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Resolving Uncertainties in the Legality of Wildlife Trade to Support Better Outcomes for Wildlife and People

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ABSTRACT

Wildlife use and trade support the livelihoods of millions of people worldwide but also threaten thousands of species. Legal instruments, when effectively designed and implemented, can help regulate trade and mitigate negative impacts. However, activities along supply chains are rarely categorically legal or illegal, with considerable uncertainties regarding legality in the wildlife trade. These uncertainties can compromise the success of efforts to ensure, or improve, sustainability, but are often overlooked. Here, we categorize legal uncertainties in wildlife trade into three dimensions: institutional, operational, and perceptual. We explore their implications for sustainable management and discuss potential interventions to address them, drawing on examples from wildlife management and other sectors. Resolving these uncertainties can reduce unsustainable and illegal trade, strengthen traceability and enforcement, and promote equitable benefit-sharing among actors. Our findings offer actionable insights for policymakers, practitioners, and researchers to improve the clarity and effectiveness of wildlife trade management, advancing both conservation and socio-economic objectives.

1 | Introduction

Wildlife trade is multifaceted and takes place for many purposes and at local to global scales. Trade can be informal in local markets, involve a small number of actors along regional supply chains, or involve many actors along complex international supply chains. Hundreds of millions of people worldwide depend on the extraction, use and/or trade of wildlife to meet their needs,

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but these activities also threaten thousands of species (Challender et al. 2023; Hinsley et al. 2023). Wildlife trade is estimated to be worth up to US$400 billion dollars annually, including both legal and illegal trade (Taskforce on Nature Markets 2023). Ensuring wildlife trade is sustainable remains a considerable challenge, undermining conservation goals and socio-economic benefits (Hughes et al. 2023).

Governance arrangements, including formal laws and structures, rulemaking and institutional coordination, are recognized as important factors affecting wild species use (Balachander et al. 2022). For instance, policies influence people's decisions to use certain species, such as the increase in trade of medicinal plants for the treatment of COVID-19 due to government endorsement of herbal medicines in multiple countries (Timoshyna et al. 2020). Wildlife trade is governed across multiple scales; for example, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) sets rules for international trade in around 40,000 species, whereas national laws set the rules for species use and trade within countries, such as the Endangered Species Act in the United States and the Wildlife Protection Act in India. Significant gaps, uncertainties, and inconsistencies exist within wildlife trade laws and regulations across international, national and even local scales (CITES 2023; Hübschle 2017). As such, activities along wildlife supply chains, from harvest to end use, are rarely categorically legal or illegal, especially when they involve multiple jurisdictions ('t Sas-Rolfes et al. 2019). Trade in many taxa falls into the "grey area" between legal and illegal (Macdonald et al. 2021). Such uncertainties in legality are widespread across all scales of trade in plants, animals and fungi (Hughes 2021).

Uncertainties can persist and multiply through supply chains, with harvesters and traders responding faster to ambiguities than policymakers, which can have adverse and far-reaching consequences (Wyatt et al. 2020). Species populations may be overexploited, and wildlife trade actors can be unfairly penalized under conditions of legal uncertainty, with Indigenous Peoples and local communities disproportionately affected (Sollund 2022). Uncertainties can also undermine law enforcement, enable the exploitation of legal "loopholes," and facilitate the involvement of organized crime (Greef and Haysom 2022). Addressing these uncertainties is therefore crucial for sustainable and equitable wildlife trade management. Laws can be a powerful tool for managing trade if designed and implemented well, and if clarity exists over their provisions and the jurisdictions to which they apply. Identifying and resolving uncertainties over wildlife trade laws at relevant scales could improve law enforcement, strengthen governance, and aid efforts to mitigate overexploitation, while supporting sustainable trade.

Here we develop a categorization of uncertainties regarding legality in wildlife trade, discuss how these uncertainties impact management efforts, and suggest how they may be addressed. We present a range of examples involving diverse taxa and geographies, and draw on insights from several other sectors where similar issues have been identified. Our work aims to improve the clarity and effectiveness of wildlife trade management, contributing to better outcomes for both wildlife and people.

2 | Legal Uncertainties in Wildlife Supply Chains

Various typologies and frameworks exist to categorize uncertainties, in disciplines such as ecology (Regan et al. 2002), environmental science (Bevan 2022; Herdieckerhoff et al. 2023), and sociology (Williams and Baláž 2011). We drew on these examples and literature on grey areas in markets (Beckert and Dewey 2017) to develop our categorization. Uncertainty here refers to the lack of clarity about the legality of an activity in wildlife trade and can include a wide range of contexts (from missing laws to unclear product labels), and can also vary based on who is experiencing it. We identified three broad dimensions of uncertainty: (1) institutional, (2) operational, and (3) perceptual, each with multiple sub-dimensions (Table 1, Figure 1A). This is not an exhaustive categorization of uncertainties but these dimensions are likely to be those most common in wildlife supply chains. Details on the process of developing our categorization are provided in Appendix I.

Institutional uncertainties can arise due to issues in formal institutions (defined as systems of established rules including constitutions, laws, and property rights; Hodgson 2006; North 1991), such as laws being absent, unspecified or conflicting. For example, trade in medicinal orchids is illegal in Nepal until a species management plan is prepared by the CITES Scientific Authority. Yet CITES identifies species through their Latin binomial name, whereas some Nepalese Divisional Forest Office Management Plans include orchids under their local names, resulting in ambiguities over whether harvesting and trade are permitted (Bashyal et al. 2023).

Operational uncertainties occur due to the overlap of legal and illegal supply chains. This is reflected in uncertainty over whether a product was legally harvested and/or traded based on where and how it was harvested, the parts being traded, when, by whom, and for what purpose. For example, trade in captive-bred live birds of certain species is permitted in Indonesia but their wild harvest is prohibited (Leupen et al. 2018). Challenges in distinguishing the origin of bird specimens have facilitated sellers laundering wild-caught birds as captive-bred (Nijman et al. 2022).

Perceptual uncertainties arise when actors have different understandings and perspectives on the laws and/or rules that apply to wildlife use and trade (CITES 2022a; Herdieckerhoff et al. 2023). These can originate from institutions, traditions, beliefs, experiences or scientific disciplines (Dewulf et al. 2005). For example, some people in Peru follow customs that normalize frog consumption, which violates formal laws (Angulo 2008).

Trade in a single product can be associated with multiple types of legal uncertainty. The global trade in sea cucumbers (class *Holothuroidea*) illustrates this complexity (Figure 1B). Multiple species of sea cucumbers are fished in over 70 countries and traded predominantly to China (Louw and Bűrgener 2020). Individual countries have imposed various regulations on the fishing of sea cucumbers, including moratoria, closed seasons, quotas, gear restrictions and no-take zones (Purcell et al. 2013), resulting in different types of *operational uncertainty* in the legal harvest of these species. For instance, sea cucumber fishing was banned in mainland Tanzania but remains legal in Zanzibar,

TABLE 1 | Categorization of uncertainties in the legality of wildlife supply chains within three dimensions (institutional, operational, perceptual), with examples for each. The colored shading refers to the type of uncertainty illustrated in Figure 1. Note that the uncertainty dimensions and types described here are not mutually exclusive and may overlap due to the complex nature of wildlife supply chains.

Type of uncertainty	Description	Example
Institutional uncertainty: Uncertainties arising because of a lack of clarity or other issues related to formal institutions. These uncertainties can occur within laws (i.e., legally binding rules created and enforced by an authority) and/or policies (i.e., guiding principles or courses of action that can help develop or apply new laws) (British Ecological Society 2017).		
Unspecified laws	Laws or policies for a particular taxon, product or trade platform are not specified	Laws about frog harvest and trade in Ghana are not specified (Sackey et al. 2022)
Conflicting laws	Laws or policies are conflicting or contradictory Conflicts regarding which authority is responsible for enforcement	Hunting laws (that prohibit hunting) vs. taxation laws (that enforce taxes on hunted products) in the Democratic Republic of Congo (J. Wright pers. Comms. 2023)
Multiple jurisdictions	Changing legal status of a species or product as it moves through jurisdictions—local, domestic, regional, and international regulation	Global sea cucumber trade (Purcell et al. 2013, see Figure 1B)
Policy change	Period of uncertainty when a law or policy is introduced or modified but not yet implemented on-the-ground	Pre-emptive fishing following the announcement of a new Marine Protected Area in Kiribati, before implementation (McDermott et al. 2019)
Interstate discrepancy	Information, species lists, and taxonomic names are applied differently or not matched between trade countries	Substantial mismatch in the taxonomic details of plant species in quarantine documents in different countries (R. Bashyal pers. Comms. 2024)
Operational uncertainty: Uncertainties arising due to the overlap or co-occurrence of legal and illegal wildlife products within a supply chain.		
Spatial	Difficulties in separating legal and illegal products harvested from protected and nonprotected areas, geopolitical boundaries, no-take zones	Fishing in the high seas that fall beyond any country's national jurisdiction (Blasiak and Yagi 2016)
Temporal	Difficulties in separating products harvested during the open and closed season, or during a moratorium Age of a product can determine whether it is legal or illegal	Hunting of bats in New Caledonia is allowed only on weekends in April (Mickleburgh et al. 2009) Commercial ivory trade is prohibited under European Union law, except for antique ivory (pre-1947), which is permitted (Kufnerová et al. 2021)
Taxonomic	Difficulties identifying species at different stages in the supply chain (particularly for parts and products) Changes in species taxonomy not reflected in the law	Global fish maw trade, where fish maw from multiple species—some CITES-listed—are included in a single general category (Sadovy de Mitcheson et al. 2019) See Morrison et al. (2009) for a review of changes in species taxonomy
Origin	Difficulties in distinguishing between captive bred and wild harvested individuals, where legality varies between the two	Live bird trade in Indonesia, where trade in captive-bred birds of certain species is permitted but their wild harvest is prohibited (Leupen et al. 2018)
Quantity/size	Uncertainty in whether a product meets harvest or trade quotas and/or minimum or maximum size	Quotas for the fishing of hake in Chile (Oyanedel et al. 2021)
Offtake method	Difficulties in distinguishing between products harvested from permitted and prohibited methods, weapons, or gear	Game bird hunting in the United Kingdom, where the only permitted methods are shooting and falconry (Stroud et al. 2021)
Community/ demographic group	Uncertainty in determining who harvested the product when harvest and trade is allowed for specific groups of people only	Fishing for salmon by Indigenous Peoples in Canada (Atlas et al. 2020)

(Continues)

TABLE 1 | (Continued)

Type of uncertainty	Description	Example
Use	Uncertainty in determining legality of use when harvest and trade is allowed for certain uses only (e.g., subsistence only and not trade)	Hunting in Gabon permitted for subsistence purposes in the local community as per Gabonese forest code (van Vliet et al. 2019)
Perceptual uncertainty: Uncertainties arising when actors have different understandings and perspectives on the laws and/or rules that apply to wildlife use and trade. These uncertainties can vary based on who is experiencing it.		
Complexity	Laws or policies are complex and difficult for actors to understand, misunderstood due to poor dissemination or open to misinterpretation	Locals struggle to understand technical words used in community forest operational plans in Nepal (Bashyal et al. 2023)
Customary	Traditional, customary, or informal laws, beliefs, and uses do not match formal laws (i.e., legality and legitimacy do not align)	Frog harvest and consumption in Peru, where actors follow customary practices rather than formal laws (Angulo 2008)
Definition	Definitions and meanings of wildlife, trade and other related concepts in formal laws are vague or nonspecific	Legal definitions of wildlife that vary between and within countries that confuse resource users, enforcement agencies, and judges (Tian et al. 2023)
Labels/codes	Product labels and trade codes can be vague, nonspecific, incorrect, or misleading	Shark meat from threatened species mislabeled as other species in the UK (intentionally or unintentionally), leading to consumers unknowingly consuming products containing illegally traded species (Hobbs et al. 2019)

leading to confusion in the regulation of this fishery (*complexity uncertainty*), and continued fishing in prohibited regions (*spatial uncertainty*, Louw and Bűrgener 2020). Six species of sea cucumber are listed in CITES Appendix II, but many more species are harvested worldwide, leading to unregulated global trade in look-alike species (*taxonomic uncertainty*) (Simone et al. 2022). Dried and processed sea cucumbers cannot be easily distinguished, and products are often mislabeled (either accidentally or deliberately) when sold to consumers (*labels/codes uncertainty*; Purcell et al. 2025). CITES trade restrictions do not always align with national legal provisions; for instance, India has imposed a blanket ban on all sea cucumber fishing and export, resulting in illegal harvest and smuggling to Sri Lanka where products are laundered and re-exported legally (*multiple jurisdiction uncertainty*, Bondaroff 2021). Additionally, new fisheries for previously unexploited species develop in countries before laws can be introduced or implemented to ensure sustainable harvests, effectively making harvest and trade legal (*unspecified law uncertainty*, Eriksson et al. 2015).

3 | Resolving Uncertainties

Appropriate interventions to address and resolve uncertainties depend on how and why the uncertainty occurs, the scale of the problem and the particular context. Solutions could sometimes be relatively straightforward, where acknowledgement of the uncertainty could, in itself, largely pave the way for its resolution. Other uncertainties may be more intractable, requiring an exploration of broader strategies and cross-sectoral collaboration to address. Below, we discuss actions taken within and beyond wildlife management to tackle uncertainties. We identify interventions that have had some success or positive impact in resolving an uncertainty and improving trade management, as well as ongoing interventions whose impact is currently unknown but may be successful (Table 2). We use these examples, across the three dimensions of uncertainty, to identify wildlife trade examples in which similar solutions could potentially be implemented while considering the specific contextual conditions.

Most institutional uncertainties require amendment or revision of the relevant legal instrument at the required scale (local, national and/or international) to remedy. This may be relatively simple, such as updating legal provisions in local management plans to align with national regulations in the orchid trade in Nepal (Bashyal et al. 2023). Others may require more exhaustive revisions. For example, laws around hunting and wild meat trade in parts of Africa and South America have been found to be outdated, contradictory and impractical (Nana et al. 2022; van Vliet et al. 2019). In Colombia, while commercial hunting by rural communities can be legal after obtaining a permit, the requirements for this permit are complicated, unspecified and subjective, making it almost impossible to obtain in practice (van Vliet et al. 2015). Similarly, marine fisheries and conservation in India fall under the jurisdiction of multiple governance bodies with sometimes contradictory mandates, posing risks to both threatened species and fishing communities (Akhilesh et al. 2023). Efforts to reform hunting and wildlife laws in Gabon to reduce uncertainties, streamline complexity, and enhance legitimacy are currently ongoing (Table 2), and could serve as a model for similar reforms in other contexts. Measures that improve clarity and legitimacy can promote compliance with laws and increase the chances of sustainable trade (Challender et al. 2025).

TABLE 2 | Uncertainties and effective actions taken to resolve them in other case studies, within and outside of wildlife trade.

Uncertainty	Interventions or actions taken to address this uncertainty in other case studies	Impact and conditions for implementation of the interventions	Examples of potential further application of the approach
Institutional uncertainty (Conflicting laws)	Legal revisions in Gabon—contradictory laws for bushmeat hunting are being reformed through review of existing laws, drafting new laws, dissemination of laws (existing and new) among target actors and capacity building for institutions responsible for implementation (Cornélis et al. 2022).	Still ongoing. Requires a favorable political context, local leadership, and collaboration with multiple international and national partners (Cornélis et al. 2022). Such reforms take a long time and may not be appropriate for more urgent contexts.	Similar reforms may be required for wildlife hunting and trade in many other countries (CITES 2022a; van Vliet et al. 2019).
Operational uncertainty (Spatial, Taxonomic, Quantity)	Timber harvest—multiple operational uncertainties are being addressed with tools like certification schemes (e.g., Forest Certification Scheme), forensic methods to determine origin (e.g., stable isotope analysis, Deklerck 2023; Watkinson et al. 2022), and technology (barcodes, radio frequency identifier tags, and blockchain). These tools aim to improve transparency and reduce corruption within these supply chains.	Mixed results, with some evidence for improved legal certainty, reduced corruption and reduced supply of illegal timber in certain contexts (e.g., Astana et al. 2020). Needs sufficient human resources, technology, data management, funding, and political will from governments. The technology must be accessible to, and used by, all actors along the trade chain.	Stable isotope analysis has been trialed for birds in the pet trade to improve traceability (Andersson et al. 2021). Shows potential for application in the sea cucumber trade (Kang et al. 2020; Figure 1B).
Operational uncertainty (Origin, Spatial)	Legal vicuña trade in Peru—it is mandatory for government officials to be present when vicuñas are sheared to ensure wool was sheared from live animals in authorized areas. The wool is tagged with a code used to ensure traceability and recorded in a database which tracks the codes as the wool is exchanged along supply chains (Kasterine and Lichtenstein 2018)	Growing vicuña populations and sustainable harvest have proven its success. Requires sufficient government personnel and resources to oversee the supply chain, and good relations between users and the state. Animals inhabit controlled areas, and other actors along the supply chain know to expect traceability measures (Kasterine and Lichtenstein 2018)	Similar mechanisms could be applied to other wildlife products that can be obtained without lethal harvest.
Operational uncertainty (Origin, Offtake method)	Diamond industry—the Kimberley Process Certification Scheme (KPCS) uses certifications and national control systems for participating countries to determine the origin of diamonds. Additionally, newer traceability methods such as blockchain and product etching are improving (Mackenzie 2015; PrimaFelicitas 2023).	KPCS has shown success in supporting more ethical trade in diamonds. A KPCS-type system needs sufficient buy-in from country representatives, local and international enforcement agencies, resource managers, and retailers. Blockchain and etching methods would likely work well only with high value and regulated products and relies on the quality of those inputting data. Notably, KPCS has received criticism for its inability to fully guarantee that its products are not conflict diamonds, and it should hence be adopted with caution.	For wildlife antiques or high-end value wildlife products—similar certifications and etching of codes could be used to verify origin and traceability.

(Continues)

TABLE 2 | (Continued)

Uncertainty	Interventions or actions taken to address this uncertainty in other case studies	Impact and conditions for implementation of the interventions	Examples of potential further application of the approach
Perceptual uncertainty (Product codes & labels)	Global tobacco trade—the WHO Framework Convention on Tobacco Control (FCTC) mandates the implementation of effective warning labels on tobacco product packaging, to prevent misleading or deceptive labeling elements (Peruga et al. 2021; WHO 2019).	Warning labels on packaging are found effective to communicate risks of tobacco consumption. Requires industries to publicly share accurate information, and donations to and interactions with policy-makers to be limited and transparent, thereby preventing corruption and maladministration of donations. Relies on civil society to monitor industry activity. Specificity in the rules around label design and implementation to prevent exploitation of loopholes, such as using low resolution images or removable stickers.	Products that are at high-risk of containing threatened and/or illegally traded species, such as sea cucumber, saiga horn, and seahorse, could benefit from mandatory labels with relevant information to improve consumer awareness of legality and sustainability. Such labeling has also been successful in the environmental energy sector (IEA/4E TCP 2021).
Perceptual uncertainty (Product codes & labels)	Existing labels and certifications for wildlife—CITES guidelines mandate labeling of some wildlife products, such as the use of labels, markings or logos to indicate a sustainably sourced vicuña product, and a universal labeling system for caviar where all primary containers must have a label that cannot be removed and reused without being damaged, to identify legal products. Other examples of labeling include certification schemes such as the Marine Stewardship Council's certification label (MSC), elephant-friendly tea, and dolphin-safe tuna.	The CITES labeling system for caviar has helped distinguish caviar traded legally and illegally and mitigate illegal trade. This system applies to all caviar in domestic and international trade, including wild caught and farmed sturgeons, and commercial or noncommercial purposes, so that law enforcement and consumers can identify legal products. The nonreusable label must include a standard species code, source code of the specimen, country of origin, year of harvest or repackaging, code of the processing plant, and lot identification number or CITES export permit number (TRAFFIC 2009).	These existing labeling systems, particularly the model for caviar, could be transferred to other sectors and supply chains within the wildlife trade.

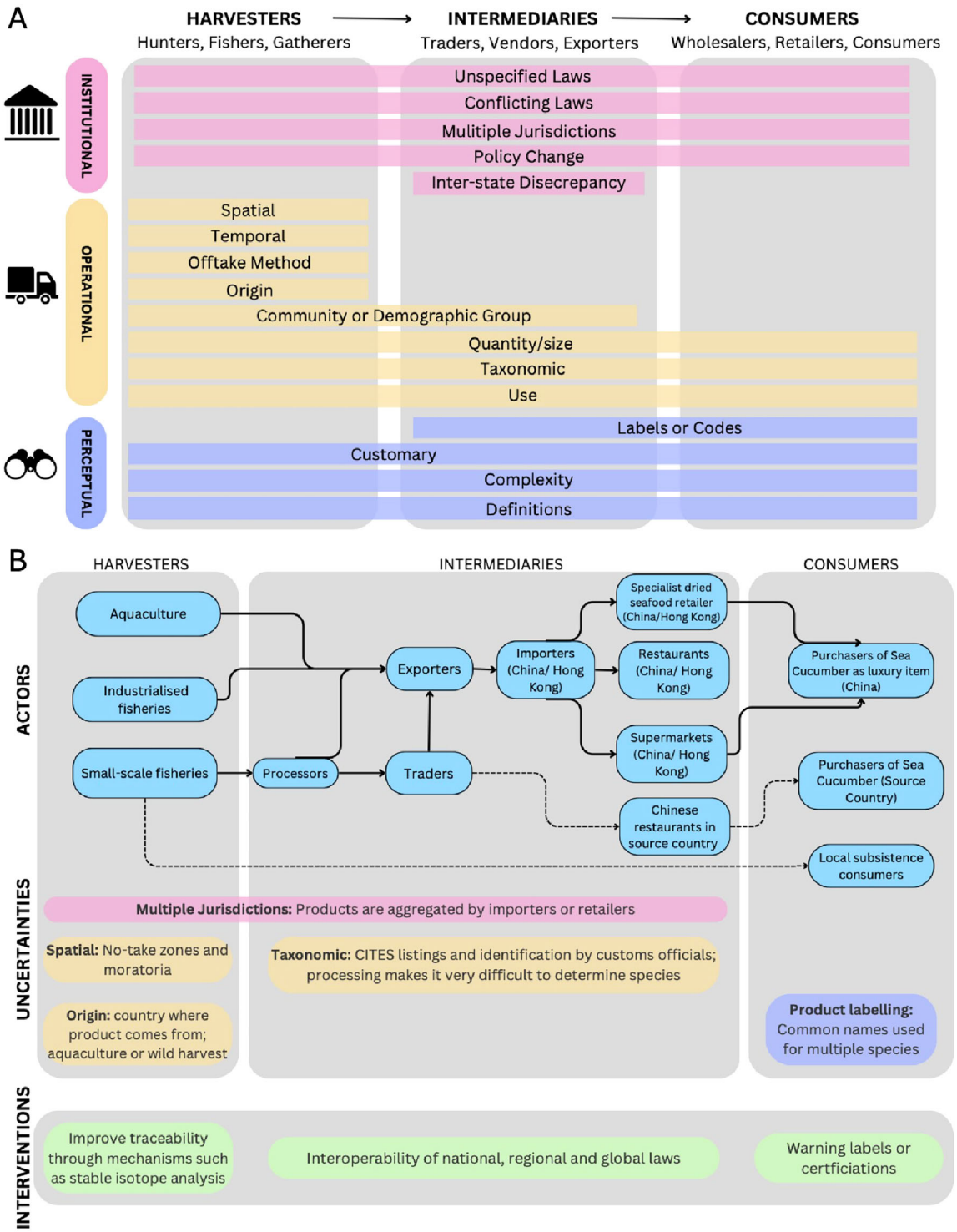

FIGURE 1 | (A) The main stages in the supply chain at which different dimensions and types of uncertainties regarding the legality of wildlife trade can take place, as listed in Table 1. (B) Different uncertainties that can exist in a wildlife product, and potential interventions to resolve them, using sea cucumber trade as an example.

For operational uncertainties, improving the transparency and traceability of supply chains is key to distinguishing between products traded legally and illegally. Stable isotope analysis, for example, has shown some success in determining the origin of timber, and has recently been tested in the mitigation of illegal trade of wild birds in Hong Kong (Table 2). This technique has potential for application in other trades, such as sea cucumbers (Figure 1B, Table 2). In Peru, legal and sustainable trade of vicuña wool has been facilitated by measures to verify origin, including requiring government officials to be present when vicuña are sheared live (Table 2). Similar mechanisms could be applied to curb other types of illegal exploitation of wildlife where products can be obtained without lethal harvest, subject to resources for monitoring being available. In the diamond industry, the Kim-

berley Process Certification Scheme (KPCS) is used to determine origin and traceability using methods including blockchain and product etching (Table 2). The KPCS system can be applied for trade in high-value or luxury wildlife products, where buy-in from stakeholders can be ensured. A KPCS-style scheme is being considered for the potential legalization of rhino horn trade in South Africa (M. 't Sas-Rolfes pers. comm.) and could be applied to ensure the origin and age of antique products made from protected wildlife species (e.g., Hatten et al. 2024).

Perceptual uncertainties require interventions to clarify and improve actors' awareness of legal frameworks and wildlife products, among other actions. These can include better communications about new legislation; for example, the harvest and trade of protected shark species in Bangladesh persists due to lack of clarity about relevant laws among actors (Haque et al. 2023). For consumers, there is substantial ambiguity and inconsistency in regulations relating to labeling of wildlife products. International regulation in the tobacco industry may be a useful model. The World Health Organization Framework Convention on Tobacco Control (WHO FCTC) has seen notable success in measures to reduce consumption through mandatory warning labels on tobacco product packaging, and restrictions on the use of misleading or deceptive labeling elements (Table 2). Efforts to inform consumers of certain wildlife products that are at high risk of containing threatened and/or illegally traded species may benefit from similarly targeted messaging (Doughty et al. 2021).

Mandatory, visible labels could be used to convey to consumers when a product contains a species that is threatened by trade (neutral messaging), or noting the negative impacts of the trade (negative messaging, like tobacco), or even that the product meets legality and sustainability standards (positive messaging). As species may be threatened by trade in some parts of their range but not in others, or even benefiting from trade in some regions, such labeling would need to be used in the appropriate context. CITES could provide guidance on the use of such systems to warn customers or to certify that a product meets certain standards. Although there is some precedent for the implementation of such an approach for wildlife products (Table 2), the impact and efficacy of such labeling needs further testing. All messaging would need to follow targeted efforts to understand consumers and their purchasing behaviour and the market, to ensure consumer compliance and cost-efficiency (Doughty et al. 2021). Such measures, if successfully implemented, can lead to more sustainable consumer behaviour.

4 | Discussion

4.1 | Rethinking Wildlife Trade Legality in Terms of Uncertainties

While wildlife trade legality is increasingly recognized as being dynamic and ambiguous, trade continues to be portrayed in simplistic terms as either legal or illegal and these uncertainties remain largely overlooked in research, conservation, and policy responses (CITES 2023; Hübschle 2017). Our study addresses this gap, offering the first holistic overview of legal uncertainties across geographies, scales, and taxa, drawing on a range of literature that highlight these issues. Through multiple case studies, we underscore the need for rethinking wildlife trade legality in terms of these uncertainties. Our categorization provides a novel contribution to thinking through grey areas within wildlife trade by specifying the instances from which uncertainties arise. This provides a common language between disciplines to bring together research, policy, and practice in addressing areas creating uncertainties. In addition, our work helps draw links between different trade systems, opening avenues for interdisciplinary collaboration in the design of sustainability interventions that go beyond traditional law enforcement ('t Sas-Rolfes et al. 2019; Gore et al. 2023).

Addressing uncertainties could reduce wildlife overexploitation and illegal trade (Hughes et al. 2023), improve traceability and efficacy of enforcement efforts (Hinsley and Roberts 2018), and could facilitate equitable benefit sharing across actors, while producing more ethical outcomes for communities that depend on wildlife trade (Robinson et al. 2018). However, it may have immediate undesirable impacts on actors who currently benefit, intentionally or unintentionally, from such uncertainties. This is especially concerning in contexts where harvest or trade is key to food security and livelihoods (e.g., bushmeat, van Vliet et al. 2019). A systems approach, that considers the social-ecological systems within which harvest, use and trade of species occur, is required to account for complex interlinkages and unintended feedbacks (Larrosa et al. 2016). More efforts should also be allocated to how different groups experience uncertainties in various ways and to fill those gaps in understanding and applying legality.

4.2 | Implications for Policy and Management

The Convention on Biological Diversity's Global Biodiversity Framework (CBD-GBF) aims to ensure the sustainable, safe and legal harvesting and trade of wild species (Target 5; CBD 2022); yet legal uncertainties undermine progress toward this target. These issues have been highlighted by other international agreements and authorities including CITES, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the United Nations Office on Drugs and Crime (UNODC) (CITES 2022a; UNODC 2020). Our categorization provides practical guidance for wildlife trade governance bodies at different scales, enabling them to explicitly identify uncertainties and consider how to address them.

For example, CITES' work highlights loopholes and inconsistencies in national legislation for CITES-listed species, leading to illegal or unmanaged trade (CITES 2022b, 2023)—including, as per our categorization, unspecified laws and multiple jurisdiction uncertainties. In resource-limited contexts, management authorities must prioritize uncertainties based on how controllable they are, the importance of their impacts on management outcomes, and the cost-effectiveness of addressing them (Holden et al. 2019; Milner-Gulland and Shea 2017). For instance, uncertainties that prevail due to actors' lack of awareness (e.g., perceptual uncertainties), rather than intentional exploitation, could be addressed more easily through measures like mandatory labeling of products and clarification of complex laws. This would reduce the burden on law enforcement officers, who could focus on commodities smuggled with criminal intent (CITES 2022a).

More broadly, legal institutions need to be robust, adaptable and responsive to changing circumstances in the legality of wildlife trade (Taskforce on Nature Markets 2023). As our work shows, existing wildlife trade laws can be outdated, ambiguous, and in some contexts viewed as illegitimate and a continuation of colonial practices (Sollund and Runhovde 2020; Tian et al. 2023; van Vliet et al. 2019). Comprehensive and participatory legal reforms are essential to improve the legitimacy of such laws while dispelling uncertainties and closing legal gaps. New wildlife legislations must proactively account for uncertainties. For instance, ongoing discussions around legalizing and regulating rhino horn trade in South Africa (M. 't Sas-Rolfes pers. comm.) and hunting of tigers in Nepal (Joshi 2023) may seem as immediate solutions to some of the institutional uncertainties in the trade of these products (Di Minin et al. 2022). However, they may introduce new operational uncertainties, where illegally harvested or traded products are laundered through legal supply chains (van Uhm 2018). Use of our categorization along with systems approaches can help anticipate and mitigate such uncertainties when designing new policies.

We highlight how practitioners and policymakers can draw lessons from successful models in analogous industries such as diamond and tobacco trade, benefitting from prior experience, technological advances, and successful regulatory frameworks. For instance, the KPCS system in the diamond industry has been compared to CITES (Mackenzie 2015), and we identify other contexts, such as trade in wildlife antiques, where such an approach may be useful. Issues around legality arise due to particular circumstances, contexts and scales, thus lessons from other sectors must be carefully adapted. Nonetheless, fostering cross-sectoral knowledge exchange could improve the efficiency of wildlife law enforcement mechanisms (Gore et al. 2023) and help to ensure that any trade in wildlife is legal and sustainable.

4.3 | Conclusion

This paper presents a novel and holistic overview of uncertainties in the legality of wildlife trade, their implications for management, regulatory, and enforcement efforts, and pathways to resolve them learning from other interdisciplinary successes. Our categorization could help end-users to analyze current legal and policy structures, revealing existing areas of uncertainty. It can also assist wildlife trade policymakers in proactively identifying potential uncertainties arising from decisions at the outset, and to develop effective mitigation strategies. We provide practical steps for policymakers, managers and researchers to think through and resolve uncertainties for better wildlife trade management and improved sustainability outcomes. Any interventions to address uncertainties need to be carefully researched, and their impacts monitored and evaluated to understand possible negative consequences.

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Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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Appendix I

Our work and categorization of uncertainties were developed through a series of discussions within the Interdisciplinary Conservation Network (ICN). This consisted of an in-person workshop from 18–20 September 2023 at the University of Oxford, UK, as well as several virtual meetings before and after this workshop. Twelve early career researchers and conservation professionals from around the globe working on a range of taxa, geographies, topics and disciplines related to wildlife trade came together to discuss the theme of "Legality in the wildlife trade," supported by three senior mentors. Our discussions focused on three key questions:

1. What are the uncertainties in the legality and sustainability of different types of wildlife trade chains?
2. What are the mechanisms driving the sustainability or unsustainability of trade across the spectrum of legality?
3. Will clarifying the legality of a trade chain improve its sustainability?

We synthesized cases of wildlife trade across different taxa, scales, and geographic regions within our collective experience to answer these questions. Our synthesis, along with a thorough review of available literature, led us to identify the three broad dimensions of uncertainties presented in our paper (Institutional, Operational and Perceptual). These dimensions emerged from the different uncertainties identified and described from the cases of wildlife trade within the participant group's experience. We refined these dimensions, and developed the different types of uncertainties within each, by reviewing and discussing further case studies and examples (at least 21 in number) within and outside of wildlife trade, and applied our categorization on these examples. We do not aim to exhaust the discussion on uncertainties and consider that these three broader dimensions are likely the most commonly found in wildlife supply chains. These dimensions are not mutually exclusive and the categories may overlap because of the complex nature of wildlife supply chains.