ANIMAL SMUGGLING IN AIR TRANSPORT AND PREVENTING ZOONOTIC SPILLOVER

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At the heart of ROUTES is a core group of partners collaborating with the U.S. Government and the transport sector that includes Airports Council International (ACI), the Center for Advanced Defense Studies (C4ADS), the International Air Transport Association (IATA), TRAFFIC and World Wildlife Fund (WWF).

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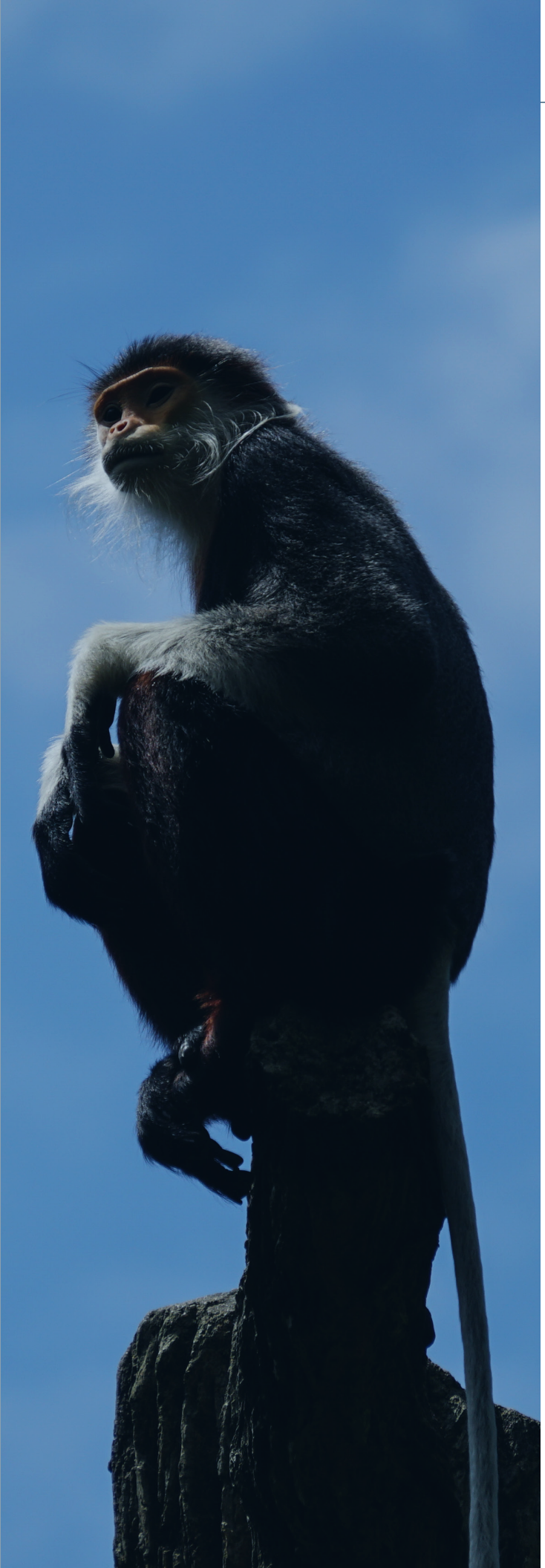
Cover photo: © glowonconcept



Executive Summary

Pathogens that transfer from animals to humans can precipitate outbreaks of infectious disease, including pandemics. Human activities that can facilitate this transfer include logging, mining, and direct contact with infected animals or animal products. While the aviation industry has programs—in support of legislation and enforcement initiatives—to mitigate the spread of zoonotic disease through legal transport of animals or animal products, the illicit transport of these goods also poses a public health risk. Illicit shipments (via cargo and passengers) circumvent regulations and practices, introducing animals to new habitats and species. Smuggled animals and illicit animal products can be stored in cramped conditions before, during, and after transport, increasing the possibility of exposure to pathogens and suppressing the immune response. These illicit supply chains constitute a potential vector through which a zoonotic disease could mutate to infect humans and precipitate a public health crisis.

The C4ADS Air Seizure Database shows that known instances of animal smuggling with a high risk of zoonotic disease occur in over a hundred countries across every continent, except Antarctica. These instances—while likely a fraction of the total illicit trade—include illicit carriage of domesticated and wild animals (the latter of which constitutes a more significant risk for emerging infectious diseases). Evidence from anecdotal testing has identified disease-causing pathogens in multiple wildlife seizures.

The aviation industry can support enforcement authorities, as well as public- and animal-health stakeholders, in preventing the outbreak of future pandemics with data-driven policies and protocols. Regulation, policies, and practices in the aviation sector aimed at legal flows of humans and goods should be supplemented with counter-animal smuggling initiatives, an extension of the good work already being undertaken by the aviation industry to reduce illicit wildlife trafficking. To help reduce risk, industry stakeholders can engage in cross-sector collaboration with traditional counter-wildlife trafficking stakeholders as well as public- and animal-health researchers to implement comprehensive measures, informed by data on zoonoses and illicit animal trafficking.

This brief offers the following recommendations to airlines, airports, and enforcement authorities for consideration, based on capacity and role:

ALL STAKEHOLDERS

Incorporate zoonotic spillover considerations into counter-animal smuggling protocols and practices (e.g., quarantine and zoonotic disease testing for both traffickers and contraband). Supplement with counter-trafficking initiatives.

Coordinate activities related to countering wildlife trafficking with animal health authorities to minimize the risk of animal disease.

AIRLINES AND AIRPORTS

Increase proactive passenger awareness measures on the public health risks of animal smuggling. Focus awareness-raising activities on high-risk species and routes in cooperation with animal and human health agencies.

Inform aviation policies and practices on counter-smuggling and zoonotic spillover mitigation initiatives with data on trends in smuggling of animals and animal products, including bushmeat for personal consumption.

ENFORCEMENT AUTHORITIES

Increase public reporting on seizures, including seizure location, flight route, transport method, and a description of the seized products.

Increase collaboration with biologists, quarantine agencies, and aviation industry stakeholders to surveil seized animals and products for disease, which will provide a better understanding of drivers and methods of high-zoonotic-risk animal smuggling.

Increase incentives among law enforcement for interdiction of illicit shipments (via cargo and passengers) of animals or animal products prior to carriage.

Monitor the development of automated detection and other emerging technologies to build capacity to identify illicit animals or animal products in airport screening systems.

Introduction

"THE MAJOR KILLERS OF HUMANITY…SMALLPOX, FLU, TUBERCULOSIS, MALARIA, PLAGUE, MEASLES, AND CHOLERA—ARE INFECTIOUS DISEASES THAT EVOLVED FROM DISEASES OF ANIMALS." [1]

Between 1980 and 2010, humanity experienced over 6,700 outbreaks of zoonotic diseases—diseases that transmit from animals to humans.[2] The H1N1 flu, SARS, and Ebola have been linked to birds, civets, and primates, respectively,[3] and current evidence suggests that COVID-19 originated from bats.[4] Research has concluded that increasing human mobility is a significant factor in the spread of infectious disease.[5] The emergence of new pathogens, in a world where humans and animals can cross continents in a matter of hours, can incite public health crises that cost countless lives and challenge the tenets of modern transport and trade.

The fallout from pandemics that arise from zoonotic spillover (i.e., the transfer of a pathogen from the original host to either humans or another species) is not hypothetical. As of August 2020, COVID-19, which originated from a zoonotic spillover event, has led to over 950,000 deaths.[6] The virus has affected virtually every country[7] and sent shockwaves across financial markets and supply chains. The aviation sector has been particularly hard hit—the International Air Transport Association (IATA) estimated a USD 419 billion loss (–50% year-on-year) for the airline industry over the course of the pandemic,[8] and Airports Council International (ACI) estimated a decline in global annual airport revenues of USD 104.5 billion (–60% year-on-year).[9] While the full repercussions on economics and geopolitics are still unfolding, they will likely be unprecedented in human history.

ZOONOTIC SPILLOVER

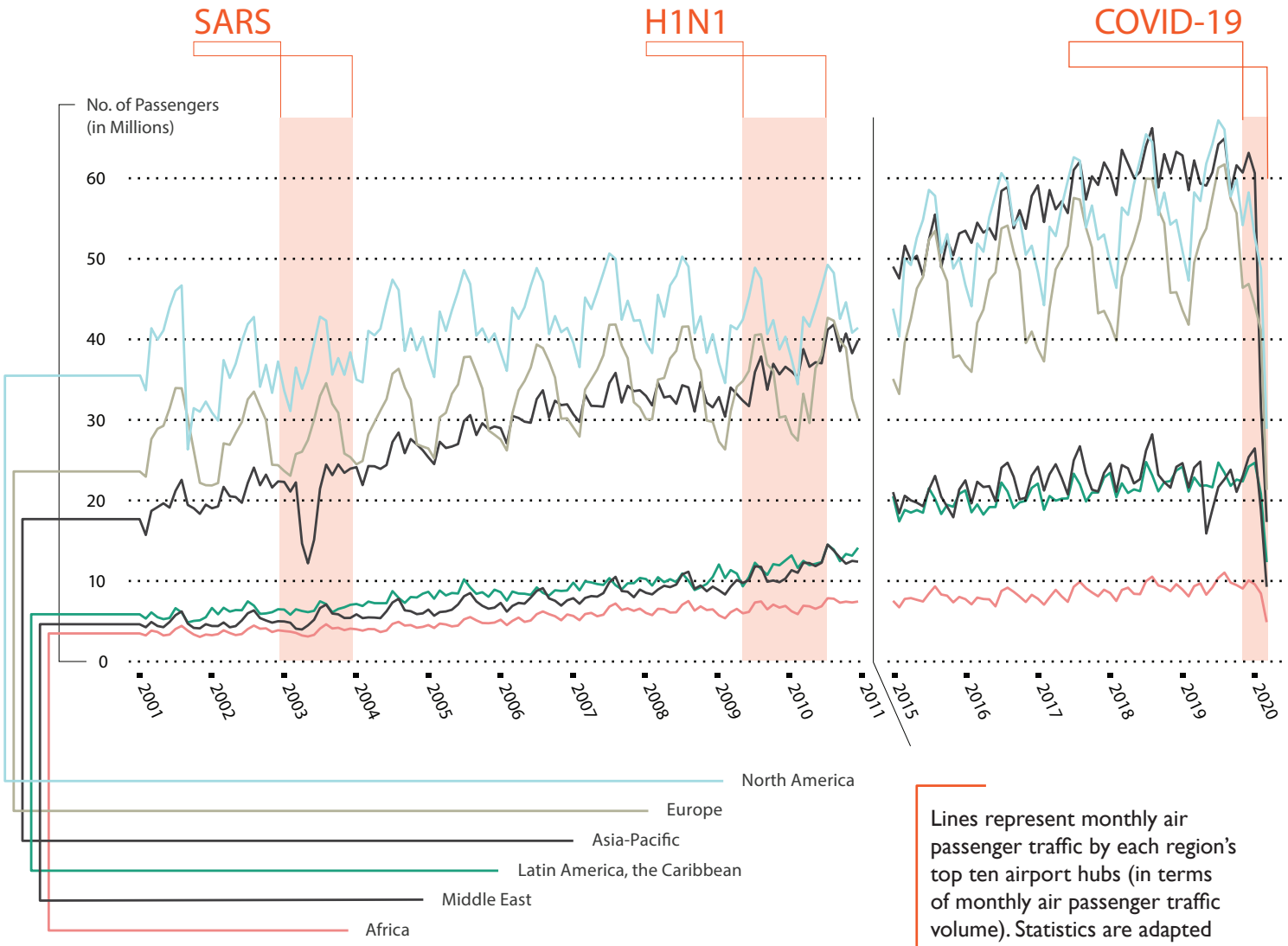
A zoonotic disease is one that can transfer between animals and humans through exposure to a live host or organic matter containing the pathogen. By contrast, a disease of animal origin is a one that originated in animals but has "spilled over" and now exists perpetually in humans.[10] For example, COVID-19 is a disease of animal origin, but the coronavirus ancestor that exists in animals and from which COVID-19 mutated is a zoonotic virus.

All outbreaks of diseases of animal origin (including epidemics and pandemics) begin with zoonotic spillover.

ANIMAL SMUGGLING

In this brief, *animal smuggling* and *illicit animal shipments* both refer to the transportation of animals or animal products that violate a law or regulation across any jurisdiction in the intended route. This includes shipments (via cargo and passengers) intended for personal consumption as well as those destined for commercial markets. These shipments can exploit different modes of air transport, as smugglers may move them through checked luggage, by air freight, in the passenger's personal items, or on their body. Lastly, animal smuggling encompasses shipments of both domesticated and wild animals, as both have the potential to facilitate zoonotic spillover.

Air Passenger Traffic Disruptions During Three Zoonotic Outbreaks



Lines represent monthly air passenger traffic by each region's top ten airport hubs (in terms of monthly air passenger traffic volume). Statistics are adapted from data provided by ACI.

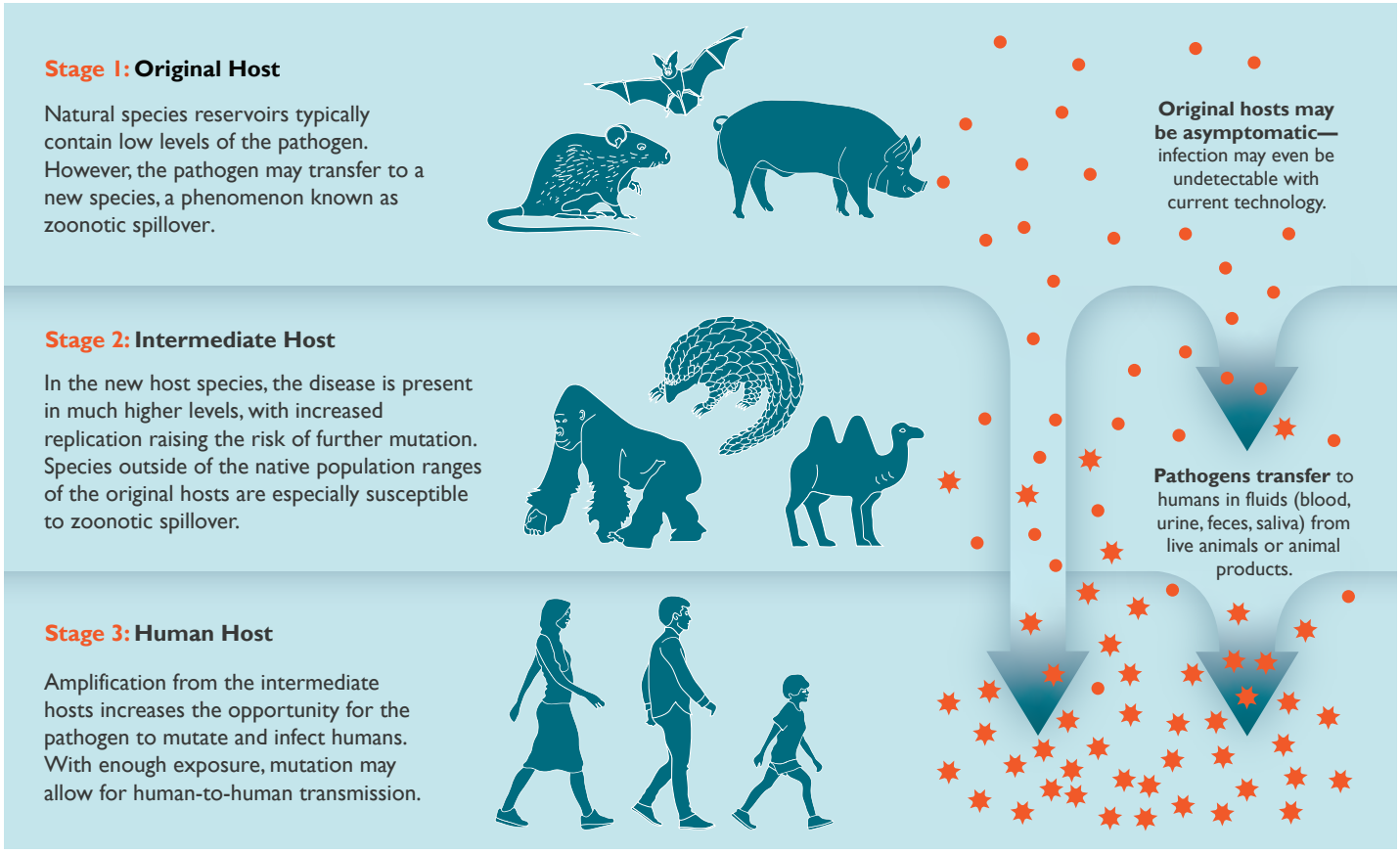
The COVID-19 pandemic has demonstrated the destructive potential of zoonotic spillover—a consequence of humanity's exploitation of the natural world. Eight hundred thousand pathogens and microorganisms linked to emerging infectious diseases currently exist in animals,[11] including 500 new coronavirus strains identified in bats alone.[12] Natural resource extraction (such as logging, mining, and poaching) is encroaching on ecosystems previously untouched by humans. Animal smuggling poses a risk for zoonotic spillover, jeopardizing the social and economic benefits of a connected world. As the circulation of humans and goods increases, understanding flows of illicit animals and animal products, and their role in zoonotic spillover, is crucial to making timely interventions and informed risk mitigation measures that will help prevent future pandemics.

Zoonotic Spillover and Animal Smuggling

"THE TRADE IN WILDLIFE HAS LED TO THE INTRODUCTION OF PATHOGENS THAT THREATEN HUMAN AND ANIMAL HEALTH, AGRICULTURAL PRODUCTION, AND BIODIVERSITY."[13]

The World Organisation for Animal Health (OIE) estimates that three new infectious diseases emerge from animals every year.[14] Humans are exposed to zoonotic diseases through contact with vectors—either a live animal or organic matter (under-cooked or poorly preserved meat, tissue, blood, urine, feces, etc.)—containing the pathogen. A disease that crosses the animal-human interface can evolve into one that is transmitted from human to human (or from human to animal), potentially precipitating a global health crisis. Understanding the vectors for zoonotic disease, and, by extension, the dangers of the illicit animal shipments, is fundamental for designing effective zoonotic disease mitigation policies and protocols.

Zoonotic Spillover Through Intermediate Host



As both domesticated and wild animals can serve as hosts for zoonotic disease, any live specimen or organic matter from either group constitutes a potential vector for exposure. However, over 70% of zoonotic diseases originate from wild animals,[15] and five recent major infectious disease outbreaks of zoonotic origin (pandemics or epidemics) have been linked to the human-wildlife interface.[16] While domesticated animals can and have served as hosts for zoonotic diseases that have precipitated pandemics,[17] zoonotic spillover is likely to be more severe when it involves animals to which humans have had less exposure and thus a less developed immune response.[18] While it is important to note the special significance of the human-wildlife interface in the risk of zoonotic spillover, comprehensive mitigation measures must address all illicit flows of animals or animal products (in addition to measures aimed at legal animal trade and transport).

Zoonotic disease mitigation policies and protocols that pertain to animal trade are managed by a variety of organizations at the international[19] and national level.[20] Interventions typically consider 1) the species and associated zoonoses and exposure vectors, and 2) local context such as veterinary capacity, surveillance programs, and previous disease outbreaks.[21] The aviation industry has measures in place to ensure safe transit of humans and goods through the proper channels. While such regimes can strongly reduce the risk of zoonotic spillover within regulated animal trade, illicit flows of animals or animal products circumvent these measures.[22]

It should be noted that, as of August 2020, there is no public evidence that a pandemic of zoonotic origin has been linked to the aviation industry. Nevertheless, the nature of illicit animal supply chains that exploit the aviation sector pose a risk of zoonotic spillover: illlicit transportation of animals or animal products introduces these shipments (and any diseases present in the specimens) to a new environment, without regard for requirements around health examinations, vaccinations, or quarantine. Illegal shipments are often consolidated, stored, and transported (frequently for hours at a time) in close proximity to other species.[23] Additionally, zoonotic transfer is more likely, and the resulting disease more severe, between species with geographically disparate population ranges (a factor is especially relevant for animal smuggling that exploits the aviation sector).[24] Shipments of multiple live species in tight quarters with unsanitary conditions—say, in a passenger's checked luggage or in the plane's cargo area—can suppress animals' immune systems[25] and facilitate disease spread. In the words of one veterinary pathologist, animal smuggling constitutes "laboratory-like conditions for zoonotic spillover."[26] Lastly, shipments that successfully transit the aviation sector can transfer pathogens to humans or animals as they are consolidated, processed, distributed, and consumed.

The exploitation of the aviation industry for animal smuggling constitutes an exposure vector which could lead to zoonotic spillover. Between 2009 and 2017, the C4ADS Air Seizure Database shows an average of 1,300 birds seized along air routes every year[27]—based solely on public reporting. Authorities at a South American airport seized an estimated 20 tons of illegal animal products between 2008 and 2009.[28] Studies of two major European airports estimate that hundreds of tons of bushmeat arrive undeclared into each airport every year.[29] One of these studies identified bushmeat smuggling via nine European, Asian, and Middle Eastern airlines.[30] As these are major hubs for international flights (and alleged transit points along bushmeat supply chains[31]), it is highly likely that some of this bushmeat flows onward to other countries.

Given the nature of illicit supply chains—the introduction of species into new geographies, the consolidation of multiple species in close quarters, the stress-induced suppression of animals' immune systems, and the lack of mitigation measures such as pathogen surveillance testing—the continuation of animal smuggling along air routes is a factor in increasing the likelihood of future disease outbreaks. However, the aviation sector, working in partnership with enforcement authorities, conservation stakeholders, and the scientific community, has the opportunity to help reduce the risk of zoonotic spillover. This opportunity exists for all stakeholders, even those who have no direct contact with passengers or freight. Collaboration with traditional counter-wildlife trafficking stakeholders, such as enforcement officials and conservation organizations, and awareness informed by analysis of animal smuggling can decrease the risk of public health crises.

Diseases Originating from Zoonotic Spillover and the Impact on the Aviation Industry

AVIAN INFLUENZA

Avian influenza refers to a variety of pathogens including the HPAI H5 virus, HPAI H5N1 virus, and H7N9 virus.[32] This virus family, which has a mortality rate in humans that can reach 60%,[33] transfers to humans through contact with wild birds and poultry. Hundreds of outbreaks of avian influenza[34] have precipitated disruptions in air traffic, the culling of millions of poultry,[35] and European bans on imports of wild birds.[36] According to the C4ADS Air Seizure Database, approximately 85% of seized bird shipments consist of live birds.[37] There have been multiple cases of trafficked birds testing positive for avian influenza.[38]

EBOLA

Ebola virus disease is caused by a pathogen that originated in bats and transferred to humans through non-human primates in Africa.[39] The mortality rate in humans is approximately 50%, and the virus is capable of human-to-human transmission.[40] In the illicit wildlife trade, zoonotic spillover can arise from the handling of live primates, the butchering of these animals, or the consumption of undercooked meat.[41] Outbreaks of the disease have disrupted air traffic and cost the aviation industry hundreds of millions of dollars.[42]

SARS

Severe acute respiratory syndrome (SARS) is a disease caused by a coronavirus that is genetically related to but distinct from COVID-19.[43] A global outbreak in 2003 was followed by a 35% decrease in Asia-Pacific revenue passenger kilometers,[44] severely impacting airlines and airports. Global financial losses from the outbreak are estimated at USD 33 billion.[45] While the pathogen's original animal reservoir is still unconfirmed, evidence suggests that SARS may have originated in bats before transferring to humans via Asian palm civets in a wildlife market in southern China.[46] Authorities at airports in this region have intercepted a wide array of smuggled wildlife, including primates, big cats, and pangolins.[47]

Note: These diseases discussed above emerged from zoonotic disease. However, spillover is not necessarily linked to animal smuggling. Likewise, while outbreaks of these diseases have impacted the aviation industry, no spillovers have been linked to air traffic or transport.

Trafficking in Pathogens

"[THE] WORLDWIDE MOVEMENT OF ANIMALS HAS INCREASED THE POTENTIAL FOR THE TRANSLOCATION OF ZOONOTIC DISEASES." [48]

According to the C4ADS Air Seizure Database, between 2009 and 2019, almost 500 high-zoonotic-risk trafficking instances were identified in the aviation sector (definition and methodology discussed below).[49] That is fifty high-zoonotic-risk trafficking instances every year, based solely on public reporting. The routes of these shipments span 104 countries, touching every continent but Antarctica. Given evidence of low interdiction rates,[50,51,52] it is likely that known trafficking instances are the tip of a much larger illicit trade, which entails a higher risk of zoonotic spillover.

Methodology for Identifying High-Zoonotic-Risk Trafficking Instances

A high-zoonotic-risk trafficking instance is an illicit shipment of animals or animal products that engenders a relatively significant risk for zoonotic spillover. Specifically, the dataset analyzed in this brief consists of seizures from the C4ADS Air Seizure Database involving live or unprocessed dead animals or animal parts that meet any of the following criteria:

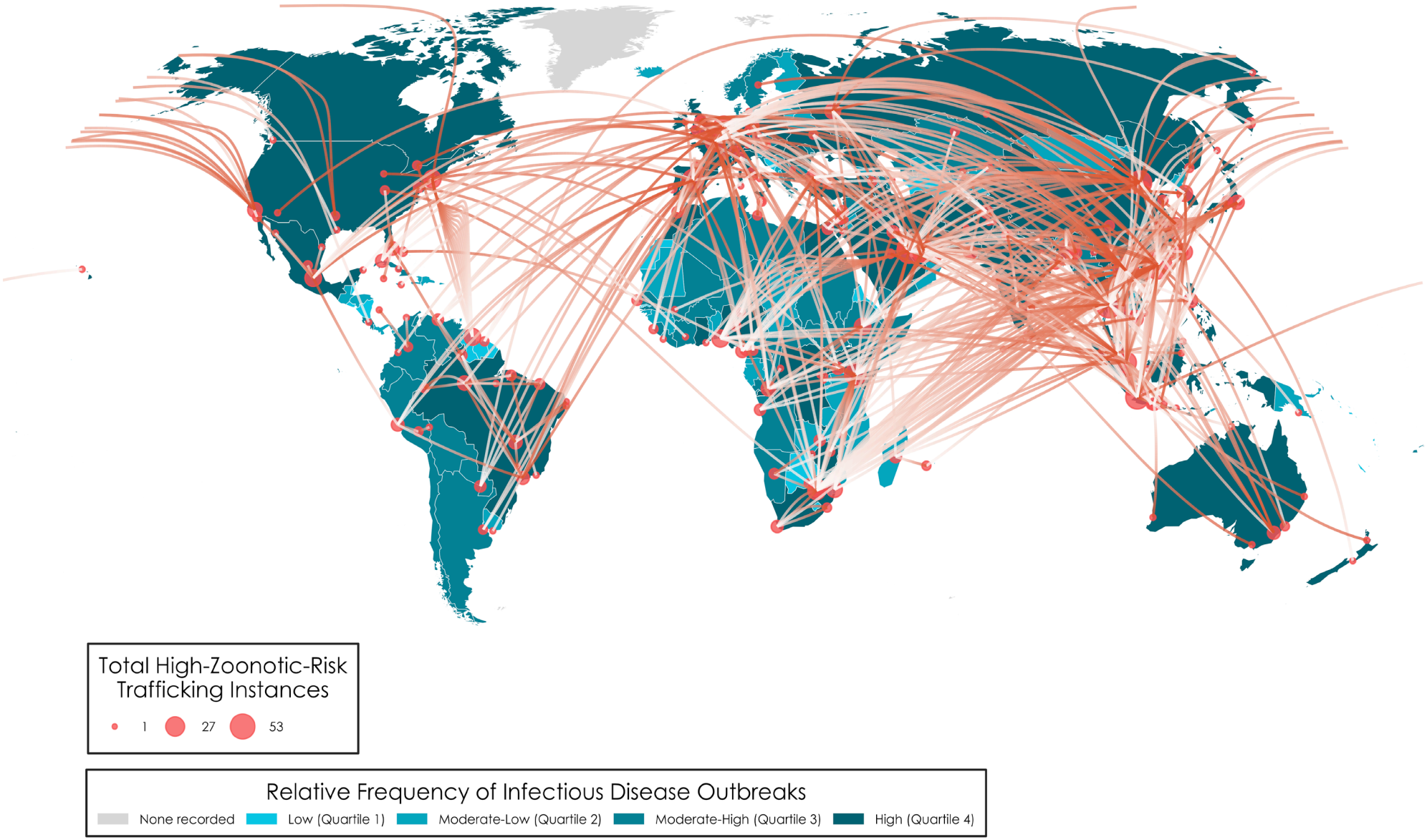
Seizures involving species from biological orders *Primates* (primates), *Rodentia* (rodents), and *Chiroptera* (bats), orders which research suggests harbor the highest number of zoonotic diseases shared with humans.

Seizures involving other mammalian species identified as reservoirs of common zoonoses and with confirmed international trade (a wide variety of mammals including kangaroos, big cats, pangolins, squirrels, civets, and gophers).

Seizures involving birds or bird parts, the trafficking routes of which passed through countries included on the USDA bird import restriction regime, restrictions which are designed to reduce the spread of animal disease.

Seizures involving multiple species contained in a single shipment (not limited to the species listed above), as the proximity of the animals or products increases the risk of zoonotic spillover.

These criteria were determined through literature review and conversations with scientific researchers **(see Appendix 1: High-Zoonotic-Risk Methodology Sources).** However, the species in this dataset do not constitute an exhaustive dataset of existing zoonotic hosts, nor do they account for diseases that will emerge in the future. Without comprehensive testing, no animal trafficking instance can be considered completely risk-free.



Known High-Zoonotic-Risk Trafficking Routes, 2009–2019, and Reported Disease Outbreaks, November 2019–May 2020 Orange points and lines represent animal smuggling routes. Blue shading represents relative frequency of infectious disease outbreaks, grouped by quartile.
(USAID Routes Partnership. C4ADS Air Seizure Database, Apr. 2020.; and HealthMap, Apr. 2020, healthmap.org.)

Live Animals

Of all smuggled animals or animal products, live animals pose the highest risk for zoonotic spillover. Pathogens within a live host reproduce indefinitely, heightening the risk of mutation. Outbreaks of Nipah[53] and Hendra[54] viruses (with human mortality rates of 90%[55] and 70%[56] respectively) have emerged through the introduction of live animals to new ecosystems. A 2003 outbreak of monkeypox in the U.S. resulted in 47 confirmed human cases across six states; the outbreak was traced to a shipment of live animals from West Africa imported for the pet trade.[57] In the C4ADS Air Seizure Database, wildlife seized between 2009 and 2019 that was reportedly intended for global pet markets included multiple types of birds (such as pigeon, finch, macaw, parrot, canary, and galah), as well as orangutan, otter, marmoset, and salamander. [58]

CASE STUDY

Birds are known to carry over 60 different zoonotic diseases.[59] In December of 2018, two passengers departing an Asian airport were detained for attempting to smuggle 12 Chinese hwamei birds in their suitcases. These animals were subsequently tested for any signs of disease. One specimen was confirmed to be carrying avian influenza strain H3N8, the suspected origin of a 19th century pandemic.[60] Since January 2018, 14 known air shipments of live birds have been discovered in passengers' clothing and carry-on items, a mode of transport that engenders risk of exposure to passengers, as well as airline and airport staff.[61]

Bushmeat

Between 2009 and 2017, the U.S. Fish and Wildlife Service seized over 19,000 pounds of smuggled meat across 32 airports, according to LEMIS data. [62] In the C4ADS Air Seizure Database, bushmeat seized between 2009 and 2019 included primate, rodent, pangolin, antelope, viper, and crocodile.[63] Evidence suggests that bushmeat seizures are especially underreported in publicly available information.[64, 65] This gap may arise from customs agencies' focus on revenue and agricultural protection or the perception that bushmeat trafficking constitutes less of a crime than the trade of charismatic wildlife products such as ivory or rhino horn. However, a study at a European airport found that 100% of bushmeat samples showed bacteria "above levels considered safe for human consumption,"[66] a statistic that demonstrates how such illicit supply chains bypass health standards and could serve as a vector for zoonotic disease spillover. HIV[67] and Ebola[68] are both suspected to have transferred to humans through bushmeat. Raw or undercooked meat can retain infected fluids, such as blood, that then transfer pathogens to humans through touch or consumption.

CASE STUDY

Reported bushmeat seizures overwhelmingly involve multiple wildlife products or species—increasing the risk of zoonotic transfer.[69] In March 2019, authorities at a European airport seized raw bushmeat from the luggage of a passenger arriving from Morocco. The passenger confirmed their intent to eat the animals, which were identified as four porcupines and one pangolin.[70] Organic matter of wild animals is especially high-risk for carrying zoonotic disease, which can transfer upon handling or consumption. Pangolins are confirmed hosts of a family of coronaviruses known as betacoronaviruses, which have been identified exclusively in specimens seized in illicit shipments.[71] While more research is needed, this finding suggests that the illicit trade may have a role in the genesis of betacoronaviruses.

Domesticated Animals

Domesticated animals and animal products have been implicated in outbreaks of avian influenza,[72] *E. coli*,[73] and Hendra virus, all of which can transfer to humans.[74] While these animals are less likely to host harmful pathogens than their wild counterparts, their smuggling circumvents mitigation measures designed to prevent outbreaks of infectious disease. As with wildlife products, it is likely that interdicted shipments of domesticated animal products constitute a small portion of total illicit flows—one study estimated that over 1,000 tons of non-wild meat products illegally entered Switzerland every year. [75]

CASE STUDY

In February of 2019, authorities at a U.S. airport seized over 20 pounds of undeclared raw animal parts from pigs, chickens, and cows from the luggage of a passenger arriving from Vietnam. Pigs, chickens, and cows are known hosts for African swine fever, avian influenza, and *E. coli*, respectively. Commenting on the seizure, one official stated: "These kinds of meat products are potential carriers for harmful diseases that could result in devastating effects on our agriculture industry."[76]

The examples discussed above are not the only types of animal trafficking instances that can spread zoonotic disease. Examples of other vectors include worked products with animal tissue still attached (e.g., raw rhino horn) and insects or other animals carried by the shipment (ticks, mosquito larvae, etc.). Nevertheless, this analysis demonstrates that animals illicitly transported through the aviation sector can constitute a public health risk as vectors for infectious disease.

Conclusion

"THE FREQUENCY, SEVERITY, AND FINANCIAL IMPACTS OF THESE EVENTS ARE GROWING, AND THE WORLD CAN NO LONGER AFFORD TO JUST WAIT AND SEE." [77]

The exploitation of the aviation sector for animal smuggling increases the risk of zoonotic spillover. Illicit flows of animals and animal products circumvent existing mitigation measures and create an opportunity for pathogens to transfer to novel, more susceptible hosts (both human and animal). Research suggests that the scale of animal smuggling is significantly larger than statistics based solely on public reporting, which nonetheless reveal over 50 high-zoonotic-risk trafficking instances every year across 104 countries. While live wild animals and bushmeat engender the most serious risk of animal smuggling, illicit shipments of domesticated animals and animal products also constitute a potential vector for zoonotic spillover.

As the world continues to grapple with COVID-19, the consequences of zoonotic spillover have been laid bare for all to see. Comprehensive protocols are being adopted across the aviation industry to stem the tide of this outbreak.[78] Once science and fortitude have won out, and the world enters the post-COVID phase, attention must shift to mitigating future pandemics. To this end, preventing the spillover of disease through zoonotic risk management is important and should be incorporated alongside measures to mitigate the consequences of a pandemic after it has emerged. Indeed, as the catastrophic fallout from the COVID-19 pandemic has demonstrated, zoonotic spillover constitutes an existential threat to the aviation sector.

As air transport stakeholders recover from the impacts of COVID-19, it is important that future pandemic prevention programs include counter-animal smuggling initiatives as a key risk mitigation activity.

The aviation industry can support enforcement authorities, as well as public- and animal-health stakeholders, in preventing the outbreak of future pandemics with data-driven policies and protocols. Regulation, policies, and practices in the aviation sector aimed at legal flows of humans and goods should be supplemented with counter-animal smuggling initiatives, an extension of the good work already being undertaken by the aviation industry to reduce illicit wildlife trafficking. To help reduce risk, industry stakeholders can engage in cross-sector collaboration with traditional counter-wildlife trafficking stakeholders as well as public- and animal-health researchers to implement comprehensive measures, informed by data on zoonoses and illicit animal trafficking.

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AIRLINES AND AIRPORTS

Increase proactive passenger awareness measures on the public health risks of animal smuggling. Focus awareness-raising activities on high-risk species and routes in cooperation with animal and human health agencies.

Inform aviation policies and practices on counter-smuggling and zoonotic spillover mitigation initiatives with data on trends in smuggling of animals and animal products, including bushmeat for personal consumption.

ENFORCEMENT AUTHORITIES

Increase public reporting on seizures, including seizure location, flight route, transport method, and a description of the seized products.

Increase collaboration with biologists, quarantine agencies, and aviation industry stakeholders to surveil seized animals and products for disease, which will provide a better understanding of drivers and methods of high-zoonotic-risk animal smuggling.

Increase incentives among law enforcement for interdiction of illicit shipments (via cargo and passengers) of animals or animal products prior to carriage.

Monitor the development of automated detection and other emerging technologies to build capacity to identify illicit animals or animal products in airport screening systems.

Appendix I

HIGH-ZOONOTIC-RISK METHODOLOGY SOURCES

"Animal Health Status of Regions." Animal Plant Health and Inspection Service, U.S. Department of Agriculture, 2 Jun. 2020, www.aphis.usda.gov/aphis/ourfocus/animalhealth/animal-and-animal-product-import-information/animal-health-status-of-regions.

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