

Original Contribution

Summarizing the Evidence on the International Trade in Illegal Wildlife

Gail Emilia Rosen^{1,2} and Katherine F. Smith^{1,2}

¹Department of Ecology and Evolutionary Biology, Brown University, 80 Waterman Street, Providence, RI 02912

²Wildlife Trust, New York, NY 10001

Abstract: The global trade in illegal wildlife is a multi-billion dollar industry that threatens biodiversity and acts as a potential avenue for invasive species and disease spread. Despite the broad-sweeping implications of illegal wildlife sales, scientists have yet to describe the scope and scale of the trade. Here, we provide the most thorough and current description of the illegal wildlife trade using 12 years of seizure records compiled by TRAFFIC, the wildlife trade monitoring network. These records comprise 967 seizures including massive quantities of ivory, tiger skins, live reptiles, and other endangered wildlife and wildlife products. Most seizures originate in Southeast Asia, a recently identified hotspot for future emerging infectious diseases. To date, regulation and enforcement have been insufficient to effectively control the global trade in illegal wildlife at national and international scales. Effective control will require a multi-pronged approach including community-scale education and empowering local people to value wildlife, coordinated international regulation, and a greater allocation of national resources to on-the-ground enforcement.

Keywords: illegal wildlife trade, emerging infectious diseases, wildlife trade, reptiles, endangered species, zoonotic diseases

INTRODUCTION

The legal global plant and wildlife market, excluding timber, was valued at US\$21 billion in 2005 (Engler and Parry-Jones, 2007), and is expanding rapidly (Roe, 2008). Each year, billions of plants, animals, and plant and animal derivatives are traded (Karesh et al., 2005) to meet consumer demand for trophies, food, clothing, decorative items, pets, and traditional medicine (TRAFFIC, 2008). The United States alone has imported more than 1.48 billion live animals since 2000, mostly from wild populations in

Southeast Asia (Smith et al., 2009). The scope of the wildlife trade places significant pressure on biodiversity through over-collection (Li and Li, 1998; Wilcove et al., 1998), while importing nations risk introducing pathogens (Daszak et al., 2000; Karesh et al., 2005) and invasive species (Vitousek et al., 1996). The legal trade, however, does not represent the entirety of the international market for wildlife. Little is known with certainty about the scale of the illegal trade in wildlife (CITES, 2007), but it is hypothesized that this trade, valued between US\$5 billion and US\$20 billion a year, is among the world's largest illegitimate businesses, after narcotics (Wyler and Sheikh, 2008). The scope and scale of the illegal wildlife trade are the focus of this report.

The global trade in illegal wildlife has myriad implications for the environment and for human and animal health. When a commoditized species is endangered, its harvest to supply illegal trade may easily reach unsustainable levels (Sodhi et al., 2004). Indeed, the demand for larger or more ornate specimens tends to remove the fittest individuals from the breeding population, which may result in reduced fitness in subsequent generations (Paquette and Lapointe, 2007). Illegal wildlife trade also poses health threats to humans, native species, and livestock (Gómez and Aguirre, 2008). As is the case with the legal trade in wildlife, the transport of large numbers of illegal live animals could facilitate pathogen pollution—human-induced movement of infectious agents to new regions (Cunningham et al., 2003; Smith et al., 2009). Additionally, illegal trade undermines the efforts of developing nations to manage their natural resources, resulting in massive potential economic losses, while the involvement of criminal organizations brings the threat of violence and corruption (Zimmerman, 2003; Milledge, 2007). Finally, specimens in the illegal market are often handled and transported under appalling conditions, creating an animal welfare concern (WSPA 2007).

The Convention on International Trade in Endangered Species (CITES) is an international treaty obliging signatory countries to monitor the global wildlife trade and to take action on behalf of threatened species. Under CITES, species are classed as Appendix I (trade permitted only under exceptional circumstances), Appendix II (nondetriment finding and export permit are required for trade), Appendix III (one member country has asked other CITES Parties for assistance in controlling trade), or non-CITES (CITES, 1973). TRAFFIC, the wildlife trade monitoring network, is an international organization committed to ensuring that the international wildlife trade is not a threat to conservation. A joint project of the World Conservation Union and World Wide Fund for Nature, TRAFFIC works closely with the Secretariat of CITES to conduct studies of trade, assist in investigation of illegal trade networks, and recommend plans of action to manage wildlife trade sustainably and responsibly. While information about the true scale of the illegal trade is restricted by nature, these organizations are uniquely positioned to provide the best available data.

Recent publications have quantified trade in legal wildlife with focus on the USA (Schloegel et al., 2009; Smith et al., 2009). To date, however, there has been no comprehensive report documenting the global trade in

illegal wildlife. In part, this is because the data are inherently incomplete. Indeed, confiscation records provide the only available data on the scope and scale of illegal trade. Nevertheless, they offer the best evidence available to begin to describe the number and diversity of wildlife illegally traded around the world. Efforts to control illegal wildlife trade vary among nations, as effective law enforcement is often impeded by the secrecy of the trade, lack of infrastructure, and a shortage of wildlife law enforcement officers (McCusker, 2006; Dinerstein et al., 2007). Without independent records of illegal trade activity and enforcement, no inference can be drawn from these records about a country's effort or progress in controlling illegal wildlife trade. Nevertheless, it is valuable to consider these data in an attempt to better understand the magnitude and diversity of illegally traded wildlife. Here, we assess the scope, scale, and implications of the global trade in illegal wildlife, using 12 years of seizure records compiled by TRAFFIC.

METHODS

We compiled all reports on illegal wildlife trade seizures from TRAFFIC Bulletins spanning the period July 1996 to October 2008. Generally, seizure reports contain information on the species confiscated, the number of individuals in the shipment, whether they were alive, dead, or in product form, country of origin, country of seizure, intended purpose, etc. Report data was organized into a categorical database and analyzed. Because seizure records are not standardized, database categories were selected to encompass a breadth of potential information. Categories included: date of seizure, country of seizure, country of origin, country of destination, method of transport, accompanying documentation, label on shipment, species name (common and scientific), form (live, product), number of individuals or items, weight, CITES appendix, intended use, condition of live specimens, date of offense or arrest, and date of trial or sentencing.

Values presented as a range, or estimate, were counted as the lowest number provided. For example, “dozens” of tiger skins were counted as 24 skins. In many cases, units were not always meaningfully comparable; e.g., there is no formula to convert kilograms of pangolin scales for comparison to numbers of shahtoosh shawls. Occasionally, no count or quantity was provided at all. In dividing seizures by year, we used the year of trade or collection; when this

was not available, year of seizure, then year of legal action (e.g., trial) was used. If trade or seizure effort took place over more than 1 year, the seizure was assigned to the most recent year provided.

RESULTS

TRAFFIC Bulletins report 967 seizures of wildlife and wildlife products between July 1996 and October 2008 (Fig. 1). The annual number of recorded seizures varied widely, from 30 in 2002 to 108 in 1997, and exhibited no

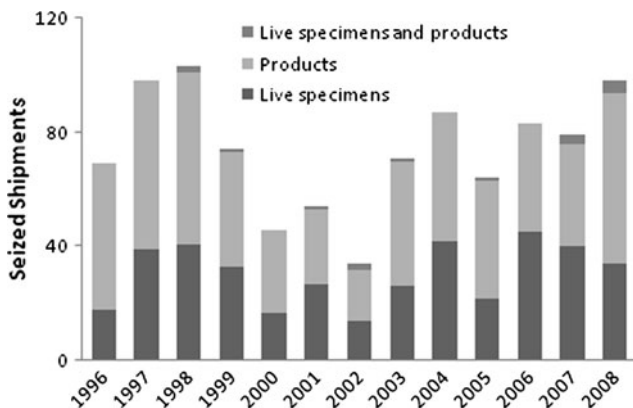


Figure 1. Number of seized shipments of animals and animal products recorded per year between 1996 and 2008, divided by live specimens, products, and mixed shipments. *Source:* TRAFFIC Bulletin.

directional pattern. Seizures originated from more than 101 different countries, with a marked concentration in South and Southeast Asia (Fig. 2). Seventy-six percent of seizures included CITES Appendix I or II listed species (Fig. 3). Seizures included more than 191,934 live animals (Fig. 4). Twenty percent of all seizures were made in India, 11% in China, with the UK (10%), the USA (6%), Belgium (6%), Australia (6%), and Malaysia (6%) following.

The trade was not evenly distributed across taxa (Fig. 4). Mammals and mammal derivatives dominated the trade, constituting 51% of all seizures. Of these, skins, pelts, and furs, mostly of tigers (49 seizures) and leopards (66 seizures), constituted 26% of mammal product seizures. Seizures of ivory constituted 25% of all seizures of mammal products (Fig. 5); more than 42,401.38 kg of elephant ivory was seized over the last 12 years. Assuming an average tusk weight of 3.95 kg (Milliken et al., 2004), this represents more than 5367 elephants. When only live animals were considered, the picture was quite different. Sixty-nine percent (127,643) of live animals seized were reptiles; 38% (72,103) were turtles and tortoises (Figs. 6, 7). Sixteen seizures included more than 4224 live primates; a further 13 contained primate products. Only reptiles and amphibians were usually traded as live specimens (Fig. 4).

The variation in shipment size was tremendous (Fig. 3). Amphibian shipments contained between 22 and 3000 individuals; one contained 49 kg of fat estimated to come from 100,000 frogs. Bird seizures consisted of



Figure 2. Animal and animal product seizures, 1996–2008, by country of origin. One dot corresponds to one seizure. Dots are randomly placed within countries. *Source:* TRAFFIC Bulletin.

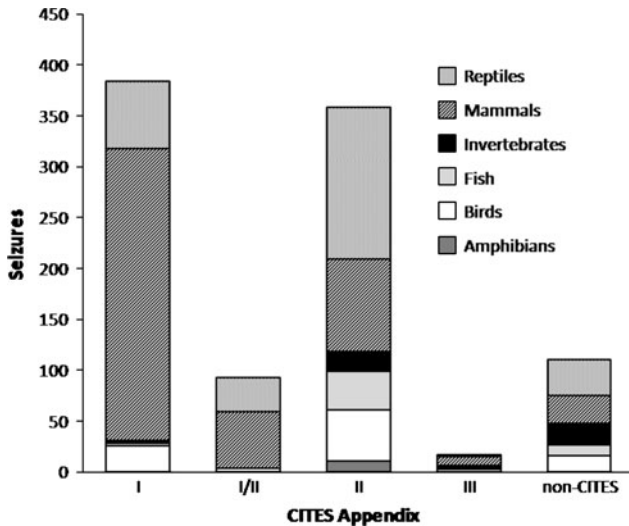


Figure 3. Seized animal shipments, 1996–2008, divided by taxonomic group and Convention on International Trade in Endangered Species (CITES) appendix. I/II refers to specimens whose species or subspecies could not be positively identified so as to class them as Appendix I or Appendix II. *Source:* TRAFFIC Bulletin.

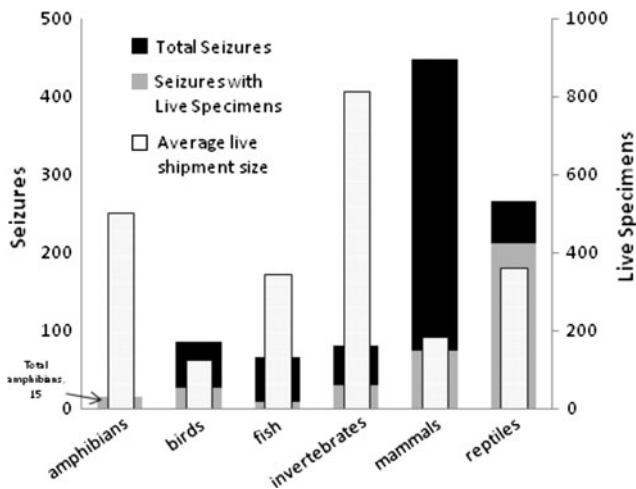


Figure 4. Number of seized shipments of animals and animal products recorded per year between 1996 and 2008, and average size of live shipments, divided by taxonomic group. *Source:* TRAFFIC Bulletin.

between 1 and 8,000 individuals. The largest seizure of fish weighed 200,000 kg, the smallest only 2 kg. Invertebrates ranged from a single scaly clam (*Tridacna squamosa*) to between 798,000 and 1.05 million queen conch (*Strombus gigas*). The mammal seizures included both a single stuffed giant panda (*Ailuropoda melanoleuca*) and 68,000 kg of pangolin (*Manis spp.*) meat.

DISCUSSION

The illegal wildlife trade is vast in species diversity and geographic scope, evidence that large numbers of illegal wildlife are traded successfully on a regular basis. Efforts to control illegal wildlife trade vary nationally. Many governments face challenges in enforcement due to the remoteness of areas where poaching occurs, lack of infrastructure, corrupt officials, the involvement of transnational crime networks, and a shortage of wildlife law enforcement officers (McCusker, 2006; Dinerstein et al., 2007). Without information on national law enforcement effort, it is impossible to estimate the relative contributions of trade and enforcement to annual changes in seizure numbers. Smugglers conceal their goods in a variety of ways (Box 1). False or invalid CITES permits are occasionally used, or CITES-listed specimens are concealed among similar-looking non-CITES species. Wild-caught specimens may be falsely declared as captive-bred, as in a 1997 case involving large numbers of Indonesian reptiles, including fly river turtles (*Carettochelys insculpta*). Ivory is painted and disguised as wood. In Asia, large quantities of wildlife are transported across borders by truck without any special effort at concealment. Amphibians and reptiles are found in luggage at airports. Smugglers of birds and reptiles commonly conceal specimens and eggs on their persons, sometimes in specially designed vests or underwear with pockets to hold their cargo. One man used a compartment in his prosthetic leg to smuggle three iguanas from Fiji to the USA. Smuggling methods are often harmful to animals, and shipments frequently contained animals that had died in transit. Consistent with what is known about the treatment of illegally traded wildlife (CITES, 1993; WSPA 2008), live animals were frequently in poor condition. In one incident, Malaysian authorities seized more than 900 crab-eating macaques in cages and sacks that were believed to be destined for food in China and laboratories in the Netherlands. Some were so hungry that they had started to eat their offspring. Additionally, many seized animals were noted to be ill, though the cause of sickness was rarely diagnosed, raising concern that illegal wildlife trade may serve as an avenue for pathogen introduction.

Pathogen Pollution in the Illegal Wildlife Trade

Little is known about the disease risks posed by the hundreds of millions of animals traded globally each year. Few

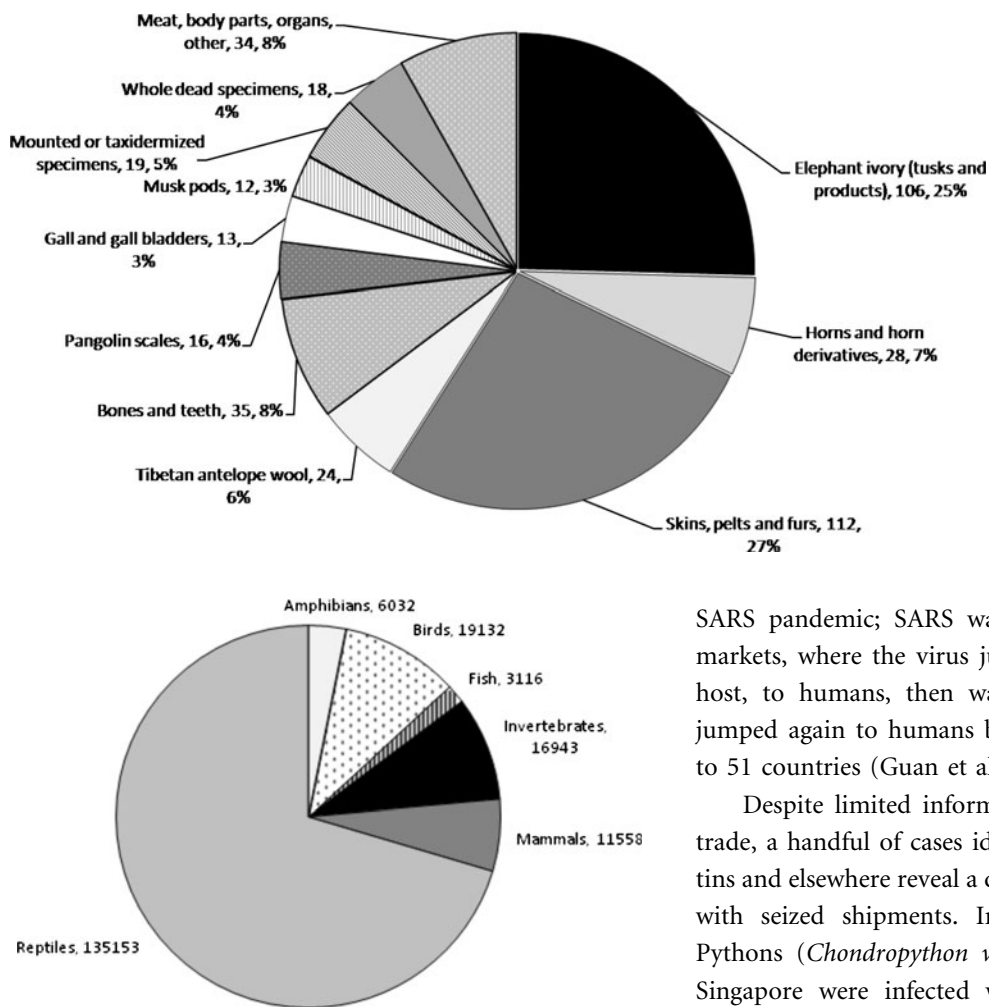


Figure 5. Total numbers and percentages of seized shipments of mammal products, 1996–2008. *Source:* TRAFFIC Bulletin.

Figure 6. Total live animals seized, by major taxonomic group, from 1996 to 2008. These numbers do not depict the total number of live animals seized, as a number of shipments did not have quantity data and some were recorded by weight rather than number. *Source:* TRAFFIC Bulletin.

nations implement adequate regulatory measures to assess the risk of pathogen introduction with imported wildlife (as opposed to livestock), and no coordinated international effort minimizes pathogen pollution through wildlife trade (Smith et al., 2009). In consequence, the legal wildlife trade provides several recent examples of the disease risks associated with the global movement of live animals. The legal wildlife trade resulted in the 2003 introduction of monkeypox virus to the USA when a shipment of infected African rodents was imported for sale in industry (Larkin, 2003). Trade in North American bullfrogs (*Rana catesbeiana*) facilitates worldwide spread of the deadly fungus chytridiomycosis, which is causing massive global amphibian loss (Schloegel et al., 2009). Additionally, the local wildlife trade in China was the source of the 2003

SARS pandemic; SARS was traced back to Chinese wet markets, where the virus jumped from bats, the reservoir host, to humans, then was amplified in civet cats and jumped again to humans before spreading internationally to 51 countries (Guan et al., 2003; Janies et al., 2008).

Despite limited information on wildlife in the illegal trade, a handful of cases identified in the TRAFFIC Bulletins and elsewhere reveal a diversity of pathogens associated with seized shipments. In one case, four Green Tree Pythons (*Chondropython viridis*) entering Australia from Singapore were infected with a previously undescribed pathogen called Wamena virus, which is potentially lethal in a wide range of poikilotherms, including fish, anurans, salamanders, turtles, tortoises, and snakes (TRAFFIC Bulletin; Hyatt et al., 2002). In the only entry in the TRAFFIC Bulletins in which a specific pathogen was named, 76 smuggled cockatoos entering the UK from Singapore were infected with psittacosis. Psittacosis is a zoonotic respiratory infection that causes severe pneumonia in humans and has a case-fatality rate of 10–15% if left untreated. Infection may also cause illness in wild and domestic birds and hoofstock (Smith et al., 2005). In a similar case in 1994, psittacosis caused atypical pneumonia in seven Customs officials who had contact with confiscated birds (De Schrijver, 1998). Other seizures contained birds infected with highly pathogenic avian influenza (HPAI), a zoonotic disease that causes significant mortality in wild birds and poultry, as well as human illness (Van Borm et al., 2005), and Newcastle disease, a virus that has the potential to decimate domestic poultry and native wild bird populations (Falcon, 2004). A study of smuggled houbara bustards (*Chlamydotis undulata*) found that the species is commonly

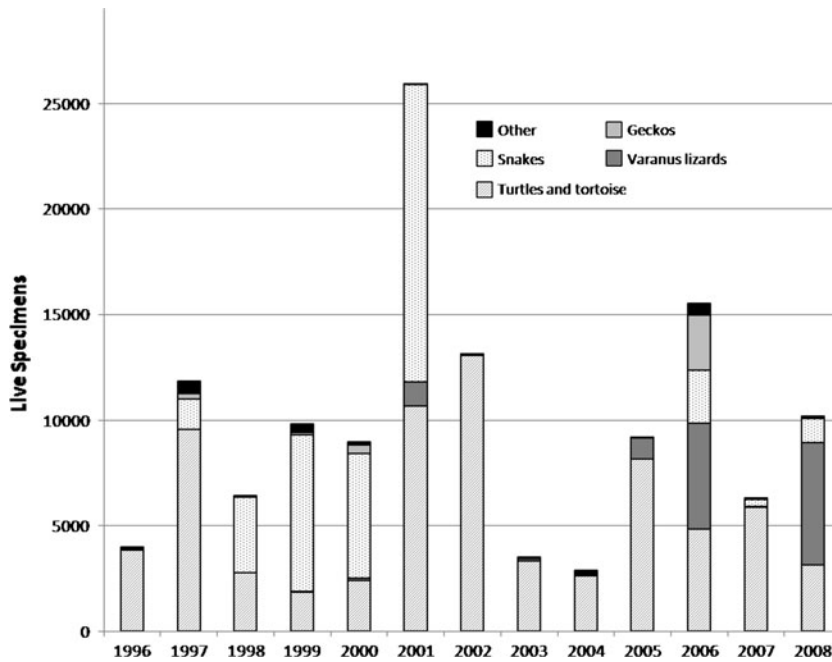


Figure 7. Seized live reptile specimens, 1996–2008, divided by taxonomic group. *Source:* TRAFFIC Bulletin.

Box 1.

Illegally traded wildlife is often creatively concealed. Customs officials have discovered live birds, eggs, and reptiles hidden inside ceramic garden gnomes, hollow books, computer hardware, a prosthetic leg, and passengers' clothing, including vests and underwear with pockets custom-designed for this purpose. Other shipments were hidden behind or among legal cargo; for example, the odor of two tonnes of dried seahorses was masked by bags of chili peppers. Still others, including four young gorillas, were transported with the aid of falsified documents. Ivory, in particular, is frequently disguised, often painted to resemble wood or marble.

Source: TRAFFIC Bulletin.

infected with a multitude of pathogens, including *Salmonella* and *Chlamydia* (Bailey et al., 1999). In spite of the diversity of infections that have been identified in wildlife seizures, most confiscated animals are never screened for pathogens, making it impossible to evaluate the true risk of pathogen pollution through the illegal wildlife trade. Nevertheless, we can identify some aspects of risk based on the geography of the trade and the taxonomic diversity of confiscated animals.

Despite the vast gaps in our knowledge of the true scope and scale of illegal wildlife trade, the best available evidence points to Southeast Asia as a hub of illegal activity (Fig. 2). The large number of illegal shipments originating in Southeast Asia is of particular interest since rapid

population growth, high population density, and high biodiversity make this region a “hotspot” for future emerging zoonoses (Jones et al., 2008). These demographic changes are linked to land use changes, which increase the risk of pathogen transmission between humans, wildlife, and domestic animals, and which may also expand disease vector habitats (Patz et al., 2004). Wildlife host species richness, meanwhile, is a strong independent predictor of zoonotic disease emergence (Jones et al., 2008). Additionally, many countries with high biodiversity and desirable specimens for trade also have high pathogen diversity (Hudson et al., 2006). They also tend to be developing nations (Balmford et al., 2002), where dire economic straits make income from wildlife collection extremely attractive (Roe, 2008), and corruption of enforcement officials is rampant (Balmford et al., 2002). The focus of illegal wildlife trade in a zoonotic disease “hotspot” multiplies the risk that future emerging zoonotic diseases will spread internationally. Moreover, poor infrastructure makes the prospect of disease outbreaks in this region especially dangerous (Weiss and McMichael, 2004).

Education, Enforcement, and Research

The tremendous volume of specimens being traded from Southeast Asia is also a great conservation concern. Large numbers of Southeast Asian turtles are sold in Chinese markets (Cheung and Dudgeon, 2006), but the wild populations are facing crisis (Sodhi et al., 2004). Similarly, the

tremendous quantity of tiger products, rhinoceros horn, and elephant ivory (Fig. 5) trafficked from India and African nations, and the more than 631,869 kg of fish seized by Customs officials represent only a part of the illegal trade, but these species all are in danger of extinction, with poaching representing a major threat (Amin et al., 2006; Dinerstein et al., 2007; Patrick and Damon-Randall, 2008; Wasser et al., 2008). Meanwhile, such large volumes suggest that the illegal trade is robust, and that enforcement efforts are only sporadically successful.

Biodiversity and ecosystem stability are effectively nonrenewable resources, and in a global economy, emerging infectious diseases do not respect national borders. The current state of the illegal wildlife trade is dangerous and destabilizing, and we cannot afford to ignore it. More resources must be devoted to investigating and regulating the illegal wildlife trade at local, regional, and international scales.

At the local scale, campaigns to educate consumers about illegal wildlife trade and its impact may help to reduce demand. Programs that encourage the people of target nations to invest in their natural resources can empower them economically, while benefiting conservation efforts.

At regional and national scales, nations without the independent capacity for enforcement will require help from other nations in the form of partnerships such as ASEAN-WEN, an intergovernmental initiative between 10 Southeast Asian governments to combat wildlife crime (ASEAN-WEN, 2009). In the long term, improving the economic stability of these nations will help to build the infrastructure necessary for effective enforcement and attenuate the economic factors driving much of the trade. To aid in enforcement at transit sites, dogs like those employed by field researchers tracking wildlife can be trained to sniff for wildlife in airports. Likewise, port officers should receive in-depth training to allow them to identify wildlife to the species level. This is a critical step in identifying shipments containing endangered species that are intentionally mislabeled. A “decision tree”-style computer program would be a vast improvement on current species identification guides and could be operated successfully by an officer with relatively little training. At the international scale, intergovernmental cooperation and information-sharing may be vital in stopping organized crime rings that exploit permeable borders and corruptible officials (Zimmerman, 2003).

Science also has applications in enforcement: DNA forensic techniques, like those used to trace seized ivory,

help enforcement officials target high-poaching areas, to stem the problem at its source. Additionally, definite knowledge of wildlife product origins exposes countries to international sanctions and pressures, forcing responsible government action on behalf of wildlife (Wasser et al., 2008). DNA forensics could be usefully applied to track tiger poachers in India, and identify reptiles entering the pet trade as wild-caught rather than captive-bred. While this approach is expensive, more successful enforcement and stiffer fines could help to offset the costs of DNA forensics. Finally, scientists can play a greater role in helping to thwart the trade by directing attention to its risks. Future research should examine the pathogens of popular traded species and their potential impact on ecosystems and public health. A more complete knowledge of the health and environmental threats posed by the global-scale illegal trade will help nations to guard against and respond to these potential impacts.

ACKNOWLEDGMENTS

We thank TRAFFIC for support with data collection. This project was supported by funding from a Brown University Undergraduate Training and Research Award (to G.E.R.).

REFERENCES

- Amin R, Thomas K, Emslie RH, Foose TJ, Van Strien N (2006) An overview of the conservation status of and threats to rhinoceros species in the wild. *International Zoo Yearbook* 40:96–117
- ASEAN-WEN (2009) www.asean-wen.org. Accessed 23 June 2009
- Balmford A, Bruner A, Cooper P, Costanza R, Farber S, Green RE, et al. (2002) Ecology—economic reasons for conserving wild nature. *Science* 297:950–953
- Bailey TA, Silvanose CD, Naldo J, Combreau O, Launay F, Wernery U, Kinne J, Gough R, Manvell R (1999) Health considerations of the rehabilitation of illegally traded houbara bustards *Chlamydotis undulata macqueenii* in the Middle East. European Association of Avian Veterinarians Conference, Italy, 1999
- Cheung SN, Dudgeon D (2006) Quantifying the Asian turtle crisis: market surveys in southern China, 2000–2003. *Aquatic Conservation: Marine and Freshwater Ecosystems* 16:751–770
- Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora (1973) [Text of the Convention]. <http://www.cites.org/eng/disc/text.shtml>. Accessed 2 June 2009
- Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora (1993) *Thirtieth Meeting of the Standing Committee, Brussels (Belgium). Summary Report*. <http://www.cites.org/eng/com/sc/30/E30-SumRep.pdf>. Accessed 23 June 2009

- Convention on International Trade in Endangered Species (CITES) of Wild Fauna and Flora (2007) *Interpretation and implementation of the Convention: compliance and enforcement issues. Fourteenth Meeting of the Conference of the Parties*. <http://www.cites.org/eng/cop/14/doc/E14-25.pdf>. Accessed 23 February 2010
- Cunningham A, Daszak P, Rodriguez JP (2003) Pathogen pollution: defining a parasitological threat to biodiversity conservation. *Journal of Parasitology* 89:S78–S83
- Daszak P, Cunningham AA, Hyatt AD (2000) Emerging infectious diseases of wildlife—threats to biodiversity and human health. *Science* 287:443–449
- De Schrijver K (1998) A psittacosis outbreak in customs officers in Antwerp (Belgium). *Bulletin of the Institute of Maritime and Tropical Medicine in Gdynia* 49:97
- Dinerstein E, Louks C, Wikramanayake E, Ginsberg J, Sanderson E, Seidensticker J, et al. (2007) The fate of wild tigers. *BioScience* 57:508–514
- Engler M, Parry-Jones R (2007) Opportunity or threat? The role of the European Union in global wildlife trade. Brussels, Belgium: TRAFFIC Europe, 52 pp
- Falcon MD (2004) Exotic Newcastle disease. *Seminars in Avian and Exotic Pet Medicine* 13:79–85
- Gómez A, Aguirre AA (2008) Infectious diseases and the illegal wildlife trade. *Annals of the New York Academy of Sciences* 1149:16–19
- Guan Y, Zheng BJ, He YQ, Liu XL, Zhuang ZX, Cheung CL, et al. (2003) Isolation and characterization of viruses related to the SARS coronavirus from animals in southern China. *Science* 302:276–278
- Hudson PJ, Dobson AP, Lafferty KD (2006) Is a healthy ecosystem one that is rich in parasites? *Trends in Ecology & Evolution* 21:381–385
- Hyatt A, Williamson M, Coupar B, Middleton D, Hengstberger S, Gould A, et al. (2002) First identification of a ranavirus from green pythons (*Chondropython viridis*). *Journal of Wildlife Diseases* 38:239–252
- Janies D, Habib F, Alexandrov B, Hill A, Pol D (2008) Evolution of genomes, host shifts and the geographic spread of SARS-CoV and related coronaviruses. *Cladistics* 24:111–130
- Jones KE, Patel NG, Levy MA, Storeygard A, Balk D, Gittleman JL, Daszak P (2008) Global trends in emerging infectious diseases. *Nature* 451:990–994
- Karesh WB, Cook RA, Bennett EL, Newcomb J (2005) Wildlife trade and global disease emergence. *Emerging Infectious Diseases* 11:1000–1002
- Larkin M (2003) Monkeypox spreads as US public-health system plays catch-up. *The Lancet Infectious Diseases* 3:461–461
- Li YM, Li DM (1998) The dynamics of trade in live wildlife across the Guangxi border between China and Vietnam during 1993–1996 and its control strategies. *Biodiversity and Conservation* 7:895–914
- McCusker R (2006) Transnational crime in the Pacific Islands: real or apparent danger. *Trends & Issues in Crime and Criminal Justice* 308:1–6
- Milledge SAH (2007) Illegal killing of African rhinos and horn trade, 2000–2005: the era of resurgent markets and emerging organized crime. *Pachyderm* 43:96–107
- Milliken T, Burn RW, Underwood F, Sangalakula L (2004) The Elephant Trade Information System (ETIS) and the illicit trade in ivory: a report to the 13th meeting of the Conference of the Parties. CoP13 Doc. 29.2, Annex. CITES Secretariat, Geneva, Switzerland
- Paquette RS, Lapointe F-J (2007) The use of shell morphometrics for the management of the endangered malagasy radiated tortoise (*Geochelone radiata*). *Biological Conservation* 134:31–39
- Patrick WS, Damon-Randall K (2008) Using a five-factored structured decision analysis to evaluate the extinction risk of Atlantic sturgeon (*Acipenser oxyrinchus oxyrinchus*). *Biological Conservation* 141:2906–2911
- Patz J, Daszak P, Tabor G, Aguirre A, Pearl M, Epstein J, et al. (2004) Unhealthy landscapes: policy recommendations on land use change and infectious disease emergence. *Environmental Health Perspectives* 112:1092
- Roe D (2008) Trading Nature: A Report, with Case Studies, on the Contribution of Wildlife Trade Management to Sustainable Livelihoods and the Millennium Development Goals. Cambridge, UK: TRAFFIC International; and Gland, Switzerland: WWF International, 84 pp
- Schloegel LM, Picco AM, Kilpatrick AM, Davies AJ, Hyatt AD, Daszak P (2009) Magnitude of the US trade in amphibians and presence of *Batrachochytrium dendrobatidis* and ranavirus infection in imported North American bullfrogs (*Rana catesbeiana*). *Biological Conservation* 142:1420–1426
- Smith K, Bradley K, Stobierski M, Tengelsen L (2005) Compendium of measures to control *Chlamydia psittaci* (formerly *Chlamydia psittaci*) infection among humans (psittacosis) and pet birds, 2005. *Journal of the American Veterinary Medical Association* 226:532–539
- Smith K, Behrens M, Schloegel L, Marano N, Burgiel S, Daszak P (2009) Reducing the risks of the wildlife trade. *Science* 324:594
- Sodhi NS, Koh LP, Brook PW, Ng PKL (2004) South East Asian biodiversity: an impending disaster. *Trends in Ecology & Evolution* 19:654–660
- TRAFFIC, The Wildlife Trade Monitoring Network (2008) *Our work: wildlife trade*. <http://www.traffic.org/trade/>. Accessed 2 June 2009
- Van Borm S, Thomas I, Hanquet G, Lambrecht B, Boschmans M, Dupont G, et al. (2005) Highly pathogenic H5N1 influenza virus in smuggled eagles, Belgium. *Emerging Infectious Diseases* 11:702–705
- Vitousek PM, Dantonio CM, Loope LL, Westbrooks R (1996) Biological invasions as global environmental change. *American Scientist* 84:468–478
- Wasser SK, Clark WJ, Drori O, Kisamo ES, Mailand C, Mutayoba B, et al. (2008) Combating the illegal trade in African elephant ivory with DNA forensics. *Conservation Biology* 22:1065–1071
- Weiss RA, McMichael AJ (2004) Social and environmental risk factors in the emergence of infectious diseases. *Nature Medicine* 10:S70–S76
- Wilcove DS, Rothstein D, Dubow J, Phillips A, Losos E (1998) Quantifying threats to imperiled species in the United States. *BioScience* 48:607–615
- World Society for the Protection of Animals (WSPA) (2007) *WSPA and Animal Planet take on the illegal wildlife trade*. <http://www.wspa.org.uk/latestnews/2007/animalplanetillegal.aspx>. Accessed 2 June 2009
- World Society for the Protection of Animals (WSPA) (2008) *WSPA urges Vietnam to stay on track to end bears suffering in bear farms*. http://www.wspa.org.uk/latestnews/2008/wspa_urges_vietnam.aspx. Accessed 24 June 2009

Wyler L, Sheikh P (2008) International illegal trade in wildlife: threats and U.S. policy. CRS Report for Congress, March 3, 2008, 49 pp

Zimmerman ME (2003) The black market for wildlife: combating transnational organized crime in the illegal wildlife trade. *Vanderbilt Journal of Transnational Law* 36:1657–1689