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Systems Approaches to Combating Wildlife Trafficking: Expanding Existing Frameworks to Facilitate Cross-Disciplinary Collaboration

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Wildlife trafficking is a complex conservation issue that threatens thousands of species around the world and, in turn, negatively affects biodiversity and human well-being. It occurs in varied social-ecological contexts; includes numerous and diverse actors along the source-transit-destination trade chain, who are involved in illicit and often covert human behaviors driven by interacting social, economic, cultural, and political factors; and involves numerous stakeholders comprising multiple sectors and disciplines. Such wicked problems can be difficult to define and usually lack simple, clear solutions. Systems thinking is a way to understand and address complex issues such as wildlife trafficking and requires multisectoral, cross-disciplinary collaboration to comprehensively understand today's increasingly complex problems and develop holistic and novel solutions. We review methods utilized to date to combat wildlife trafficking and discuss their strengths and limitations. Next, we describe the continuum of cross-disciplinarity and present two frameworks for understanding complex environmental issues, including the illegal trade in wildlife, that can facilitate collaboration across sectors and disciplines. The Open Standards for the Practice of Conservation provides guidance and tools for defining complex social-ecological systems and identifying strategic points of intervention. One Health focuses on the nexus of human, wildlife, and environmental health, and can provide a framework to address concerns around human-wildlife interactions, including those associated with the illegal wildlife trade. Finally, we provide recommendations for expanding these and similar frameworks to better support communication, learning, and collaboration in cross-disciplinary efforts aimed at addressing international wildlife trafficking and its intersections with other complex, global conservation issues.

Keywords: illegal wildlife trade, cross-disciplinary, planning frameworks, conservation, One Health, Open Standards for the Practice of Conservation, systems thinking, COVID-19

INTRODUCTION

Wildlife trafficking, or the illegal wildlife trade (IWT), is a "wicked" problem that occurs in complex social-ecological systems (Arroyave et al., 2020; Thomas-Walters et al., 2020). It varies by species and scale, threating not only thousands of plant and animal species globally, but also biodiversity, livelihoods, security, and human health (McMurray, 2009; Phelps et al., 2016). As a result, there are numerous stakeholders comprising multiple sectors, including government, law enforcement, public health, and wildlife conservation, as well as local-level civic groups and individuals—each with varied and potentially competing interests and goals. Additionally, there are diverse actors along the source-transit-destination trade chain involved in illicit and often covert human behaviors driven by interacting social, economic, cultural, political and ecological factors. Such wicked problems can be difficult to define and usually lack simple, clear solutions (Rittel and Webber, 1973; Game et al., 2014), highlighting the need for collaboration across sectors and disciplines; holistic intervention strategies; and frameworks that facilitate systematic, strategic, collaborative planning.

The need for systems approaches to address complex problems was underscored by the outbreak of Coronavirus Disease 2019 (COVID-19), which intensified international attention on IWT and the potential threats posed by interactions between people and wild animals. Early speculation suggested that SARS-CoV-2, the virus that lead to COVID-19, might have originated in bats and spread to humans via an intermediate host such as the pangolin (Burki, 2020; World Health Organization, 2021). Despite the lack of a strong understanding of the transmission route, there were swift calls to overhaul the regulation and management of wildlife trade, including local bans on consuming wildlife for food, closure of live animal markets, bans on domestic and international wildlife trade, and amending international agreements related to wildlife trade. Whereas, some of these actions may mitigate health risks and protect wildlife, they may also have unintended, negative impacts on both people and wildlife (Roe et al., 2020). This response illustrates a frequent occurrence in conservation, whereby solutions to complex problems are proposed and implemented without first developing a comprehensive understanding of the issue and the range of potential impacts of interventions.

Systems thinking with systemic problem analysis can lead to a more comprehensive understanding of a complex system and inform the development of tailored interventions designed through multisectoral, cross-disciplinary collaboration (Hieronymi, 2013; Mahajan et al., 2019). Cross-disciplinarity offers many benefits, including increased diversity of thought, innovation, and resources, but there are also logistical and conceptual challenges (Ding et al., 2020; Núñez-Regueiro et al., 2020). As we seek new ways to address IWT, it is important to understand the successes and limitations of early approaches and seek frameworks that can facilitate working at varied scales and across sectors and disciplines. This includes taking a social-ecological approach that incorporates the social sciences to understand and address the human dimensions of IWT. Here we review current approaches for combating wildlife trafficking and discuss useful frameworks for the cross-disciplinary collaboration needed for more effective, holistic solutions.

CURRENT APPROACHES TO COMBATING WILDLIFE TRAFFICKING

Legal Regulation

Regulation of wildlife trade has been a predominant approach to addressing wildlife trafficking (Pires and Moreto, 2011; Challender and MacMillan, 2014; Wallen and Daut, 2017; 't Sas-Rolfes et al., 2019). The Convention for the International Trade of Endangered Species of Flora and Fauna (CITES) is the primary international agreement on wildlife trade and employs permitting and trade bans to prevent the overexploitation of species threatened by trade. Some countries have also implemented regulations to ban or control trade at the national level (Pires and Moreto, 2011; Felbab-Brown, 2017). Regulation can increase the risk of and thus discourage engagement in IWT (Felbab-Brown, 2017). In the short term, regulation can also reduce trade pressure on species and, in some cases, can enable population recovery via reduced illegal trade over the long term (Pain et al., 2006; Weber et al., 2015). However, regulations may not meaningfully reduce pressure on wildlife if they do not account for the underlying socio-economic factors that drive trafficking (e.g., poverty, consumer demand) (Challender and MacMillan, 2014; Weber et al., 2015; 't Sas-Rolfes et al., 2019) or may have unintended consequences. For instance, bans may drive wildlife trade underground and inadvertently increase the profitability of IWT by creating market scarcity. Bans themselves can also be undermined by lack of awareness (Van Schendel and Abraham, 2005; Page and Radomski, 2006; Kean et al., 2011; Weber et al., 2015; Roe et al., 2020).

Law Enforcement

Efforts to combat IWT have also heavily focused on strong law enforcement, including antipoaching efforts at source locations and inspections and seizures at transit points (Pires and Moreto, 2011; Felbab-Brown, 2017). Where resources are sufficient, enforcement proves a vital tool for combating wildlife trafficking (Hilborn et al., 2006) by increasing the risk of participation in IWT and motivating voluntary compliance with regulations (Filteau, 2012; Kurland et al., 2017). However, enforcement does not fully address local conditions (e.g., motivations to poach, economic needs and cultural uses of wildlife) and can marginalize communities, and compromise food security (Filteau, 2012; Cooney et al., 2017). Additionally, the effectiveness of enforcement can be limited by lack of capacity and coordination, minimal sentencing, and corruption (Pires and Moreto, 2011; Challender et al., 2015; Mulualem et al., 2017). Some antipoaching enforcement approaches have also become increasingly militarized and can motivate retaliatory poaching (Cooney et al., 2017; Duffy et al., 2019). Law enforcement alone cannot address the varied drivers of IWT and ideally should be combined with other methods, including robust judiciary action and demand reduction (Challender et al., 2015; Cooney et al., 2017; Duffy et al., 2019).

Demand Reduction

Recognizing that regulation and law enforcement do not address the growing demand for wildlife, conservation organizations are increasingly implementing campaigns to reduce demand (Veríssimo and Wan, 2018; Wallen and Daut, 2018; Thomas-Walters et al., 2020). These approaches aim to produce voluntary behavior change through awareness-raising and social-marketing (Challender et al., 2015; Wallen and Daut, 2017, 2018; Thomas-Walters et al., 2020). While demand reduction campaigns have increased in number, there has been minimal evaluation of their effectiveness (Veríssimo and Wan, 2018; Thomas-Walters et al., 2020). Additionally, demand reduction efforts are hindered by limited resources, as robust intervention design and evaluation requires significant time, money, and social science expertise to understand and influence consumers (Veríssimo and Wan, 2018; Greenfield and Veríssimo, 2019; Thomas-Walters et al., 2020). Dedication of additional resources and evaluation of existing efforts is needed to produce targeted and more effective demand reduction efforts (Margulies et al., 2019; Thomas-Walters et al., 2020).

TOWARD NEW APPROACHES TO COMBATING WILDLIFE TRAFFICKING

Legal regulation, law enforcement, and demand reduction are each essential in combating IWT, but, if implemented in isolation, are unlikely to address the array of interacting factors driving IWT across the varied contexts in which it occurs. Many conservationists have long recognized the complexity of these and other social-ecological contexts in which they work (Allen and Gould, 1986; McCool and Guthrie, 2001; Lachapelle et al., 2003; Liu et al., 2007; Game et al., 2014). Calls for systems thinking and cross-disciplinarity across conservation issues, including using social-ecological approaches that integrate the social and natural sciences, are not new (Ban et al., 2013; Game et al., 2014; Mahajan et al., 2019; Núñez-Regueiro et al., 2020). However, advances in collaboration between sectors and disciplines are limited, with few examples of application to a full project cycle (Mahajan et al., 2019).

Taking a *multisectoral* approach, or deliberate collaboration between different sectors of society (e.g., government, civil society, private sector), to address IWT has many advantages, such as the ability to leverage resources and expertise, avoid duplicative actions, and improve effectiveness (Salunke and Lal, 2017; Mahlangu et al., 2019). Embedded in this approach is cross-disciplinarity, which we use here as an umbrella term to describe a continuum of collaboration, ranging from multidisciplinarity to interdiscipinarity to transdisciplinarity in which disciplinary concepts, theories, and methods are combined or integrated to different degrees (Choi and Pak, 2006; Reckinger and Wille, 2018; Ding et al., 2020).

Multidisciplinarity occurs when people from multiple disciplines work on different aspects of a complex problem and share information but maintain disciplinary boundaries without convergence or integration (Choi and Pak, 2006; Reckinger and Wille, 2018). *Interdisciplinarity* moves toward convergence and collaboration, with synthesis and integration of knowledge, but still maintains disciplinary perspectives (Reckinger and Wille, 2018). In contrast, *transdisciplinarity* tends to be multisectoral with collaboration between researchers from different disciplines and members of public and private sectors, including civil society (Choi and Pak, 2006; Reckinger and Wille, 2018; Pohl et al., 2021), potentially facilitating inclusion of stakeholder groups that have typically been excluded in the past. It is typically more integrative, applied, and likely to produce novel solutions (Mitchell et al., 2017).

Combating IWT requires the involvement of multiple sectors and disciplines, yet there can be significant difficulties in convening diverse stakeholders with varied expertise, different practical knowledge and experience, and potentially competing interests and goals, all of which, in turn, may lead to differing problem definitions and lack of coordination or collective action (Ding et al., 2020). While there is considerable recognition of the need for collaboration, less is known about how to effectively put it in into practice (Mahlangu et al., 2019). Planning frameworks have been recommended to help overcome the challenges of cross-disciplinary approaches and to develop more effective, holistic solutions to complex conservation problems (Ostrom, 2009; Núñez-Regueiro et al., 2020).

FRAMEWORKS FOR CROSS-DISCIPLINARY APPROACHES

A *framework* is a set of tools and guidelines that provide structure and direction to a project or program (Schwartz et al., 2018) while still allowing for adaptation to changing conditions, including changes brought about by ongoing interventions. Frameworks may be broad and conceptual in nature, offering suggested steps, or detailed with concrete guidance and tools. They can help overcome the challenges of cross-disciplinarity by enabling: (1) development of a clear, shared definition of the problem and goals; (2) identification of key stakeholders; (3) improved communication; (4) contributions of multiple types of knowledge; and (5) coordination of actions (Lachapelle et al., 2003; Aguirre et al., 2021; Wilcox and Steele, 2021). Bosch et al. (2013) demonstrate the application of systems thinking within the generic, iterative, process-based Evolutionary Learning Library (ELLab) framework that includes: (1) an initial "issues workshop;" (2) capacity building sessions; (3) development of a systems model; (4) identification of leverage points for systematic intervention; (5) an integrated action plan; (6) implementation; and (7) reflection meetings on successes and failures. Local-level lessons are fed into the Global Evolutionary Learning Laboratory, which serves as a platform for continuous sharing and co-learning (**Figure 1**).

Ostrom (2009) states that a common framework is needed for multidisciplinary efforts in single, focal social-ecological systems. Alternatively, Schwartz et al. (2018) note that some practitioners promote mixing tools from different frameworks to meet project needs. Selecting an appropriate framework or a cross-framework approach depends on stakeholders, contexts, goals, and the relative strengths of each framework and their associated tools.

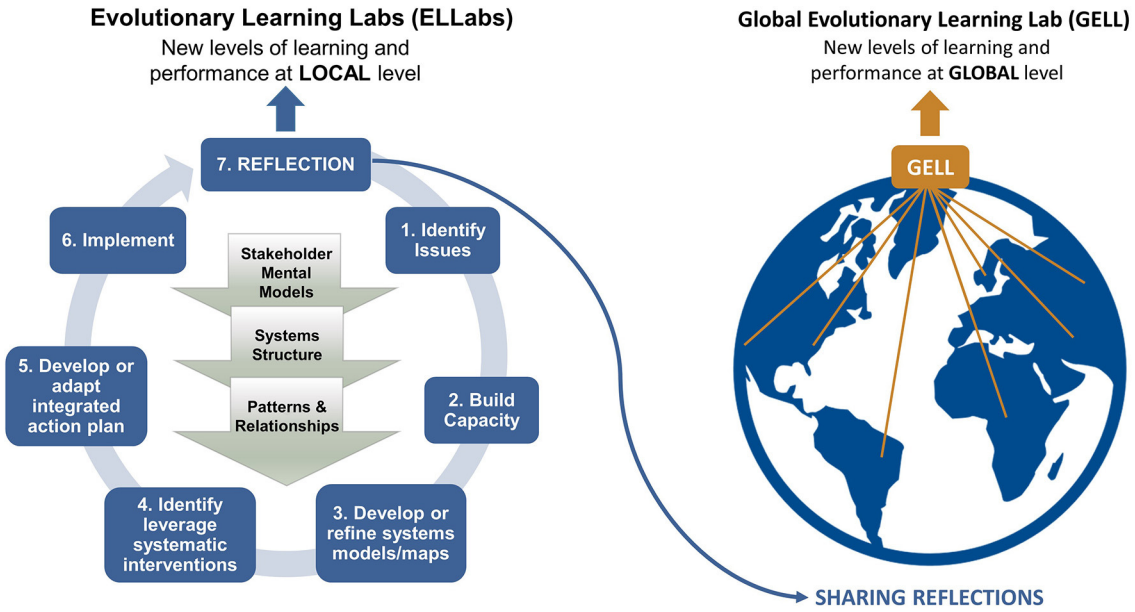

FIGURE 1 | The local Evolutionary Learning Laboratory (ELLabs) and the Global Evolutionary Learning Laboratory (GELL) (adapted from Bosch et al., 2013).

We focus on two frameworks that have been applied to IWT generally, as well as in the context of the COVID-19 pandemic specifically: the Open Standards for the Practice of Conservation and One Health.

Open Standards

The Open Standards for the Practice of Conservation (OS), also known as the Conservation Standards, is a decision-support, adaptive management framework and common property resource developed by a consortium of conservation organizations to help overcome the challenges of addressing wicked conservation problems and improve conservation outcomes. It is a five-step (assess, plan, implement, analyze and adapt, and share), iterative process that provides a structure for individuals and organizations with varied interests and expertise to work together to systematically develop a shared understanding of a problem and develop, implement, and evaluate solutions. In the case of conservation, OS integrates the social and natural sciences, along with other areas of expertise and interest. The framework includes resources, tools (e.g., project management software), and a body of shared terminology that facilitate communication and collaboration of cross-disciplinary teams. It is complementary to many other frameworks and, in turn, enables mixing of tools and processes that suit the needs of project teams [Dietz et al., 2010; CMP (Conservation Measures Partnership), 2020].

A primary principle of OS is collaboration. Accordingly, an initial step of the framework is to form a project team. From practice, we have found that including key stakeholders early in the process is critical to creating buy in and fostering a collaborative environment. In one recent example, we convened a planning team representing multiple areas of expertise, including wildlife biology, wildlife trade, law enforcement, international policy and diplomacy, and social science, as well as multiple sectors, including government and non-governmental organizations, to define the problem (trafficking of *species X*), develop key intervention strategies, and identify indicators of success. Following the OS framework, the team defined the project scope (a key region in which *species X* is trafficked), defined the desired future state, and conducted a situation analysis. The framework and the accompanying software provided common language and structure for our international, cross-disciplinary team to collaborate virtually during the COVID-19 pandemic and systematically develop a shared understanding of the issue. The analysis resulted in a conceptual model that visually depicted relationships between the conservation target (*species X*), direct threats to the target (with a focus on trafficking), and the complex system of interacting, indirect threats driving the direct threats (**Figure 2A**). Indirect threats are often the social, cultural, economic, political, and institutional factors that drive the situation, underscoring the need to include social and natural scientists as well as representatives from other relevant disciplines and sectors.

Conceptual models serve as a foundation for planning and help teams identify stakeholders associated with each threat, locate and prioritize points of intervention, and provide the basis for strategies and their related objectives and activities. OS also provides guidance and tools for developing action plans that include results chains representing theories of change, which describe how interventions are expected to result in intended outcomes. Selecting key intervention points and strategies in this systematic way helps teams identify the areas they are most suited to act and can increase the likelihood of more impactful

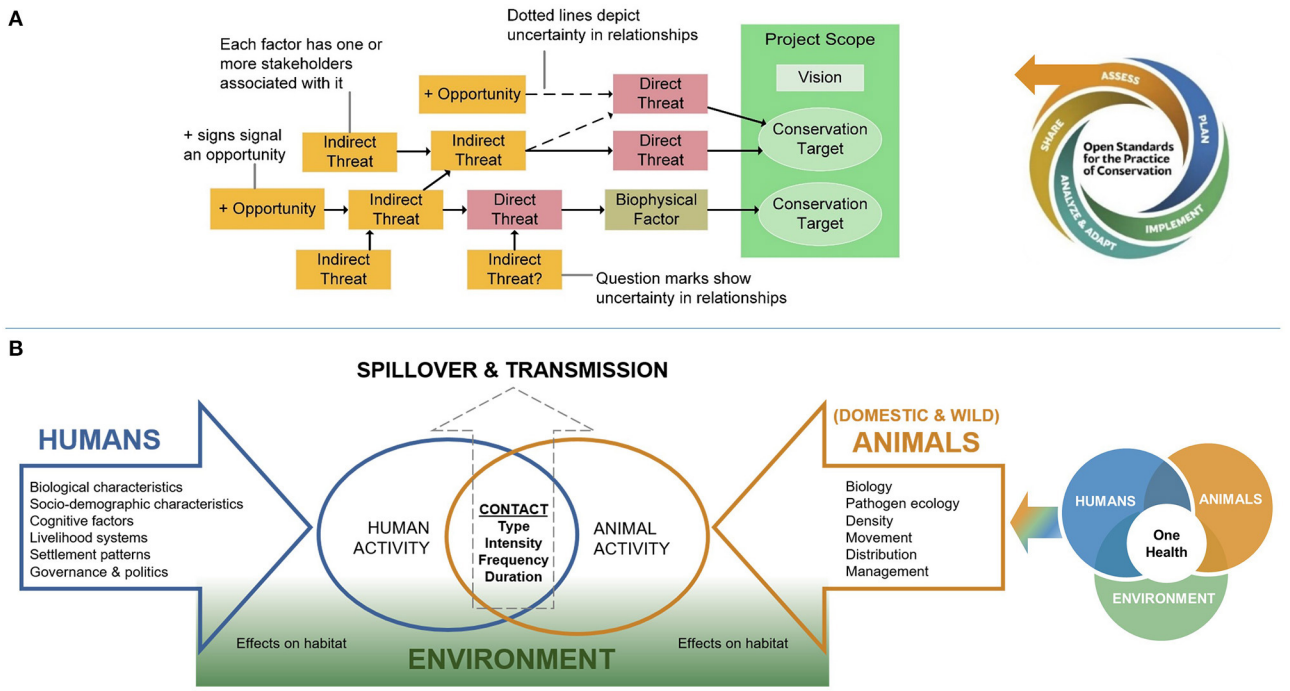

FIGURE 2 | (A) Open Standards conceptual model representing socio-ecological factors identified in a cross-disciplinary situation analysis [CMP (Conservation Measures Partnership), 2020]. **(B)** One Health model of zoonotic disease transmission, showing the determinants of human and animal activities and the environment that affect human-animal exposure to zoonotic disease transmission (adapted from Woldehanna and Zimicki, 2015).

outcomes. The *species X* conservation planning team developed three intervention strategies, produced a theory of change for each, and then presented the conceptual model and results chains to other experts and stakeholders, including those already implementing interventions, in order to obtain feedback and facilitate better coordination of interventions and foster a more holistic approach. At the time of writing this article, the team was developing a work plan based on the results chains and will continue follow the OS adaptive management framework by monitoring, learning, and adapting throughout the project cycle.

Whereas, published examples of projects that have applied the full OS framework are lacking, there are multiple examples of projects that have applied it to different stages of the project cycle, including efforts to combat wildlife trafficking (Núñez-Regueiro et al., 2020). These include planning law enforcement and outreach strategies to recover tiger populations in Lao PDR (Johnson et al., 2016), reducing opportunities for wildlife trafficking in commercial transportation sectors (Spevack, 2021), and addressing poaching of elephants and other species in Central Africa (Muir et al., 2014). Theories of change for projects addressing IWT are available through the Conservation Action and Measures Library located on the Miradi Share website[1] Although there are still few examples that focus on IWT, we believe the OS framework provides the structure, flexibility, and tools for cross-disciplinary collaboration needed to effectively address the complex issue of IWT from problem definition to strategy implementation to evaluation and adaptation by providing the structure and tools to convene planning teams representing relevant sectors and disciplines.

One Health

"One Health" refers to the concept that ecosystem, human, and animal health are interdependent and most effectively understood using a transdisciplinary approach (Wilcox and Steele, 2021). Because it recognizes the interplay between social and ecological factors related to human, animal, and environmental health, One Health has great utility when adapted to include the social, cultural, economic, political, and institutional factors around specific issues, such as the intersection between wildlife trafficking and zoonotic disease (diseases caused by pathogens that can be transmitted between humans and animals) (Woldehanna and Zimicki, 2015). Although wildlife conservation professionals have been applying the One Health concept for many years (e.g., Decker et al., 2012; Hanisch-Kirkbride et al., 2013; Buttke et al., 2014), the global impacts and suspected wildlife trade-based origin of the COVID-19 pandemic have prompted scientists and practitioners to apply One Health tenets more comprehensively as a unifying framework to better understand the current pandemic and prevent future pandemics related to wildlife, including those traded illegally (e.g., Aguirre et al., 2021; Bezerra-Santos et al., 2021). Wildlife trafficking routes can serve as transmission "gateways" for zoonotic disease spread (Bezerra-Santos et al.,

[1]https://www.miradishare.org/ux/program/cmp-conservationaction?nav1=caml-projects.

2021) and the clandestine nature of trafficking makes early detection of emerging infectious diseases in traded wildlife extremely challenging (Bezerra-Santos et al., 2021).

The expanded One Health framework proposed by Woldehanna and Zimicki (2015)—which we adapt for further precision (**Figure 2B**)—can be applied to elucidate novel solutions for reducing disease risk in wildlife trafficking. An example of this One Health framework application is seen in a recent cross-sector health-conservation intervention in Borneo, Indonesia (Jones et al., 2020).

> Near Gunung Palung National Park, men from low-income households illegally logged ("socio-demographic characteristics" and "livelihood systems" in **Figure 2B**) protected forest ("effects on habitat") to earn income. Illegal logging in Indonesia is associated with the creation of new roads ("effects on habitat") and enhanced access to markets ("livelihood systems," "governance and politics"), resulting in increased wildlife poaching and trafficking ("livelihood systems," "biology," and "distribution" in the animal health component; "contact" at the confluence of human and animal activity) and a decline in wildlife species ("density"), including orangutans ("biology," "density," "distribution"; Clements et al., 2014; Alamgir et al., 2019). To better understand local attitudes and potential interventions on these issues, a non-profit organization conducted extensive focus groups with community members, which revealed that a lack of access to health care was a potential driver of illegal logging. The organization then bridged human, animal, and environmental health by partnering with the district government and national park management to establish a local health clinic ("biological characteristics," "governance and politics," "socio-demographic characteristics") and run conservation and education programs ("cognitive factors," "contact") and alternative livelihoods trainings ("livelihood systems"). This multi-faceted, holistic approach reduced illegal logging by 70% ("effects on habitat") and resulted in significant declines in human cases of malaria and neglected tropical diseases ("biology," "contact").

The efforts in Borneo illustrate how interventions that holistically and simultaneously address the human, animal, and environmental dimensions of the One Health concept can reduce the risks of zoonotic disease associated with environmental degradation and wildlife trafficking.

Despite its potential and increasingly prominent role in international conversations, many barriers persist in applying One Health as a cross-disciplinary framework. These include the need for: (1) wider acceptance among health professionals for increased engagement of a broader conceptualization that engages animal, wildlife, and environmental health experts; (2) enhanced collaboration between multiple disciplines; (3) developing guidelines and collaborative process-oriented tools, such as those available in the OS; (4) navigating varied stakeholder agendas; and (5) demonstrations of the framework's efficacy in solving problems (Wilcox and Steele, 2021). Nonetheless, we believe One Health offers novel traction for addressing the role of wildlife trafficking in the spillover and spread of zoonotic diseases and encourages scientists and practitioners to further develop the framework for this purpose.

CONCLUSIONS

Approaches to combating IWT have predominantly focused on regulation, law enforcement, or reducing demand, with methods largely implemented in isolation and functioning independently. While each is necessary to combat IWT, alone they have had limited ability to address the interconnected, site-specific, highly varied factors that drive IWT (Challender and MacMillan, 2014; Game et al., 2014; Veríssimo and Wan, 2018). The emergence of COVID-19 and its implications for human-wildlife interactions demonstrate that the wicked complexity of IWT will only continue to grow as globalization intensifies. Cross-disciplinary approaches that facilitate knowledge exchange and collaboration between sectors are needed to help conservationists better understand the diverse factors driving IWT and design more holistic and effective interventions (Zscheischler et al., 2017; Mahajan et al., 2019, p. 2). Cross-disciplinary approaches, however, bring their own challenges, especially in convening diverse stakeholders with their own perspectives, theories, and experience (Crowley et al., 2016). While there are many more tools that need further exploration and testing, frameworks such as the those described here can help overcome some of these challenges by providing a structure for diverse teams to develop shared problem definitions, and plan, coordinate, and evaluate project actions (Lachapelle et al., 2003; Schwartz et al., 2018; Aguirre et al., 2021; Wilcox and Steele, 2021). We encourage individuals, communities, and organizations to utilize planning frameworks to facilitate cross-disciplinary collaboration in order to better understand and address IWT, while fostering collaborative relationships, leveraging resources and expertise, sharing lessons learned, and refining best practices. In the words of Hellen Keller, "Alone we can do so little; together we can do so much."

AUTHOR CONTRIBUTIONS

CB developed the concept of the manuscript. CB and ER wrote the first draft of the manuscript. JM, YK, and SG wrote sections of the manuscript. All authors contributed to review of the submitted version.

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