



Supplementary Materials for

Status and Ecological Effects of the World's Largest Carnivores

William J. Ripple,* James A. Estes, Robert L. Beschta, Christopher C. Wilmers, Euan G. Ritchie, Mark Hebblewhite, Joel Berger, Bodil Elmhagen, Mike Letnic, Michael P. Nelson, Oswald J. Schmitz, Douglas W. Smith, Arian D. Wallach, Aaron J. Wirsing

*Corresponding author. E-mail: bill.ripple@oregonstate.edu

Published 10 January 2014, *Science* **343**, 1241484 (2014)
DOI: 10.1126/science.1241484

This PDF file includes:

Figs. S1 to S4
Tables S1 to S3

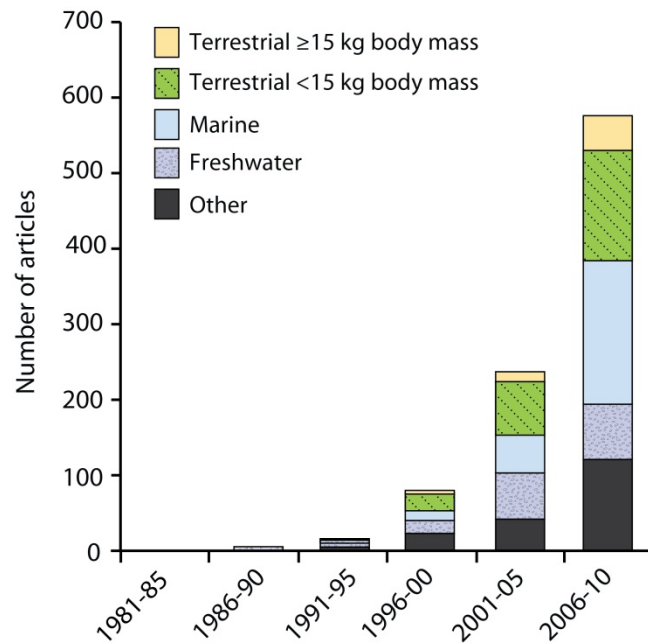


Fig. S1. Number of articles published involving trophic cascades. We accessed the ISI Web of Science and searched on the string “trophic cascades,” which returned 910 articles published between 1981-2010. Upon inspection, each article was placed into one of five predator type categories.

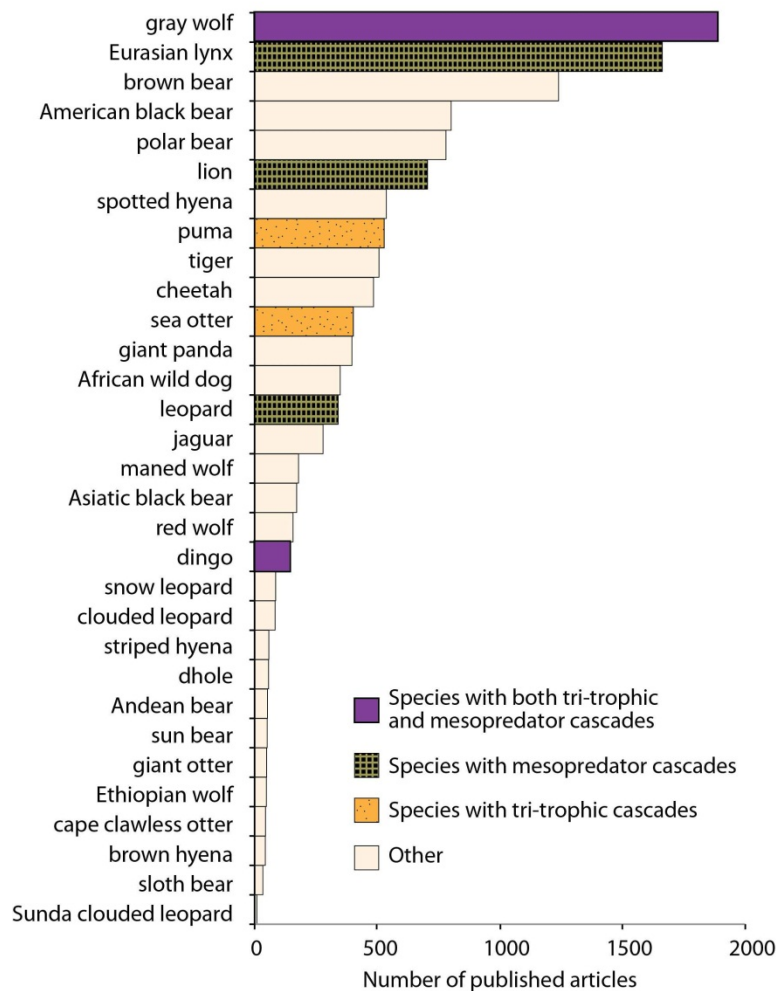


Fig. S2. Number of articles published between 1965 and 2012 involving each of the 31 large carnivore species. Shown by bar color are species with tri-trophic cascades (large carnivore/prey/plant), mesopredator cascades (large carnivore/mesopredator/prey), and both. Bar length refers to the total number of articles published on any aspect of a species, while bar color shows if a trophic cascade has been reported for a species in one or more articles. Source: We accessed the ISI Web of Science and searched on the scientific names of each species to obtain the total number of published articles and on the scientific names of each species with either the term trophic cascade or mesopredator to determine previous research by species.

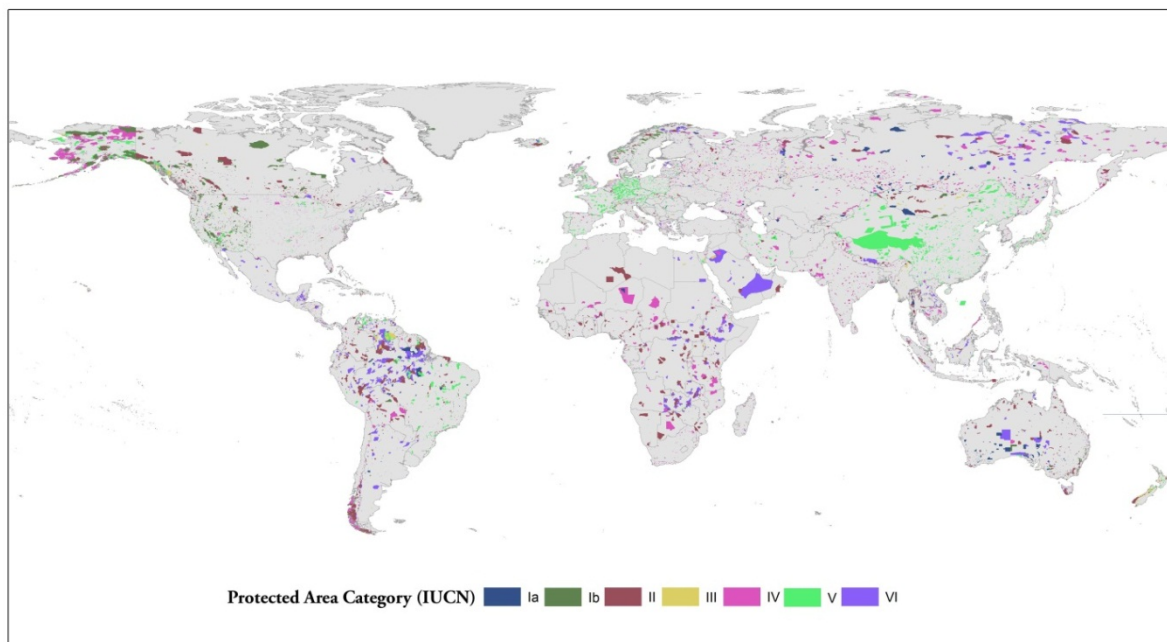


Fig. S3. Protected areas map showing 7 categories of protection. Southeastern Asia has areas with the highest large carnivore richness, but little land in protected areas. Source for map and legend: IUCN (<http://www.iucnredlist.org>.)

Ia Strict Nature Reserve

Category Ia are strictly protected areas set aside to protect biodiversity and also possibly geological/geomorphic features, where human visitation, use and impacts are strictly controlled and limited to ensure protection of the conservation values. Such protected areas can serve as indispensable reference areas for scientific research and monitoring

Ib Wilderness Area

Category Ib protected areas are usually large unmodified or slightly modified areas, retaining their natural character and influence without permanent or significant human habitation, which are protected and managed so as to preserve their natural condition.

II National Park

Category II protected areas are large natural or near natural areas set aside to protect large-scale ecological processes, along with the complement of species and ecosystems characteristic of the area, which also provide a foundation for environmentally and culturally compatible, spiritual, scientific, educational, recreational, and visitor opportunities.

III Natural Monument or Feature

Category III protected areas are set aside to protect a specific natural monument, which can be a landform, sea mount, submarine cavern, geological feature such as a cave or even a living feature such as an ancient grove. They are generally quite small protected areas and often have high visitor value.

IV Habitat/Species Management Area

Category IV protected areas aim to protect particular species or habitats and management reflects this priority. Many Category IV protected areas will need regular, active interventions to address the requirements of particular species or to maintain habitats, but this is not a requirement of the category.

V Protected Landscape/ Seascape

A protected area where the interaction of people and nature over time has produced an area of distinct character with significant, ecological, biological, cultural and scenic value: and where safeguarding the integrity of this interaction is vital to protecting and sustaining the area and its associated nature conservation and other values.

VI Protected area with sustainable use of natural resources

Category VI protected areas conserve ecosystems and habitats together with associated cultural values and traditional natural resource management systems. They are generally large, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area.

Fig. S4. Range maps of 31 species of large carnivores. Sources: IUCN (<http://www.iucnredlist.org>.) and www.panthera.org.

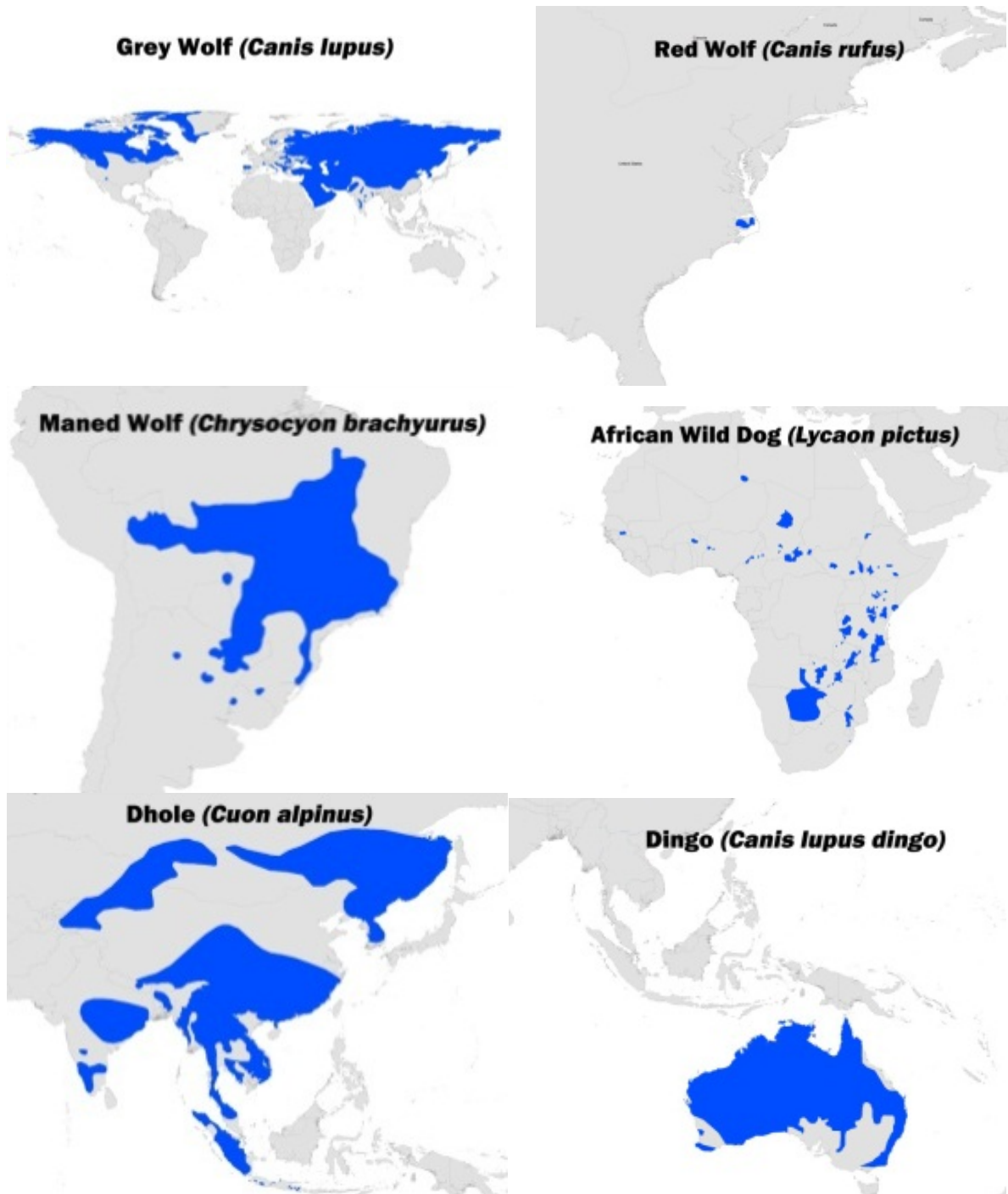


Fig. S4 continued

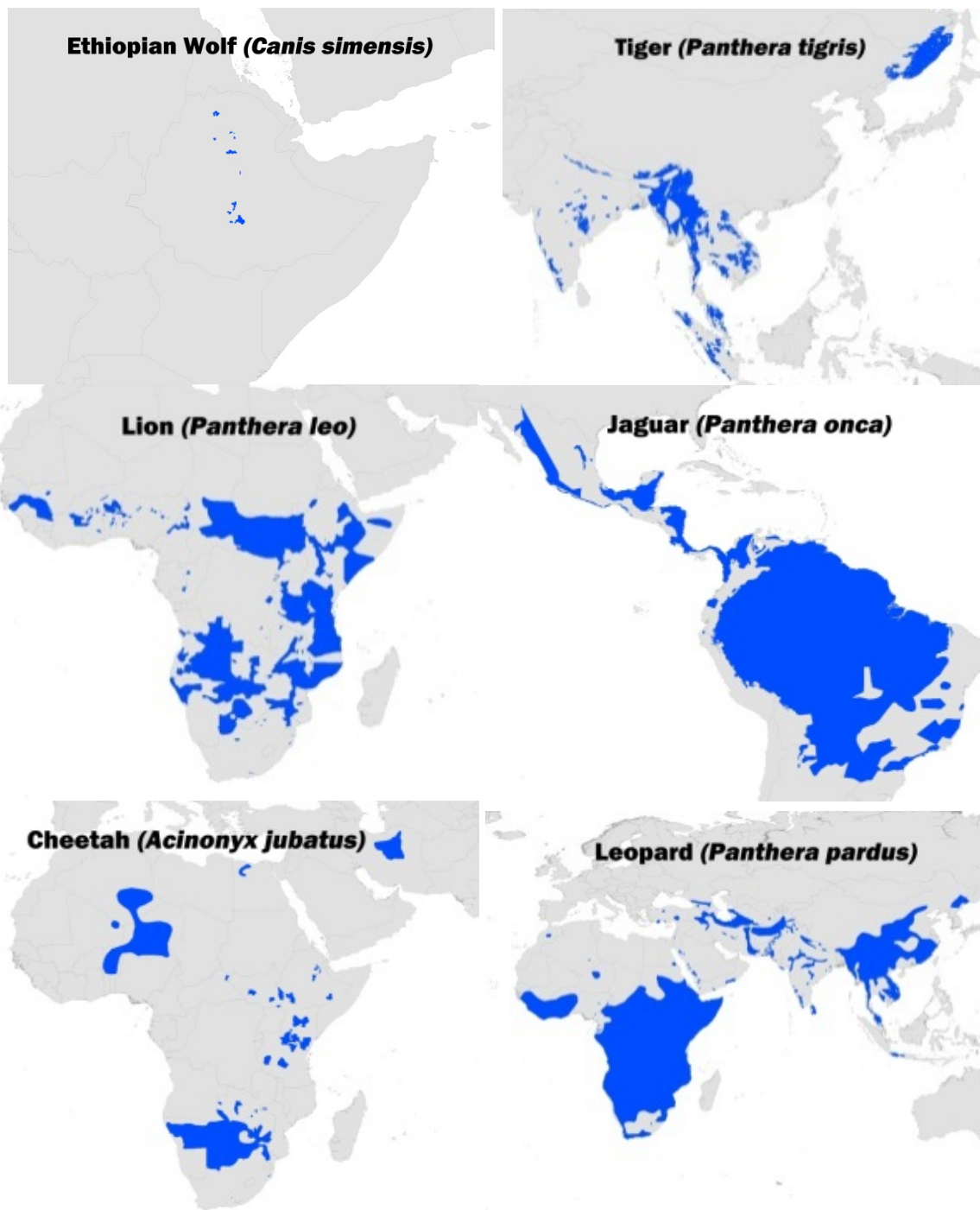


Fig. S4 continued

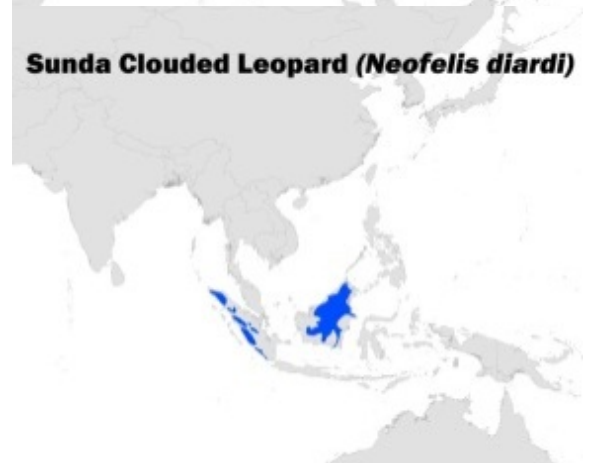
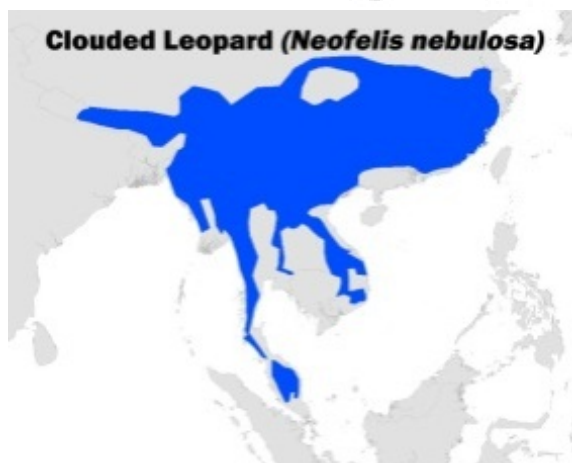


Fig. S4 continued

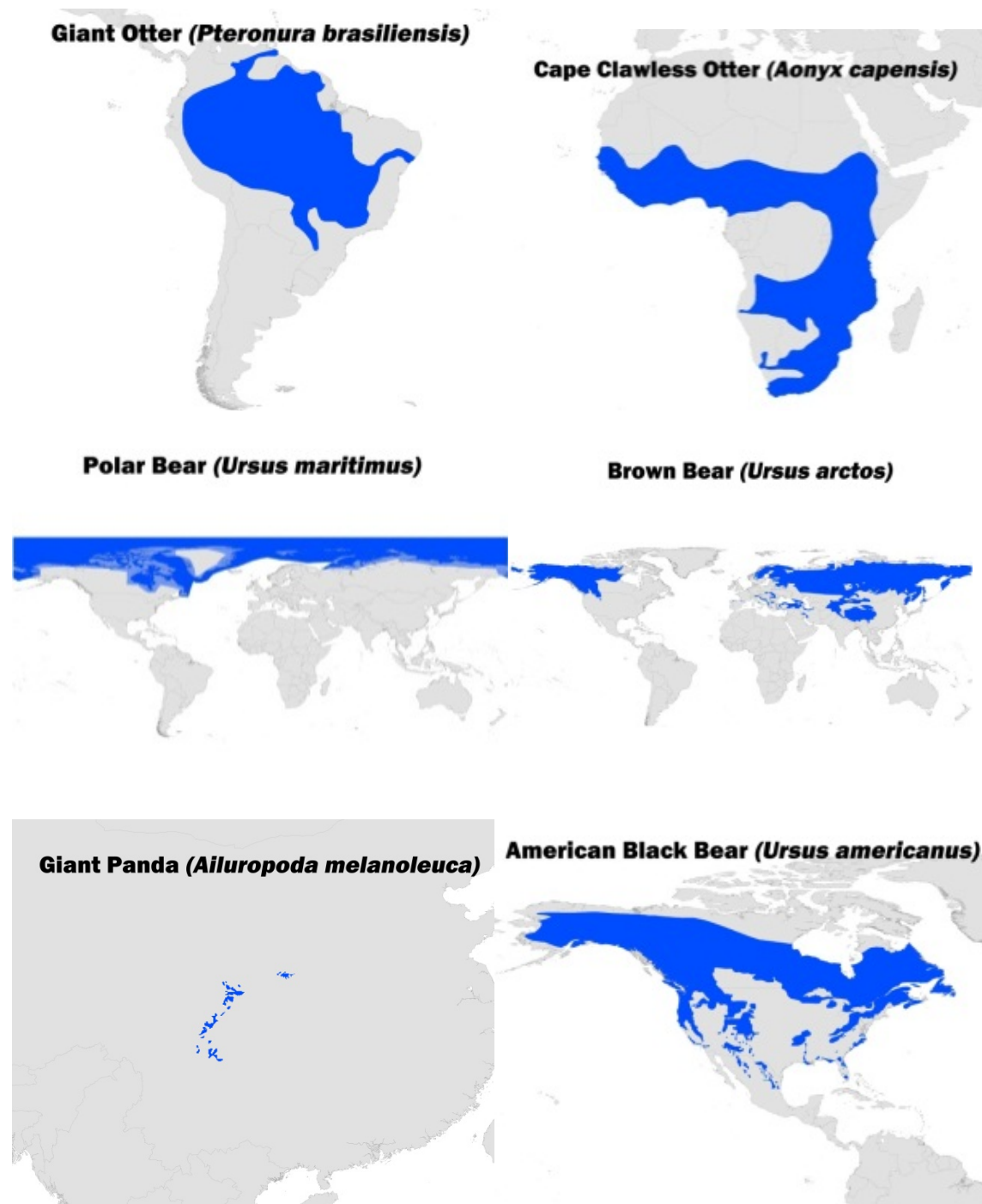


Fig. S4 continued

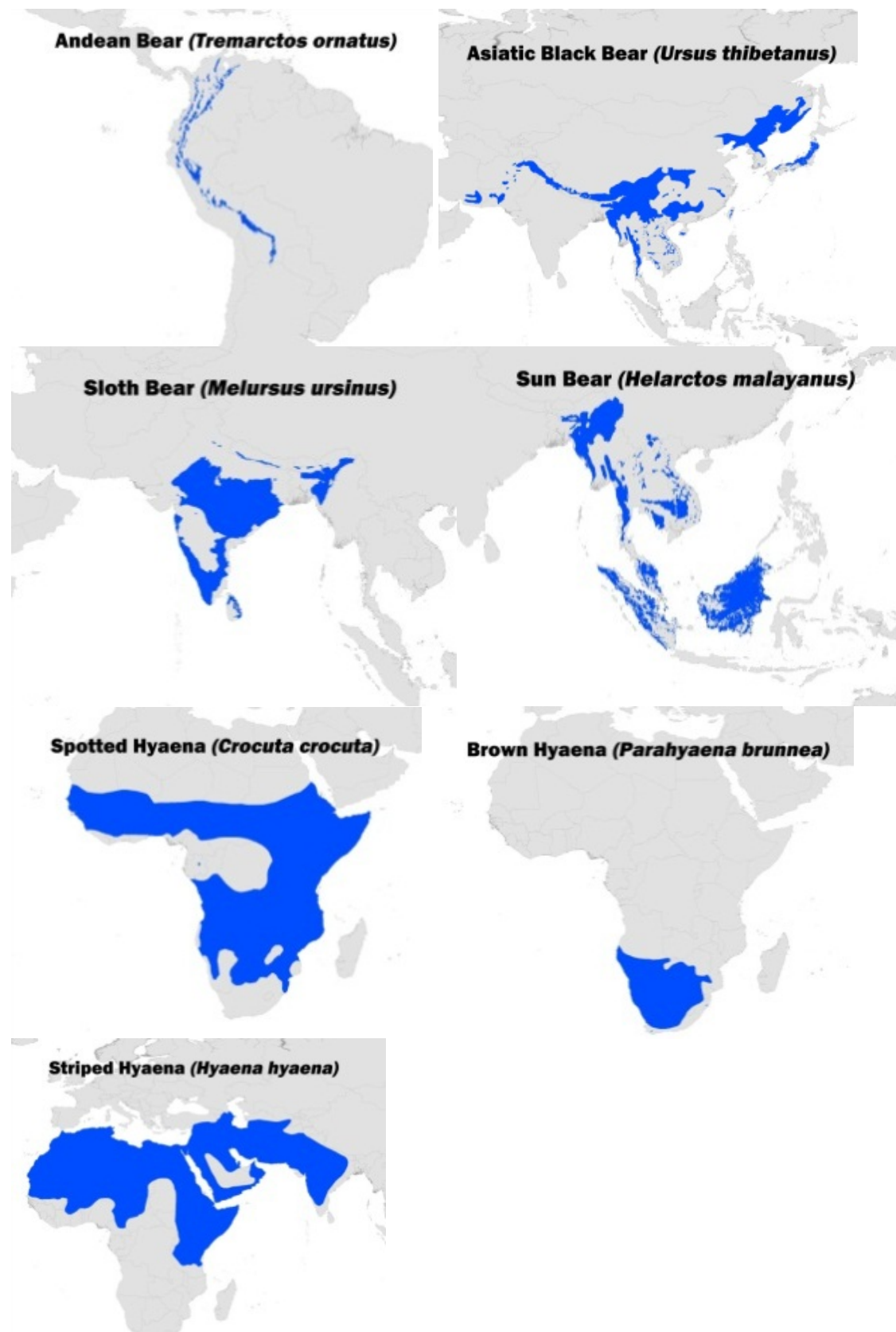


Table S1. Population estimates and range sizes for large carnivores. Source: IUCN (<http://www.iucnredlist.org>.)

Family/Species	Common name	Current range (Sq. Km.)	Current population size
Canidae			
<i>Canis lupus</i> *	Gray wolf	51,035,000	168,000-183,000
<i>Canis rufus</i>	Red wolf	3,200	>100
<i>Chrysocyon brachyurus</i>	Maned wolf	3,153,300	23,600
<i>Lycaon pictus</i>	African wild dog	1,276,900	6,600
<i>Cuon alpinus</i>	Dhole	10,181,100	<2,500
<i>Canis dingo</i>	Dingo	6,576,000	--
<i>Canis simensis</i>	Ethiopian wolf	6,200	--
Felidae			
<i>Panthera tigris</i>	Tiger	1,502,300	4,000
<i>Panthera leo</i>	Lion	5,262,000	32,000
<i>Panthera onca</i>	Jaguar	11,217,400	--
<i>Acinonyx jubatus</i>	Cheetah	2,793, 700	10,000
<i>Panthera pardus</i>	Leopard	21,895,900	--
<i>Puma concolor</i>	Puma	22,297,000	--
<i>Panthera uncia</i>	Snow leopard	3,985,500	4,080-6,590
<i>Neofelis nebulosa</i>	Clouded leopard	3,660,600	--
<i>Neofelis diardi</i>	Sunda clouded leopard	491,000	--
<i>Lynx lynx</i>	Eurasian lynx	21,848,000	>50,000
Mustelidae			
<i>Enhydra lutris</i>	Sea otter	--	106,822
<i>Pteronura brasiliensis</i>	Giant otter	--	1,000-5,000
<i>Aonyx capensis</i>	Cape clawless otter	--	--
Ursidae			
<i>Ursus maritimus</i>	Polar bear	--	20,000 to 25,000
<i>Ursus arctos</i>	Brown bear	27,360,700	--
<i>Ailuropoda melanoleuca</i>	Giant panda	15,900	1,000–2,000
<i>Ursus americanus</i>	American black bear	9,665,300	>850,000–950,000
<i>Tremarctos ornatus</i>	Andean bear	297,900	5,000 - 30,000
<i>Not surUrsus thibetanus</i>	Asiatic black bear	3,313,500	49,000-58,000
<i>Melursus ursinus</i>	Sloth bear	1,508,400	20,000
<i>Helarctos malayanus</i>	Sun bear	1,507,200	--
Hyaenidae			
<i>Crocuta crocuta</i>	Spotted hyena	14,529,900	27,000 - 47,000
<i>Hyaena brunnea</i>	Brown hyena	2,407,400	5,000 - 8,000
<i>Hyaena hyaena</i>	Striped hyena	23,566,900	5,000 - 14,000

*Estimate of gray wolf population from: L. D. Mech, L. Boitani (eds.) Wolf-Prey Relations. Wolves: Behavior, Ecology, and Conservation (University of Chicago Press, Chicago, 2003).

Table S2. Threat categories for large carnivore species. HL – Habitat Loss (including fragmentation), P – Persecution (due to conflict with humans), U – Utilisation (e.g. hunting for meat and fur and body parts for traditional medicine), AM – Accidental Mortality, DP – Depletion of Prey, D – Disease, IC – Intraspecific Competition (including intraguild predation), Po – Pollution, H – Hybridization, CC – Climate Change. Source: IUCN species reports (<http://www.iucnredlist.org>.)

Family/Species	Common name	HL	P	U	AM	DP	D	IC	Po	H	CC
Canidae											
<i>Canis lupus</i>	Gray wolf										
<i>Canis rufus</i>	Red wolf		*								
<i>Chrysocyon brachyurus</i>	Maned wolf										
<i>Lycaon pictus</i>	African wild dog										
<i>Cuon alpinus</i>	Dhole										
<i>Canis dingo</i>	Dingo										
<i>Canis simensis</i>	Ethiopian wolf										
Felidae											
<i>Panthera tigris</i>	Tiger										
<i>Panthera leo</i>	Lion										
<i>Panthera onca</i>	Jaguar										
<i>Acinonyx jubatus</i>	Cheetah										
<i>Panthera pardus</i>	Leopard										
<i>Puma concolor</i>	Puma										
<i>Panthera uncia</i>	Snow leopard										
<i>Neofelis nebulosa</i>	Clouded leopard										
<i>Neofelis diardi</i>	Sunda clouded leopard										
Mustelidae											
<i>Lynx lynx</i>	Eurasian lynx										
<i>Enhydra lutris</i>	Sea otter										
<i>Pteronura brasiliensis</i>	Giant otter										
<i>Aonyx capensis</i>	Cape clawless otter										
Ursidae											
<i>Ursus maritimus</i>	Polar bear										
<i>Ursus arctos</i>	Brown bear										
<i>Ailuropoda melanoleuca</i>	Giant panda			*							
<i>Ursus americanus</i>	American black bear										
<i>Tremarctos ornatus</i>	Andean bear										
<i>Ursus thibetanus</i>	Asiatic black bear										
<i>Melursus ursinus</i>	Sloth bear										
<i>Helarctos malayanus</i>	Sun bear										
Hyaenidae											
<i>Crocuta crocuta</i>	Spotted hyena										
<i>Hyaena brunnea</i>	Brown hyena										
<i>Hyaena hyaena</i>	Striped hyena										
Total number of large carnivores threatened:		21	20	19	12	11	8	4	5	3	1
Percent of large carnivores threatened:		68	65	61	39	35	25	12	16	10	3

* Past threat (excluded from analysis)

Table S3. IUCN conservation priorities by large carnivore species.

PS - Population status, distribution, ecology and life history, HC - Habitat condition, prey and plant food availability and anthropogenic threats, LS - Legal status, management and enforcement, G - Genetic variability and hybridization, TP - Influence of carnivore on a threatened prey species, EC - Education and community involvement, C - Actions to reduce conflict with humans (e.g. livestock guarding, compensation schemes, waste management, ecotourism), HP - Protection of habitat and food sources (including limiting pollution), PO - Reduce poaching and illegal trade, CB - Captive breeding and reintroduction, D - Monitoring and prevention of disease, HM - Habitat modification to increase food abundance (e.g. burning, artificial water points), EF - Phase-out or limit practices of captivity for entertainment and farming (dancing bears, bile and body part farming for traditional medicine).


Source: IUCN Status Survey and Conservation Action Plan series-

(http://www.iucn.org/about/work/programmes/species/publications/species_actions_plans/)

Family (year published)/ <i>species</i>	Common name	Assessment and monitoring plans						Recommended actions							
		PS	HC	LS	G	TP	EC	C	HP	PO	CB	D	HM	EF	
Canidae (2004)															
<i>Canis lupus</i>	Gray wolf														
<i>Canis rufus</i>	Red wolf														
<i>Chrysocyon brachyurus</i>	Maned wolf														
<i>Lycaon pictus</i>	African wild dog														
<i>Cuon alpinus</i>	Dhole														
<i>Canis dingo</i>	Dingo														
<i>Canis simensis</i>	Ethiopian wolf														
Felidae (1996)															
<i>Panthera tigris</i>	Tiger														
<i>Panthera leo</i>	Lion														
<i>Panthera onca</i>	Jaguar														
<i>Acinony jubatus</i>	Cheetah														
<i>Panthera pardus</i>	Leopard														
<i>Puma concolor</i>	Puma														
<i>Panthera uncia</i>	Snow leopard														
<i>Neofelis nebulosa</i>	Clouded leopard														
<i>Lynx lynx</i>	Eurasian lynx														
Mustelidae, Lutrinae (1990)															
<i>Enhydra lutris</i>	Sea otter														
<i>Pteronura brasiliensis</i>	Giant otter														
<i>Aony capensis</i>	Cape clawless otter														
Ursidae (1999)															
<i>Ursus maritimus</i>	Polar bear														
<i>Ursus arctos</i>	Brown bear														
<i>Ailuropoda melanoleuca</i>	Giant panda														
<i>Ursus americanus</i>	American black bear														
<i>Tremarctos ornatus</i>	Andean bear														
<i>Ursus thibetanus</i>	Asiatic black bear														

<i>Melursus ursinus</i>	Sloth bear														
<i>Helarctos malayanus</i>	Sun bear														
Hyaenidae															
<i>Crocota crocuta</i>	Spotted hyena														
<i>Hyaena brunnea</i>	Brown hyena														
<i>Hyaena hyaena</i>	Striped hyena														
Total number of large carnivores included in action category		29	20	16	12	1	23	21	18	15	14	5	4	3	
Percent of large carnivores included in action category		97	67	53	40	3	77	70	60	50	47	17	13	10	

 Denotes assessment and monitoring plans for the indicated large carnivore species.

 Denotes action recommendations for the indicated large carnivore species.