Research article

A synthesis of wild animal-related trade laws in some of the world's most biodiverse countries

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ABSTRACT

We examined the laws and legal provisions governing the commercial trade of terrestrial wild fauna across the trade chain in some of the world's megadiverse countries and how these relate to key animal welfare and conservation concerns. Over the past century, an increase in the quantity and complexity of laws related to commercial wildlife trade has been observed in the 11 focal countries examined. Our review identified 95 laws with 560 provisions adopted since 1910 across these countries. Surprisingly, the level of biological diversity in a country does not correlate with the extent of legislation addressing wildlife trade. Moreover, legislation is unevenly distributed across different stages of the wildlife trade chain, with more provisions on extraction and transportation compared to captive management. Notably, animal welfare considerations are relatively underrepresented in legislation related to wildlife trade, despite their broad implications for public health and economies. Urgent legislative action is needed to meet global biodiversity targets and respond to the challenges posed by the growing scale and complexity of the wildlife trade. Recommendations are made to streamline legislation, consider the legal status of wild animals, and address gaps in enforcement mechanisms. We conclude that alignment of national and international regulations is crucial for the effective protection of both wild animal populations and individual animals' welfare in the context of commercial trade. Further research is needed to assess the effectiveness of existing laws, bridge legal gaps, and address diverse concerns related to wildlife trade, including public health and the rights of local communities.

1. Introduction

With an estimated value of USD 300 billion annually, the global trade in wildlife (excluding timber) is a burgeoning business, with live plants, animals, and their by-products sold at an increasing scale worldwide (Harvey, 2022; Hughes, 2021; McConkie and October, 2021). It is currently estimated that at least 7600 terrestrial vertebrates (Scheffers et al., 2019) and several thousand invertebrate species (Fukushima et al., 2020; Marshall et al., 2022) are involved in the trade to satisfy the demand for a variety of purposes, including for food, pets,

luxury goods, sports, entertainment, research, and for traditional medicines (UNODC, 2019; Li et al., 2023).

In many parts of the world, wildlife is exploited for essential subsistence purposes to meet the basic needs of families or communities (Santos-Fita et al., 2012; Schloenhardt et al., 2022). However, distinct from this is the commercial exploitation of wildlife, which provides a means to generate economic wealth and financial benefits (Harrison et al., 2015). The commercial trade in wildlife can range from domestic (within local communities and from rural to urban areas) to regional and international scales, and (although not easily distinguishable; Broad

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et al., 2014; Macdonald et al., 2021) it can be both legal and illegal, with the latter occurring when this trade contravenes national or international laws and conventions (Turner and Usher, 2021).

If carried out sustainably (in which relevant uncertainties are appropriately monitored), wildlife trade can have positive development and livelihood benefits. For example, by increasing food security and by generating economic opportunities for rural communities where other non-consumptive employment and alternative sources of income are inadequate (Cooney et al., 2015; Harrison et al., 2015; Roe, 2008). Wildlife trade can also have positive conservation impacts by providing incentives for the protection of species and habitats or by reducing pressure on traded species through legal mechanisms and pathways (CITES Secretariat, 2022). Although if trade is carried out legally and sustainably, it can aid conservation efforts in theory, overall, in light of the current prevalence of illegal and unsustainable practices, the commercial trade in wildlife is recognized to be exacerbating the current biodiversity crisis (Phelps et al., 2022) and increasing species extinction rates (IPBES et al., 2019), with the potential to destroy local livelihoods where people depend on natural resources (Cooney et al., 2015).

In addition to the detrimental impacts that the commercial exploitation of wildlife can have on socioeconomics, biodiversity, and the environment, an increasing body of scientific knowledge related to animal sentience and the capacity of animals across a range of taxonomic groups to experience emotional states, such as both pleasure and pain, has led to growing concerns over the impacts of wildlife trade on animal welfare (Caporale et al., 2005; Lambert et al., 2019, 2021, 2022a, 2022b; Sigaud et al., 2023; Wyatt et al., 2022). Of special attention are the conditions encountered when wild animals are captured, killed, temporarily stored, transported, and subsequently kept in captivity (Baker et al., 2013; Wyatt et al., 2022). Due to this recognition that individual animals can suffer as a result of their use (in both legal and illegal aspects of the commercial wildlife trade), ethical views regarding animal welfare have also become a serious topic of discussion, among which are that animal species deserve not just protection and better treatment, but also to be respected (Sollund, 2022; Wise, 2023).

Wildlife trade chains vary in their complexity. The main stages of the commercial wildlife trade chain include taking from the wild, captive breeding, in-country intermediate storage, transporting, killing, processing, selling, and possessing (Baker et al., 2013; Sosnowski and Moreto, 2020). Taking from the wild, captive breeding, farming, and rearing animals taken as eggs or juveniles from the wild (often referred to as "ranching" or "rearing") can be implemented in an unsustainable manner (Hughes et al., 2023b), and each stage poses various risks to animal welfare (Baker et al., 2013; Green et al., 2023). In legal contexts, the taking of live wildlife or killing in situ is alternatively referred to as wildlife "extraction", depending on the nature of the trade and the target species (Aguilar and Morgera, 2009; Tsioumani and Morgera, 2010). At this stage, wild-caught animals are also often captured and/or killed by inhumane methods, such as poisoning and trapping (Baker et al., 2013; RSPCA, 2017). In most cases, neither illegal nor legal trade is supported by rigorous evidence of sustainability or population monitoring data, which obscures accurate assessments of species or population-level impacts, and has been identified as being particularly problematic in this regard (Hughes et al., 2023b).

Given the aforementioned potential negative impacts that unsustainable and unregulated trade practices can have on biodiversity and wild animal welfare, the wildlife trade is regulated at both the international level [via convention-based governance, such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Biological Diversity (CBD)], and at national levels [via statutes, decrees, and regulations, such as the National Environmental Management Biodiversity Act (Act No.10 of 2004) in South Africa, or the Minister of Agriculture Regulation (K.R.120/5/2017) in Indonesia] (Macdonald et al., 2021). As such, private individuals and commercial entities can (knowingly or not) engage in the unlawful sourcing, possession, or sale of wildlife, either in living form or

as derivative products (Warchol et al., 2003). Yet, although there are national and international laws and agreements in place to ensure that trade in live wild animal species and their body parts is sustainable, humane, and safe, complexity and, in many cases, inconsistency too often render existing regulations ineffective (Macdonald et al., 2021). Furthermore, many countries, such as Iran, Thailand, China, and Morocco, currently have no legislation concerning animal welfare standards in place (Animal Policy International, n.d.; World Justice Project, 2023).

Research examining a variety of aspects of the wildlife trade has grown exponentially in the past several decades (Carpenter et al., 2014; Marshall et al., 2020; Taylor et al., 2005), resulting in a number of qualitative [including those focused on the impacts of extractions from the wild, captivity (e.g., Ortega-Argueta et al., 2016), or transport and commercial trade, on biodiversity (e.g., Harrington, 2015; Shanee, 2012) and animal welfare (e.g., Wyatt et al., 2022)] and quantitative studies [such as those focused on a taxonomic – species level (e.g., Nijman et al., 2022), a national level (e.g., Masés-García et al., 2021), and a transnational or regional level (e.g., Arroyo-Quiroz and Wyatt, 2019)]. However, in contrast, relatively fewer studies have quantitatively examined the extent and adequacy of the laws that govern the various aspects of wildlife trade. Some studies that do exist focus on the effectiveness of national laws (Taylor et al., 2005), hunting legal provisions across countries (Pascual et al., 2021), and compliance with international trade law commitments (Whitehorn et al., 2019), among others.

In this study, we examine the scope and scale of laws and legal provisions governing the commercial trade of terrestrial wild fauna across the trade chain in some of the world's megadiverse countries across multiple jurisdictions and how these relate to key animal welfare and conservation concerns. The study explores four main research questions: (1) What laws and provisions currently exist in relation to the commercial exploitation of wild animals (extraction from the wild, captive management, and trade (including commercial transportation and sale)? (2) How do these laws and provisions vary among different countries and geographic regions? (3) When did these laws and provisions come into effect, and what temporal trends can be observed? (4) What are the main gaps in current laws and provisions regarding the commercial trade of wild animals?

By better understanding the scope and scale of laws and provisions that currently exist in relation to the commercial trade of wildlife, we hope to identify any gaps in the varying laws, as well as stimulate future research and associated measures that can strengthen and improve protection laws to minimize any negative impacts on biodiversity and wild animal welfare across the globe.

2. Material & methods

2.1. Sampling strategy

This research focuses on laws and provisions that currently exist in relation to the commercial trade of wild animals in the world's 10 most biodiverse countries,[1] as well as South Africa. These countries were ranked using the cumulative Global Biodiversity Index (Nash, 2022). This Index combines five different major data sources, including Birdlife DataZone, AmphibiaWeb, FishBase, Animalia, the Reptile Database, as well as over 190 various sources for data on plants. The Index is calculated by using a combination of the weighted total number of vascular plants, fishes, amphibians, reptiles, birds, and mammals for each country, and, in some instances, the species extinction rate or endangered status. South Africa was ranked 19th on this list, however, the country was included in our study due to its unique characteristics, such

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[1] These include Brazil, Indonesia, Colombia, China, Peru, Mexico, Australia, Ecuador, India, United States, in that order.

as its status as a floral region, the Capensis, as well as the country's recent policies focused on commercial wildlife use. All analyses detailed here are based on a systematic review of the legislation of these 11 countries.

2.2. Data sources

2.2.1. Systematic review of legislation

ECOLEX (www.ecolex.org), a comprehensive and open-access database of environmental law jointly operated by FAO, IUCN, and UNEP, is the primary source for the collection of information on the legislation pertaining to the commercial extraction, transport, captive breeding, and the sale of terrestrial wildlife species. The database claims to provide the "most comprehensive possible global source of information on environmental law", and is considered to be one of the most reputable data sources on this topic (ECOLEX, 2023). ECOLEX is systematically reviewed and refined to ensure that the most up-to-date data are provided on international environmental agreements, treaties, national environmental legislation, judicial decisions, and other supporting files, such as technical guidance documents and policy literature (ECOLEX, 2023).

The full legal documents analyzed for this research were provided by ECOLEX. To locate these records, we searched the database using the following keywords: "wildlife", "animals", "fauna", "captive", "extract", "animal protection", "hunting", "export", "import", "commercial", and "transportation". To be included in this study, the legislation needed to pertain to either the commercial extraction, transport, captive breeding, or sale of terrestrial wild animal species. Any law that is not directly related to these three specific criteria has been excluded from the analyses. For each piece of relevant legislation, we collected the following information: country, name of legislation, date implemented, document type, and source. For each country, we restricted the search for the laws at the federal level (i.e., we excluded any laws introduced at the state or provincial levels). All data were extracted for the 11 countries from January 2022 through April 2023.

Within ECOLEX, each legislative instrument is categorized into various subjects and indexed with keywords. For example, the Environmental Protection and Biodiversity Act (1999) is indexed with "Environment general; Fisheries, Forestry, Land & Soil; Water; Wild Species & Ecosystems" as its subject and "Basic Legislation, Institution, Ecosystem Preservation, Environmental Planning, Authorization/Permit … Marine Area" as the keywords associated with it. We utilized these indices and keywords for the analyses pertaining to the thematic classification of these laws.

2.2.2. Country level expert consultation

In addition to using the ECOLEX database, we consulted country experts (for all 11 target countries) and alternative sources, including the Animal Law Legal Center (University of Michigan), Legal Atlas, World Legal Information Institute (WorldLii), Library of Congress of the United States of America, and the Convention on the International Trade in Endangered Species of Fauna and Flora (CITES) National Legislation Project, to ensure that the legislation identified by the database constituted the most up-to-date information available, including any laws or resolutions that were under review at the time of the assessment of the country's laws. We also analyzed official national legislation databases for the respective countries to obtain implementing regulations and standards. For example, we reviewed the Official Register of Laws (Ecuador, Australia and Mexico), Official Government websites (South Africa, India, Peru), Government agency databases (*Departamento Administrativo de la Función Pública* (DAFP) in Colombia), and official national codes (USA Code and the Code of Federal Regulations).

2.2.3. Identifying gaps in legislation

Identification of the main gaps (i.e., weaknesses, bottlenecks, and conflict of law) in current laws and provisions regarding the commercial

trade of wild animals involved three stages. In the first stage, we performed a systematic review of published literature using only the name of each piece of legislation as the search term. The databases we searched included OneSearch, Google Scholar, EbscoHost, Scopus, and other popular databases available through the City University of New York, John Jay College of Criminal Justice institutional subscription. No timeframe was set for the search of the literature, allowing us to capture all relevant available published studies and reports (in the English language only[2]). Each piece of returned literature was screened for relevance. To be included in the analysis, the literature captured required a critical review of existing legislation in the target countries and identified key gaps in legal provisions relating to the exploitation, captive breeding, and trade of terrestrial wildlife. A total of 77 peer-reviewed scientific papers, reports by governments and NGOs, opinion pieces, and other documents specifically met these criteria. From each piece of relevant litearture we extracted the gaps reported for each piece of legislation.

In the second stage, the information extracted from the systematic review was validated through consultations with in-country legal experts (for all 11 target countries), as well as consulting the expertise of one of the authors of this study (JK), who is an animal rights and welfare attorney. In the final stage, one of the authors of this study (JK) performed an in-dept analysis of the 95 legal texts compiled to examine the nature and content of these laws and to identify any future gaps not identified in stages one and two.

2.2.4. Wild animal trade

In order to understand recent wild animal trade patterns across the 11 focal countries, data were collected on legal and illegal trade. Data on the volume of legal trade of wild terrestrial fauna were gathered from the CITES trade database (https://trade.cites.org/) and data on the volume of illegal trade of wild terrestrial fauna were gathered using the TRAFFIC Wildlife Trade Portal database (https://www.wildlifetradeportal.org). For both databases, we searched only for the trade of wild terrestrial fauna for the period 2014 to 2020. For each country, we searched the CITES trade database for all sources of trade in terrestrial wild fauna excluding "confiscations/seizures" (code: I), all purposes, and all trade terms. These records were filtered to examine the trade in *Animalia* for each of the 11 focal countries over this time period. Illegal wildlife trade and seizure records were extracted for each country from the TRAFFIC Wildlife Trade Portal. The database was searched for incidents pertaining to *Animalia* recorded from 2014 to 2020. No other exclusions were made in searching the TRAFFIC database. This database utilizes publicly accessible, or "open" sources, to aggregate international data on illicit trade. The database is, therefore, likely skewed in terms of the types and breadth of species included, as well as on the volume of records per country. Nevertheless, it is currently the only publicly available international illegal wildlife trade database that can be used to make country-to-country comparisons.

2.2.5. The World Justice Project

In order to understand the correlation between the number and complexity of laws with the overall rule of law within each country, we collected data through the World Justice Project (WJP). WJP is an independent organization that engages in research on rule of law. The organization has surveyed 139 countries and devised various indices designed to measure the different aspects of rule of law in these

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[2] We acknowledge that relying on only English-language literature may limit the generalizability of the findings/assumptions in this research. However, the gap analyses did not only rely on the English-language literature, but also on the close examination of the 95 legal texts compiled to examine the nature and content of these laws (some of which were translated using Google Translate to be able to make the assessments). Additionally, in most cases, the English text of these laws was available through the various databases consulted.

countries, including: constraints of government powers, absence of corruption, open government, fundamental rights, order and security, regulatory enforcement, civil justice, and criminal justice. Scores for each of these indicators are calculated from 0.00 to 1.00, where higher scores indicate stronger rule of law (World Justice Project, 2023).

2.2.6. World Bank

Lastly, in order to examine the correlation between a country's gross domestic product (GDP) and the number, as well as the complexity of laws for each of the 11 focal countries examined, we collected data through the World Bank data bank (World Bank, 2022).

2.3. Classification of laws into thematic fields

During the systematic search of ECOLEX, over 190 keywords associated with 95 laws were identified. A total of 12 thematic classifications emerged from these keywords. These are summarized in Table 1. Of these classifications, five themes specifically pertaining to various animal welfare and conservation-related concerns, were further analyzed in this research. These include 'animal welfare', 'captive management for non-conservation purposes', 'extraction from the wild', 'biological conservation', and 'wildlife trade'.

Using the cumulative score of the presence of each keyword within the examined laws of the 11 countries, we derived an index to capture the five thematic classification fields ('animal welfare', 'captive management for non-conservation purposes', 'extraction from the wild', 'biological conservation', and 'wildlife trade'). The index is based on the cumulative presence of keywords within each legal instrument, a measure used to assess the degree to which these laws encompass these core animal welfare and conservation concerns. The indices do not use every keyword within each thematic classification, rather the most relevant ones. For example, while the "*Animal Welfare Index*" was built by using all three keywords within this thematic field (see Table 1), the "*Captive Management Index*" included only 'keeping of live animals' and 'ranching/captive breeding' keywords; the "*Extraction from the Wild Index*" excluded 'game'; the "*Wildlife Trade Index*" excluded 'transport/storage', and the "*Biological Conservation Index*" only included nine out of 29 keywords (biodiversity, ecosystem preservation, endangered species, forest management and conservation, protected animal species, protected area, protection of habitats, protection of species, and sustainable use). Terms that were too broad (i.e. they did not focus directly or solely on the different stages of the wildlife trade, e.g., alien, wildlife, national parks) were excluded from these indices.

2.4. Analytical strategy

A combination of quantitative and qualitative analysis techniques was used to examine the proposed research questions. Descriptive analysis was primarily used to summarize and visualize the data related to the laws that specifically addressed wildlife extraction, captive breeding, and sale in the 11 focal countries. These analyses were limited to tabulating and reporting the frequencies of the existing laws and the specific provisions within these laws, as well as isolating the laws that specifically addressed the key conservation concerns (i.e., animal welfare, captive management, extraction from the wild, wildlife trade, and biological conservation). Data visualization comprised two components. Content analysis and visualization of the legislative text, as well as the literature reviewed to identify core gaps, was performed using the Voyant Tools (Sinclair and Rockwell, 2023) program. ArcGIS Pro was used to join the scores for the five indices derived from Table 1, as well as seizure incident data so that these data could be displayed spatially.

Additionally, as each legislation was classified on the basis of keywords assigned by ECOLEX, these keywords were utilized to chart the adoption of legislation over time. For this temporal analysis, keywords of interest were color-coded on the basis of their categorization for graphing (see Legend in Fig. 6). Selected legislation that did not have

dates associated with its adoption was left out of this analysis. Correlation analyses and T-tests were performed using STATA to examine temporal trends, and bivariate correlation analyses were run to examine whether the number of laws of each country were associated with their Global Biodiversity Indices and the Rule of Law Index of the World Justice Project. Similarly, correlations were run with the number of laws and the volume of CITES export and import permits issued by these countries (as a measure of the overall volume of trade). Specific examples of the key gaps identified through the systematic review of the literature are provided throughout in this study for context.

3. Results

3.1. Research question 1: What laws and provisions currently exist in some of the world's most biodiverse countries in relation to commercial exploitation of wild animals (extraction from the wild, captive management, and trade (including commercial transportation and sale))?

3.1.1. Number of laws

A total of 95 pieces of legislation relating to the commercial exploitation of wild animals were identified for the 11 focal countries (Table 2). Seven (over 60 %) countries have eight (8) or fewer laws, with Mexico and Indonesia having the fewest laws overall. Additionally, while the United States ranked 10th on the Global Biodiversity Index, it had the most legal instruments in place (n = 24), whereas Brazil, the country ranked 1st on the Global Biodiversity Index, had only six such laws in place. Among the countries in South America, Colombia (ranked 3rd on the Global Biodiversity Index) has the most laws in this regard, with 11 such laws in place.

3.1.2. Provisions[3] within laws

Within the 95 legislations examined, there were a total of 560 provisions; 222 provisions specifically pertained to species extraction from the wild, 112 to captive management of wild animals, and 226 related to wild animal trade (commercial transportation and sale) (Fig. 1). There was a total of 59 provisions within the 24 identified laws of the United States related to wild animal trade (commercial transport and sale) alone, while Mexico, Indonesia, Brazil, and India had less than ten provisions in this regard. Regarding the number of specific provisions related to species extraction from the wild, five countries, namely the United States, China, Ecuador, Australia, and Colombia, had between 30 and 35 such provisions. Brazil, India, and South Africa, on the other hand, had less than 10. Most countries had less than 15 provisions related to captive management of wild animals, with only the United States and Australia having twenty-seven and twenty-two provisions, respectively.

3.1.3. Content analysis of the provisions

Content analysis of the text of the title and summary descriptions of the 560 provisions using the Voyant Tool identified a total of 85 key terms. After eliminating redundant, irrelevant and non-substantive vocabulary, such as conjunctions, adjectives, and propositions, the ten most frequently occurring keywords were: "wildlife" (n = 169), "species" (n = 154), "wild" (n = 141), "animals" (n = 137), "hunting" (n = 119), "export" (n = 99), "prohibited" (n = 88), "products" (n = 84), "import" (n = 84), and "animal" (n = 79) (Fig. 2).

While some of these emerging keywords were generic, such as "wildlife", "species", "wild", "animals", others specifically related to the nature of the legality/illegality of the activity, such as "hunting", "export", "products", and "import". The provisions related to "hunting" were quite varied. For example, § 742j–1 of the Airborne Hunting Act of the United States is a provision specific to the prohibition and penalties related to the airborne hunting of wildlife that carries penalties of up to

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[3] These refer to stipulations, clauses, and terms within the legislation.

Table 1
The thematic classification of keywords from ECOLEX.

Animal Welfare	Captive Management for Non-conservation	Extraction from the Wild	Biological Conservation	Wildlife trade	Other
Animal Welfare	**Purposes**	Game	Alien species	**Wildlife trade**	Bioenergy
Against cruelty and ill treatment*	Animal production	Hunting authorization/permit*	Biodiversity*	Export*	Birds
Animal health*	Animal reproduction	Hunting gear/hunting methods*	Biosphere reserves	Import*	Camelids
Animal welfare*	Keeping of live animals*	Hunting rights*	Climate change	Internal trade*	Drugs
	Ranching/captive breeding*	Hunting/capture*	Ecosystem preservation*	International trade*	EIA
	Slaughtering		Endangered	Trade in species*	Energy conservation/energy production
	Working animal	**Marine and fisheries**	Endangered species*	Transport/storage	Expropriation
		Basin/catchment/watershed	Environmental planning	Wildlife products*	Fertilizers/nutrients
Human-dimensions	**Human Health**	Cartilaginous fishes	Environmental standards		Genetic resources
Access and benefit-sharing	Children's Health Insurance Programs (SCHIPs)	Coastal zone management	Fauna	**Enforcement/Policy**	GMO
Access right	Health Care infrastructure	Fish disease	Forest management and forest conservation*	Basic legislation	Institution
Access-to-information	Biosafety	Fish products	Forestry protection measures	Classification/declassification	Inventory
Access-to-justice	Biosecurity	Fisheries	Land clearing	Enforcement/compliance	Migratory species
Authorization/permit	Food quality control/food safety	Fishery management and conservation	Land-use planning	Framework law	Mining
Capacity building	Hygiene/sanitary procedures	Fishing authorization	Management/conservation	Fraud/deceit/adulteration	Pests/diseases
Certification	Medical Assistance	Foreign fishing	National parks	Inspection	Quality Improvement
Community management	Medicare	Freshwater quality/freshwater pollution	Plant protection	International agreement-implementation	Quarantine
Concession	Public health	High seas	Protected animal species*	International agreement-text	Recycling/reuse
Concession		Inland fisheries	Protected area*	International relations/cooperation	Reptiles
Consumer protection	**Pollution**	Mariculture	Protection forest	Law reform/harmonization/deregulation	Rescue
Court/tribunal	Air quality/air pollution	Marine area	Protection of environment	Legal proceedings/administrative proceedings	Research
Cultural heritage	Aquaculture	Marine fisheries	Protection of habitats*	Monitoring	Residues
Dangerous animal/harmful animal	Emissions	Marine mammals	Protection of species*	Non-governmental entity	Royalties/fees
Data collection/reporting	Hazardous substances	Marine pollution	Public forest	Offences/penalties	Seasons
Dispute settlement	Hazardous waste	Marine protected areas	Sustainable use*	Policy/planning	Shelter
Education	Noise pollution	Non-commercial fishing	Wild fauna	Procedural matters	Special fund
Environmental fees/charges	Pollution control		Wild flora	Registration	Timber
Indigenous peoples	Soil pollution/quality	**Agriculture**	Wild species & ecosystems	Search seizure penalty and confiscation	Timber extraction/logging
Right to clean/healthy environment	Waste disposal	Agricultural development	Wildlife	Sub-national agreement	Use restrictions
Social protection	Waste management	Agricultural land			Wetlands
Sustainable development	Waste prevention	Animal feed/feedstuffs			Zoning
Tourism	Water abstraction	Cattle			
Traditional/Indigenous knowledge		Livestock			
Traditional rights/customary rights		Stock enhancement/repopulation			

Table 2
Number of currently relevant laws and provisions related to wildlife extraction, captive management, and trade by country.

COUNTRY	NUMBER OF LAWS	NUMBER OF PROVISIONS WITHIN THESE LAWS
United States	24	116
Colombia	11	62
Australia	10	95
China	9	83
Peru	8	32
Ecuador	7	55
South Africa	7	34
Brazil	6	19
India	6	22
Indonesia	4	19
Mexico	3	23

USD5,000 or imprisonment, and an excerpt of the provision reads as:

"Any person who— (1) while airborne in an aircraft shoots or attempts to shoot for the purpose of capturing or killing any bird, fish, or other animal … …shall be fined not more than $5,000 or imprisoned not more than one year, or both."

The General Environmental Law No 28611 of Peru captures the hunting provision within its broader context of sustainable use of forest resources, and contains provision § 92.1. that reads as:

"*The State establishes a forest policy guided by the principles of this Law, promoting the sustainable use of forest resources and wildlife, as well as the conservation of natural forests, highlighting, without prejudice to what is indicated, the principles of ordering and zoning of the national forest area, the management of forest resources, legal certainty in the granting of rights and the fight against illegal logging and hunting.*"

South Africa's hunting provisions are captured within its Animal Health Act of 2002, article 28 that regulates the

"*hunting, shooting, capture, and disposing of game*".

Lastly, Indonesia's 1994 Government Regulation on Game Hunting Affairs (No 13) spells out the hunting provisions as they relate to hunting locations, licenses, and paraphernalia, as well as contains provisions specific to regulating traditional hunting of local people, such as in the following provision:

"Local people conducting traditional hunting need not possess a hunting act or a hunting guide and need not pay a levy on a hunting license."

The provisions related to wildlife "products" were also varied. For example, Article 32 of the Wild Animal Conservation Law of the People's Republic of China specifically prohibited the provision of online platforms that can be used to trade wildlife illegally, and reads as:

"The provision of trading platforms for the illegal sale, purchase or utilization of wildlife and the products thereof or prohibited hunting equipment by internet trading platforms, goods exchange markets or other trading space is prohibited."

The Political Constitution of 1991 of the Republic of Colombia, Article 289 details the procedures of the trade of wildlife products, and reads as:

"Strict control will be exercised over the importation, introduction, production, transformation, transportation, storage, marketing, distribution and use of animal and plant species and their products."

Lastly, Brazil's Decree No. 6514, which establishes the penalties and administrative offenses for illegal activities against the environment, details the trade in wildlife products in Article 14 that is specific to regulating the:

"seizure of animals, products and by-products of fauna and flora, products and by-products subject to the infraction, instruments, gear, equipment or vehicles and vessels of any nature used in the infraction."

3.1.4. Thematic classification of the keywords by country

The alluvial diagram in Fig. 3 shows the links between each country's legislative instrument and the key constructs comprising the five thematic indices identified in this study (1. Animal welfare; 2. Captive management; 3. Extraction from the wild; 4. Wildlife trade; and 5. Biological conservation). Results indicate that the weight given within these thematic categories (measured by the number of laws) varies substantially. Notably, there are fewer laws specifically addressing animal welfare within the provisions of these countries than those related to biological conservation (that include such constructs as the protection of species, protected areas; and endangered species). Of the top 10 most prevalent key constructs, six (6) were related to biological conservation,
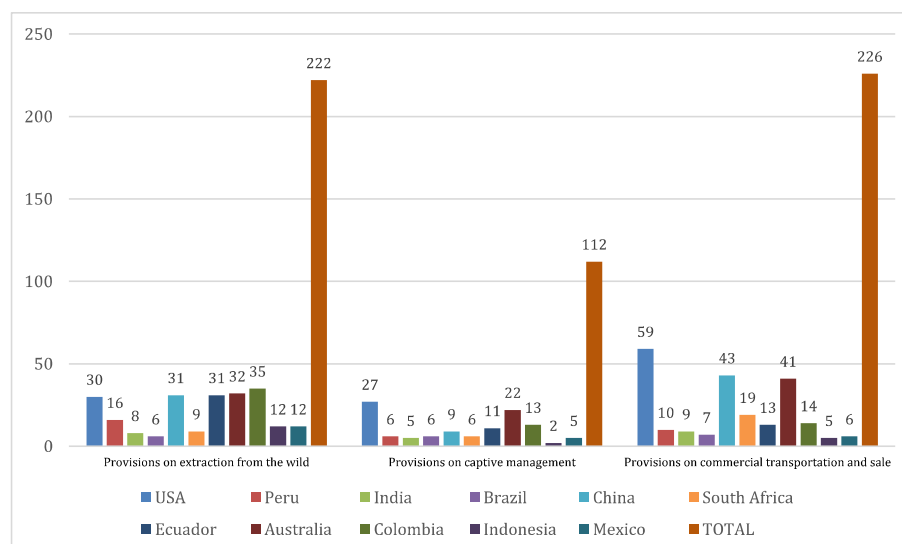

Fig. 1. The number of provisions within the laws of 11 focal countries related to the extraction, captive breeding, and commercial trade of wild animals.

Fig. 2. Emerging keywords from the content analyses of the 560 provisions of 95 laws across 11 focal countries. The size of the word indicates the frequency at which the word appears in the text.

while one was related to the extraction of animals from the wild (hunting and capture), one to the wildlife trade (international trade), and two to animal welfare (animal welfare and animal health).

Despite the overall availability of laws collectively addressing various biodiversity and animal welfare concerns across countries, not every country sufficiently addresses these concerns. For example, only Brazil contains a single law specifically detailing animal cruelty provisions, while general animal health-related issues are only addressed in the laws of Australia, China, Colombia, Indonesia, South Africa, and the United States. Moreover, China, Colombia, India, Mexico, Peru, South Africa, and the United States have laws pertaining to animal welfare, while Ecuador has no laws related to either of the three key constructs related to animal welfare (animal welfare, against cruelty, or animal health).

The laws of these countries are more focused on addressing biodiversity conservation, capturing issues of biodiversity, endangered species, protection of habitat, nationally protected animals and species, ecosystem preservation, and others. Nevertheless, there was a significant range between countries in the number of laws pertaining to biodiversity conservation. For example, while the United States had 11 laws that specifically covered issues related to species protection and endangered species, the coverage of other countries of these specific concerns ranged from zero (Brazil and Indonesia for endangered species; and Brazil for protection of species) to eight (Australia), with the average of two (2) such laws for the remaining countries.

When examining the bivariate correlations between the number of laws of each country and the Global Biodiversity Index, no significant correlations emerged ($r = -0.29$, $p > 0.05$). Similarly, we found no significant correlations between the number of laws and the volume of CITES export and import permits issued by these countries (for export permits: $r = 0.04$, $p > 0.05$; for import permits: $r = -0.24$, $p > 0.05$). However, significant and strong correlations were found between a country's GDP and both the number of laws ($r = 0.78$, $p < 0.01$), and the complexity of these laws ($r = 0.71$, $p < 0.05$).

When examining the bivariate correlations between each country's Global Biodiversity Index (Nash, 2022) and the number of laws captured within the five thematic indices (i.e. (1) animal welfare; (2) captive
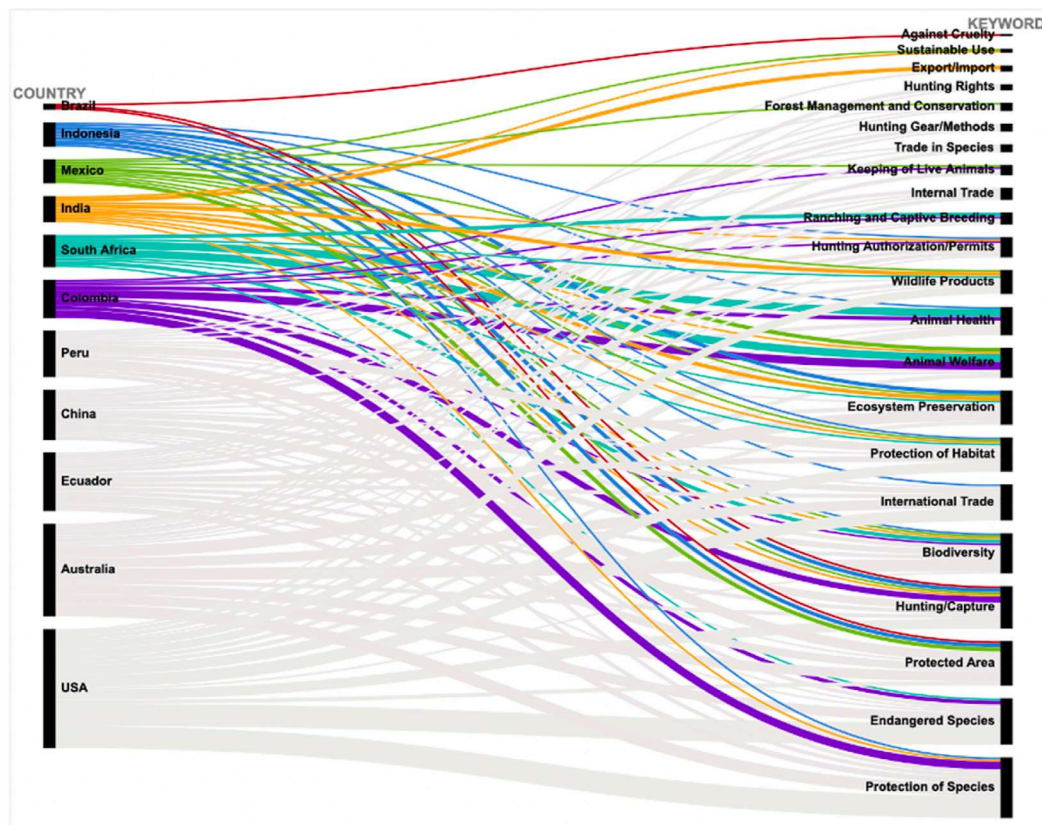
management; (3) extraction from the wild; (4) wildlife trade; and (5) biological conservation), the results showed that a country's Global Biodiversity Index was not overall associated with any of the five indices, indicating that being ranked high on the Global Biodiversity Index did not affect the number of wildlife trade-related laws a country had to protect its natural resources.

However, analysis of the specific components comprising these five indices revealed some statistically significant correlations (see Table 3). For example, animal health, which is one of the components of the "*Animal Welfare Index*", was significantly and positively correlated with hunting/capture, a component of the "*Extraction From the Wild Index*" ($r = 0.94$, $p < 0.01$), indicating that countries that had a higher number of laws on animal health also had a higher number of laws pertaining to hunting/capture. Additionally, the various components of the "*Wildlife Trade Index*" were associated with those of the "*Biological Conservation Index*". For example, the number of international trade laws was positively correlated with both the number of laws specifically addressing endangered species provisions ($r = 0.86$, $p < 0.05$) and those related to the protection of the species ($r = 0.97$, $p < 0.05$), while the number of internal trade laws was negatively correlated with the number of laws specifically addressing protected areas ($r = -0.96$, $p < 0.05$).

Each country's Rule of Law Index, which comprised eight different indicators, was correlated against (a) the number of laws identified and (b) the number of total provisions within these laws (as a measure of the complexity of these laws). Results indicate that the Rule of Law Index was positively correlated with the complexity of these laws ($r = 0.67$, $p < 0.05$), but not with the number of laws ($r = 0.58$, $p > 0.05$).

3.2. Research question 2: how do these laws vary among different countries and world regions?

Fig. 4 shows the geographic/regional patterns in legislation related to the five thematic categories. When examining the "*Wildlife Trade Index*" (which reflects the relative number of laws specifically addressing commercial trade of wild animals, including commercial transportation and sale), it is evident that the United States, Australia, and the countries in East and South and Southeastern Asia (India and China)

A.
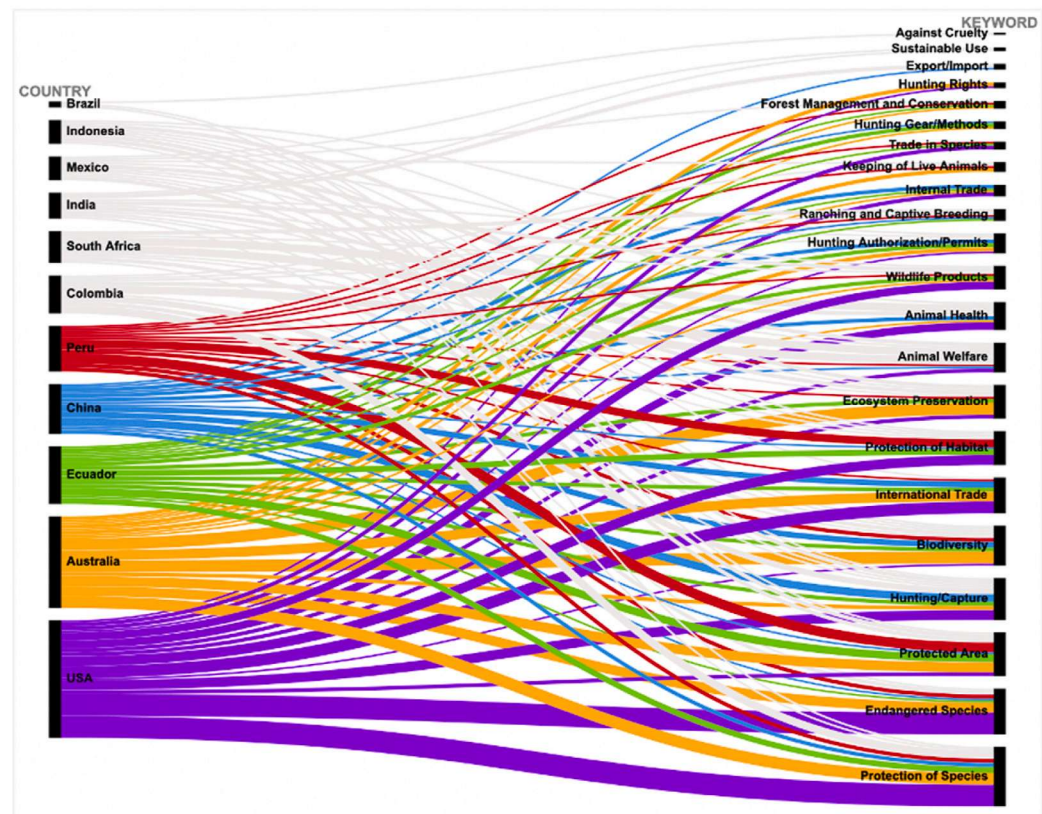
B.

Fig. 3. Linking legislative instruments of the different countries to the key constructs comprising five indices examined in this study (animal welfare, captive management, extraction from the wild, wildlife trade, and biological conservation).

Table 3
Correlations between specific components comprising the five thematic categories.

Components Within Indices	Animal Health	Biodiversit	Endangered Species	Protected Area	Protection of Species
Animal Health	-	-	-	-	-
Biodiversity	-	-	-	-	-
Ecosystem Preservation	-	.861**	-	-	-
Endangered Species	-		-	-	-
Protected Area	-	.770*	-	-	-
Protection of Species	-		.937**	-	-
Hunting Authorization/Permit	-	.859**	-	-	-
Hunting/Capture	.939*	-	-	-	-
Internal Trade	-	-	-	-.962*	-
International Trade	-	-	.861*		.974**
Keeping of Live Animals	-	.980*	.962*	-	-

** Correlation is significant at the 0.01 level

* Correlation is significant at the 0.05 level

◼ = concepts within biological conservation index
◼ = concepts within wildlife trade index
◼ = concepts within animal welfare index
◼ = concepts within captive management index
◼ = concepts within extraction from the wild index

have a greater number of laws to specifically address wildlife trade than all the countries in South America (with the exception of Ecuador). The "A*nimal Welfare Index"* is better reflected in the laws of South Africa, as well as Colombia, Mexico, and the United States. The various conservation concerns captured in the "B*iological Conservation Index"* were relatively uniformly covered by all the countries across the continents, so too were the "C*aptive Management"* and "E*xtraction From the Wild"* indices, suggesting that there was no geographically discernible pattern for these indices.

The supplementary analyses related to the number of seizures by country (extracted from TRAFFIC's database) and the number of CITES import and export permits issued by these countries (extracted from CITES) reveal interesting geographic patterns (Fig. 5). Recorded seizure incidents (Fig. 5a) were highest in the United States (n = 10,600), followed by India (n = 2462); China (n = 1399); Indonesia (n = 1134); and Mexico (n = 1064). Excluding the United States, the number of seizures were highest in East and Southeast Asia. The same Southeast Asian countries were also among those with the highest number of CITES export permits issued (Fig. 5b), with Indonesia issuing 36,642 permits during 2014–2020; China- 14,142; and Mexico - 2420. The remaining top five exporters included South Africa (with 22,252 export permits issued) and Australia (n = 18,433). This indicates that a notable number of wild animals are presumably legally exported from the South and Southeast Asia regions. Fig. 5c shows that, along with Australia (n = 6308) and South Africa (n = 5646), the countries in the North, Central,

and South Americas are those that issued the highest number of import permits, with the United States, Mexico, and Brazil issuing 45,000; 6212; and 5038 import permits, respectively.

3.3. Research question 3: When did these laws come into effect and what are the temporal trends?

The legislation reviewed across the 11 countries was adopted as early as the 1910s and spans the 2020s. There were no particular trends observable in regard to the adoption of laws related to the five key indices (animal welfare, captive management, extraction from the wild, biological conservation, and wildlife trade) over time. For example, there were no categories of legislation that countries adopted prior to others (e.g., countries did not adopt animal welfare legislation typically prior to biological conservation). There are, however, clusters of legislation implementation that occur across the countries. Countries appear to have adopted legislation in bursts as opposed to continuously over the years. For example, regarding commercial wildlife trade legislation overall, several bursts of legislation covering the topics discussed can be observed, such as in the US in the mid to late 1960s, in China between the mid-1970s to early 1990s, then again from 2015 to the present, in Ecuador from the early 1990s to 2010, and in Australia from around 2005 to 2010 (see Fig. 7). For animal welfare specifically, there was a cluster of legislation introduced addressing animal welfare across Brazil, South Africa, the US, India, and Colombia that occurred during the late
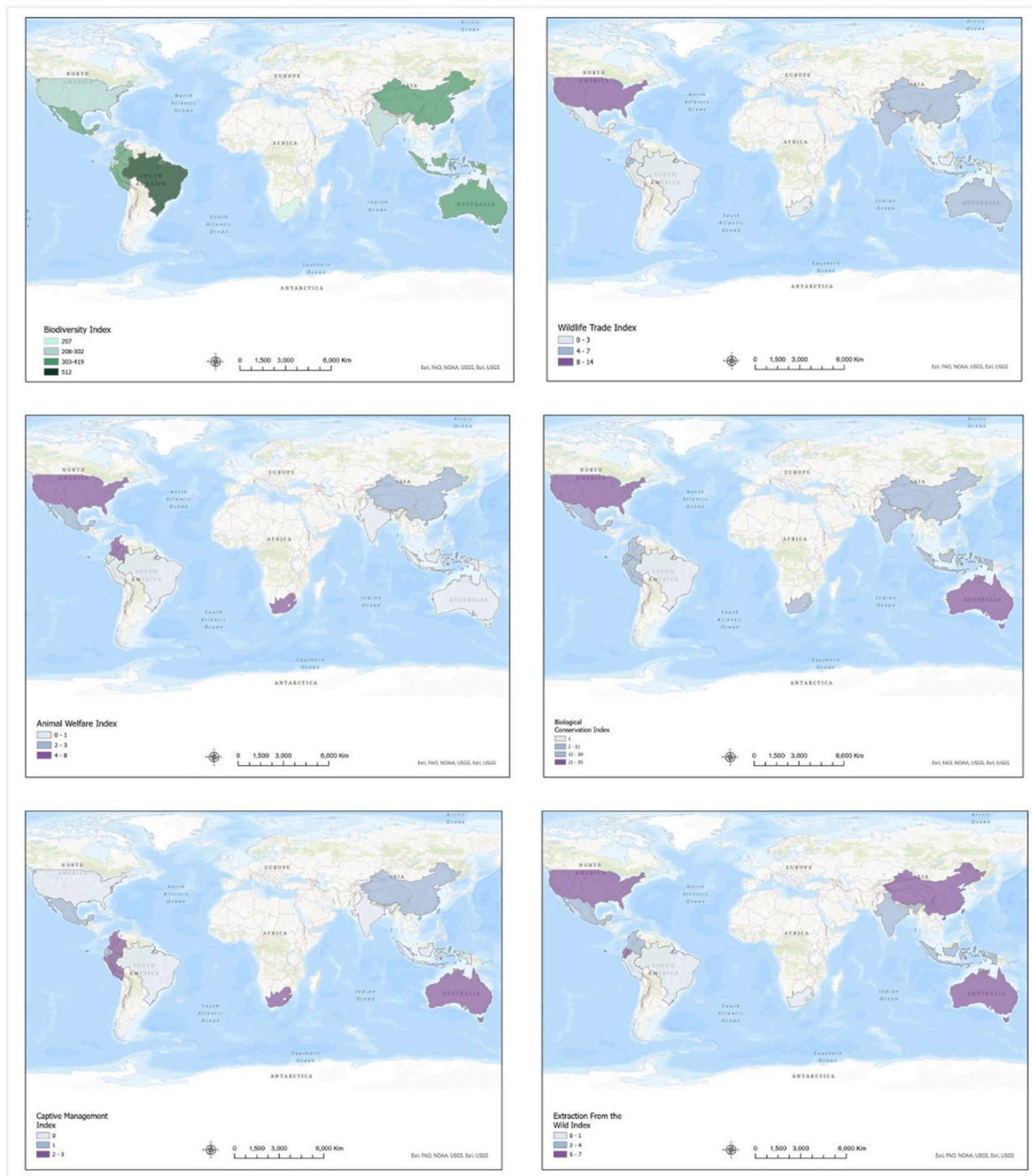
Fig. 4. The Global Biodiversity Index and performance on the five key indices: wildlife trade, animal welfare, biological conservation, captive management, and extraction from the wild for the 11 focal countries. The indices are based on the number of laws for each category. The boundaries shown, and the designations used on this map may not be correct and do not imply any official endorsement and/or acceptance by the authors or their respective institutional affiliations.

1930s to early 1970s. More recently, there was an observable burst for biological conservation as a prevalent theme of legislation appearing after the adoption of the Convention on Biological Diversity (CBD). However, the adoption of major international treaties - such as CITES, CMS, and CBD - do not appear to be statistically tied temporally to any of these bursts. When examining the overall number of laws for all countries by year, no statistically significant correlations were discovered ($r = 0.198$, $p > 0.5$). Neither were there significantly different (mean) number of laws developed pre- and post-CITES, CMS, and CBD convention adoptions (*CITES*: $t(49) = -0.352$, $p > 05$; *CMS*: $t(49) = -1.163$, $p > 0.05$; *CBD*: $t(49) = -0.551$, $p > 0.05$).

3.4. Research question 4: What are the main gaps in current legislation designed to address the commercial exploitation of wild animals (wild animal extraction, captive breeding, and trade)?

The word cloud shown in Fig. 8 reveals several frequently occurring themes from the analysis of gaps in current legislation related to the commercial exploitation of wild animals that were shared by the 11 focal countries. The most frequently occurring term identified as a major gap was "welfare" ($n = 17$). This indicates that, collectively, there seem to be significant gaps in these laws (e.g., weaknesses, bottlenecks, or conflict of law), specifically in relation to animal welfare. "Penalties" ($n = 15$), "regulation" ($n = 14$), and "enforcement" ($n = 14$) emerged as the second, third, and fourth most frequently occurring themes from the
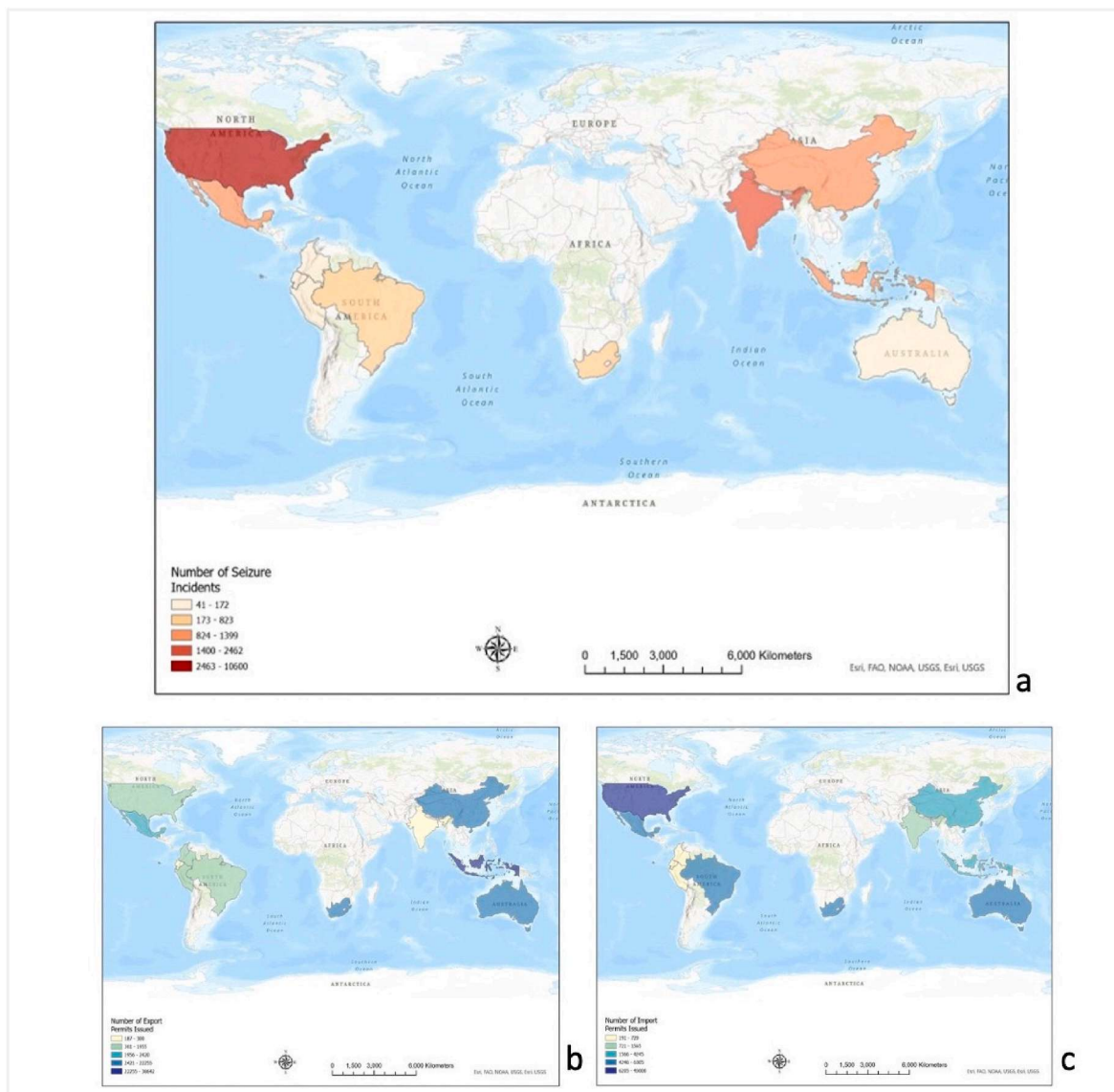
Fig. 5. Geographic patterns of wildlife seizure incidents, and CITES import/export permits issued by the 11 focal countries. Data source: TRAFFIC trade database (for seizure incidents) and CITES trade database (for imports and exports). The boundaries shown, and the designations used on this map may not be correct and do not imply any official endorsement and/or acceptance by the authors or their respective institutional affiliations.

analysis of gaps shared by these laws, respectively. Other frequently occurring themes included those related to "species" (n = 12) broadly defined, and the "poor[ly]" (n = 12) and "lack" (n = 8) of their "protection" (n = 11), as well as those associated with broader "environmental" (n = 8) regulatory provisions that holistically capture the nature of these crimes and their associated impacts.

A systematic content analysis of the gaps identified by the word cloud revealed that those related to animal "welfare" shared some key weaknesses, as captured in the descriptions below:

"The public health and animal welfare link is not covered …; for example, it ignores coverage of zoonotic disease issues." (United States: The, 1973 US Code 50 CFR Part 23)

"The law has animal fighting exemptions, which contradicts its own definitions of "animal welfare", "entertainment show", and "unnecessary suffering". (Peru: The, 2016 Animal Protection and Welfare Law No. 30407)

"The law allows for sport hunting which violates the welfare of wildlife" (Peru: The, 2011 Forest and Wildlife Law No. 29763)

"The code lacks a broad range of wildlife specific offenses related to animal welfare such as transportation and captivity, or trade such as sale of illegally acquired species or protected species." (India: The Indian Penal Code of 1860)

"This law is poorly enforced with inspections on animal welfare being conducted in a piecemeal fashion, and many zoos go unmonitored." (Brazil: The, 1983 Federal Law No 7,173/1983)

There were also significant gaps pertaining to the nature of the "penalties" associated with the laws addressing species extraction from the wild, captive management, and commercial trade of wild animals (transportation and sale). The most common gaps shared by the countries as related to penalties were the inadequacy of the fines as a deterrent mechanism, weakness of these penalties, and the outdated nature of the laws pertaining to them. Examples of these gaps are provided in the excerpts below:

"This law has penalties restricted and capped to a maximum of one to two years imprisonment with or without option of a fine. Fines are not specified in the law and the Adjustment of Fines Act applies specifying up to a
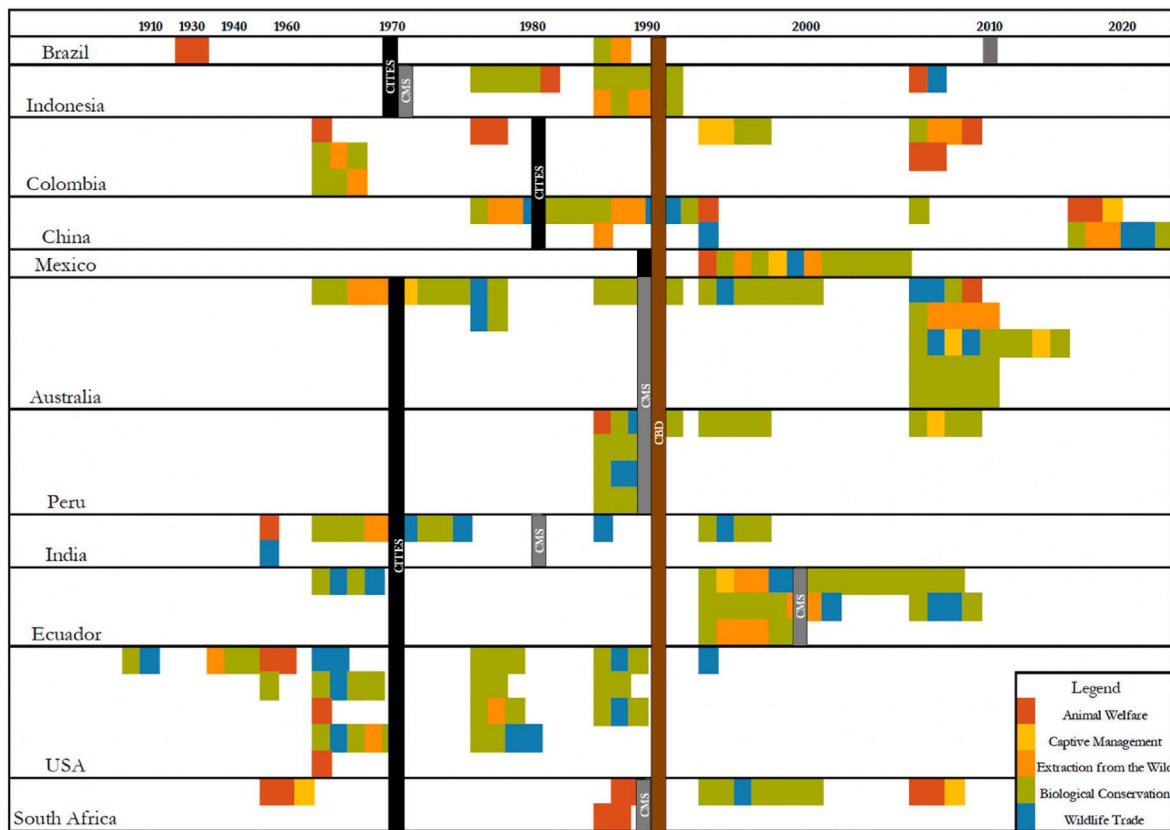
Fig. 6. Temporal mapping of legislation adoption by theme across the 11 focal countries
Note: Each individually-colored rectangle/block represents a keyword falling into one of the color-coded categories for a particular piece of legislation. For ease of interpretation, all blocks are merged into the smallest amount of space per country. Colors together, therefore, represent either one piece of legislation with multiple keywords and/or multiple pieces of legislation merged. Temporal categorizations are shown in decade sections. For reference, the Convention on the International Trade in Endangered Species of Fauna and Flora (CITES), the Convention on the Conservation of Migratory Species (CMS) and the Convention on Biological Diversity (CBD) adoption dates are also shown. Countries are sorted by biodiversity index ranking (highest ranked to lowest ranked). (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)
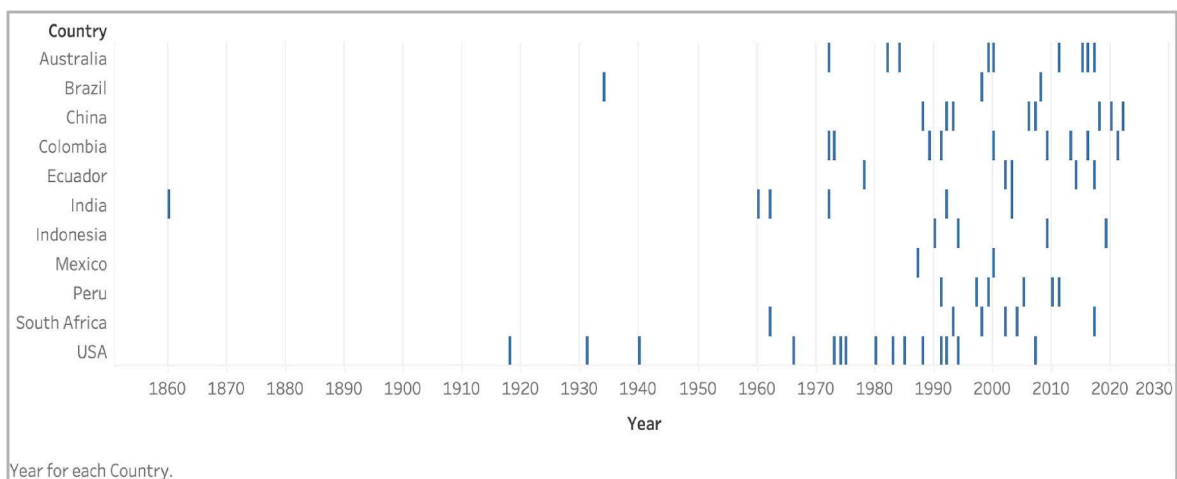

Fig. 7. Temporal mapping of legislation adoption across the 11 focal countries.

maximum of R80,000 ($4500)" (South Africa: The Animals Protection Act No 71 of 1962) and *"Penalties under this law attract a low fine of R40,000 with the option of a maximum imprisonment of one year"*. (South Africa: Performing Animals Protection Act (No. 24 of 1935))

"This law is outdated with lenient penalties for wildlife-related offenses" or *"Penalties for offenses under this Act do not have minimum terms and amounts, which means offenders can get away with light punishments"*. (Indonesia: Natural Resources Conservation Law (Act No. 5 of 1990))

Fig. 8. Word cloud of key gaps identified in the legislation related to the commercial exploitation of wild animals of the 11 focal countries. The size of the word indicates the frequency that the word appears in the text related to the gaps in legislation.

"Penalties relating to wildlife crime-related offenses are relatively low. (Imprisonment for a maximum of three (3) years). (Ecuador: The 2014 Comprehensive Organic Criminal Code (COIP) (R.O 180))

Lastly, the gaps as they pertained to "regulation" and "enforcement" either discuss goals contrary to the species protection, such as in the China example below; are vague in the provision of specific guidelines to regulate wildlife law enforcement; or lack specific provisions pertaining to the illegal possession of wildlife as pets. Examples of these are included below:

"The law and its implementing regulations have put a putative emphasis on wildlife utilization in encouraging captive breeding and expanding opportunities for wildlife utilization, rather than protecting it." (China: The, 1988 Law of the People's Republic of China on the Protection of Wildlife)

"This law does not describe or provide guidelines and regulations for the coordination of law enforcement agencies in enforcement." (Colombia: Law 2153 of 2021)

"This law lacks the regulations needed to prevent the trafficking and illegal possession of wildlife as pets." (Mexico: The, 2000 General Wildlife Law)

4. Discussion

4.1. Key findings

This is the first comprehensive study to review the extent of national legislation pertaining to the commercial exploitation of wild animals, including their extraction from the wild, captive management, transport, and sale in 11 megadiverse countries around the world. Specifically, we sought to explore what legislation currently exists and to delve deeper into its characteristics by examining when these laws and their provisions came into effect, how these laws vary geographically, and identifying any of the main gaps in the legislation designed to address the commercial exploitation of wild animals. Following our investigation of four research questions, several key findings have emerged.

Over the past century, there has been an apparent increase in the number of laws and their complexity (as indicated by the number of provisions within them) pertaining to the commercial wildlife trade in the world's most biodiverse countries. We identified 95 laws with a total of 560 provisions adopted since 1910 across the 11 focal countries examined. The United States, Australia, and China had the highest number of provisions, respectively, while Mexico, India, and Brazil had the fewest. It is noteworthy that a country's level of biological diversity (indicated by its Global Biodiversity Index) does not appear to be correlated with the number of laws and provisions the country has in place to address commercial wildlife trade or the volumes of international commercial trade in CITES-listed species. This observation is surprising because, in a sense, we had expected that biodiversity, being such an essential resource for these countries and a source of national identity, would also be one of the most guarded resources, maintained in part through the application of relevant legislation and associated provisions governing its use.

However, our study also reveals that the focus of these laws and provisions for the world's most biodiverse countries is not uniformly distributed across different stages of the wildlife trade chain, such as extraction, captive management, and transport and sale. For example, far more provisions exist specifically pertaining to species extraction from the wild and commercial transportation and sale of wildlife compared to those specifically focused on captive management of wild animals. Furthermore, laws focused on wildlife trade are not evenly distributed across various key areas of concern, such as habitat protection, species conservation, and safeguarding animal welfare. For each of the countries assessed, there are notably fewer laws that specifically address animal welfare in the context of commercial wildlife trade than those focused on biological conservation. This observation is perhaps not unexpected, considering that key factors, such as attitudes towards wildlife and animal sentience, levels of consumption, political will, enforcement, and capacity to deal with confiscated wildlife, can vary greatly between different countries (Wyatt et al., 2022). Furthermore, from local to international scales, wildlife policy agendas and interventions are often more focused on delivering the social goals of biodiversity conservation, development, and poverty alleviation (Niesenbaum, 2019). Moreover, currently, the various international

bodies/agreements and legal instruments that have some influence on wildlife trade (such as CITES, IPBES, CBD) appear mostly to be focused on regulating trade or attempting to ensure sustainability, and very few international legal instruments appear to acknowledge sentience or the intrinsic value of wildlife (Nyilas, 2021).

Of particular note is the relatively lower inclusion of animal welfare considerations apparent across the proliferation of laws and provisions related to the international commercial wildlife trade. This observation raises multiple concerns that warrant attention relating to increasing recognition, not only regarding the suffering experienced by individual animals that are commercially traded due to an enhanced understanding of animal sentience [research increasingly demonstrates the sentience of wild animals, extending to taxonomic groups that have been previously overlooked such invertebrates, fishes, and reptiles (Lambert et al. 2021, 2022a, 2022b Caporale et al., 2005; Sigaud et al., 2023; Wyatt et al., 2022)], but also in terms of the broader implications associated with the One Health concept (One Health, n.d.). Poor animal welfare can have adverse effects on public health (Bonilla-Aldana et al., 2020), livestock (Fernandes et al., 2021), and economies (One Health, n.d.), underscoring the importance of addressing this aspect in wildlife trade regulations. Yet practice and legislation do not always properly reflect this (Wyatt et al., 2022).

Likewise, it is of potential concern that the number of legislative measures and provisions related to captive management (particularly captive breeding) is comparatively lower when compared to the regulations governing the extraction of wildlife from the wild and commercial transportation and sale. From an animal welfare perspective, this stage of the wildlife trade chain can include high concentrations of animals, poor hygiene, and close contact with caretakers (e.g., Harrington et al., 2021) resulting in disease, malnourishment, stress-induced behaviors, injuries, infected wounds, cannibalism, and premature death (Baker et al., 2013; Hilderink and de Winter, 2021; Robinson et al., 2015; Wyatt et al., 2022). Moreover, from a conservation perspective, commonly applied "sustainable solutions" to commercial wildlife trade and use, such as commercial captive breeding and ranching of wild animals, are not always as sustainable as intended, given they may only be appropriate for a limited number of wild animal species that fit certain specific criteria (Tensen, 2016). It also risks the introduction of invasive species (Hughes et al., 2023b) and genetic pollution of wild populations, leading to the erasure of genetically distinct populations if effective management is not in place (Auliya et al., 2020).

Lastly, in addition to identifying countries that were quick to adopt legislation focused on the various different aspects of the commercial wildlife trade, and those that have lagged behind, our analysis of temporal patterns in the emergence of legislation over time revealed that the pattern of this proliferation is one characterized by clusters, or bursts of legislative action. This pattern of policy change and growth of legal jurisprudence in relation to wildlife law aligns with the prepositions of the Punctuated Equilibrium Theory as applied by Baumgartner and Jones (1993), which asserts that policies undergo periods of radical change and long periods of development stagnation and stasis that emerges and recedes. However, although some new legislation is generally required at a national level when adopting international treaties (such as CITES), our study indicates that the observed surges in national legislation do not appear to be directly linked to the creation of new international treaties. Instead, it appears that countries have been pursuing their own unique trajectories in this regard. This aspect should be taken into account when refining existing international policy forums (e.g., as has been proposed by some for CITES) and creating new ones (e.g., the proposed Pandemics Treaty).

It is also important to note that the political economy of wildlife exploitation at a particular point in time is largely seen as a major influence on the nature of animal welfare protection laws a country promulgates and enforces (Hårstad, 2023; Parlasca et al., 2023). Countries and/or governments that have a more permissive wildlife exploitation and utilization agenda often ordinarily put emphasis on encouraging extraction, captive breeding, hunting, consumption, and trade, often at the expense of animal welfare protections. They often do this by maintaining wide exemptions for exploitation in law (e.g., South Africa, Ecuador, Peru, Bolivia), exceptions on the use of wildlife (e.g., USA and Mexico), weak monitoring or evaluation of the legal framework, or through fragmented law enforcement coordination frameworks (e.g., Indonesia and Mexico).

4.2. Policy implications

The extent of the laws identified in this study may seem comprehensive. However, it is important to acknowledge that the sheer number of laws and their complexity (indicated by the number of provisions within laws) should not solely be relied upon as an indicator of their adequacy and suitability for their intended purpose. For example, inconsistencies between the variety of provincial, national, and international legislation relating to the commercial captive breeding of lions in South Africa have been criticized for creating inconsistencies and "legal loopholes" for criminal actors to exploit (de Waal et al., 2022). Likewise, the number of laws does not necessarily correspond directly to how well those laws are implemented or enforced, or their efficacy (UNODC, 2020).

While wildlife-related laws exist on paper, the provisions related to the actual mechanisms of enforcement, the strength and proportionality of the penalties, and the regulatory provisions are not always well-defined and developed to fully address the problems of wildlife extraction, captive management, transport, and sale (Sollund and Maher, 2015). Capacity levels, the extent of political will to address IWT, and political limitations to enforcement, mean that there is also often huge variation in the ability of countries to enforce wildlife trade laws ('t Sas-Rolfes et al., 2019; Hamers et al., 2023). The lack of monitoring of wildlife trade across scales from local to international also presents a major barrier to the legal protection of wildlife (Hughes et al., 2023a). Corruption can also facilitate IWT while undermining the efficacy of laws and the trust in governments to enforce them (Van Uhm and Moreto, 2018). Furthermore, previous analysis has shown that penalties related to wildlife crime are highly variable globally, with fines being the predominant response, and that major gaps exist in our knowledge of whether and how these penalties are actually imposed and how effective they are (Hutchinson et al., 2023). In this regard, the relatively lower inclusion of references to "penalties", "regulation", and "enforcement" in the laws and provisions analyzed in this study is concerning and warrants further scrutiny to assess the extent to which this is impeding conservation and animal welfare policy goals.

Moreover, it must also be fully recognized that just because commercial trade in a given species is legal or certified, it does not necessarily mean it is safe, humane, or sustainable at a given point in time (Hughes et al., 2023a). Related to this fact, geopolitical variations among different stakeholders and cultural differences influence what laws should seek to achieve and prioritize, which should also be taken into account (Balane et al., 2020; Ribeiro et al., 2022). In particular, this can lead to the emergence of competing goals – for example, in relation to economic development, equitability, conservation, and animal welfare-focused outcomes. Whilst acknowledging the complexity of this situation, the many varied approaches to wildlife utilization that are promoted in policy can broadly be categorized into two main camps: those that are predominantly focused on improving regulation of commercial consumptive use of wildlife and those that prioritize non-consumptive wildlife uses.

The ongoing polarized solution-focused debates among academics, NGOs and policymakers as it pertains to biodiversity conservation include, on one side, those who call for an expansion characterized by improved regulation and monitoring of the commercial trade in wild animals (free market approach) to make it more sustainable (e.g., Park et al., 2022; Roe and Lee, 2021); and on the other side, those that call for

a reduction, via increased prohibition or phase-out (as a more conservative approach) as a conservation and development tool (e.g., D'Cruze et al., 2020). With regards to animal welfare, similarly, there are those who broadly call for improved regulation and monitoring of the commercial trade in wild animals to make it more humane (e.g., bigger cages, improved diet, and veterinary care) (e.g., Beekmans et al., 2023; Mellor et al., 2021); on the other side, there are those that, instead, call for reducing and/or eliminating the consumptive utilization of wild animals in trade (subsistence use only), and prioritizing non-consumptive alternatives as a default approach that is more animal welfare inclusive (e.g., Moorhouse et al., 2017, 2020; D'Cruze et al., 2020b; Green et al., 2022).

4.3. Recommendations

Irrespective of one's standpoint, it is evident that relevant existing legislation and provisions would greatly benefit from adopting a streamlined and interconnected approach that acknowledges the necessity to address and mitigate any potential adverse impacts stemming from the commercial trade in wildlife. Specifically, there is a need to ensure that both biodiversity conservation and animal welfare are considered in wildlife trade related policies, whilst also ensuring that these policies are in lock-step at a provincial, national, and international level (Ribeiro et al., 2022; Nijman et al., 2019). Likewise, current international policy agreements (such as CITES, CMS and CBD) have an important role to play, but are also in need of review and revision to safeguard animal welfare. However, as our temporal analysis of legislation adoption highlights, this will not necessarily guarantee an immediate cascade effect at the national level.

With regard to conservation, exploitation of wild animals to meet the demands of growing local and global markets was recently ranked among five key drivers of harmful ecosystem change in the most recent global assessment of biodiversity and ecosystem services (Watson et al., 2019). This underscores the fact that, overall, countries are failing to meet global biodiversity targets. To have a chance of meeting global initiatives, such as United Nation's 30×30 – which aims to reduce by half the risk of species extinctions across all taxonomic and functional groups, safeguard genetic diversity of wild species with at least 90 % of genetic diversity within all species maintained (UNCBD United Nations Convention of Biological Diversity, 2021) – urgent legislative action is required.

Even though it is encouraging that biological conservation-related terms have featured more prominently in the existing legislations and provisions related to commercial wildlife trade, the scope of the commercial trade in wild animal species is growing in scale and complexity (Watson et al., 2019), particularly in terms of species, products, consumers, platforms (e.g., social media), and pushes by various government-backed initiatives (e.g., Scheffers et al., 2019; MacDonald et al., 2021; Hinsley et al., 2020; Harrington et al., 2021; Martin et al., 2018). Consequently, there is a need to ensure that relevant wildlife laws are amended appropriately to keep pace with the growing and emerging commerce challenges and opportunities in legal development to elevate the status of wildlife protection in law.

With regard to animal welfare, animal sentience and the "rights of nature" provisions have been a key legal development that considerably enhances the legal status of animals as enshrined in constitutional provisions or proclaimed in legal jurisprudence in several countries covered in this study. However, despite the protections promised by this legal status of personhood, there remain challenges in streamlining this legal status in the other existing animal welfare, captivity, and exploitation-specific laws. Some legal frameworks around the world currently conflate conservation and the economic exploitation of species. For example, Peru recognizes animal sentience and the intrinsic value of animals while, at the same time, providing a legal framework that facilitates the permitting of sport hunting and consumptive wildlife use (Organic Law for the Sustainable Use of Natural Resources Law No.

26821). The legal standard offered by personhood is largely undermined by overt wildlife exploitation laws when it is not clear which of these two constitutional norms takes priority ("best interests of the animal" standard versus "commercial interests to exploit" the same animal). To meet this challenge, we suggest that wildlife exploitation laws in countries recognizing the sentience and intrinsic value of animals be streamlined to enhance the welfare and status of animals in statute with considerations to necessary exemptions for wildlife management methods, such as problem animal control or invasive species control.

In terms of future research, it is important to note that our study provides insights into the number of laws and adequacy of provisions (the extent and scope), but it does not provide information on their effectiveness and how well these laws are implemented. Consequently, to build on our initial findings, follow-up research is required to delve deeper into the degree to which these laws and their provisions are characterized by gaps, are applicable for their intended purpose, and whether robust mechanisms exist to ensure that they are effectively enforced across all of the various phases of the trade chain. In particular, understanding the complexity of laws, enforcement and efficacy across geographies and in relation to different geopolitical settings would be an important next step for research. We also call for increased measures and vigilance to address the lack of political will and corruption, alongside efforts to strengthen law enforcement. Ensuring that trade is adequately monitored at multiple levels from local to subnational, national and international, is also required to increase understanding of the drivers and trends in trade, and to assess the impact and efficacy of laws and enforcement (Nijman et al., 2019).

In addition, our study focuses only on certain impacts of commercial wildlife trade on terrestrial wild fauna – namely, conservation and animal welfare-related issues. Other concerns, such as public health, equitability, indigenous peoples, and local communities (IPLCs) rights to their environment, along with laws that address the growing commercial trade of freshwater and marine wildlife, fell outside the current scope of this study but are also in need of similar research attention. Lastly, our analyses did not assess the extent to which countries introduced legislative instruments as a result of CITES-related requirements, and neither did it assess whether the upticks in the adoption of legislation are related to external phenomena, such as pandemics (e.g., SARS, MERS, COVID-19). Future research can, thus, explore these questions.

5. Conclusions

At a time of accelerating biodiversity crisis and growing concerns over the negative impacts of commercial wildlife use on individual animals' welfare, biodiversity, public health, and the economy, there is an urgent need to effectively respond to harmful, unsustainable, and illegal activities related to wildlife. In this research, we set out to explore the landscape of laws as they pertained to wildlife extraction, captive breeding, and sale. We strategically selected 11 megadiverse countries (Mittermeier et al., 1997) as these were the countries that ranked among the highest on the Global Biodiversity Index. Geopolitical variations among different stakeholders and cultural differences influence what laws should seek to achieve, including as they pertain to issues of conservation and animal welfare concerns. This can lead to the emergence of competing goals – for example, in relation to economic development, equitability, conservation, and animal welfare-focused outcomes. These different stances aside, our research findings suggest that although a number of national legal frameworks exist, the distribution of provisions within these legislations varies across different aspects of protection and components of the wildlife trade chain. Considering the ongoing substantial expansion of the international commercial wildlife trade in terms of its scope and scale (estimated by some to reach USD 300 billion annually, excluding timber), as well as the growing acknowledgment of the potential adverse effects it can have on biodiversity and individual animals' welfare, there is a need for reviews and amendments to fill any legal gaps, streamline legislation, and reduce any legal loopholes to

enhance the protection of traded and captive wildlife. Effective protection of wild animal populations and the welfare of individual animals in commercial trade can only be possible when international and intranational regulations work in sync. To meet this challenge, we suggest that efforts are made to ensure that national and international laws are aligned to protect wildlife.

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Declarations

Competing interests

The authors declare no competing interests. Neil D'Cruze holds the position of Head of Wildlife Research at World Animal Protection, an international animal welfare-focused NGO. Angie Elwin holds the position of Wildlife Research Manager. Our results pertaining to this study were in no way influenced by either the funding source, or our own personal views on conservation or animal welfare.

Generative AI

The authors did not use generative AI or AI-assisted technologies in the writing or editing of this manuscript.

Research data

Data for this research, including the original text of the laws used in the analyses, are available upon request.

CRediT authorship contribution statement

Gohar A. Petrossian: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Angie Elwin:** Conceptualization, Investigation, Methodology, Project administration, Validation, Writing – original draft, Writing – review & editing. **Monique Sosnowski:** Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Thanaphon Nunphong:** Investigation, Writing – original draft, Writing – review & editing. **Ho-Tu Chiang:** Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. **Jim Karani Riungu:** Investigation, Writing – original draft, Writing – review & editing. **Neil D'Cruze:** Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. Two authors are employed by the animal welfare organisation World Animal Protection (NDC holds the position of Head of Animal Welfare and Research; AE is Wildlife Research Manager). Our results pertaining to this study were in no way influenced by our own personal views in animal welfare.

Data availability

Data will be made available on request.

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