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Contributed Paper

Priorities for global felid conservation

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Abstract: *Conservation resources are limited, necessitating prioritization of species and locations for action. Most prioritization approaches are based solely on biologically relevant characteristics of taxa or areas and ignore geopolitical realities. Doing so risks a poor return on conservation investment due to nonbiological factors, such as economic or political instability. We considered felids, a taxon which attracts intense conservation attention, to demonstrate a new approach that incorporates both intrinsic species traits and geopolitical characteristics of countries. We developed conservation priority scores for wild felids based on their International Union for Conservation of Nature status, body mass, habitat, range within protected area, evolutionary distinctiveness, and conservation umbrella potential. We used published data on governance, economics and welfare, human population pressures, and conservation policy to assign conservation-likelihood scores to 142 felid-hosting countries. We identified 71 countries as high priorities (above median) for felid conservation. These countries collectively encompassed all 36 felid species and supported an average of 96% of each species' range. Of these countries, 60.6% had below-average conservation-likelihood scores, which indicated these countries are relatively risky conservation investments. Governance was the most common factor limiting conservation likelihood. It was the major contributor to below-median likelihood scores for 62.5% of the 32 felid species occurring in lower-likelihood countries. Governance was followed by economics for which scores were below median for 25% of these species. An average of 58% of species' ranges occurred in 43 higher-priority lower-likelihood countries. Human population pressure was second to governance as a limiting factor when accounting for percentage of species' ranges in each country. As conservation likelihood decreases, it will be increasingly important to identify relevant geopolitical limitations and tailor conservation strategies accordingly. Our analysis provides an objective framework for biodiversity conservation action planning. Our results highlight not only which species most urgently require conservation action and which countries should be prioritized for such action, but also the diverse constraints which must be overcome to maximize long-term success.*

Keywords: conservation likelihood, conservation limitations, geopolitics, priority setting

Prioridades para la Conservación Global de Félidos

Resumen: *Los recursos para la conservación son limitados, por lo que necesitan de la priorización de especies y localidades para actuar. La mayoría de las estrategias de priorización están basadas solamente en las características biológicamente relevantes de los taxones o áreas e ignoran la realidad geopolítica. Hacer esto lleva consigo el riesgo de un pobre retorno de la inversión en la conservación debido a factores no-biológicos, como la inestabilidad económica o política. Consideramos a los félidos, un taxón que atrae una atención intensa de conservación, para demostrar una estrategia nueva que incorpora tanto los rasgos intrínsecos de la especie como las características geopolíticas de los países. Desarrollamos puntajes de prioridad de conservación para los félidos salvajes con base en su estado de acuerdo a la Unión Internacional para la Conservación de la Naturaleza, su masa corporal, hábitat, extensión dentro de un área protegida, peculiaridad evolutiva, y potencial como paraguas de conservación. Utilizamos datos publicados sobre el gobierno, economía y bienestar, presiones de la población humana, y políticas de conservación para asignar puntajes de probabilidad de conservación a 142 países con poblaciones de félidos. Identificamos a 71 países*

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como prioridades altas (por encima de la media) para la conservación de los félidos. Estos países englobaron colectivamente a las 36 especies de félidos y mantuvieron a un promedio de 96% de la extensión de cada especie. De estos países, 60.6% tuvo un puntaje de probabilidad de conservación por debajo del promedio, lo que indica que estos países son potencialmente riesgos de inversión para la conservación. El gobierno fue el factor limitante más común para la probabilidad de la conservación. También fue el principal contribuyente para los puntajes por debajo del promedio del 62.5% de las 32 especies de félidos que se presentaron en países de menor probabilidad de conservación. Al gobierno lo siguió la economía, para la cual los puntajes estuvieron por debajo de la media para el 25% de las especies. Un promedio de 58% de la extensión de las especies se presentó en 43 países de prioridad alta con probabilidad baja. La presión de la población humana fue segunda al gobierno como factor limitante al tomarse en cuenta el porcentaje de extensión de las especies en cada país. Conforme disminuya la probabilidad de conservación, será cada vez más importante identificar las limitaciones geopolíticas y confeccionar estrategias de conservación acordes a ellas. Nuestro análisis proporciona un marco de trabajo objetivo para la planeación de acciones para la conservación de la biodiversidad. Nuestros resultados resaltan no sólo cuáles especies requieren más urgentemente de acciones de conservación y cuáles países deberían ser prioridad para dichas acciones, sino también las restricciones diversas que se deben superar para maximizar el éxito a largo plazo.

Palabras Clave: establecimiento de prioridades, geopolítica, limitantes de la conservación

Introduction

Biodiversity loss is occurring at a rate that constitutes a sixth great extinction period, with species extinction rates thousands of times greater than the background level (Ceballos et al. 2010). Furthermore, mammal range contractions are on average 68% (Ceballos & Ehrlich 2002). This global biodiversity crisis requires urgent action, but deciding what and where to prioritize is difficult for both conservation biologists and wider society (Macdonald et al. 2006). Prioritization exercises range from broad-scale location-based approaches, such as biodiversity hotspots and ecoregions (Olson & Dinerstein 1998; Myers et al. 2000), to priority-setting methods for individual taxa, such as mammals (Isaac et al. 2007). One approach is to select areas which offer the greatest rewards, in terms of endangered species, as illustrated for North American carnivores (Valenzuela-Galvan et al. 2008) or for groups of threatened felids and primates (Macdonald et al. 2012).

In practice, however, conservation effectiveness is driven not only by biological characteristics of the species or their habitats, but also by practicalities, such as politics, infrastructure, and logistics. Most prioritization efforts fail to incorporate issues such as the cost and likelihood of conservation success; thus, misallocation of scarce resources and failure of the conservation action could result (Joseph et al. 2009). We examined potential conservation priorities for Felidae, one of the most high-profile mammal families. We used a species-level approach followed by a country-level approach. We incorporated not only the biological aspects of the species concerned, but also socio-economic factors such as a country's wealth, purchasing power, and level of corruption, which are likely to affect conservation success on the ground. We sought to determine which wild felids are of higher conservation priority than other felids and to determine the countries where an investment in them is most likely to yield realistic conservation gains. Recent collaborative efforts aimed at wild cat conservation (Panthera 2014) could result in substantial policy and conservation impacts, but only if effort and funds are targeted effectively. Therefore, we aimed to garner information that would be useful to people who make such resource allocation decisions.

Determining which felid species to invest in over others and where specifically to target that investment is a substantial problem, one that has not been systematically analyzed previously. Some felids—particularly big cats, such as lion (*Panthera leo*), tiger (*Panthera tigris*), and cheetah (*Acinonyx jubatus*)—are both familiar and charismatic, and as such they attract huge support (Brodie 2009). However, Felidae is a diverse taxon, ranging from the diminutive rusty-spotted cat (*Prionailurus rubiginosus*), which can weigh around 1 kg, to the tiger, which can exceed 300 kg (Macdonald et al. 2010). Despite the intense attention paid to charismatic cats, many of the smaller felids are elusive and poorly known (Brodie 2009); thus, they may appear as low priorities on the conservation agenda, even if they are highly threatened. To provide a practical framework for decision makers to prioritize felids and countries for conservation action, we sought to identify which felid species are most in need of conservation, to determine which countries support concentrations of these higher priority felids, and to determine the likelihood of conducting effective, long-term felid conservation in countries where conservation dollars might be spent. This conservation likelihood can be affected by many factors such as amount of habitat, ability of a country to invest in conservation and enact relevant policies, and intensity of other pressures likely to divert attention from conservation (e.g., conflict or political instability) (Kanyamibwa 1998; Smith et al. 2003).

Protected areas are fundamentally important for many conservation efforts (Bruner et al. 2001), both at a species and national level (Walston et al. 2010; Henschel et al. 2014), so protected area size was included in our metrics

for species priority scores and conservation likelihood. However, in reality, such protected areas may be poorly governed and fail to effectively secure biodiversity (Bonham et al. 2008). Several factors affect how effective protected areas are, including a country's level of corruption, poverty (measured as Gross Domestic Product per capita), conflict intensity, and instability; human development index (HDI); and governance effectiveness (Wright et al. 2007; Irland 2008). We therefore used these metrics to provide some insight into likely protected area effectiveness. Although gaining insights into effectiveness of protected areas is informative, even relatively ineffective protected areas offer some protection (Bruner et al. 2001). Thus, we retained percentage of range protected in the felid priority and nation-wide conservation likelihood scores because we believe it is a valid index of future conservation need.

Methods

We based our analyses on range maps of 36 felids from IUCN's (2013) Red List of Threatened Species. Protected area shapefiles were obtained from the World Database on Protected Areas (IUCN [International Union for Conservation of Nature] and UNEP [United Nations Environment Programme] 2014). Country shapefiles were obtained from Natural Earth (2013). Evolutionary distinctiveness (ED) data were obtained from EDGE of Existence (2013). Sources for data used to calculate country national conservation likelihood (NCL) scores are in Supporting Information.

We calculated felid conservation priority (FCP) scores for each species and national conservation priority (NCP) and NCL scores for those countries that support populations of wild felids.

FCP Scores

We used a 2-step process to develop an FCP score for each wild felid species. First, we calculated standardized scores for each felid for IUCN red-list category, mean body size, habitat association, protected area coverage, and ED.

The IUCN (2013) bases categorization of a species' extinction risk on population size, range area, and rate of population decline (Joseph & Possingham 2008). To maintain a proportionate change in score between categories and assuming that each additional rank achieved represented a doubling of conservation need for the species, we scored felids according to their red-list category: 1, least concern; 2, near threatened; 4, vulnerable; 8, endangered; 16, critically endangered. A higher score indicated higher conservation priority.

Large mammals tend to be more extinction prone than small ones (Cardillo & Bromham 2001). For example, large cats range over wider areas and elicit greater conflict with humans than small cats (Inskip & Zimmerman 2009), and these traits are conservation risk factors (Woodroffe & Ginsberg 1998). For each species, we used average body mass across sexes (Inskip & Zimmerman 2009). A higher score denoted higher body mass and higher conservation priority.

Felids associated with a narrow spectrum of habitats are considered at greater risk of extinction than felids with a broad spectrum of habitats (Nowell & Jackson 1996), so we used the habitat association scores in the IUCN Wild Cats Action Plan. We calculated inverse scores, so that a higher value represented a narrower habitat association and therefore greater conservation priority.

Wild felids are usually most threatened in human-dominated landscapes (Nowell & Jackson 1996), so we examined the percentage of each felid's geographic range covered by an existing protected area network. Inverse scores were calculated, so that higher values denoted less protection and higher conservation priority.

ED is a measure of how much each species contributes toward overall phylogenetic diversity (Isaac et al. 2007). Felids which are genetically more distant from other species have high ED. More genetically distinct felids were deemed a priority for conservation, meaning a higher score represented greater ED and higher priority. A separate ED score was not available for the recently described Sunda clouded leopard (*Neofelis diardi*), so we used the ED score for *Neofelis nebulosa* for both clouded leopard species.

The 5 standardized variables were summed per species and the most negative score plus 0.01 added to the sum to generate a positive preliminary FCP (pFCP) score for each species. This summed score is a composite measure of individual conservation priority factors and reveals where each species emerges relative to others in terms of overall conservation priority. Combining factors can provide a more informative picture than examining factors individually (Andersen et al. 2003), and summing z scores is an established method for producing composite measures (Andersen et al. 2006; Tanha et al. 2011). There are arguments for giving some factors (such as endangerment) more weight than others. However, we believe equal weighting introduces the least subjective bias. Despite some correlation ($-0.45 \leq r_s \leq 0.67$), we retained the variables individually because each contributed additional value (e.g., endangered species restricted to particular habitats merit more attention than those that are just endangered, even if the 2 processes are related).

Umbrella Score

Felids face multiple common threats, so conservation strategies aimed at 1 species are likely to benefit others as well (Macdonald et al. 2012). Thus, we calculated a

score that measured how many other felids a conservation effort for a given felid could additionally benefit (hereafter umbrella score). We created a raster of felid range distributions (cell size of 5 min or approximately 9 × 9 km at the equator) with packages raster and rgdal in R (version 2.13.1) to extract the degree of interspecific overlap in pairwise comparisons. The most valuable umbrella species were those which overlapped the most with multiple higher priority felids. The umbrella score for each species was calculated as

$$U_{f1} = (\%RO_{f2} * pFCP_{f2}) + (\%RO_{f3} * pFCP_{f3}) \ldots\ldots\ldots\ldots + (\%RO_{fn} * pFCP_{fn}), \quad (1)$$

where f is the focal species; %RO is percentage of the range of other felid species (f2, f3, etc.) that the focal species' range encompasses; and pFCP is the preliminary FCP score of those species. The sum of all 6 standardized variables (IUCN ranking, body mass, habitat association, protected area coverage, ED, and umbrella score) was made positive and used as the final FCP score for each species.

NCP Scores

The NCP scores were calculated as

$$NCP_{c1} = (FCP_{f1} * \%R_{f1}) + FCP_{f2} * \%R_{f2} \ldots\ldots\ldots\ldots + FCP_{fn} * \%R_{fn}, \quad (2)$$

where c1 is the target country, f1 . . . . . fn the felid species which occur in that country, FCP is the FCP score for the species concerned, and $\%R_f$ is the percentage of that species' range falling within the country's borders.

NCL Scores

We considered 16 variables (Supporting Information) important indicators of likely conservation effectiveness in a country. These are not the only factors which affect conservation; rather, they are an initial indicator of conservation likelihood and were derived from national-level data which were uniformly available for all countries. Six countries with incomplete data on felids were excluded (Andorra, French Guiana, North Korea, Somalia, Western Sahara, and Zimbabwe), and East Timor and South Sudan were excluded because data were not available for these countries independently. Sudan was included as a single country, to provide some insight into its value for felids and likely conservation effectiveness.

The variables were standardized and the resulting z scores inversed when a lower value of a given measure was deemed better for conservation likelihood, such as for population density and conflict intensity. As before, no additional weighting was imposed, and despite some correlation ($0.04 \leq r_s \leq 0.60$), we retained metrics individually because poor, corrupt countries were deemed a riskier conservation investment than merely poor countries, even if underlying mechanisms are linked. Each standardized value was allocated to 1 of 4 categories (governance, economics and welfare, habitat and environment, and conservation policy), such that each category had from 3 to 5 contributing variables (Supporting Information). The mean values of the variables in each category were summed to produce an overall NCL score for each felid range country that would show where each country was relative to others in terms of overall conservation likelihood.

EFFECTIVENESS OF PROTECTED AREAS

The 6 national-level variables in our NCL score identified as likely factors in the effectiveness of protected areas (corruption, GDP per capita, conflict intensity, political stability, government effectiveness, and HDI) (Wright et al. 2007; Irland 2008) were standardized and summed to derive a protected-area effectiveness score for each country. A high score indicates a country is likely to have more effective protected areas. For each felid species, the percentage of protected range in each country was multiplied by that country's effectiveness score, with the summed value providing an index of protected-area effectiveness at a species level.

Results

Preliminary FCP, Umbrella, and Final Conservation Priority Scores

Just under half of wild felid species (44%, $n = 16$) had an IUCN ranking of vulnerable or above, and a significantly greater proportion of felid range occurred in protected areas ($t = 3.40$, df 35, $p = 0.002$). Protected areas encompassed 17.8% of felid ranges on average. Because protected areas are an important conservation strategy for felids, we prioritized those species with less representation in current protected areas. There was no significant relationship between the percentage of range protected and felid body mass ($r_s = 0.321$, df = 34, $p = 0.056$), IUCN ranking (KW $\chi^2 = 7.328$, df = 4, $p = 0.120$), or ED score ($r_s = 0.240$, $n = 36$, $p = 0.159$).

The pFCP score (all pFCP scores in Supporting Information) (without umbrella scores) ranked the tiger as the felid most in need of conservation action; the wild cat (*Felis silvestris*) was the least in need of conservation. Felids differed markedly in terms of the umbrella effect they offered one another. On average, species overlapped with 8.81 other felid species in total across their ranges (range 1–20). The Iberian lynx (*Lynx pardinus*) had the lowest umbrella score and the leopard (*Panthera pardus*) the highest (Supporting Information). The average pFCP score of other cats under a felid's umbrella was

highest for the Sunda clouded leopard and lowest for the Iberian lynx (Supporting Information). Contrary to what might have been expected, larger-bodied felids were not significantly more effective umbrella species for other felids ($r_s = 0.042$, $n = 36$, $p = 0.809$).

Species with a wide geographic distribution were better umbrella species because they have the opportunity to overlap with more felids globally ($r = 0.576$, $n = 36$, $p < 0.001$). When the umbrella score was calculated per 100,000 km^2, the most efficient umbrella species was the Sunda clouded leopard, and the Iberian lynx was the least efficient (Supporting Information). The species most negatively affected by calculating the umbrella score per unit area was the Eurasian lynx (*Lynx lynx*), which emerged as fractionally above average according to the initial umbrella score, but was a very inefficient umbrella per unit area due to its restricted range. In contrast, the flat-headed cat (*Prionailurus planiceps*) was in the lowest quartile for umbrella score, but its umbrella score per 100,000 km^2 was the fourth highest of all felids (Supporting Information). This is because the distribution of the flat-headed cat overlaps with many other species, despite its relatively small range.

When umbrella z scores were incorporated to produce the final FCP scores, the 6 highest priority (highest conservation need) species were tiger, flat-headed cat, cheetah, leopard, puma (*Puma concolor*) and marbled cat (*Pardofelis marmorata*). These felids had FCP scores more than 1 SD greater than the mean. The leopard and leopard cat (*Prionailurus bengalensis*) were most positively affected by including umbrella score in the final FCP rankings; both rose 23 places after inclusion, whereas the kodkod (*Leopardus guigna*) was most negatively affected (it fell 11 places) (Supporting Information). Including umbrella score in the final FCP rankings did not alter the position of the 3 highest ranked felids.

NCP and Likelihood Scores

The NCP and NCL scores for the 142 countries with extant or probably extant felid populations varied markedly within and among the 5 continents examined (Fig. 1). India supported the highest number of felid species (15 known felids) followed by China (11 felids) and Argentina, Malaysia, Myanmar, Nepal, and Pakistan (each with 10 felids [Supporting Information]). China, Indonesia, and India had the highest NCP scores, whereas Luxembourg, Japan, and the Czech Republic had the lowest scores for felid priority (Supporting Information).

We defined as higher priority the 71 countries with above-median NCP scores (Supporting Information). These countries collectively represented all 36 felid species and covered a mean of 96% (81–100%) of each species' range (Supporting Information). Ten of the highest priority countries collectively provided some representation of all 36 species, together averaging nearly half (48.0%, range 12.7–100%) of those species' ranges (Supporting Information).

Germany had the highest NCL score with good governance, economics, and conservation policy (Supporting Information). India had the lowest NCL score, mainly due to poor governance and intense human pressure. Iraq had the second lowest NCL score; poor governance and conservation policy were the key limiting factors (Supporting Information).

These results highlight that countries lie on spectra of conservation priority and likelihood, so we combined NCP and NCL scores in a quadrant-based framework to better understand where different conservation planning strategies might be most advisable (Fig. 2). Twenty-eight (39%) higher priority countries had above-median NCL scores and thus were in the higher priority, higher likelihood quadrant (Supporting Information). These 28 countries represented all but 1 of the 36 felid species (Canada lynx [*Lynx canadensis*] occurs only in the United States and Canada, both higher priority, lower likelihood countries), but collectively they averaged less than half (44%, range 2.8–100%) of those 35 species' ranges. The remaining 43 higher priority countries (which supported 32 felid species and averaged 58% [0.4–99.9%] of species' ranges) scored below average for conservation likelihood (lower likelihood [Supporting Information]). There was marked variation between countries in both the degree of conservation likelihood and its drivers (Fig. 3). For instance, China and Indonesia were ranked the highest 2 countries for FCP. However, Indonesia had an above-median conservation likelihood score, whereas China was a low-likelihood country (Supporting Information). Both human pressure and governance were limiting factors in China, but human pressure was by far the greater issue, contributing over 60 times more negative value than governance. In contrast, only governance, not human pressure, was a limitation in Indonesia (Supporting Information). Other countries such as the United States and Canada scored very high on governance and economics, but they were limited by relatively low engagement with international conservation agreements.

Impact and Drivers of Low Conservation Likelihood

Felid distributions spanned between 1 and 95 countries (Supporting Information). Thirty-two felids, including 5 of the 6 top priority species, occurred to varying extents in lower-likelihood countries. Only the Bornean bay cat (*Pardofelis badia*), flat-headed cat, Iberian lynx, and Sunda clouded leopard occurred exclusively in higher likelihood countries (Supporting Information). Dependence upon lower-likelihood areas varied substantially between cats; thus, the degree of risk of any investment in their conservation would also vary. The tiger (the top priority species) was affected by lower likelihood in 46% of countries in which it occurred and in 69% of its range,

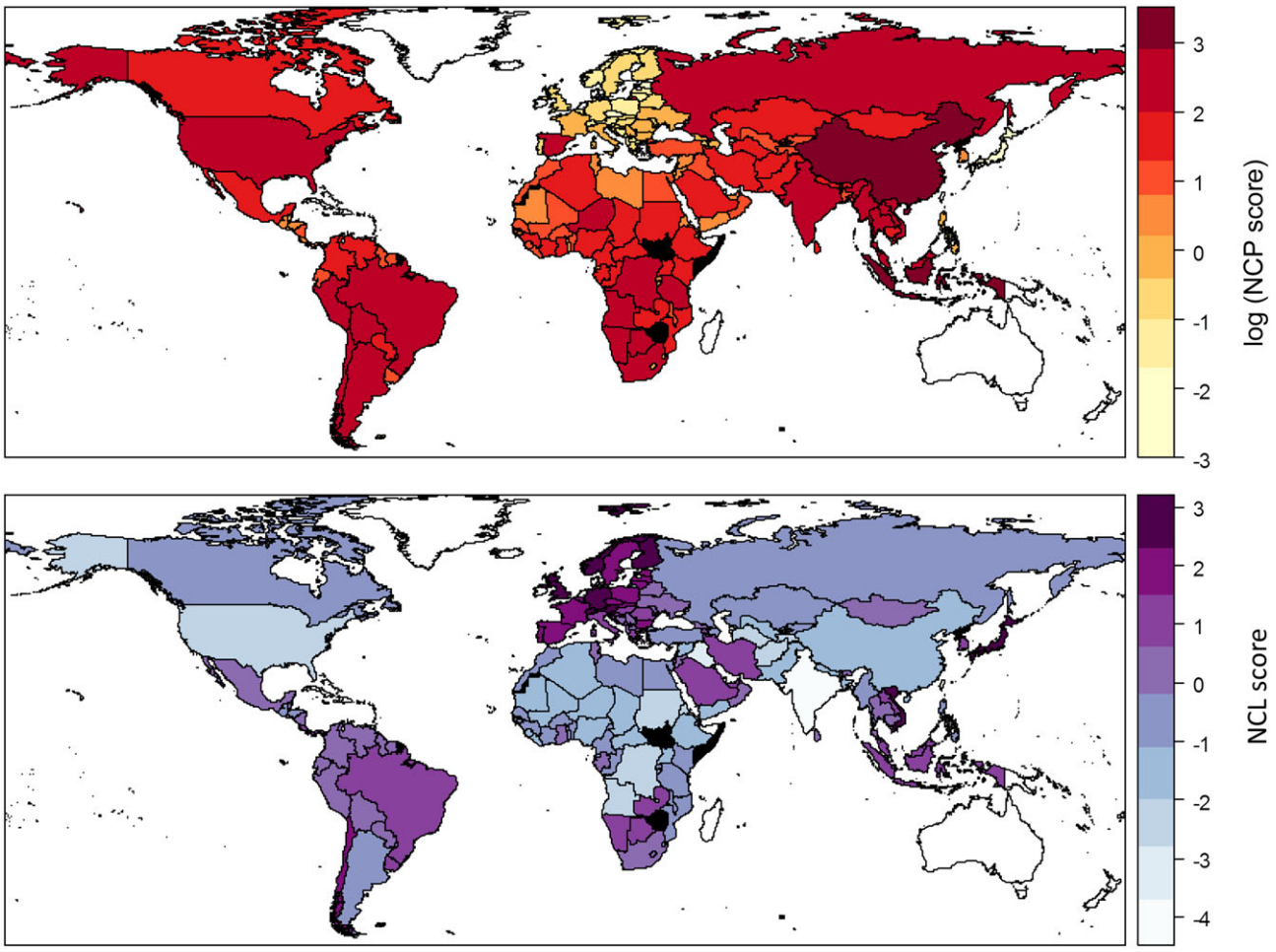

Figure 1. Map of (a) log national conservation priority (NCP) scores (darker shades, countries which support felid populations that are higher priority for conservation) and (b) national conservation likelihood (NCL) scores (darker shades, countries where conservation investment is more likely to produce long-term success). Countries in black have felids but insufficient data for analysis, whereas countries in white have no wild felid populations according to International Union for Conservation of Nature range maps.

whereas the flat-headed cat (second highest priority) was relatively unaffected by geopolitical pressures because it occurred in 1 higher likelihood country (Supporting Information).

Of the 32 felid species that occurred in lower likelihood countries, governance was the major contributor to below-average NCL values for 62.5% of them; poor economics was the major factor for 25%, whereas human pressure and conservation policy were each major factors for 6.25% at the country scale (Supporting Information). The impact of poor governance declined slightly when we considered the percentage of species' ranges in each country, although it remained a key limitation for 59.4% of felids. The influence of human pressure increased substantially relative to the country scale and was the major limiting factor for 21.9% of felid species. Poor economics and conservation policy were each major limiting factors for 9.4% of species when range was considered, meaning that the importance of economics decreased and policy increased relative to the country scale.

Effectiveness of Protected Areas

Protected area extent (KS = 5.35, $p < 0.001$) and the likely effectiveness of those areas (KS = 3.45, $p < 0.001$) varied significantly between countries, although there was no significant relationship between these 2 variables ($r_s = -0.100$, $n = 142$, $p = 0.236$). India, which had below-average scores for conflict intensity, corruption, government stability, and HDI, had the highest risk of ineffective protected areas, followed by Afghanistan and Sudan (Supporting Information). Conversely, protected areas in the United States, Japan, and Germany were the most likely to be effective (due to relatively great wealth and good governance) (Supporting

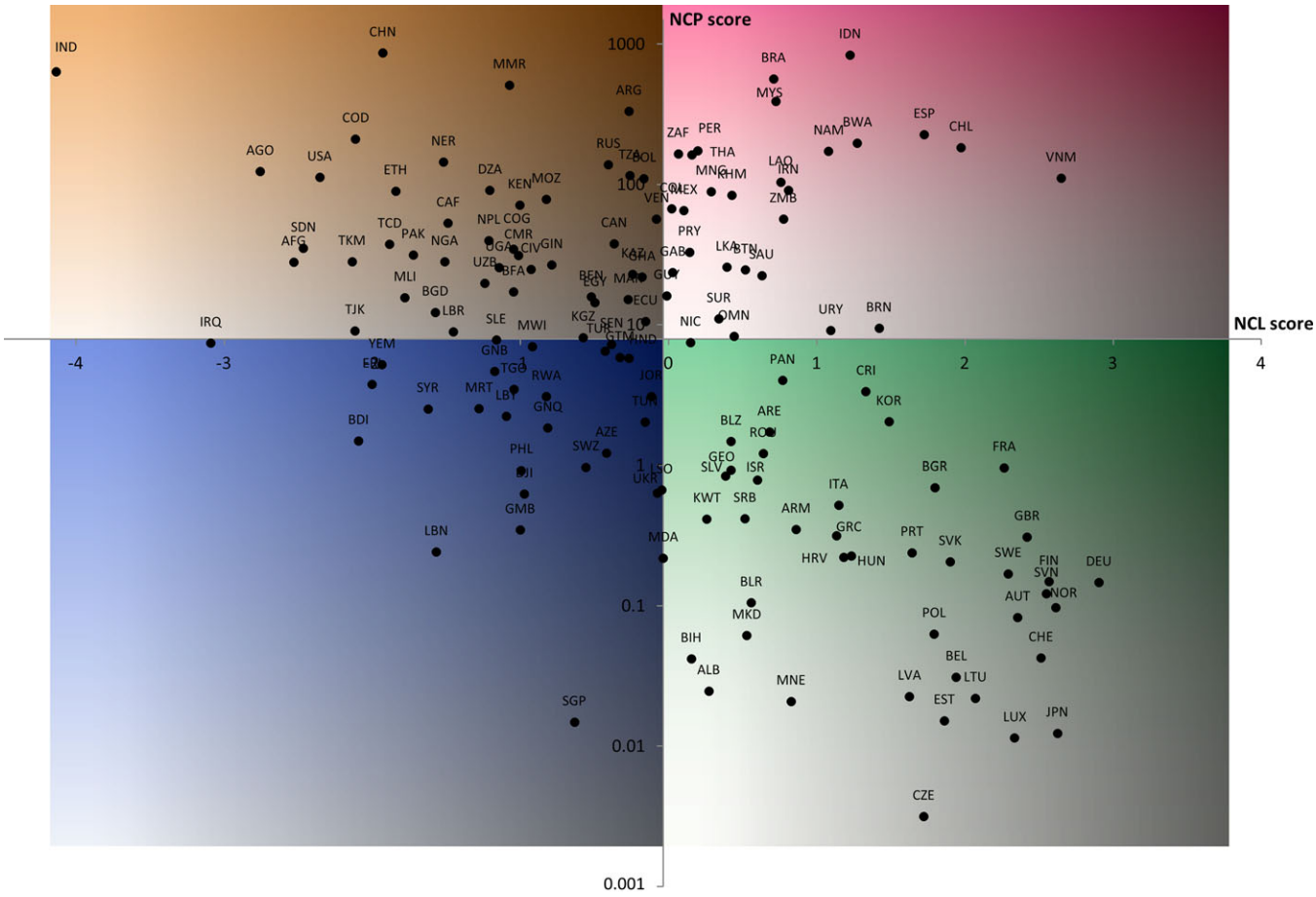

Figure 2. Country classifications according to their national conservation likelihood (NCL) scores and log national conservation priority (NCP) scores. Axes are positioned at median values, and country codes are provided in Supporting Information. The more intense the color, the higher the NCP score, whereas the darker the grey shading, the higher the NCL score.

Information). This international variation influenced the threat to individual species of ineffective protected areas; we examined a mean of 98.7% (range 92.0–100%) of felid species' protected area range (Supporting Information). The rusty-spotted cat was at the highest risk from protected area ineffectiveness. It is the only species where 100% of its examined protected area range occurred in countries with above-average risk of ineffective protected areas (Supporting Information). Ninety-four percent of tiger protected area range was in countries with above-average risk of ineffective protected areas (Supporting Information). At the other end of the scale, Canada lynx, bobcat (*Lynx rufus*), and Iberian lynx were likely to receive more than just token protection in protected areas because 100% of their ranges occurred in countries with low (below-average) risk of ineffective protected areas. Overall, there was a marginally positive significant relationship between a species' FCP score and likelihood of ineffective protected areas ($r_s = 0.334$, $n = 142$, $p = 0.046$).

Discussion

There is often a disconnect between conservation planners and people making resource allocation decisions (Game et al. 2013), but increasingly, major funders of wild cat conservation are partnering with academic institutions whose research can help inform resource allocation. Our results may help those decision makers identify species in most need of conservation action, although we are not suggesting that lower priority species do not also deserve attention. We acknowledge that prioritization results depend on which metrics are selected for inclusion and on the data, methods, and scales used to derive scores (Wolman 2006; Game et al. 2013). We restricted our analyses to publicly available data from reliable sources such as the World Bank, rather than creating arbitrary scales, and used only data where a single source provided comparable data for all species or countries. These decisions affected the results generated, and alternative choices or methods could have

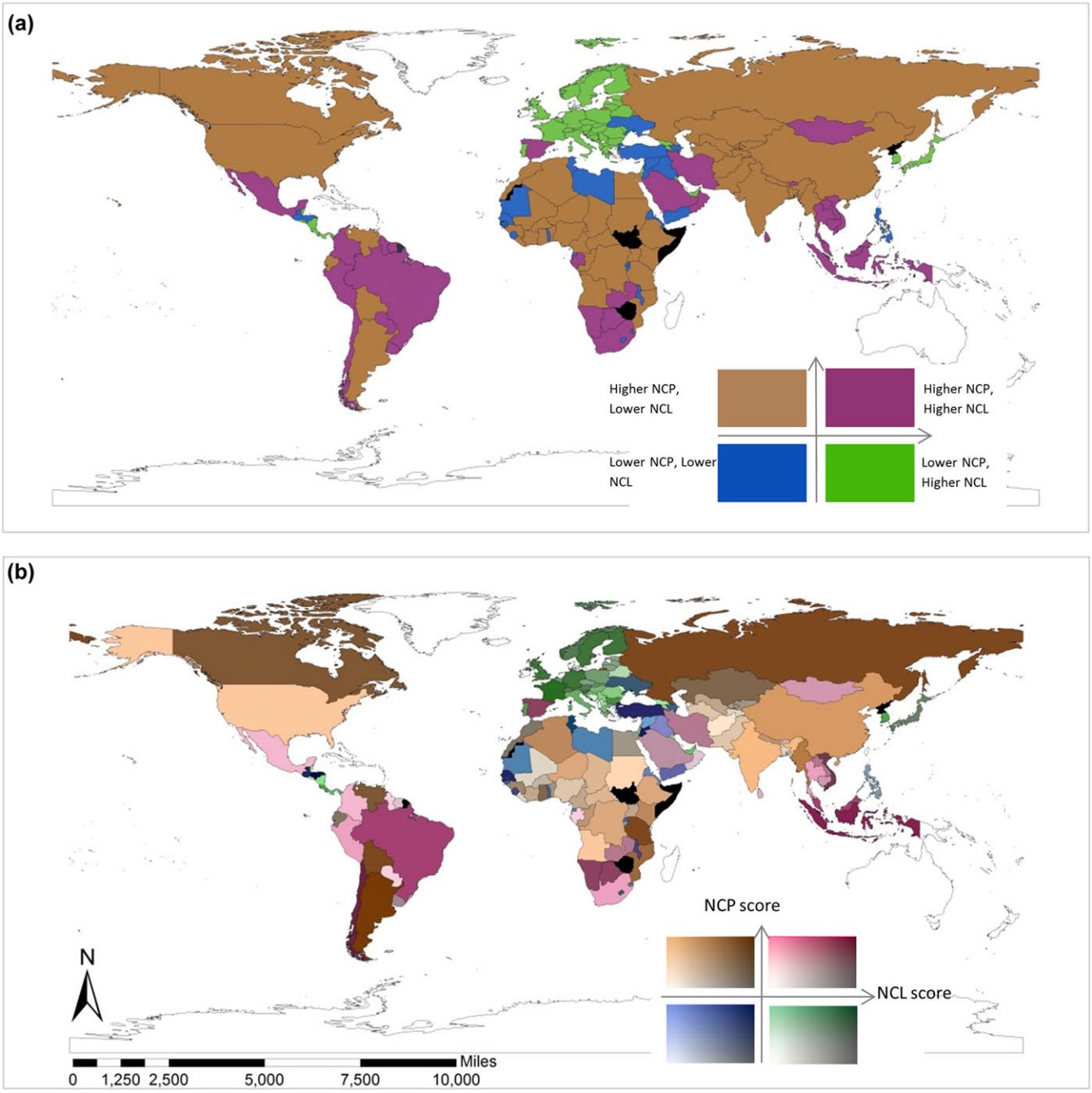

Figure 3. Global patterns of national conservation priority (NCP) and national conservation likelihood (NCL) scores (a) classified into 4 broad groups based on whether a country had above-median (higher) or below-median (lower) NCP and NCL scores and (b) as in (a) but with more detail on variation within the 4 categories (e.g., Brazil, Columbia, and Saudi Arabia are pink because they are higher priority, higher likelihood countries). There is variation in where countries score within each category, shown in (b) as different shades of pink for the high-NCP, high-NCL category. Columbia's NCL score is much closer to the median than that of Brazil, so it is lighter pink. Saudi Arabia's NCP score is closer to the median than either of the 2 South American countries, so it is a more grey-tinted pink. Countries in black have felids but insufficient data for analysis, whereas countries in white have no wild felid populations according to International Union for Conservation of Nature range maps.

produced markedly different results. Furthermore, the metrics we used to develop FCP scores were intrinsically dynamic, so factors such as conservation endeavors would affect species' rankings over time. Nonetheless, we believe the species rankings we determined are valuable, particularly because they reveal where investment in 1 species could generate efficient conservation for other felids under the target species' umbrella. Although the extent of efficiency depends upon the commonalities of threats faced by overlapping species, a comprehensive analysis of all available felid conservation action plans shows that threats to wild cats are often similar and occur in the same place (Macdonald et al. 2012), strengthening our argument for this umbrella-based approach.

Prioritizing species also helps determine which countries most urgently require conservation investment in their wild cat populations, which will help decision makers develop both immediate and long-term conservation plans. Nearly two-thirds of the higher conservation priority countries (61%) we identified had below average NCL scores, suggesting that in the majority of countries where felid conservation should be prioritized, effective conservation may be harder to achieve given the prevailing geopolitical backdrop. Funding bodies are sensitive to the risk of wasting money (Ferraro & Pattanayak 2006), so our NCL scores also provide a valuable estimate of how risky a conservation investment might be. Based on our results, we suggest the safest strategy would be to focus on the 28 higher priority, higher likelihood countries—effective conservation there would secure the majority of geographic ranges for 39% of felid species. However, this would neglect at least 114 countries with felids and over half of all felid ranges. Therefore, it is equally urgent to support the 43 countries in the higher priority, lower likelihood quadrant, but these countries are likely to require different strategies to achieve the same conservation gain as in higher likelihood countries. For instance, our results highlight the importance of considering the risk of ineffective protected areas. Although such areas likely offer some protection (Bruner et al. 2001), improving their management could have important consequences for species that rely heavily upon protected areas, especially in politically unstable or poor countries.

Lower likelihood does not preclude conservation success—countries such as India have maintained a wide diversity of wild felids despite daunting geopolitical challenges which hinder the likelihood of long-term conservation effectiveness. Future conservation success in such countries necessitates tailor-made approaches that focus on wider issues such as development and policy and may require greater funding over a longer period. Specific strategies depend upon the limiting factors relevant to that country. For example, in the United States conservation likelihood could most easily be improved by focusing on policy, whereas in India human pressure is unlikely to be resolved, so conservation action plans should focus upon securing effective protected areas. Because the relative importance of geopolitical pressures can very according to the scale of an analysis, be that national, range wide, or local, decision makers and practitioners must evaluate these pressures at the correct scale to best understand the threats to likelihood of success of their conservation efforts. For example, conservation policy was the major driver of lower likelihood for the North American bobcat, whereas for the South American kodkod, human pressure was the major driver (Supporting Information). As with prioritizing felids, national conservation prioritization is dynamic and will change with circumstances.

Our analysis represents only 1 stage of felid prioritization. Ultimately, decisions about resource allocation will depend upon a finer-scale examination of specific actions that need to be taken and their costs (Joseph et al. 2009; Game et al. 2013). Although these factors are not specifically examined here for reasons of brevity, our results highlight tactics for species-focused conservation in general. For instance, long-term lion conservation necessitates improving governance and economics, whereas Iberian lynx programs might focus on more traditional conservation, such as improving prey populations and habitat. However, individual actions can be very context specific, even within a species. For instance, in Nigeria recommendations for lion conservation involve protecting and linking remaining habitat patches (Henschel et al. 2010), while in Tanzania strategies for the same species prioritize reducing retaliatory killing and improving trophy hunting management (TAWIRI 2007). The NCL scores and drivers presented here are particularly valuable because they highlight likely limitations affecting different countries, which can inform decision makers of the likely costs, benefits, and chances of success of implementing conservation strategies. We provide an initial, broad prioritization of felid species and range countries, laying the groundwork for more detailed studies at the scale of individual species and countries.

Economic cost is clearly a key concern for decision makers and conservationists because failing to consider the financial constraints associated with different species or locations can reduce conservation efficiency, hinder effective management, and increase the risk of extinction (Joseph et al. 2009). We did not examine specific costs because the global scale of our analysis precluded recommending individual actions for species and countries and assigning a realistic cost. Although lower management costs in a country may be attractive, lower economic costs are often associated with limiting factors such as political instability (McCreless et al. 2013). Although we included a national-scale economic metric in our NCL calculations, which included factors such as a country's wealth and its purchasing power parity, we gave this equivalent weight to other factors such as corruption and the pressures of human population density and growth,

because they all play a substantial role in affecting conservation likelihood (McKee et al. 2004; Smith & Walpole 2005). We hope our work will stimulate further studies focused upon a subset of countries or species that examine the specific actions required for conservation and their associated economic costs, as has been done for threatened species in New Zealand (Joseph et al. 2009).

Ultimately, our results emphasize the need for conservationists to take an interdisciplinary approach to maximize chances of long-term success for felid conservation, considering both ecological priorities and geopolitical pressures. This pragmatic approach to prioritization could be applied to many different taxa, at varying spatial scales, to inform which conservation strategies are likely to produce effective outcomes in an increasingly human-dominated world.

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Supporting Information

Sources of the data used to calculate national conservation likelihood (NCL) scores (Appendix S1), the felid conservation priority (FCP) scores for all felid species (Appendix S2), the NCL and national conservation priority (NCP) scores for all felid range countries (Appendix S3), species distributions in NCL and NCP countries (Appendix S4), list of the 10 highest-priority felid range countries (Appendix S5), factors that limit NCL scores for felid range countries (Appendix S6), and the extent and effectiveness of protected areas in felid ranges (Appendix S7) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

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