ZOONOTIC DISEASES: USING ENVIRONMENTAL LAW TO REDUCE THE ODDS OF A FUTURE EPIDEMIC

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Note

I. INTRODUCTION

SARS. AIDS. Ebola. These viruses have caused some of the most feared epidemics in modern history, and they all originated in animals.[1] Zoonotic diseases,[2] also known as "zoonoses,"[3] are diseases that can be transmitted between humans and animals. Approximately seventy-five percent of current emerging infectious diseases are zoonotic, and approximately sixty percent of all known human pathogens originated

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[1] David Quammen, *Disease: The Next Big One*, N.Y. TIMES, Oct. 14, 2013, http://www.nytimes.com/2013/10/15/opinion/disease-the-next-big-one.html.

[2] Peter Daszak et al., *Emerging Infectious Diseases of Wildlife—Threats to Biodiversity and Human Health*, 287 SCIENCE 443, 446 (2000).

[3] *Zoonoses and the Human-Animal-Ecosystems Interface*, WORLD HEALTH ORG., http://www.who.int/zoonoses/en/ (last visited Jan. 23, 2015).

in animals.[4] Despite the widespread awareness of such diseases,[5] we remain extremely vulnerable to many zoonoses. Almost twenty thousand people contracted the Ebola virus in 2014.[6] Some analyses predict that hundreds of thousands of people will be infected before the outbreak ends.[7] Previous zoonotic epidemics have had even more dire results: during the flu season of 1918–19, fifty million people died.[8] Little is known about the transmissibility and lethality of new viruses at the beginning of an outbreak, and there is always a chance that the latest outbreak will become "the next big one."[9]

Our legal system can take steps to address this threat. This note proposes different ways that we can use environmental laws to reduce the likelihood of future zoonotic outbreaks. Part II provides a scientific background on zoonotic diseases. Part III explores what factors increase the frequency of zoonotic infections, in both animal and human populations. Part IV examines laws that currently address zoonotic diseases and how they focus on responding efficiently to existing outbreaks. Part V proposes new legal frameworks to help combat the spread of zoonotic diseases by emphasizing the prevention of future outbreaks. Part VI concludes with recommendations on how different regulatory authorities in the United States can meet the risk posed by zoonotic diseases.

II. WHAT ARE ZOONOTIC DISEASES?

When a pathogen that has previously only existed in animals is transmitted to a human, the event is called a "spillover,"[10] and the pathogen becomes a zoonotic disease. If the pathogen successfully adapts to a human host, becomes established in a local human

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[4] CTRS. FOR DISEASE CONTROL & PREVENTION, ZOONOTIC DISEASE: WHEN HUMANS AND ANIMALS INTERSECT 2 (2011), *available at* http://www.cdc.gov/24-7/pdf/zoonotic-disease-factsheet.pdf.

[5] Tyson Wanjura, *International Standards for Managing Emerging and Re-Emerging Zoonoses of Public Health Significance: A Call for Horizontal Collaboration Between Intergovernmental Organizations*, 41 INT'L LAW. 975, 976 (2007).

[6] *Ebola Facts: Where Are the Most New Cases Being Reported?*, N.Y. TIMES, Dec. 5, 2014, http://www.nytimes.com/interactive/2014/07/31/world/africa/ebola-virus-outbreak-qa.html.

[7] Denise Grady, *U.S. Scientists See Long Fight Against Ebola*, N.Y. TIMES, Sept. 12, 2014, http://www.nytimes.com/2014/09/13/world/africa/us-scientists-see-long-fight-against-ebola.html?_r=0.

[8] U.S. Dep't of Health and Human Servs., *Pandemic Flu History*, FLU.GOV, http://www.flu.gov/pandemic/history/ (last visited Jan. 23, 2015).

[9] *See* Quammen, *supra* note 1.

[10] Daszak et al., *supra* note 2, at 444.

population, and spreads, the disease has then "emerged."[11] Many zoonotic diseases that spill over hit dead ends and are unable to successfully emerge. For instance, a pathogen may infect humans inconsistently and require individuals to be exposed to a large amount of the pathogen before infection becomes likely.[12] Alternatively, a pathogen may be very infectious, able to infect someone with just a tiny exposure (i.e. an accidental pin prick in a lab), but the pathogen could still fail to be very contagious.[13] A contagious disease is one that is able to spread easily from person to person.[14] Ebola, for example, is extremely infectious (researchers have contracted the virus from pin pricks in a lab),[15] but it is not very contagious, as it requires direct exposure to blood or tissue in order to infect someone.[16]

Organizations like the Centers for Disease Control and Prevention ("CDC") closely monitor diseases that are infectious and highly lethal but have not yet become significantly contagious, like avian flu.[17] The lethal H5N1 strain of avian flu has shown a very limited ability to be transmitted between humans.[18] However, influenza viruses mutate frequently, increasing the odds of the virus hitting upon a genetic combination that is highly lethal, infectious, and contagious.[19]

There is a certain random aspect to zoonoses. The avian flu could become a global pandemic, or it could not.[20] Simian Immunodeficiency Virus ("SIV") spilled over into humans at least twelve times before taking hold and creating the global Acquired Immune Deficiency Syndrome ("AIDS") pandemic.[21]

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[11] Stephen S. Morse, *Factors in the Emergence of Infectious Diseases*, 1 EMERGING INFECTIOUS DISEASES 7 (1995).

[12] *See* DAVID QUAMMEN, SPILLOVER 98 (2012).

[13] *Id.*

[14] *Id.*

[15] *Id.* at 97–100.

[16] *Ebola Virus Disease*, WORLD HEALTH ORG., http://www.who.int/mediacentre/factsheets/fs103/en/index.html (last visited Jan. 23, 2015).

[17] *See Public Health Threat of Highly Pathogenic Avian Influenza A (H5N1) Virus*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/flu/avianflu/h5n1-threat.htm (last updated June 22, 2012).

[18] *See id.*

[19] QUAMMEN, *supra* note 12, at 506–11.

[20] H5N1 has been found in over sixty countries and persists in bird populations despite its lethality. Whether or not it can start a pandemic depends in large part on its ability to mutate into a form that is more infectious and transmissible between humans. *See* Donald G. McNeil, Jr., *A Pandemic That Wasn't but Might Be*, N.Y. TIMES, Jan. 22, 2008, http://www.nytimes.com/2008/01/22/science/22flu.html?pagewanted=all&_r=0.

[21] QUAMMEN, *supra* note 12, at 407.

Once a zoonotic disease has emerged, it is harder to eliminate than a non-zoonotic disease.[22] Non-zoonotic diseases, like polio, can be eradicated entirely if vaccinations are made available to an entire population at a given time.[23] In the case of zoonotic diseases, even if an entire human population is vaccinated, the disease would persist in animal populations. This leaves open the possibility of future infections through spillovers.[24]

Animals that consistently carry zoonotic diseases are called "reservoir hosts."[25] Reservoir hosts may or may not become sick from the disease they carry,[26] and it can often be difficult to determine which species is the reservoir host for a given disease.[27] A reservoir host may infect humans directly, or the disease may need to go through an "amplifier host" to effectively reach humans.[28] For example, from 2004–2005 a number of Bangladeshis became infected with Nipah virus by drinking sap that contained bat excrement.[29] The flying fox bat is a reservoir for Nipah virus,[30] so scientists were able to find a direct connection between the reservoir host and the disease, although it still took time to figure out that the link between the hosts and the victims involved drinking fresh sap.[31] Flying fox bats are also a reservoir for Hendra virus,[32] but bats cannot directly infect humans with Hendra.[33] Instead, bats can infect horses with Hendra virus, and the horses "amplify" the disease, so that symptomatic horses can then infect humans with Hendra.[34] Because amplifier hosts can pose a greater immediate risk to humans than reservoir hosts, amplifier hosts are sometimes identified and slaughtered in large numbers by national

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22 QUAMMEN, *supra* note 12, at 517–18.

23 *See id.*; *Updates on CDC's Polio Eradication Efforts*, CTRS. FOR DISEASE CONTROL & PREVENTION, (Jan. 23, 2015) http://www.cdc.gov/polio/updates/.

24 QUAMMEN, *supra* note 12, at 518.

25 Daszak et al., *supra* note 2, at 446.

26 For years scientists believed SIV did not make chimpanzees sick, but they eventually discovered that chimpanzees can get sick and die from the simian version of AIDS. Lawrence K. Altman, *Study Finds Chimps Die From Simian AIDS, Dispelling Widely Held Belief*, N.Y. TIMES, July 22, 2009, http://www.nytimes.com/2009/07/23/science/23chimp.html.

27 *See, e.g.*, QUAMMEN, *supra* note 12, at 191–95.

28 QUAMMEN, *supra* note 12, at 36.

29 Stephen F. Luby et al., *Foodborne Transmission of Nipah Virus, Bangladesh*, 12 EMERGING INFECTIOUS DISEASES 1888, 1892 (2006).

30 *Id.* at 1888.

31 QUAMMEN, *supra* note 12, at 328–29.

32 *Id.* at 32.

33 *See Hendra Virus (HeV) Infection*, WORLD HEALTH ORG., http://www.who.int/csr/disease/hendra/en/ (last visited Jan. 23, 2015).

34 *See id.*

governments.[35] While this may be temporarily effective in reducing the number of infections, it does not address the problem of spillovers directly.

III. FACTORS THAT INCREASE THE LIKELIHOOD OF SPILLOVERS

A. Increased Exposure to Wild Animals

Some zoonotic diseases, such as Lyme disease, infect humans on a regular basis.[36] Ticks carrying Lyme disease exist in many populated parts of the U.S.,[37] making it virtually impossible for humans to avoid their habitat. In other parts of the world, it is aggressive exploration of relatively unpopulated areas, rather than consistent contact with populated areas, that creates new opportunities for spillovers. In 2007 and 2008, two tourists contracted Marburg Hemorrhagic Fever after visiting a remote attraction called "Python Cave" in Uganda.[38] While the cave is known for its African rock pythons, it is also home to a large Egyptian fruit bat population.[39] Egyptian fruit bats are a reservoir for Marburg virus,[40] and their guano covers the cave.[41] But for their trip into the cave, it is highly unlikely the tourists would have been significantly exposed to the fruit bats and thus infected with Marburg virus.

In many parts of the world, wild animals are enthusiastically hunted for their meat. In China, there was a recent "wild flavor" movement in which wild animal delicacies surged in popularity.[42] The growth in demand for wild animal meat led to increased wild animal hunting, and consequently, more people came into contact with wild animals at the market or in restaurants.[43] When SARS (severe acute respiratory

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[35] For example, in Malaysia, pigs were identified as an amplifier species for Nipah virus, and 1.1 million pigs were killed between September 1998 and May 1999. ANIMAL PROD. & HEALTH COMM'N FOR ASIA & THE PAC., FOOD AND AGRIC. ORG. OF THE U.N., MANUAL ON THE DIAGNOSIS OF NIPAH VIRUS INFECTION IN ANIMALS 2 (Hume Field et al. eds., 2002), *available at* ftp://ftp.fao.org/docrep/fao/005/ac449e/ac449e00.pdf.

[36] *See Reported Cases of Lyme Disease by Year*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/lyme/stats/chartstables/casesbyyear.html (last visited Jan. 23, 2015).

[37] *Lyme Disease Transmission*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/lyme/transmission/index.html (last visited Jan. 23, 2015).

[38] Brian R. Amman et al., *Seasonal Pulses of Marburg Virus Circulation in Juvenile* Rousettus Aegyptiacus *Bats Coincide with Periods of Increased Risk of Human Infection*, PLOS PATHOGENS, Oct. 2012, at 1, 2.

[39] *Id.*

[40] *Id.*

[41] QUAMMEN, *supra* note 12, at 359–61.

[42] *See* QUAMMEN, *supra* note 12, at 187–88.

[43] *See* QUAMMEN, *supra* note 12, at 188–89.

syndrome) broke out in Hong Kong, the source of the disease was unclear.[44] One microbiologist suspected a zoonosis, and he swabbed a variety of animals at a Hong Kong wild animal market.[45] Several of the animals were infected with SARS.[46] Five hundred animals at the market were slaughtered, and the number of new SARS cases declined soon thereafter as that particular "infection chain" was cut off.[47] Wild animal markets are also popular in parts of Africa, where thousands of pounds of wild animal meat can pass through a single market every week.[48] These markets can include illegal ape and chimpanzee meat[49] potentially infected with SIV or Ebola.[50]

Increased exposure to wild animals may also be incidental, as people seek to clear forest and develop land. On the island of Borneo, for example, there has been a high rate of deforestation[51] that is destroying the habitat of many animals, including long-tailed macaques.[52] Many of the macaques carry a particularly dangerous strain of malaria called *P. knowlesi*.[53] *P. knowlesi* is spread by a certain type of mosquito that lives in the deep forests of Borneo.[54] As people increasingly enter[55] and cut down Borneo's forests, there are more chances for infected macaques and mosquitos to infect humans. There is also the risk that as people make themselves more readily available to the forest mosquitos while simultaneously eliminating the habitat of the macaques. The mosquitos may take to biting humans more regularly and infecting large numbers of people with the *P. knowlesi* strain of malaria, even potentially causing *P. knowlesi* to adapt to humans as its new primary host.[56]

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[44] Katie Hunt, *SARS Legacy Still Felt in Hong Kong, 10 Years On*, BBC NEWS (March 19, 2013), http://www.bbc.co.uk/news/world-asia-china-21680682.

[45] QUAMMEN, *supra* note 12, at 189.

[46] *Id.*

[47] Emily Tsang, *Scientists Warn of More Serious Disease Threats than SARS*, S. CHINA MORNING POST, Feb. 21, 2013, http://www.scmp.com/news/hong-kong/article/1154871/scientists-warn-more-serious-disease-threats-sars.

[48] QUAMMEN, *supra* note 12, at 451.

[49] *Id.* at 452.

[50] Robin A. Weiss & Jonathan L. Heeney, *HIV Can Kill Chimps*, 460 NATURE 470, 471 (2009).

[51] QUAMMEN, *supra* note 12, at 161.

[52] *Id.*

[53] *Id.* at 160–62.

[54] Janet Cox-Singh & Balbir Singh, *Knowlesi Malaria: Newly Emergent and of Public Health Importance?*, 24 TRENDS IN PARASITOLOGY 406, 407 (2008).

[55] In addition to developers, Borneo's forests also attract backpacking tourists. *See, e.g.*, Ulf Bronner et al., *Swedish Traveller with Plasmodium Knowlesi Malaria After Visiting Malaysian Borneo*, 8 MALARIA J. 15 (2009).

[56] *See* QUAMMEN, *supra* note 12, at 161–62.

B. Higher Incidence of Disease in Animal Populations

Regardless of how frequently humans and animals come into contact, if the majority of the animals we interact with are sick, a spillover becomes much more likely than if we were interacting with a healthy animal population. Some of the activities that lead to increased contact with animals also lead to a higher incidence of disease within animal populations. Before the 2003 SARS outbreak in Hong Kong, it was typical for wild animals at markets to be held in tiny wire cages. These cages were stacked vertically so that each animal's excrement simply fell down onto the animal below.[57] Even an animal that entered the market healthy did not necessarily stay healthy for long. Cramped, unhygienic conditions have similarly proved problematic in industrial settings featuring traditional livestock.[58] The stress and poor sanitation can make animals more susceptible to illness and can facilitate the spread of infections.[59]

Extensive development encroaching on animal habitats can lead to wild animals coming out of their habitats and coming into contact with humans more frequently, as described above with the forest mosquitos and long-tailed macaques of Borneo. Another worrisome scenario is if the animals remain in their diminished habitats. What used to be one large unified population can find itself divided into several different populations, with towns or cities in between them. This scenario can lead to animal populations that periodically have an extremely high incidence of disease.[60] Normally, when a potent infectious disease moves through a population, it infects the susceptible individuals, kills some of them, and leaves behind a large number of newly immune individuals.[61] The next time the disease comes through, there are far fewer susceptible individuals to infect, because most of the population has already been exposed to the disease and had a chance to develop an

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[57] *Id.* at 189.

[58] *See, e.g.*, RANALD D. A. CAMERON, A REVIEW OF THE INDUSTRIALIZATION OF PIG PRODUCTION WORLDWIDE WITH PARTICULAR REFERENCE TO THE ASIAN REGION (2000), *available at* http://www.fao.org/ag/againfo/resources/en/publications/agapubs/awi_concept_pig_product.pdf.

[59] *See id.*; QUAMMEN, *supra* note 12, at 218. As a biologist explained in the context of psittacosis (parrot fever), wild bird populations might carry a latent infection, without harm to themselves or humans, but when "birds are crowded into small spaces, with inadequate food and sunlight, their latent infection is lit up." Once the pathogen is multiplying in their system and the birds become symptomatic, the infection spreads much more readily. QUAMMEN, *supra* note 12, at 218.

[60] QUAMMEN, *supra* note 12, at 367–68.

[61] *Id.*

immunity.[62] If the disease visits the population on a regular basis, the number of susceptible members stays fairly low.[63] However, if the population is isolated, there are relatively few chances for the disease to re-enter the population.[64] If the disease comes through only very rarely, when it does, a majority of the population is likely to be susceptible.[65] The result is an animal population where a majority of the animals can become suddenly sick with a potent infectious disease in close proximity to cities or towns.

One additional way development can increase the incidence of disease is by killing off or driving away predators. With Lyme disease, "forest fragments" smaller than three acres have been found to hold three times as many ticks as larger areas of forest, and contain seven times as many infected ticks.[66] The smaller forest areas do not support predators well, but they do support small mammals like white-footed mice.[67] White-footed mice are very efficient at harboring and transmitting Lyme disease, and they often provide blood meals to young ticks.[68] The ticks get Lyme disease from the mice, and if a person becomes the tick's next blood meal, the tick passes Lyme disease onto that person.[69] If the land were not subdivided into "forest fragments," predators would limit the number of white-footed mice, forcing ticks to feed on other mammals that are not such capable hosts for Lyme disease (such as deer, which actually clear the disease fairly quickly)[70] thereby limiting the number of infected ticks and the overall tick population size.[71]

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[62] *See id.*

[63] *Id.*

[64] *Id.*

[65] *Id.*

[66] Brian F. Allan et al., *Effect of Forest Fragmentation on Lyme Disease Risk*, 17 CONSERVATION BIOLOGY 267, 269 (2003).

[67] *Id.* at 270.

[68] Kelly Slivka, *Predators, Prey and Lyme Disease*, N.Y. TIMES GREEN BLOG (June 18, 2012), http://green.blogs.nytimes.com/2012/06/18/predators-prey-and-lyme-disease/; QUAMMEN, *supra* note 12, at 257.

[69] QUAMMEN, *supra* note 12, at 253.

[70] Slivka, *supra* note 68.

[71] QUAMMEN, *supra* note 12, at 257.

IV. THE CURRENT LEGAL FRAMEWORK ADDRESSING ZOONOTIC DISEASES

Countries around the world are aware of the threat posed by zoonotic diseases.[72] Efforts have been focused primarily on monitoring and reacting quickly to outbreaks. The World Health Organization ("WHO"), World Organization for Animal Health, and the Food and Agriculture Organization of the United Nations run a Global Early Warning System ("GLEWS") to detect outbreaks quickly and coordinate the response of the three organizations.[73] In 2005, after the SARS and avian flu epidemics in Asia, WHO adopted a new set of International Health Regulations ("IHR") with the goal of detecting and responding to outbreaks of infectious diseases faster than ever before.[74] Some commentators have objected to WHO's efforts as creating unduly heavy burdens on certain member countries who cannot afford sophisticated public health systems.[75] However, given that many of the most dangerous outbreaks in recent memory have occurred in less developed countries,[76] there is arguably greater need to spend money on public health systems precisely in the countries that can least afford it. The 2014–2015 Ebola outbreak might not have become the largest Ebola outbreak in history[77] if the outbreak had been identified sooner, or if the response had not been hindered by the lack of such basic medical equipment as protective gowns and gloves.[78]

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[72] *See, e.g.*, Press Release, World Trade Org., International Bodies Join Forces to Advise OIE Animal Health and Welfare Fund (Nov. 1, 2006), *available at* http://www.wto.org/english/news_e/pres06_e/pr456_e.htm.

[73] *About Glews*, GLEWS, http://www.glews.net/about-glews/ (last visited Jan. 23, 2015).

[74] Press Release, World Health Org., *World Health Assembly Adopts New International Health Regulations* (May 25, 2005), *available at* http://www.who.int/mediacentre/news/releases/2005/pr_wha03/en/index.html. China's reaction to the SARS outbreak in 2003 was criticized widely at the time for being slow and deliberately opaque about the details and extent of the crisis. *See* Willy Wo-Lap Lam, *China Pledges to Tell SARS 'Truth'*, CNN (Apr. 14, 2003), http://www.cnn.com/2003/WORLD/asiapcf/east/04/13/china.wen/.

[75] Eric Mack, *The World Health Organization's New International Health Regulations: Incursion on State Sovereignty and Ill-Fated Response to Global Health Issues*, 7 CHI. J. INT'L L. 365, 371 (2006).

[76] Two such examples are the Nipah outbreaks in Malaysia from 1998 to 1999 and the Nipah outbreaks in Bangladesh that have been occurring sporadically since 2001. Michael K. Lo et al., *Characterization of Nipah Virus from Outbreaks in Bangladesh, 2008–2010*, 18 EMERGING INFECTIOUS DISEASES 248 (2012).

[77] *2014 Ebola Outbreak in West Africa*, CTRS. FOR DISEASE CONTROL & PREVENTION (Sept. 12, 2014), http://www.cdc.gov/vhf/ebola/outbreaks/guinea/index.html.

[78] Sheri Fink, *Cuts at W.H.O. Hurt Response to Ebola Crisis*, N.Y. TIMES, Sept. 3, 2014, http://www.nytimes.com/2014/09/04/world/africa/cuts-at-who-hurt-response-to-ebola-crisis.html.

The United States has few statutes that address zoonoses. The Commissioner of Food and Drugs, the Director of the CDC, and the Secretary of Agriculture are charged with the surveillance of zoonotic diseases.[79] Congress has authorized agencies to spend money on detecting zoonotic diseases in our food and livestock,[80] and to control animals that may be reservoirs for zoonoses.[81] The CDC addresses zoonoses most directly, through their National Center for Emerging and Zoonotic Infectious Diseases ("NCEZID").[82] NCEZID tracks both relatively routine zoonotic diseases, such as salmonella infections from chickens, and more exotic outbreaks, such as cases of Hantavirus in Yosemite National Park.[83] NCEZID also coordinates with the Food and Drug Administration ("FDA") and the Department of Agriculture's Food Safety and Inspection Service ("USDA-FSIS") to maintain surveillance of foodborne diseases including zoonotic diseases such as salmonella and E. coli.[84]

The Department of Agriculture's Animal and Plant Health Inspection Service ("APHIS") examines agricultural products, animals, and animal products that come into the U.S., but there is not a particularly strong focus on screening for zoonotic diseases.[85] The U.S. is one of the world's largest importers of wild animals, but we screen only certain types of animals and require testing for a very small number of diseases.[86] The CDC is especially aware of the risk of zoonoses from primates and strictly limits the importation of primates to those acquired for scientific, educational, and exhibition purposes.[87]

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[79] 7 U.S.C. § 8319 (2012).

[80] 21 U.S.C. § 399 (2012); 21 U.S.C. § 113a (2012).

[81] 7 U.S.C. § 426c (2012).

[82] *See National Center for Emerging and Zoonotic Infectious Diseases*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/ncezid/ (last visited Jan. 23, 2015).

[83] *Outbreak of Hantavirus Infection in Yosemite National Park*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/hantavirus/outbreaks/yosemite-national-park-2012.html (last visited Jan. 23, 2015); *CDC Current Outbreak List*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/outbreaks/ (last visited Jan. 23, 2015).

[84] *Foodborne Diseases Active Surveillance Network (FoodNet)*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/foodnet/about.html (last visited Jan. 23, 2015).

[85] *See* ANIMAL & PLANT HEALTH INSPECTION SERV., U.S. DEP'T OF AGRIC., IMPORTING FOOD AND AGRICULTURAL PRODUCTS INTO THE UNITED STATES, (Aug. 2012), *available at* http://www.aphis.usda.gov/publications/plant_health/2012/fs_imp_food_ppq.pdf.

[86] Boris I. Pavlin et al., *Risk of Importing Zoonotic Diseases Through Wildlife Trade, United States*, 15 EMERGING INFECTIOUS DISEASES 1721 (2009).

[87] *Final Rule on Regulations for the Importation of Nonhuman Primates*, CTRS. FOR DISEASE CONTROL & PREVENTION (Apr. 16, 2013), http://www.cdc.gov/animalimportation/lawsregulations/nonhuman-primates/nprm/index.html.

The USDA-FSIS is responsible for inspecting meat within the U.S., though their focus is also not primarily on zoonotic diseases, but on making sure that meat for human consumption is not "adulterated" in a more general sense.[88] The USDA has the authority pursuant to the Animal Welfare Act to regulate the treatment of warm-blooded animals used for research or sold as pets, but the Act explicitly excludes livestock.[89] Therefore livestock can be put into stressful, unsanitary environments that increase the risk of disease so long as the risk does not cross the line into making meat "adulterated." Some states have sought to address this gap by passing bills that address the welfare of livestock raised on commercial farms.[90]

Recently, the FDA proposed for the first time a rule that would regulate the production of livestock feed and make sure the feed is safe for animals to eat.[91] However, the larger concern in the media has been over the use of antibiotics in livestock feed.[92] Approximately eighty percent of all antibiotics sold in the U.S. end up on farms, where they are fed routinely to livestock to keep them from becoming sick and to promote weight gain.[93] The constant presence of antibiotics in livestock encourages the development of antibiotic-resistant diseases, which may in turn spill over into humans.[94] Some European countries have recognized this risk and taken steps to curb the use of antibiotics in livestock,[95] but the U.S. so far has pursued only voluntary measures for pharmaceutical companies.[96]

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[88] *See* 21 U.S.C. § 604 (2012). "Adulterated" has a broad definition in 21 U.S.C. § 601(m) (2012), including meat containing any substances that may be "injurious to [human] health."

[89] 7 U.S.C. § 2143 (2012) in conjunction with 7 U.S.C. § 2132(g) (2012) define "animal" to exclude any animal that is intended to be used for food.

[90] *See* Craig A. Wenner, *Judicial Review and the Humane Treatment of Animals*, 86 N.Y.U. L. Rev. 1630, 1639 (2011) (detailing a number of recently passed state bills).

[91] Sabrina Tavernise, *F.D.A. Bids to Regulate Animal Food, Acting After Recall and Deaths*, N.Y. TIMES, Oct. 25, 2013, http://www.nytimes.com/2013/10/26/health/fda-moves-to-regulate-food-for-animals.html; Current Good Manufacturing Practice and Hazard Analysis and Risk-Based Preventive Controls for Food for Animals, 78 Fed. Reg. 64735 (proposed Oct. 29, 2013) (to be codified at 21 C.F.R. pts. 16, 225, 500, 507, 579).

[92] *See* Matthew Perrone, *FDA Wants Limits on Antibiotics Given to Animals*, NBC NEWS (Apr. 11, 2012), http://www.nbcnews.com/id/47017555/#.UpDVBBZ1JFQ.

[93] *Id.*

[94] *See* Dan Ferber, *From Pigs to People: The Emergence of a New Superbug*, 329 SCIENCE 1010, 1011 (2010).

[95] In Denmark, for example, farmers need to report each time they administer antibiotics to their livestock. *See* Julia Koch, *Cutting Antibiotics: Denmark Leads Way in Healthier Pig Farming*, DER SPIEGEL ONLINE (Nov. 13, 2013), http://www.spiegel.de/international/europe/danish-pig-farmers-reduce-antibiotics-to-prevent-drug-resistance-a-933344.html.

[96] Sabrina Tavernise, *F.D.A. Restricts Antibiotics Use for Livestock*, N.Y. TIMES, Dec. 11, 2013, http://www.nytimes.com/2013/12/12/health/fda-to-phase-out-use-of-some-antibiotics-in-

The Environmental Protection Agency ("EPA") has some authority over concentrated animal feeding operations ("CAFOs").[97] The EPA can require permits via the Clean Water Act for all discharges (including manure) from farms with more than one thousand "animal units."[98] However, fewer than ten thousand of the nation's 1.1 million livestock farms have been subject to the permitting program.[99] Manure can contain zoonotic pathogens, which travel readily once they are introduced to a water source.[100] The EPA is aware of the risk of zoonotic diseases from manure,[101] but the zoonotic threat is not the focus of its regulations.[102]

Other countries have tried to address zoonotic diseases directly, with limited success. China prohibits the hunting of certain wild animals, but despite steep fines and the previous discovery of SARS in wild animal markets, many wild animals still find their way onto expensive menus in China.[103] Various African countries have different types of restrictions on "bushmeat" hunting,[104] but it is estimated that 579 million wild

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animals-raised-for-meat.html (reporting that the FDA asked drug makers to alter antibiotic labels so that they would bar farmers from using the drugs to promote growth).

97 ROBERT V. PERCIVAL ET AL., ENVIRONMENTAL REGULATION: LAW, SCIENCE, AND POLICY 696 (6th ed. 2009).

98 *Id.* An "animal unit" is the size of a slaughter steer or stock cow, so approximately thirty chickens is only one "animal unit." *See, e.g.*, *Animal Unit Calculation Worksheet*, MINN. DEP'T OF AGRIC., http://www.mda.state.mn.us/animals/feedlots/feedlot-dmt/feedlot-dmt-animal-units.aspx.

99 PERCIVAL ET AL., *supra* note 97, at 696.

100 *See* Charles Duhig, *Health Ills Abound as Farm Runoff Fouls Wells*, N.Y. TIMES, Sept. 17, 2009, http://www.nytimes.com/2009/09/18/us/18dairy.html (describing one town where residents had to dig new wells when agricultural runoff contaminated their existing wells).

101 *See* U.S. ENVTL. PROT. AGENCY, EPA/600/R-04/042, RISK MANAGEMENT EVALUATION FOR CONCENTRATED ANIMAL FEEDING OPERATIONS, 35–36 (2004), http://nepis.epa.gov/Adobe/PDF/901V0100.pdf.

102 *See Concentrated Animal Feeding Operations: Objectives*, U.S. ENVTL. PROT. AGENCY, http://www.epa.gov/ada/gw/cafos.html (last updated Aug. 5, 2014) (noting a focus on surface water quality, nitrogen, and hormones). *See also* U.S. ENVTL. PROT. AGENCY, CONSOLIDATED CONCENTRATED ANIMAL FEEDING OPERATIONS (CAFO) REGULATIONS (2008), *available at* http://www.epa.gov/npdes/regulations/cafo_final_rule2008_comp.pdf.

103 Capturing or killing endangered animals carries a sentence of up to ten years in prison in China. *See* Michelle FlorCruz, *China Cracks Down on Monkey Brain and Other Wild Animal Delicacies*, INT'L BUS. TIMES, Dec. 3, 2012, http://www.ibtimes.com/china-cracks-down-monkey-brain-other-wild-animal-delicacies-916161.

104 "Bushmeat" refers to wild animals such as elephants and hippos that are hunted illegally. P. LINDSEY ET AL., WILDLIFE CONSERVATION SOC'Y, ILLEGAL HUNTING & THE BUSHMEAT TRADE IN SAVANNA AFRICA 4, 23 (2012). Bushmeat hunters often act illegally in that they lack the appropriate permits, hunt in protected areas, use prohibited hunting methods, or hunt endangered species. *Id.* at 15.

animals are caught and consumed in the Congo basin each year,[105] including as many as thirty different types of primates.[106] The chance of a spillover from primates is especially high, given the biological similarities between humans and other primates and the rudimentary butchering methods typically used on bushmeat.[107]

Laws that can help prevent spillovers, such as restrictions on hunting bushmeat, or inspections of imported and domestic meat, do not focus on zoonotic diseases as such. They may focus on overall health concerns, such as the many ways meat may become "adulterated,"[108] or on wholly unrelated concerns, such as wildlife conservation.[109] Some statutes therefore do not grant agencies the authority to address zoonoses, but others implicitly contain the authority in broadly worded health-based standards,[110] though the agency may choose not to exercise it. The laws and organizations that address zoonotic diseases directly are more concerned with how quickly we can react to zoonotic diseases.[111] They assume spillovers and new zoonotic diseases will continue to occur and that the best course of action is to enhance our public health systems worldwide so we may quickly isolate and treat new outbreaks wherever they may occur.[112] However, this is arguably too fatalistic an outlook. Spillovers and car accidents both have a random aspect to them, but we prohibit drunk driving because it obviously increases the chances of a car accident. The following part introduces preventative approaches to combatting zoonotic outbreaks.

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[105] Michael Greger, *The Human/Animal Interface: Emergence and Resurgence of Zoonotic Infectious* Diseases, 33 CRITICAL REVS. MICROBIOLOGY 243, 247 (2007).

[106] *Id.* at 248.

[107] *Id.*

[108] *See* 21 U.S.C. § 601(m) (2012).

[109] *See, e.g.*, 16 U.S.C. § 1538 (2012) (protecting endangered species).

[110] For example, the definition of "adulterated" is broad enough to capture any "substance which may render [processed meat] injurious to human health." 21 U.S.C. § 601(m) (2012). Similarly, the Secretary of Agriculture has the authority to forbid the importation of any animal she determines will introduce or disseminate "any pest or disease of livestock." 7 U.S.C. § 8303(a)(1) (2012). This authority is used in a narrowly targeted way in some regulations, e.g., 9 C.F.R. § 93.101(a) (2014), which specifically prohibits the importation of birds vaccinated against the H5 or H7 variants of avian influenza.

[111] *See supra* pp. 161–62 (discussing WHO's and CDC's activities).

[112] *See About Glews*, GLEWS, http://www.glews.net/about-glews/ (last visited Jan. 23, 2015).

V. PROPOSED LEGAL FRAMEWORKS FOR ADDRESSING ZOONOTIC DISEASES

A. Assessing the Potential for Spillovers

The National Environmental Policy Act ("NEPA") requires federal agencies to consider the likely environmental effects of their proposed actions and alternative actions that may reduce any negative effects.[113] NEPA has had a significant impact on the decision-making process at many agencies.[114] NEPA-like statutes have in fact been enacted worldwide.[115] In order to reduce the likelihood of future spillovers, these NEPA analyses could be required to incorporate an analysis of whether or not a proposed action is likely to cause future spillovers. In a few areas of the world, performing such an analysis would be relatively straightforward. For example, in the case of *P. knowlesi* infections on the island of Borneo, all known human infections have been mapped onto two specific areas.[116] It is reasonable to assume that any further intrusion into those particular forests is highly likely to result in spillovers of *P. knowlesi*. In most other areas of the world, the analysis would be more complex. However, Environmental Impact Statements required by NEPA are often complex assessments running hundreds or even thousands of pages long,[117] so the complexity or scientific uncertainty of the task should not necessarily exempt any agency from performing the analysis. The analysis should be more than a cursory mention.[118] It should examine: if the proposed action would bring wild animals into closer contact with humans; if the action would likely sicken, stress, or isolate local animal populations; and if there has been a history of spillovers in the area. An analysis that shows a proposed action carries a significant risk of increased spillovers could have a

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[113] *See* PERCIVAL ET AL., *supra* note 97, at 858.

[114] James Allen, *NEPA Alternative Analysis: The Evolving Exclusion of Remote and Speculative Alternatives*, 25 J. LAND RESOURCES & ENVTL. L. 287, 289 (2005).

[115] *See* Nicholas A. Robinson, *International Trends in Environmental Impact Assessment*, 19 B.C. ENVTL. AFF. L. REV. 591 (1992).

[116] Cox-Singh & Singh, *supra* note 54, at 408.

[117] *See* PERCIVAL, *supra* note 97, at 859.

[118] *See, e.g.*, BUREAU OF OCEAN ENERGY MGMT., U.S. DEP'T OF THE INTERIOR, BOEMRE 2011-041, CHUKCHI SEA PLANNING AREA, OIL AND GAS LEASE SALE 193: FINAL SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT 173, 179 (2011), *available at* http://www.boem.gov/uploadedFiles/BOEM/About_BOEM/BOEM_Regions/Alaska_Region/Environment/Environmental_Analysis/2011-041v1.pdf. This Environmental Impact Statement is over five hundred pages long, and has dozens of pages on how the proposed action will affect local wildlife, but it only mentions zoonotic diseases twice in passing, without any analysis of how they might impact the local human or animal populations.

powerful effect on agency thinking and encourage the serious consideration of safer alternatives.

B. Prohibiting Proposed Actions that Significantly Increase the Odds of Future Spillovers

NEPA imposes purely procedural requirements on agencies.[119] However, given the high lethality of some zoonotic diseases, an outright prohibition on certain proposed actions that dramatically increase the likelihood of spillovers may be appropriate. A prohibition based on risk is not unheard of: the U.S. currently prohibits actions that will "probably" result in serious harm to human or animal life in certain protected areas.[120] Prior to the 2014–2015 Ebola outbreak, the virus struck multiple times near the border of Gabon and the Republic of the Congo with a lethality rate over seventy percent.[121] It is hard to imagine a compelling argument for any proposed action that would bring humans into closer contact with primates or other host animals[122] in the area. To determine when an outright prohibition is appropriate, the following factors should be examined: 1) if the proposed action is in an area where spillovers have previously occurred; 2) if the local zoonotic disease has a high lethality rate; 3) if the disease is very infectious, very contagious, or both; and 4) if the proposed action would significantly increase the likelihood of future spillovers. The stringency of the test would depend on how broadly an "area" was defined, at what point a disease is considered "very contagious" or "very infectious," and what is considered a "significant" increase in the likelihood of future spillovers (even in the case of Ebola, a one percent or two percent increase in the odds of contracting the virus may not be enough to make an outright prohibition appropriate from a policy standpoint.)

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[119] *See* Jason J. Czarneki, *Revisiting the Tense Relationship Between the U.S. Supreme Court, Administrative Procedure, and the National Environmental Policy Act*, 25 STAN. ENVTL. L.J. 3, 11 (2006).

[120] The Secretary of the Interior must disapprove any oil or gas lease in the outer Continental Shelf if the lease will "probably cause serious harm or damage to life (including fish and other aquatic life)." 43 U.S.C. § 1340(c)(1) (2012) and 43 U.S.C. § 1334(a)(2)(A)(i) (2012).

[121] *Ebola Virus Disease Distribution Map*, CTRS. FOR DISEASE CONTROL & PREVENTION, http://www.cdc.gov/vhf/ebola/resources/distribution-map.html (last updated Nov. 7, 2014).

[122] Ebola infections have been reported after victims handled animals besides primates including fruit bats, forest antelope, and porcupines. *Ebola Virus Disease*, WORLD HEALTH ORG., http://www.who.int/mediacentre/factsheets/fs103/en/ (last updated Sept. 2014).

C. Prohibiting Tourism in Areas with Frequent Spillovers

Prohibiting certain proposed agency actions may serve to keep new developments from intruding on animals' habitats, but we should also consider taking steps to keep individuals out of areas where there have been multiple, life-threatening spillovers. The "Python Cave" described above made at least one tourist deathly ill and killed another.[123] Miners in nearby caves also have been infected with Marburg virus.[124] While the miners may need to go into the caves out of economic necessity, the tourists have no compelling reason to take such a risk. The same four factors listed above in the context of a prohibition on a proposed action could be used in determining if tourists should be prohibited from entering a specific area. Particular attention would have to be paid to the size of the prohibited area. In the case of "Python Cave," one particular cave was determined to be the source of the infections.[125] In other cases, the dangerous area may be less well defined, making an outright prohibition impractical.[126]

If an area has a demonstrated risk of spillovers, but the relevant disease is not sufficiently lethal or otherwise dangerous enough to warrant an outright prohibition, a law mandating certain safety precautions may be appropriate. Such a statute could mandate that all individuals going into an area wear protective gear, or stay in the area for only a limited amount of time. New York follows an approach like this for its "confined spaces," only allowing individuals to enter such spaces if they follow certain safety procedures.[127] This type of statute may, however, be more difficult to enforce than an outright prohibition that could be enforced with a physical barrier because a behavioral mandate requires active monitoring.

D. Creating a Liability Regime

Instead of prohibiting proposed actions that increase the risk of future spillovers, agencies or developers could be permitted to pursue their proposed actions under a strict liability regime. Based on the NEPA-like

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[123] Amman et al., *supra* note 38, at 2.

[124] *Id.* at 2.

[125] *Id.* at 2.

[126] For example, a Swedish backpacker fell ill with *P. knowlesi* after a week in Borneo's forests. The territory the backpacker was able to cover in a week would likely be too large an area from which to effectively prohibit tourists. Bronner et al., *supra* note 55, at 8–9.

[127] New York's Department of Labor specifies safety procedures and equipment for individuals entering confined spaces such as manholes under the street. N.Y. COMP. CODES R. & REGS. tit. 12, § 12-1.9 (2006).

analysis, their projects could be designated as "abnormally dangerous activities"[128] and they then would be liable for any subsequent spillovers in the area. To cabin their liability somewhat, the area should be strictly defined, and there should be a list of specific zoonotic diseases the agency or developer would be liable for. If the liability extended for dozens of miles, or encompassed any disease that may pass through a town, then the liability regime would essentially function as a strict prohibition, given the high potential cost of all zoonotic illnesses in an area.

A more lenient alternative would be to impose a traditional liability regime. Plaintiffs affected by spillovers would need to prove causation, which would likely be an extremely difficult burden to meet. The hypothetical liability regime would only be imposed in the first instance of a spillover because the exact cause of any new spillovers would be difficult to prove on an individual basis in an area with a known history of spillovers (even if the overall number of spillovers obviously went up when the proposed action was carried out).

Either type of liability regime could potentially apply to area employers who would not normally go through any NEPA-like process. A statute could impose strict liability on any employers who ask their employees to undertake abnormally dangerous activities, such as going into a Borneo forest at dusk,[129] or wading through manure at a farm with a history of spillovers. Depending on the area and the nature of the past spillovers, the statute could outline the exact activities that were considered abnormally dangerous. Under a traditional liability regime, the employee may still be able to prove causation, particularly if he lives some distance from the spillover area and his employer consistently requires him to perform acts that risk contracting a zoonotic disease.

VI. CONCLUSION

We can do more than just react faster to zoonotic outbreaks. In the U.S., each branch of the federal government can take action to help prevent future outbreaks. As noted at the end of Part III, some agencies already have the authority to tackle zoonoses by way of broadly worded, health-based standards in their statutes. President Obama should issue

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[128] RESTATEMENT (THIRD) OF TORTS: PHYSICAL AND EMOTIONAL HARM § 20(a)–(b) (2010).

[129] On Borneo, where forest mosquitos carry the *P. knowlesi* strain of malaria, farmers often go out and chase away macaques from their crops at night, exposing themselves to potentially infected macaques and nocturnal forest mosquitoes in the process. QUAMMEN, *supra* note 12, at 157–58.

an executive order instructing all agencies to focus on the problem of zoonotic diseases and to use their authority to more tightly regulate potential sources of zoonotic diseases. For example, the EPA could regulate more than just a fraction of the CAFOs in the country.[130] The CDC should not be the only agency thinking about zoonotic diseases. An executive order could make zoonotic diseases every agency's concern, similar to how NEPA made every agency consider the environmental impacts of their actions.

The Supreme Court has been constricting the scope of NEPA for some time,[131] so it is unrealistic to hope for them to bolster NEPA in any way in the near future. Nevertheless, the Court should interpret NEPA so that agencies must consider if their actions are likely to result in a greater risk of spillovers. NEPA is concerned with the "quality of the human environment"[132] which arguably includes the health of humans in the area. The Court could hold that a "spillover analysis" is necessary any time an Environmental Impact Statement reports an increased risk of disease for animals or any time the proposed action would put an animal population into significantly closer contact with humans. This would force agencies to seriously consider the risk of zoonotic diseases, and it would create a greater base of scientific knowledge for how spillovers occur as agencies would necessarily begin to study the problem.

Lastly, Congress should pass a version of the Animal Welfare Act for livestock. The FDA's small steps on antibiotics are insufficient to keep our nation's animals healthy.[133] Congress should ban the routine use of antibiotics and create minimal sanitation requirements that allow the livestock to stay healthy without the use of antibiotics. This will result in fewer sick animals, fewer antibiotic-resistant diseases,[134] and fewer chances for spillovers.

Outside the U.S., there are extreme circumstances like the *P. knowlesi* strain of malaria in Borneo[135] and the Python Cave in

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[130] *See supra* pp. 163–64 (discussing CAFO regulations).

[131] Jeannette MacMillan, *An International Dispute Reveals Weaknesses in Domestic Environmental Law: NAFTA, NEPA, and the Case of Mexican Trucks* (Department of Transportation v. Public Citizen), 32 ECOLOGY L.Q. 491, 517 (2005).

[132] 42 U.S.C. § 4332(2)(C) (2012).

[133] *See* Sabrina Tavernise, *F.D.A. Restricts Antibiotics Use for Livestock*, N.Y. TIMES, Dec. 11, 2013, http://www.nytimes.com/2013/12/12/health/fda-to-phase-out-use-of-some-antibiotics-in-animals-raised-for-meat.html.

[134] *See* Ferber, *supra* note 94, 1010–11 (2010).

[135] *See supra* p. 158.

Uganda[136] that may warrant a liability regime or an outright prohibition on entering a given area. The U.S. lacks such dramatic risks, so any extremely hazardous situations are likely best handled in a more targeted way by individual agencies, such as New York's Department of Labor regulating "confined spaces."[137] The above recommendations for each branch go after the most obvious source of zoonotic diseases inside the U.S. (factory farms), and encourage the administrative state as a whole to focus on the risk of spillovers. The more we study the problem, and the more steps we take to avoid risks, the greater our chances of avoiding a future epidemic.

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[136] *See supra* p. 157.
[137] *See supra* p. 168.