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Global opportunities and challenges for transboundary conservation

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Rapid biodiversity loss has prompted global action to prevent further declines, yet coordinated conservation action among nations remains elusive. As a result, species with ranges that span international borders—which include 53.8% of terrestrial birds, mammals and amphibians—are in increasing peril through uncoordinated management and artificial barriers to human movement, such as border fences. Transboundary conservation initiatives represent a unique opportunity to better protect species through coordinated management across national borders. Using metrics of governance, collaboration and human pressure, we provide an index of transboundary conservation feasibility to assess global opportunities and challenges for different nations. While the transboundary conservation potential of securing multinational threatened species varied substantially, there are distinct opportunities in South-East Asia, Northern Europe, North America and South America. But to successfully avert the loss of transboundary species, the global community must be prepared to invest in some regions facing greater implementation challenges, including the nations of Central Africa, where efforts may necessitate establishing rapid conservation interventions postconflict that align with local socio-cultural opportunities and constraints. Sanctioned and coordinated approaches towards managing transboundary species are now essential to prevent further declines of many endangered species, and global policy efforts must do more to produce and enact legitimate mechanisms for collaborative action in conservation.

The international community is facing a biodiversity crisis—with extinctions occurring up to 100 times higher than the background rate[1]. This rapid loss of biodiversity has highlighted the necessity to coordinate and sanction international collaboration and cooperation for the protection of nature[2]. International treaties, such as the Convention on the Conservation of Migratory Species of Wild Animals (CMS), the Convention on Biological Diversity (CBD) and the Convention on Trade in Endangered Species of Wild Fauna and Flora (CITES), have strategic plans that increasingly advocate for coordinated and collaborative efforts that respond to threats impacting biodiversity and prevent further declines of threatened species[2–5]. In particular, the CBD and CMS promote the need for ecological connectivity between species ranges in and among nation-states[5,6].

Ecological processes and edges of species ranges are rarely coincident with socio-political borders, nor are the environmental issues and conservation challenges surrounding conservation planning[7–11]. For species with ranges that span socio-political borders, these administrative divisions have potentially deleterious effects. The proliferation of border fences (a consequence of geopolitical forces such as the US–Mexico border) and contrasting protection statuses (a reflection of scalar mismatch and differing conservation priorities) exacerbates threatening processes including entanglement, encouraging harvesting and habitat conversion, and disrupting metapopulation dynamics[10,12,13]. Despite this, policy development and management actions almost always remain a matter of national sovereignty, whether cross-boundary protective measures for species are warranted or not[14,15].

The utility of transboundary conservation extends beyond its strong ecological rationale. While far from guaranteed as an effective enterprise, transboundary conservation has been proposed as a means for peacemaking[16]. Even throughout conflict these initiatives have been successful in maintaining some ecological integrity by providing refuge for threatened species when the incidence of human–wildlife conflict is high, as has been the case for the Greater Virunga Transboundary Collaboration[17,18]. Coordinated planning across borders supports cost savings in both marine[19–21] and terrestrial[22] realms and has enormous potential to triple the average coverage of species ranges and ecoregions in protected areas[23]. Despite the global nature of the biodiversity crisis, prior research on transboundary conservation initiatives has primarily focused on regional-scale case studies, and to date, no global research has been undertaken to determine the global state of, opportunities for and challenges for terrestrial transboundary conservation.

Here, we assess the potential for transboundary conservation across the globe by combining metrics of biodiversity and the feasibility of implementation (Fig. 1 and Methods). We quantified the number of terrestrial species—birds, mammals and amphibians—with transboundary ranges across each border segment and compared this number with a feasibility index that included indices of collaboration[24], governance[25] and human pressure[26]. This approach highlights regions with the highest potential for transboundary conservation and identifies challenges for transboundary initiatives in regions of high conservation importance.

Results

Globally, 53.8% of all terrestrial species had ranges that crossed an international border. This included 55.6% of all mammals, 27.4% of all amphibians and 68.6% of all birds (Fig. 2a). Of threatened species, 21% had transboundary ranges, and 8% had ranges that intersected with three or more international borders (Fig. 2b).

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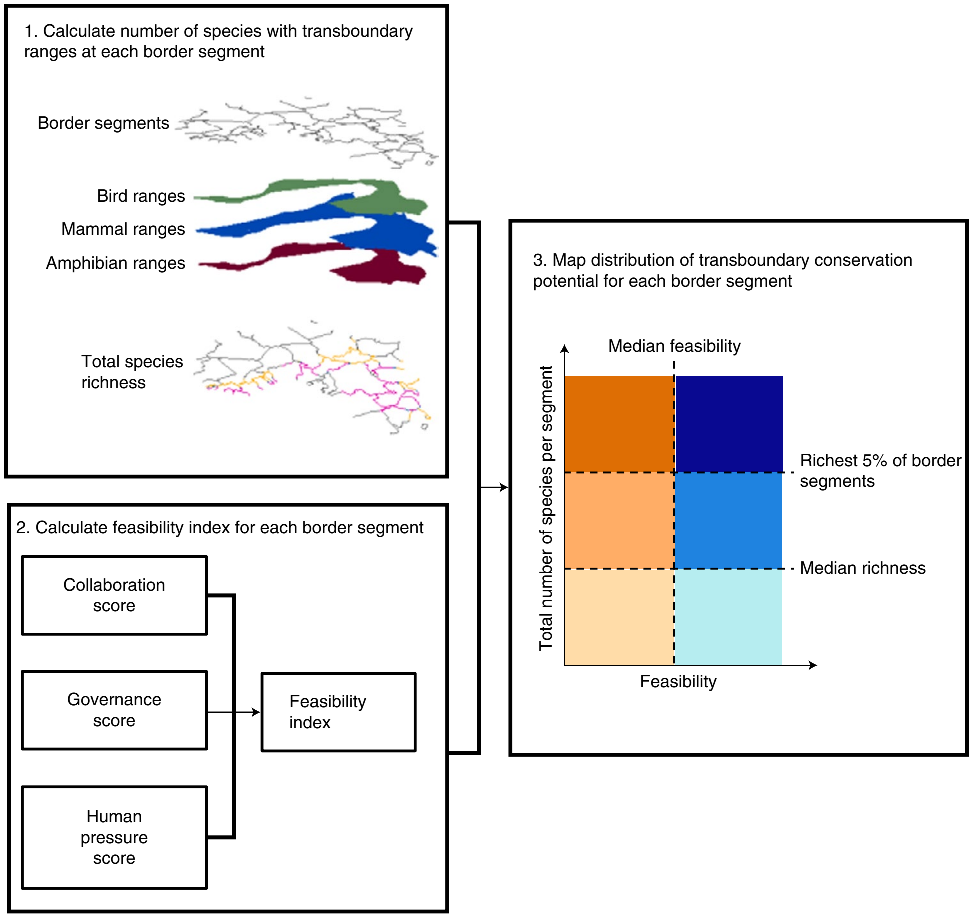

Fig. 1 | Framework for determining the global potential for transboundary conservation. We quantified the richness of all transboundary species and threatened transboundary species across international borders, which were divided into segments (<100 km). For each segment we calculated a feasibility index for implementing transboundary initiatives, which incorporated governance and collaboration scores shared between neighbouring countries, as well as human pressure surrounding the border region.

The distribution of threatened species with transboundary ranges was concentrated primarily in South-East Asia (Fig. 3a). Asia contained approximately 82% of global border hotspots (the richest 5% of border segments) for threatened transboundary species, with other notable areas occurring in South America, Central Africa and West Africa. These patterns of transboundary threatened species differ considerably from total species richness (Extended Data Fig. 1). There was also substantial global variability in the feasibility index (Fig. 3b) driven by inconsistent political environments, sociocultural conditions and human pressure (Extended Data Fig. 2). Lower feasibility scores were most densely distributed throughout Africa and parts of Asia. In these regions the collaboration potential and governance tended to be lower (Extended Data Fig. 2a,b). Lower feasibility scores for European nations were primarily attributed to higher human pressure (Extended Data Fig. 3a).

Of the transboundary threatened species hotspots, 46.2% were located in areas with relatively high feasibility (Fig. 4a). Higher feasibility hotspots in Asia were primarily distributed along the border of Vietnam and the island of Borneo (Fig. 4a). Low human pressure in Central Borneo was a key driver of the high score in this region (Extended Data Fig. 3a), and in Vietnam, collaboration and human footprint were key contributors (Extended Data Figs. 2a and 3a). High human pressure was a key characteristic of the lower feasibility score for the Nepal–India hotspot (Extended Data Fig. 3a). Conversely, hotspots in Central Africa received lower feasibility scores owing to lower governance and collaboration scores that characterize the region—of particular note was the hotspot region spanning Uganda, Rwanda and the Democratic Republic of Congo (DRC) (the Greater Virunga Transboundary Collaboration, Fig. 4a and Extended Data Fig. 2a,b).

South America exhibited relatively high feasibility scores along the Andean range and the Amazon Basin (Fig. 3b). These were primarily associated with presently lower human pressure along the border (Extended Data Fig. 3a). The Chile–Argentina border also presented higher collaboration and governance scores (Extended Data Fig. 2).

Border regions of the United States and Canada and those shared by Norway, Sweden and Finland are distinctly high-scoring locations (Fig. 4b) with relatively undisturbed tracts of land in the immediate border regions. These regions represented the relatively rare cases where all three aspects of feasibility scored highly (Extended Data Fig. 2). These regions were not biologically high priorities for threatened transboundary species, on the basis of richness.

We undertook a sensitivity analysis to assess the effects of changes to spatial and temporal scales in our analysis. We found that changes to spatial and temporal scales had limited effects on global patterns of feasibility (Extended Data Figs. 3 and 4). However, when we compared the feasibility scores of an older five-year dataset (1998–2000) with those of a more recent time frame (2011–2015), several regions, notably in Asia, shifted from lower to higher feasibility (Extended Data Fig. 4c,d and Supplementary information).

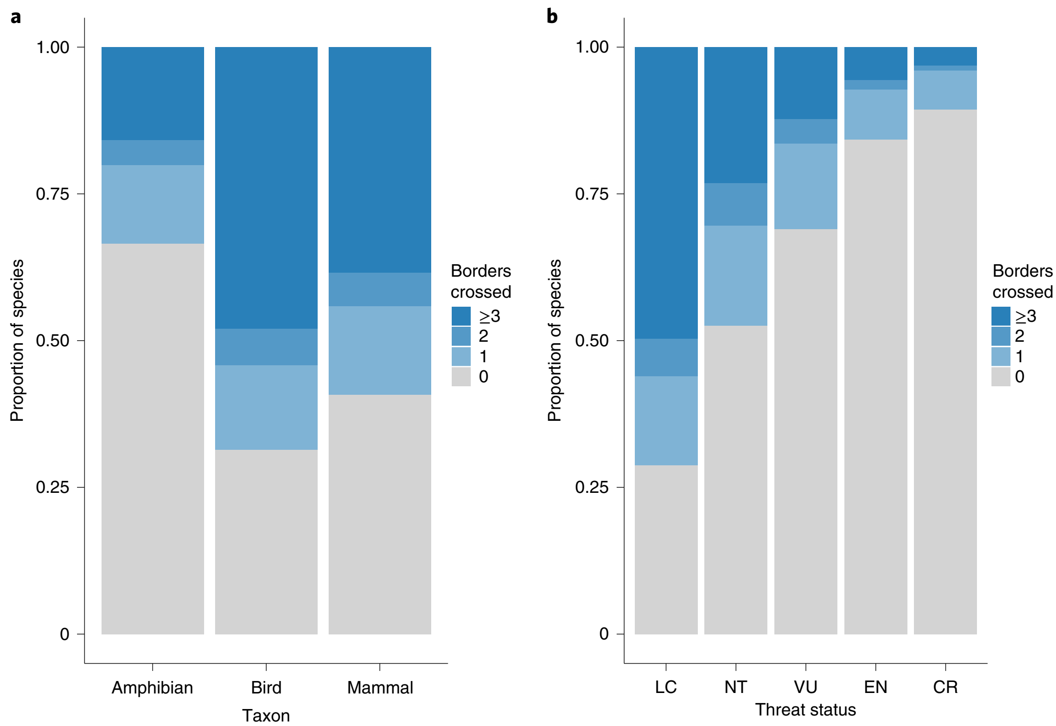

Fig. 2 | Proportions of terrestrial species with transboundary ranges. a, Numbers of borders intersecting species ranges by taxonomic group. **b**, Numbers of borders intersecting species ranges by threat status. LC, Least Concern; NT, Near Threatened; VU, Vulnerable; EN, Endangered; CR, Critically Endangered.

Discussion

Here we have presented a global assessment that spatially analyses the need for transboundary collaboration for birds, mammals and amphibians, and provided insight into potential state-level and institutional challenges for establishing transboundary conservation across international borders. Transboundary conservation has been increasingly advocated through international conventions such as the CBD, CMS and CITES and is becoming increasingly recognized as an important component of post-2020 global biodiversity framework discussions[27,28]. We have shown that over half of global terrestrial species of birds, mammals and amphibians and 21% of threatened species in these taxa have transboundary ranges (Fig. 2), with distinctive global geographic patterns in species richness (Fig. 3a). This research highlights that coordinated management across national borders is required to support ongoing efforts towards the conservation, protection and restoration of the Earth's ecosystems.

Implementing transboundary conservation means operating in an environment with enormous variability in economic, political and socio-cultural conditions. As a consequence, we observed significant variability in global feasibility for securing transboundary conservation initiatives (Fig. 3b). The feasibility index presented in this analysis is intended to highlight that global low-hanging fruit for transboundary initiatives exist, and to highlight where some challenges faced by neighbouring countries would arise in the process of establishing and sustaining transboundary initiatives. Outcomes for transboundary projects are also heavily influenced by various subnational and community directives including land tenure, community engagement and cultural barriers[2,29]. More nuanced, case-oriented approaches are clearly necessary to comprehensively assess the feasibility of transboundary initiatives and understand the interplay of governance mechanisms at a regional scale[13,16,30–33]. Here we provide an analysis that attempts to capture overarching issues such as governance quality, governance capabilities and collaboration potential, all of which provide some insight into the ability for national governing bodies to design, contribute to and have ongoing accountability for the management of transboundary conservation features[34–36].

Regions that presented the highest global feasibility scores were clear low-hanging fruit for transboundary conservation, in particular Fennoscandia, the United States and Canada. Although they were globally lower-priority conservation areas, this does not diminish the importance of collaborative efforts for species in these regions. For the United States and Canada, large-ranging species such as caribou (*Rangifer tarandus*), grey wolves (*Canis lupus*), grizzly bears (*Ursus arctos*) and wolverine (*Gulo gulo*) are prevalent species requiring large-scale management planning. The initiative Yellowstone to Yukon, which crosses the US–Canadian border, is a large-scale programme critical for the landscape protection of transboundary species, where core protected habitats are embedded in a matrix of traversable lands including protected areas, indigenous protected areas and privately owned land[37]. The strength of this initiative stems from diverse, multiagency partnerships across the region. These partnerships have allowed the organization to work with partners to develop policies and actionable strategies, such as constructing wildlife over- or underpasses and acquiring priority lands to prevent urban sprawl and reduce fragmentation[37,38].

Similarly, the Natura 2000 network (Fig. 4a) is a coordinated conservation response established in an intensively developed landscape (Extended Data Fig. 3a). The programme embraces broader landscape approaches to conservation that restore elements of unprotected areas through mechanisms such as agri-environment schemes and other effective conservation mechanisms[39] to improve landscape permeability and that are increasingly becoming important tools for conservation[4].

The interior of Borneo was a particularly prominent region in the analysis, presenting relatively high feasibility scores and high conservation values (Fig. 4b). Here, the implementation of transboundary initiatives is facilitated by low human pressure across the mountainous core and border regions. This relatively intact region is

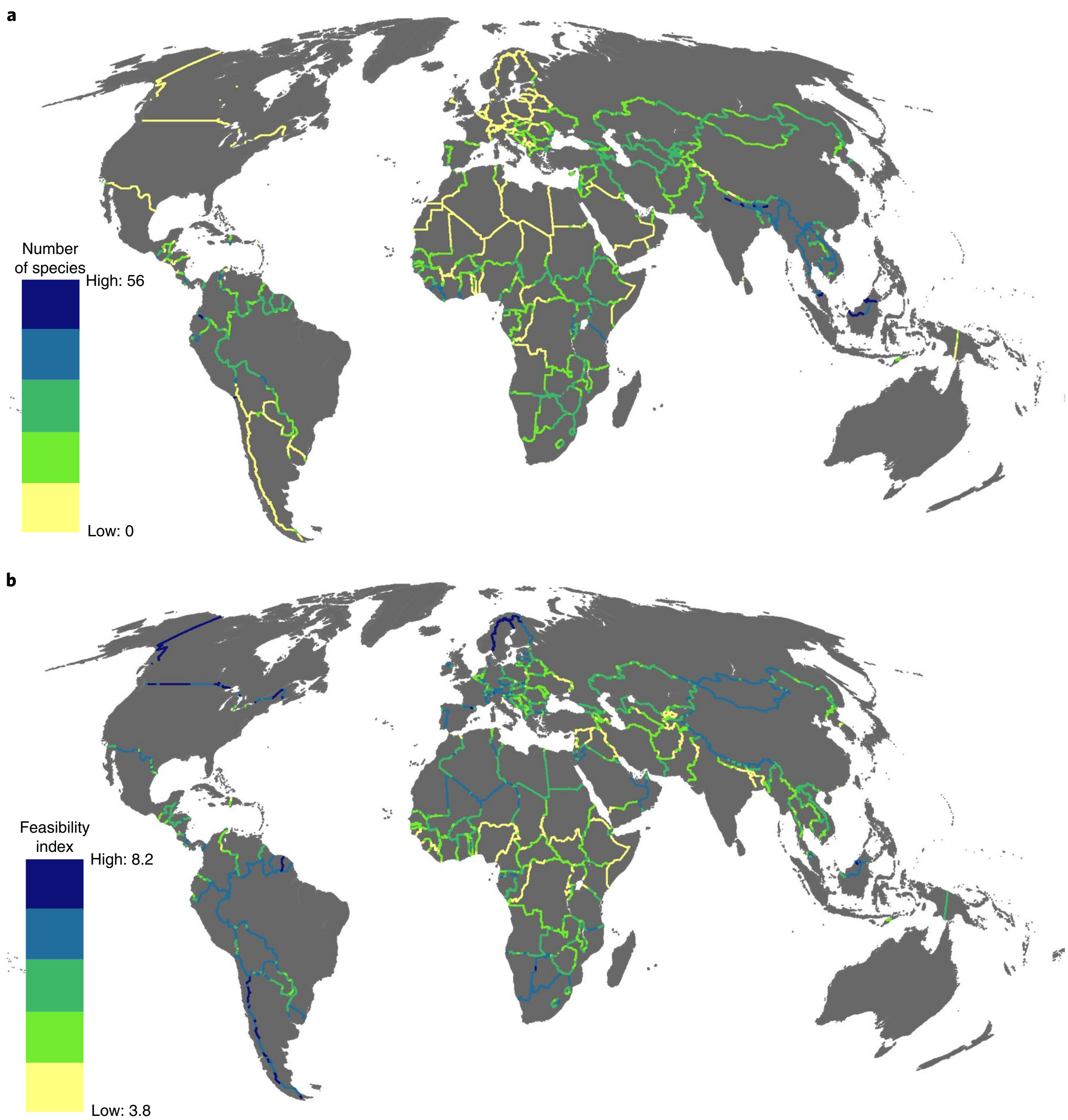

Fig. 3 | Distribution of threatened species richness and feasibility scores. a, Numbers of threatened species with ranges intersecting a national border. **b**, Feasibility index scores. Colour gradients are defined by natural breaks.

critical for species such as the Borneo bay cat (*Catopuma badia*), the orangutan (*Pongo pygmaeus*) and many forest-dependent birds, but it is also threatened by future landscape transformation[40]. The Heart of Borneo Initiative[41] indicates some progress towards establishing sustainable management of the island's interior landscape. However, sovereignty issues, the limited use of legally binding instruments and lawlessness have hindered meaningful cooperation and planning, resulting in a patchwork of in-country legislations, management and law enforcement activities[35]. Despite these challenges, the mountainous interior of Borneo remains one of the few remaining intact forest landscapes on Earth, and with improved political buy-in[34] and government commitment under legally binding instruments designating operational rules for biodiversity conservation[35], this initiative could become a globally important transboundary conservation response.

Lower-feasibility locations, such as those located in Africa, are challenged by shortcomings in institutional capacities and governance. Further complications arise when placed in the context of ongoing and sporadic national and cross-border disputes, which impact existing protected areas[30]. In the hotspot region spanning Uganda, Rwanda and the DRC, civil and cross-border conflict has resulted in population declines for several species including buffalo (*Syncerus caffer*), topi (*Damaliscus lunatus*) and elephants (*Loxodonta africana*)[17,42]. Where disputes exist, the diminished integrity of socio-political systems and different national priorities for economic investment mean that establishing a formal conservation management agenda through national political institutions is unlikely.

However, throughout periods of conflict and poor relations, initiatives such as the Greater Virunga Transboundary Collaboration have been established through bottom-up efforts. Conservation partners facilitated the development of a regional framework for collaboration and subsequently observed the formation of strong partnerships between Protected Area Authorities field personnel

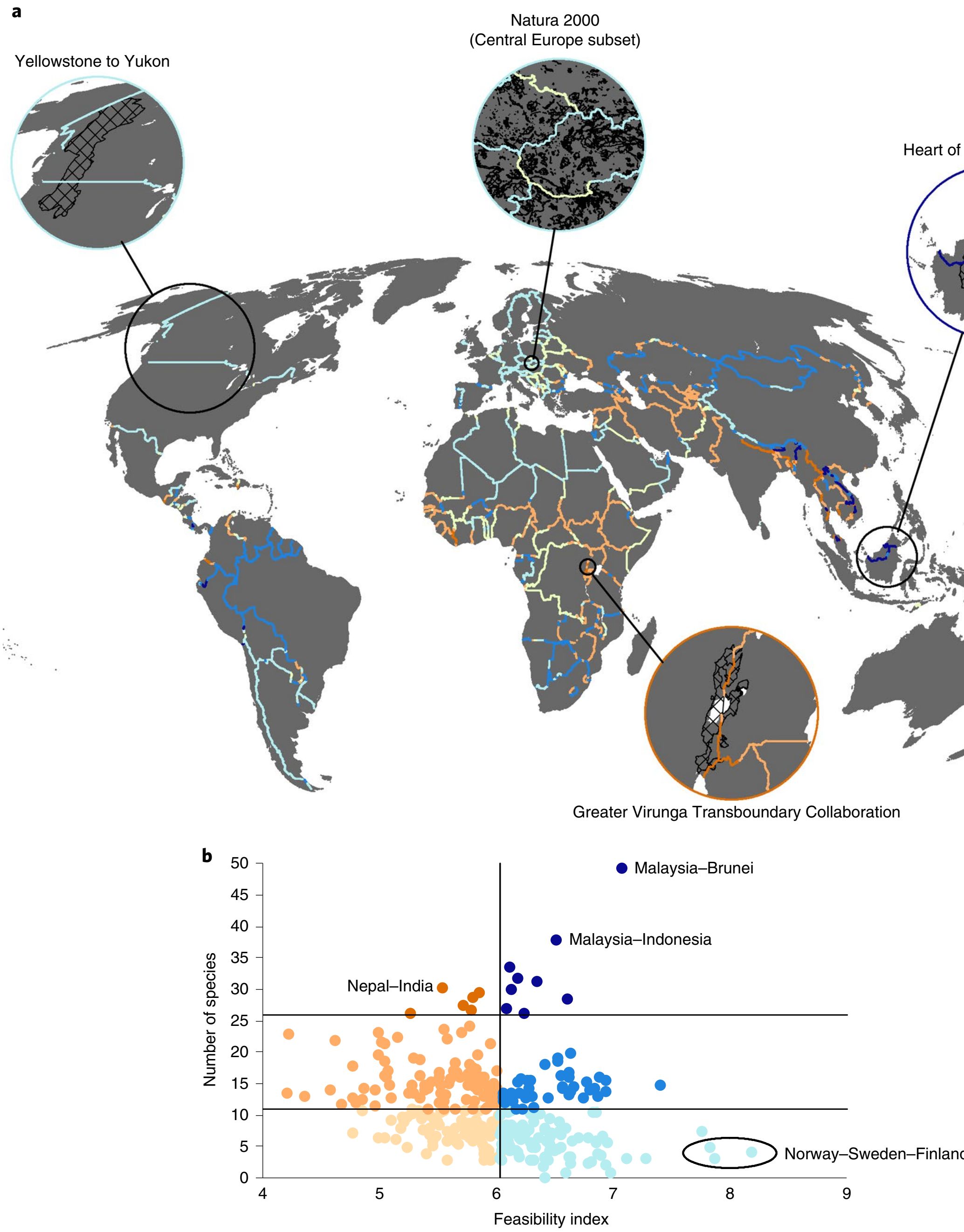

Fig. 4 | Global opportunities for transboundary conservation. **a**, Here we present the global potential for transboundary conservation and provide examples of initiatives along border segments. The point of separation for high and low feasibilities is the global median (6.03). Borders are also separated by their conservation values highlighting hotspots, and regions above and below the global median for species richness. **b**, Mean feasibility and richness across border segments for each neighbouring country pair.

and regional representatives of Uganda, Rwanda and the DRC[43,44]. This relatively informal cooperation continued to improve communication, information sharing, coordinated monitoring and collaboration within parks, despite ongoing conflict after the Rwandan war and genocide[43], highlighting the remarkable power of locally established institutions in conservation. The non-governmental-organization-designed and enacted model—which required face-to-face interaction between key operational stakeholders—built relationships in the context of shared identity and stewardship that transcended the constraints of an unfavourable political climate[43]. Work towards formalizing frameworks for cooperation and ongoing management strategies secures commitment and accountability, and improves economic investments and return[42,43,45].

The Kgalagadi Transfrontier Park in Southern Africa was similarly established through bottom-up planning and presented a greater capacity to respond to changes in the social–ecological system and operational challenges[32]. Conversely, government-established collaborations (such as Greater Limpopo Transfrontier Park) show strengths in other aspects of management, particularly in formalizing relations, moving more efficiently to harmonize policy decisions and enact treaties[32]. However, in many top-down scenarios, inadequate inclusivity mechanisms for engaging with local communities and their interests result in resistance[46–48] and the lack of effective cooperative mechanisms at a regional scale[49], threatening the long-term viability of the conservation initiative[2]. A shift towards governance approaches that engage multiple institutions and actors in policy development and enforcement is likely to be the way forward[50]. Alternative approaches in conservation, including access to the exploitation of wildlife resources, may incentivize the careful management of resources and result in greater conservation[51]. Zimbabwe's Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) attests to this concept and to the devolution of natural resource management approaches to participatory models of management[52]. Providing rights to rural communities to benefit from resources and devolving responsibilities for natural resource management have slowed rates of habitat loss and have provided co-benefits in providing direct payments to communities[52,53]. Ultimately, further research is required at regional scales to determine which policy options can best support transboundary conservation.

We recognize that a single index of feasibility fails to capture all the nuances in neighbour relationships that can either hinder or enhance the potential for formulating and implementing transboundary programmes. It is not possible to capture the variations in policy mechanisms and the influence of external organizations[46,54] in establishing initiatives when assessing feasibility at a global scale. Similarly, a single metric of biodiversity, as we have used here, fails to capture the full complement of biodiversity conservation and ecosystem service goals that would benefit from collaborative cross-border management. However, our biodiversity indicator is a readily available and recognizable indicator of biodiversity and is applicable at the global scale. The temporal dynamics of conflict, collaboration and climate are added complexities with implications for prioritizing localities and resourcing for transboundary initiatives. These dynamics will be critical for identifying the impacts of future global change scenarios to determine where interventions are needed immediately (Supplementary information).

Individual nations still have an immense responsibility to protect nationally endemic species; substantial numbers of terrestrial species (46.2% of terrestrial species analysed, including 72.6% of amphibians) have ranges that are entirely contained within a single country. However, given the prevalence of transboundary species, the global community must also be prepared to establish conservation initiatives beyond national borders to successfully avert biodiversity losses. Coordinated conservation actions have been incorporated in numerous international conventions[5], as is foundational in the Rio Principles[55] and Sustainable Development Goals, but implementing these conventions will require innovative solutions that address conflicts, establish good governance and build on strong community engagement practices. Our analysis has highlighted significant challenges for transnational cooperation for threatened species conservation in many parts of the world. However, effective policy mechanisms, local support and sufficient resourcing will bolster the effectiveness of transboundary conservation initiatives[42,43].

Methods

We determined the potential for transboundary conservation by quantifying the richness of species with transboundary ranges along national border segments and calculating the feasibility of implementing cross-border collaborative initiatives.

Calculating transboundary species richness. We obtained species distribution maps for birds (10,933 species), mammals (5,447 species) and amphibians (6,458 species) from the IUCN Red List[56] and Birdlife International and Handbook of the Birds of the World[57]. Species were included if their presence was coded as extant and their origin as native or reintroduced[58,59]. We determined the distributions of threatened species with transboundary ranges to include species in the Red List categories of Critically Endangered, Endangered or Vulnerable, which included 2,066 amphibians, 1,160 mammals and 1,442 birds.

We obtained global administrative divisions from the Global Database of Administrative Areas v.2.8 (ref. [60]). All national borders were split into segments no larger than 100 km in length as an appropriate compromise between capturing finer-scale variation in patterns of biodiversity and computational efficiency[61]. Terrestrial borders were clipped to the extent of the Human Footprint dataset[26], updated to 2013, thereby excluding borders that passed through water bodies. Species were counted as present where any part of their range intersected with a border segment. Spatial data were processed in vector format in the world Mollweide equal-area projection using Python v.2.7 (ref. [62]) and ESRI ArcMap v.10 (ref. [63]).

Calculating transboundary conservation feasibility. We generated a method to identify the potential for transboundary conservation initiatives by aggregating information on collaboration, governance and human pressure to produce an index of feasibility for national border segments. The index (**F**) comprised three normalized and equally weighted indices of collaboration, governance and human pressure, and is presented as a single score for each border segment ranging from 0 to 10, calculated using the following formula:

$$\mathbf{F} = 10\sum_{k=i}^{K} w_k \left(\frac{\mathbf{x}_k - \min(\mathbf{x}_k)}{\max(\mathbf{x}_k) - \min(\mathbf{x}_k)}\right) \quad (1)$$

where w is the weight of each of the indices (which was 1/3), k is the collaboration, governance, or human pressure score and $\mathbf{x}$ is a vector representing the border segments.

Measure of collaboration. To quantify the potential for bilateral collaboration, we used the Worldwide Integrated Crisis Early Warning System, which is a daily dataset of coded interactions between socio-political actors from 1995 to February 2017. This was the longest available time frame to assess collaboration between neighbouring countries and is used to determine the extent to which neighbours have been cooperative in the past as an indicator for potential collaboration (see Supplementary information). These interactions are extracted and identified from news articles by an event coder (CAMEO), which rates each event type (e) between individuals, groups, sectors and nation-states on a Goldstein score, g_e, from −10 (hostile) to 10 (cooperative). The collection of interaction events (E) consists of three main components: the source actor, the event type (according to the taxonomy of events defined by CAMEO) and the target actor[24]. To measure the potential collaboration between each neighbouring country pair, we calculated the average Goldstein score (GS) over the past 22 yr using the following formula:

$$\mathrm{GS(E)} = \sum_{e\in C} \frac{g_e \times f_E(e)}{\sum_{e\in C} f_E(e)} = \sum_{e\in C} g_e \times p_E(e) \quad (2)$$

Where C is the complete set of CAMEO event types, $f_E(e)$ is the frequency of event e in E and $p_E(e)$ is the probability of event e in E occurring[64].

Measure of governance. We used the Worldwide Governance Indicators to generate the governance index. The Worldwide Governance Indicators dataset reports on six dimensions of governance for more than 200 countries and territories, from which we used the longest available time series of data (1996–2016). Indicators are based on 31 different data sources, rescaled and combined using a statistical methodology and presented as units running from −2.5 to 2.5[65]. Here we used all six dimensions of governance—voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption—to calculate the mean governance score for each country pair.

As in Amano et al.[66], we calculated the mean governance score for each indicator and each country over the period from 1996 to 2016. These were then combined to produce an overall mean governance score for each country pair (that is, the mean of the two countries).

Measure of human pressure. We used updated global terrestrial human footprint maps[26] updated for 2013—a cumulative index of eight variables measuring human pressure on the global environment—to calculate the average human pressure immediately surrounding the border segments. Using a 10 km buffer (see Supplementary information), we calculated the mean human footprint for each border segment. These values were rescaled (equation (1)) and then inverted such that lower scores denoted higher average human footprint values, to match the direction of the scores for collaboration and governance.

Integrating feasibility and species richness. To identify the distribution of priority regions with high potential for transboundary collaboration, we categorized border segments on the basis of their feasibility scores and species richness values. We calculated the median feasibility score for all border segments to demarcate the point above which we expected a relatively higher likelihood of success for transboundary conservation initiatives. Regions with high potential were defined as having a species richness greater than or equal to the value for a hotspot at the 5% threshold, with a feasibility greater than the median. The remaining regions above the 5% threshold for species richness (that is, those with feasibility scores below the median) were still considered priorities, but would face additional challenges when implementing transboundary conservation. The lower-priority regions were border segments with richness values below the median richness.

This assessment was applied in four different ways: for all species or only threatened species at the global scale and at the continental scale. We chose to address threatened species specifically because they are the most likely to go extinct and are therefore important in slowing biodiversity loss. Further, they relate directly to biodiversity objectives established throughout international conservation policy, in particular the objectives of the CMS and CBD.

The assessment was also applied at the continental scale to prevent masking important patterns for conservation in regions where richness tends to be much lower than in the tropical centres of biodiversity. At the continental scale, we recalculated median feasibility (thereby presenting relationships relative to the political and development situations experienced within the given continent) and the 5% threshold for species richness hotspots. We used the ESRI World Continents layer package to demarcate the boundaries for which borders would be included in the assessment of each continent[67].

Reporting Summary. Further information on research design is available in the Nature Research Reporting Summary linked to this article.

Data availability
The datasets analysed in this paper are available via the UQ eSpace digital repository at https://doi.org/10.14264/uql.2020.156 (ref. [68]).

Code availability
Transboundary species richness and feasibility were calculated using a combination of Python v.2.7 (ref. [62]) and ESRI ArcMap v.10 (ref. [63]). The Python code is available from the corresponding author upon reasonable request.

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Author contributions

R.K.R., J.E.M.W. and O.V. conceived the study. N.M. conducted the analyses with assistance from M.W. and R.K.R. All authors contributed to the interpretation of the results. N.M. led the writing of the manuscript with input from all authors.

Competing interests

The authors declare no competing interests.

Additional information

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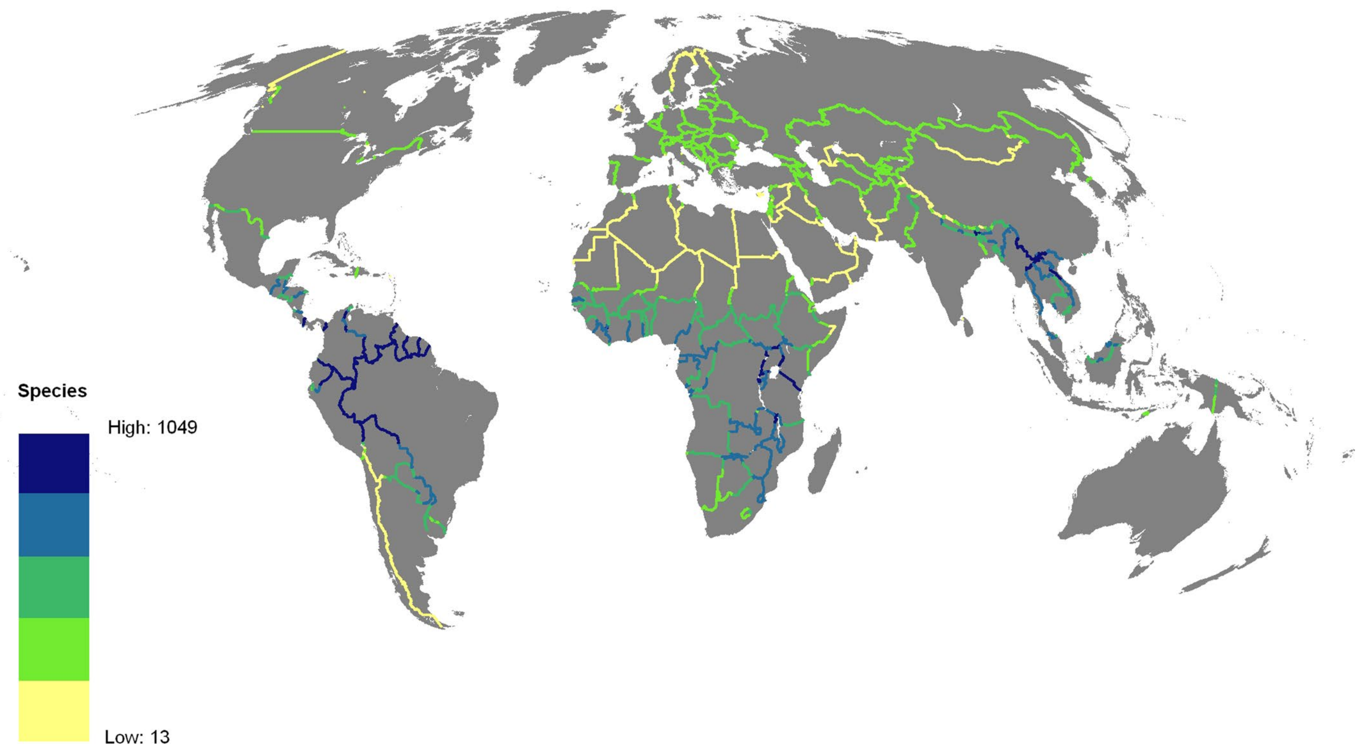
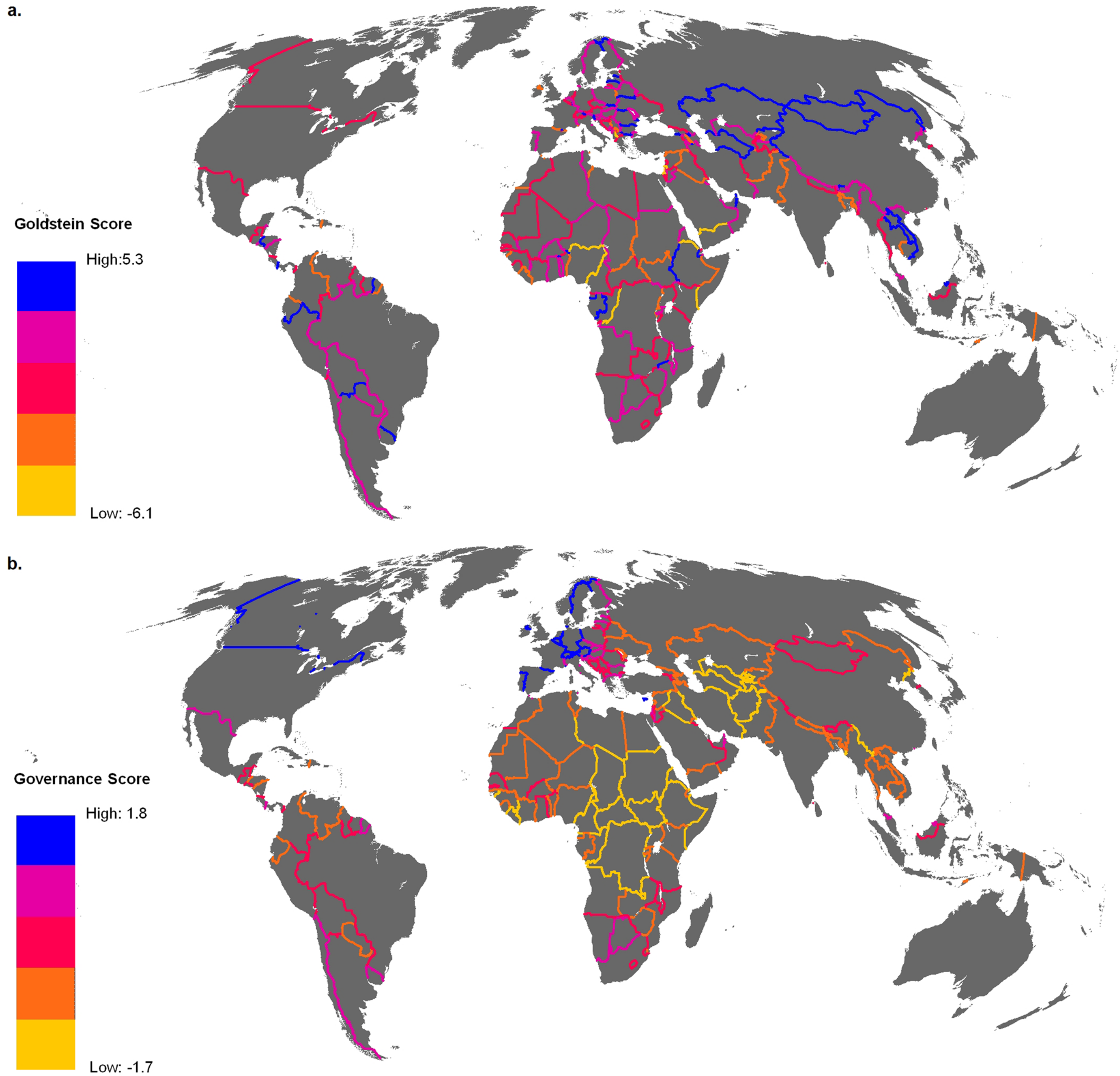
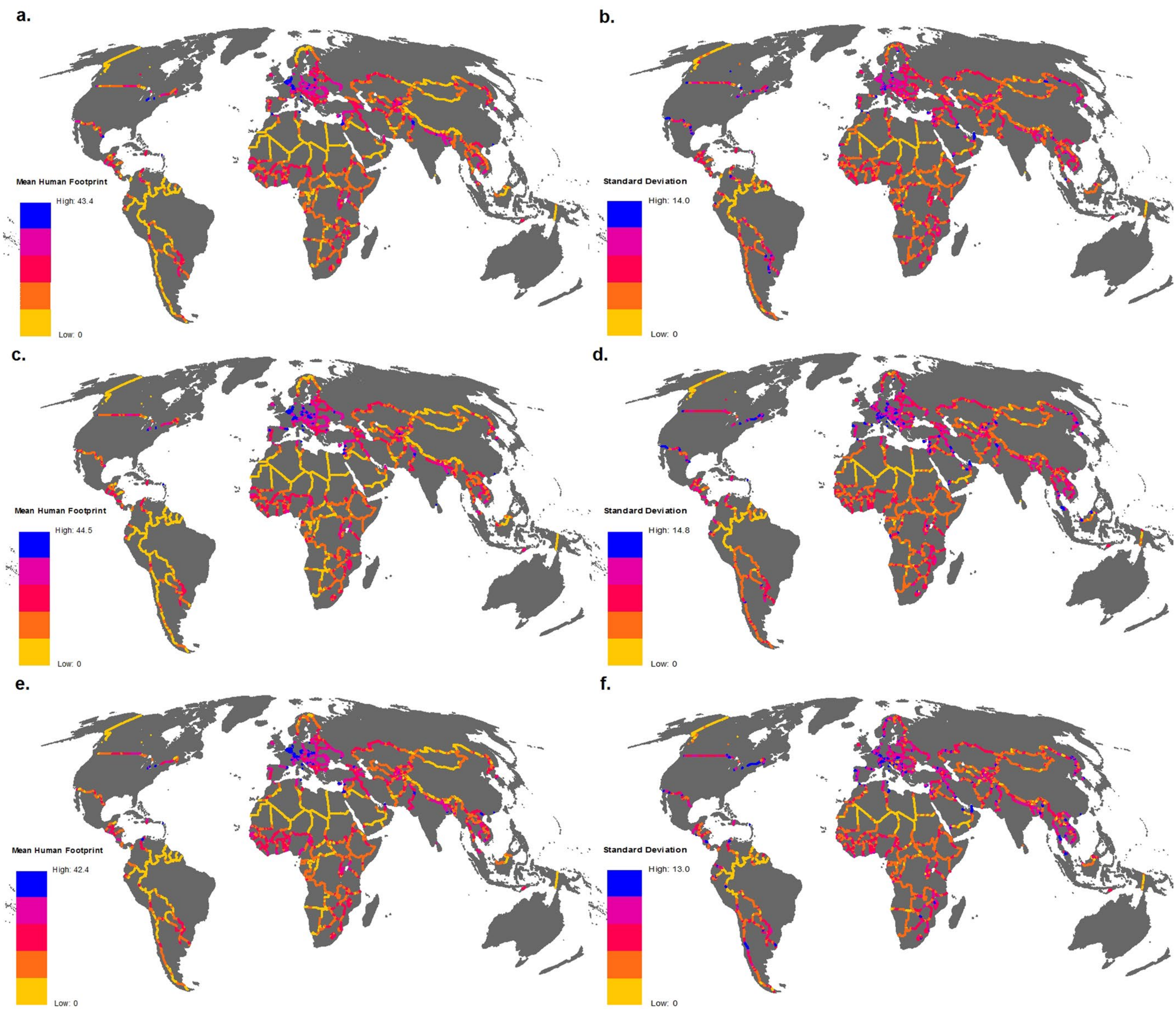


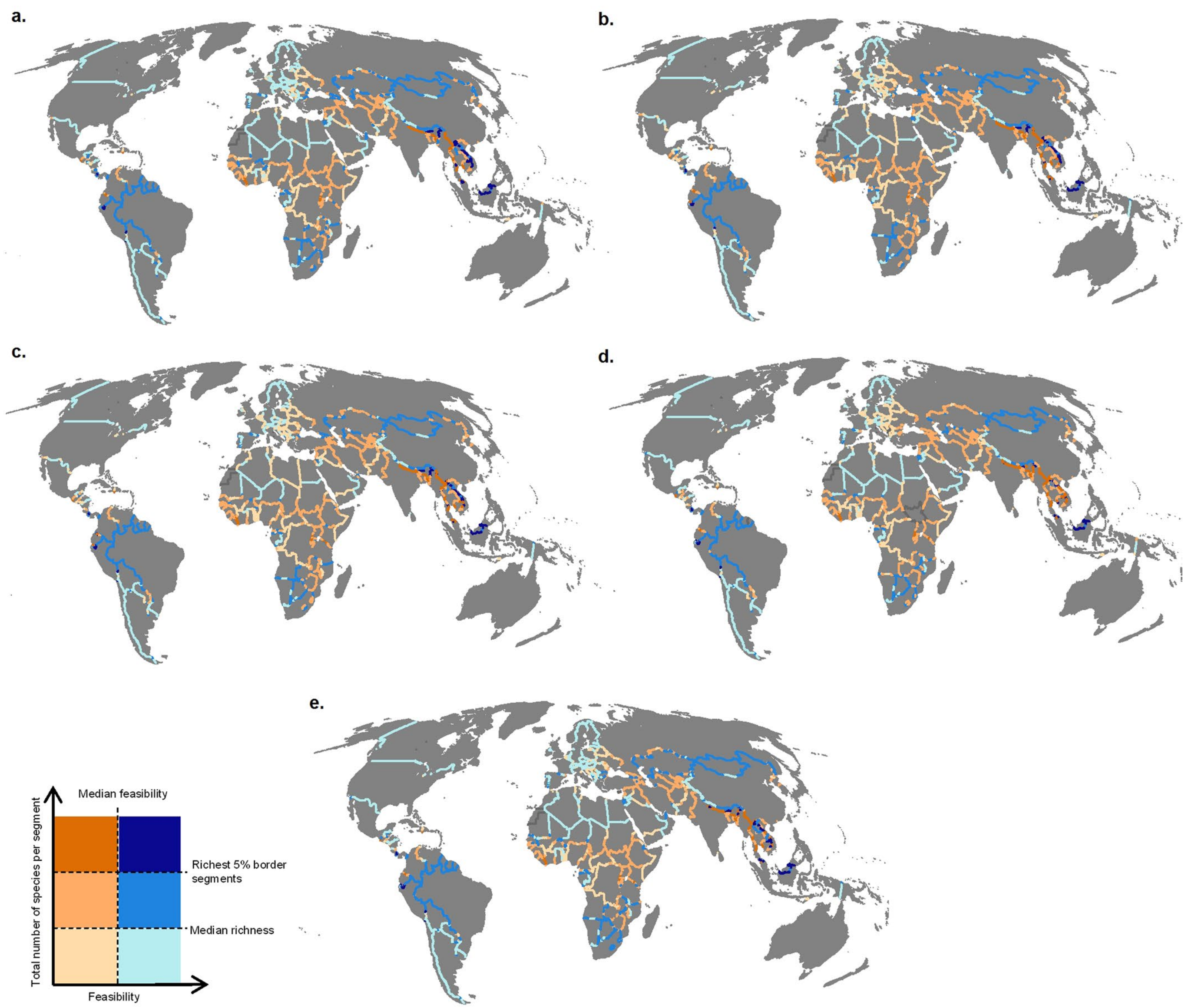
Extended Data Fig. 1 | Number of transboundary species with ranges that span national borders. Number of transboundary species with ranges that span national borders. Figure includes species of any threat status, including least concern.



Extended Data Fig. 2 | Raw values used in the feasibility index. Raw values used in the feasibility index. Shows (**a**) collaboration (Goldstein) Score calculated for each country pair over the time period 1995-2017, and (**b**) mean governance score for each country pair over the time period 1996-2016 calculated using the Worldwide Governance Indicators.



Extended Data Fig. 3 | Human pressure score sensitivity to changes in human pressure by altering buffer width. Sensitivity to changes in human pressure by altering buffer width. This shows the mean human footprint and standard deviation calculated using line buffer widths of (**a**, **b**) 10km, (**c**, **d**) 50km and, (**e**, **f**) 100km over the human footprint dataset 2013.



Extended Data Fig. 4 | Changes in global feasibility scores under different temporal and spatial analysis. Changes in global feasibility scores under different temporal and spatial analysis. This shows how global feasibility scores shift when restricting the length of timescale for governance and collaboration data from (**a**) the 20-year timescale, (**b**) past 10 years, (**c**) a 5-year period (2011-2015) around the 2013 human footprint dataset, (**d**) a 5-year period (1998-2002) around the 2000 human footprint dataset. We showed how feasibility scores shift when using a 100km buffer (**e**) with the original 20-year timescale. Grey lines indicate borders where there was no calculable feasibility score.

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Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	All data related to the feasibility index are freely available from; Harvard Dataverse https://doi.org/10.7910/DVN/28075, The World Bank http://info.worldbank.org/governance/wgi/index.aspx#home, and Dryad Digital Repository http://doi.org/10.5061/dryad.052q5.2. Border files are available from https://gadm.org/data.html, and species range files from http://www.iucnredlist.org.
Data analysis	Transboundary species richness and feasibility was calculated using a combination of Python v2.7 and ESRI ArcMap v10. The Python code is available from the corresponding author upon reasonable request.

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Data combining the national borders, threatened species richness, and feasibility are available in the University of Queensland eSpace repository [DOI to be inserted upon acceptance].

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Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	We determined the potential for transboundary conservation by quantifying the richness of species with transboundary ranges along national border segments and calculating the feasibility of implementing cross-border collaborative initiatives. This study aimed to assess global opportunities and challenges for different nations and regions, rather than conduct a statistical analysis.
Research sample	This study used existing datasets. We obtained species distribution maps for birds (10933 species), mammals (5447 species) and amphibians (6458 species), from the IUCN Red List (2017), and Birdlife International and Handbook of the Birds of the World (2017). All data related to the feasibility index are freely available from; Harvard Dataverse https://doi.org/10.7910/DVN/28075, The World Bank http://info.worldbank.org/governance/wgi/index.aspx#home, and Dryad Digital Repository http://doi.org/10.5061/dryad.052q5.2. Border files are available from https://gadm.org/data.html, and species range files from http://www.iucnredlist.org.
Sampling strategy	NA - this was not a statistical analysis
Data collection	Data was collected using existing data as described in "Research sample"
Timing and spatial scale	This study included global terrestrial areas with national borders. The existing datasets used to calculate feasibility spanned the period 1995 to 2017.
Data exclusions	Species were included if their presence was coded as extant and origin as native or reintroduced in the IUCN Red List or Birdlife International datasets.
Reproducibility	NA - this was not a statistical analysis
Randomization	NA - this was not a statistical analysis
Blinding	NA - this was not a statistical analysis

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Methods

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☒	☐	MRI-based neuroimaging