (Frankham 2009).

Why are the African wild dog and red wolf the only large predators affected by changes to native species dynamics that are not affected by an alteration to their prey base? Many influential authors have highlighted the supposed importance of intraguild predation and interference competition on African wild dogs (e.g., Creel & Creel 1996; Gorman et al. 1998), and others have highlighted the same effects on cheetahs (Laurenson 1995; Laurenson et al. 1995); yet, interference competition and intraguild predation are not considered threats to the wild dog. Prey is clearly important to the strictly carnivorous wild dog and other predators of Africa's savannas (Hayward & Kerley 2008), and the relationship between prey abundance and large-predator density suggests they are all food limited (Carbone & Gittleman 2002; Hayward et al. 2007).

Finally, why is the lion the only large predator considered threatened by human disturbance from war or civil unrest when cheetahs, spotted hyaenas, and wild dogs have similar distributions? For war to be a threat to an entire species, the species must either have a small distribution in a war-torn country or the war must be very widespread. Thus, the smaller distributions of the bonobo, chimpanzee, and Bornean orangutan make war a more plausible threatening process for them—justifying its listing on the IUCN Red List as a threat. Nonetheless, regular assessments of the risk of war must be made to keep the list up to date.

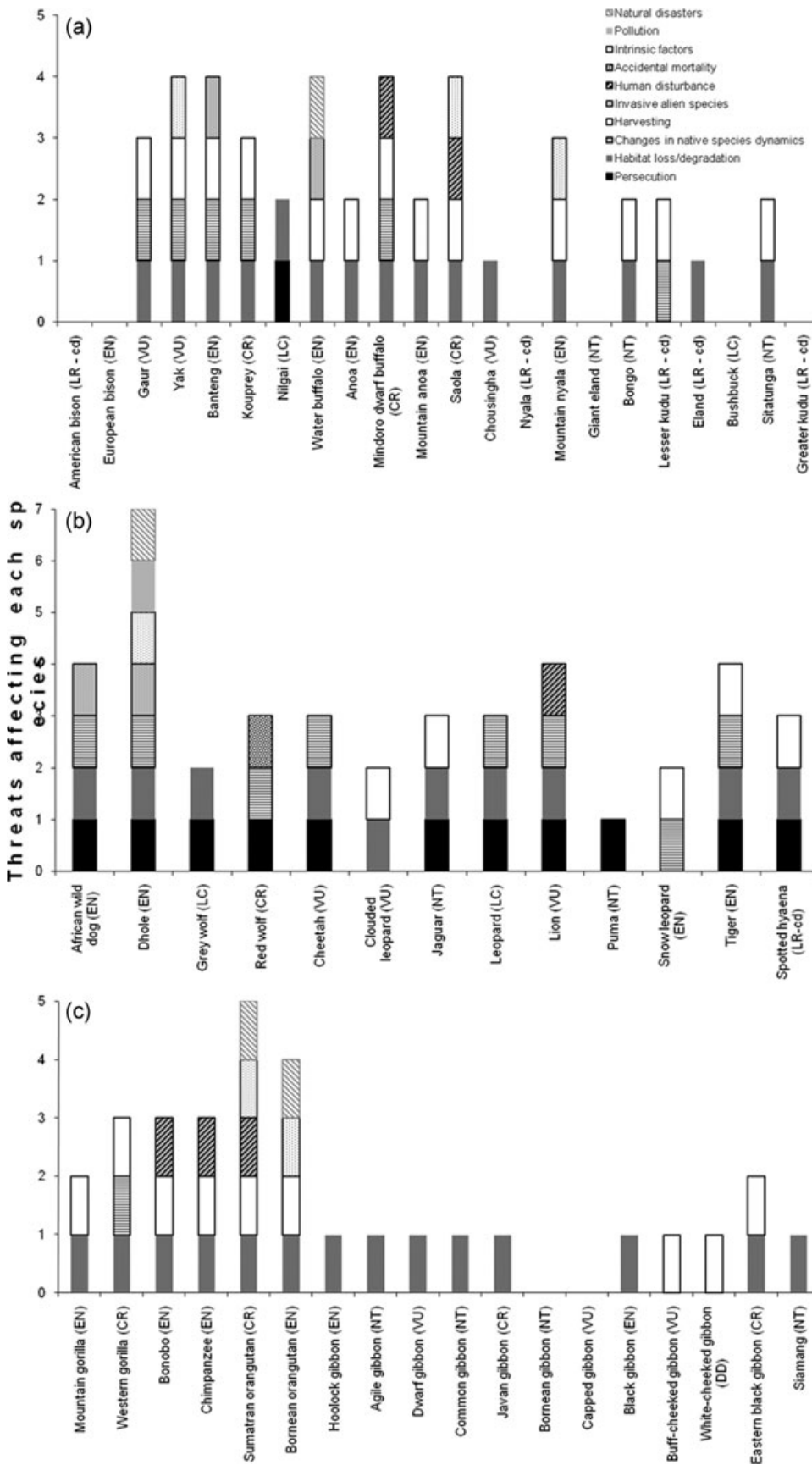


Figure 2. Number of threatening processes affecting each study group: (a) bovine artiodactyls, (b) large carnivores, (c) nonhuman hominoideans (CR, critically endangered; EN, endangered; VU, vulnerable; NT, near threatened; LR-cd, lower risk—conservation dependent; LC, least concern).

There are some potential problems that arise from red-list data that will affect conservation efforts. First, the focus of the IUCN Red List is on determining the status of species, not specifically at alleviating their extinction risk. The focus on ensuring the listing process is robust and theoretically sound has meant the listing of threats has lagged behind the determination of conservation status. This reflects the dichotomy in theoretical comprehension of factors relating to the extinction of small populations in contrast to the factors driving them to extinction (Caughley 1994).

Second, conservationists are either unable to agree on what threats are actually affecting a species or, where several threatening processes are listed for a species, consensus as to the importance of each threat is lacking. This means actions cannot be undertaken that will achieve conservation success because different groups believe in different threats and therefore different conservation strategies (Hayward 2009). This may be realistic at the scale of individual populations but rarely at the scale of an entire species.

Third, representation of participants to the Global Biodiversity Assessment workshops may be biased by people with experience from single sites (e.g., where a war is occurring or where intraguild predation is rife). The IUCN Red List is a global-level assessment, so local biases should be avoided at all costs. It is possible that local actions have a greater impact on large-predator conservation than global actions; however, given the large distributions and overlaps of the majority of these, it is hard to envisage how the threats to entire species do not have elements in common.

This issue is perhaps best highlighted by the continued debate over the causes of the Pleistocene extinctions. Global colonization of a technologically advanced, predatory species (*Homo sapiens*) led to widespread extinction of large-bodied fauna (Burney & Flannery 2005). Others discount invasive species as the cause of these declines and cite climate change as the cause, despite a lack of correspondence between the extinctions and large-scale climatic variation (Wroe et al. 2004). Both of these threats still affect biodiversity, but until there is consensus as to the importance of each, conservation strategies will be difficult to prioritize. Until conservation biologists agree on these issues, conservation action and success will be hampered by scattering scarce resources too widely and implementing often conflicting conservation strategies at a global scale (Hayward 2009).

Accurate identification of threats is needed to successfully implement conservation actions (Butchart et al. 2006). Where the agent of a species' decline has been removed, the results are often phenomenal. When South Africa's Kruger National Park was proclaimed in 1901, the elephant population was estimated at <10 individuals (Carruthers et al. 2007). Today, following fencing and the removal of human predation, that founder population

has risen to around 14,000 (Whyte et al. 2003), and calls to resume human predation have succeeded.

The haphazard and uncoordinated approach to identifying threatening processes affecting species listed on the IUCN Red List requires urgent rationalization and prioritization. Reviewers of the status-assessment process highlight similar problems in comparisons of assessment methods and stress the importance of independent peer review and consensus among multiple assessors (Regan et al. 2005). This is also critical for designating threatening processes, and the use of training manuals and formal methods of estimating threats that provide transparency should be incorporated.

Uncertainty of what the threats are appears to have been addressed by listing any potential threat by way of a precautionary approach. A more critical assessment of threats that focuses on whether a threat will lead to the extinction of the species rather than a population is required. The evaluators of each conservation status-assessment report could be given greater responsibility to do this rather than simply determining whether the species should be listed or not, although differences in the number of threats afflicting each study group suggest there is substantial variation among evaluators. Perhaps, the overall coordinators of the IUCN Red List should be charged with this role or a coordinator of threatening processes should be created.

Ultimately, the threats listed on the IUCN Red List should be assessed and refined as thoroughly as the status-listing process to create a similarly robust and repeatable threat-listing system. This seems likely to evolve into a mathematical model that includes an assessment of the probability that each threat will drive a species' extinction. The threats to better-studied species may be prioritized by modeling the probability that a threat will cause each population of a species to become extinct and then combining these probabilities in a species-level assessment. The same models used to prioritize the financial benefits of conservation actions are likely to be beneficial here (Possingham 1996). These models could also categorize threats into species-, regional-, or population-level risks to inform conservation managers about their relative importance. Until such models are adequately created, tested, and verified, however, a role should be created at the IUCN to oversee the threat-listing process. The greatest failing of this process is the very experts that ensure the status-listing process is accurate because they often appear to fail to grasp the holistic view of conservation of the species rather than conservation of the population they study.

For many species, there is insufficient knowledge of what is threatening them. In such situations, it may be justifiable to use ecologically or geographically equivalent species to draw up a list of potential threats, as I did here. It is unnecessary and inappropriate to list the threats to each population of widespread species in the IUCN Red

List. Rather, regional or national conservation assessment reports can list the threats to each relevant population. Ultimately, these threats will be reflected in population recovery plans or conservation-area management plans. Where threats are identified from ecologically or geographically equivalent species, it must be reported that these threats are assumed rather than known.

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