

An aerial photograph showing a vast herd of white cattle grazing in a lush green field. The cattle are scattered across the landscape, with some forming distinct lines. The field is densely packed with green vegetation, and the overall scene is captured from a high angle, emphasizing the scale of the herd.

Animal Markets and Zoonotic Disease in Brazil

COUNTRY SUMMARY: BRAZIL

CULTURAL CONTEXT

Brazil, the largest, most populous country in Latin America, is undergoing rapid anthropogenic change, affecting ways humans and animals interact and making Brazil a potential hotspot for zoonotic disease emergence. Home to the Amazon rainforest, it is the most biodiverse country globally and one of the world's largest livestock producers. Raising livestock has put increasing pressure on native and fragile ecosystems, particularly in the Amazon rainforest and the Cerrado. Since 1990, over 192 million acres have been lost to deforestation, and with it, some 2,000 animal species. The primary driver of both has been expansion of pastureland for cattle, accounting for roughly 80% of deforestation. Meat consumption in Brazil has nearly doubled since 1990, outpacing almost all developed countries, and Brazil is also a major exporter of meat, particularly beef.

ANIMAL MARKETS

The Brazilian wildlife trade is robust, some legal, some illegal, serving both domestic and international markets. Demand comes from the pet trade, zoos and aquariums, private collectors, commercial breeders, scientific institutions, the fashion industry, producers of ornamental home products, the food industry, and users and producers of traditional medicine. Consumption of wild meat is part of some local cultures and practiced heavily in Amazonia. Although only subsistence hunting is legal, wild meat consumption remains a primary driver of the illegal wildlife trade. Social media is increasingly facilitating wildlife trafficking in Brazil. Brazil is among the world's top meat producers in terms of both livestock production and export figures. Beef production is one of the country's flagship industries, which relies on extensive amounts of pasture land and other resources.

DRIVERS OF ZOOONOTIC DISEASE RISKS

The volume and diversity of Brazil's wildlife trade puts the country at risk of zoonotic disease. Close animal-human interactions along the supply chain present myriad opportunities for disease spread as animals change hands from trappers to traders to sellers and customers. Many remain unaware of these public health risks. Primate trade is of particular concern; primates are both kept as pets and consumed as wild meat. Captive wildlife farming also creates close contact between humans and wild animals while providing cover for the illegal trade. Captured wild animals are moved across expansive, porous borders with very little oversight. Land use change is a primary driver of zoonotic disease risk in areas of high-biodiversity. As forests are felled and livestock brought in, displaced wild animals interact more closely with domestic animals and humans, creating conditions favorable to disease emergence. Production, transport, and slaughter of livestock on such a large scale in areas of high biodiversity with limited

biosecurity pose zoonotic risks. Sanitary controls of slaughterhouses under state/municipal inspection are sometimes inadequate and have been linked with serious food safety and animal welfare issues.

RISK MITIGATION AND RELEVANT CHALLENGES

Brazil's size, diversity, and geography pose significant regulatory challenges. Its vast quantities of domestic animals and wildlife carry substantial zoonotic risk. Authorities' efforts to combat the illegal trade of wild animals are limited due to a lack of resources, lack of data, and corruption. Public education may also play a role in reducing demand for wildlife and wildlife products for non-subsistence usage, alongside more clearly defined limits for "subsistence use" of wild animals. A longstanding legal framework for addressing environmental protection and food safety exists on federal, state, and municipal levels, but is not sufficient for mitigating zoonotic risks to human health. The number of federal inspectors cannot keep pace with the growth of the meat industry. Some policymakers push for deregulation, alongside layoffs and funding reductions for agencies tasked with preventing unauthorized forest clearing. Despite the existing regulatory framework and surveillance, non-compliance and illegalities remain; there is inadequate knowledge and training on best practices and legal requirements.

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INTRODUCTION

Brazil is the largest country in South America and in the Southern Hemisphere.¹ Heterogeneities concerning climate, food habits, cultural tradition, and socioeconomic indicators across its territory are a hallmark of Brazil. Formed by the indissoluble union of States, Municipalities, and the Federal District, Brazil has 26 states, one Federal District, and 5,570 municipalities distributed along its 8,510,345,538 square kilometers. According to the Brazilian Institute of Geography and Statistics (IBGE) 2020 report, the country has a population of approximately 211,755,692 individuals unevenly spread across five regions as following: 18,672,591 in the north; 57,374,243 in the northeast; 16,504,303 in the central-west; 89,012,240 in the southeast, and 30,192,315 in the south.^{2,3} Its various regions and terrains present complexities that are addressed through local governance at the state and municipal level. In addition to the geographical aspects, other differences across regions are the outcome of the varying presence of European colonists, African slaves, indigenous peoples, and immigrants from countries including Italy, Germany, and Japan, among others, who have inhabited Brazil over the years.

Brazil has six biomes: Amazon, Caatinga, Cerrado, Atlantic Forest, Pampa, and Pantanal, each with distinct characteristics and types of flora and fauna. Its Amazon River is one of the longest in the world, while its expansive tropical regions are known throughout the world for their biodiversity and natural resources. Besides the vegetation and animal species native to Brazil, the country produces a variety of minerals and metals, including rare earth minerals. At the same time, its ecosystems are undergoing rapid anthropogenic change, affecting the ways in which humans and animals interact. These factors combine to make Brazil a potential “hotspot” for zoonotic disease emergence.⁴

Large numbers of both wildlife and livestock animals can be found in the country. Brazil is the most biodiverse country on Earth and home to over 10% of its animal species, which is more than 7,000.⁵ Brazil is also one of the biggest producers and exporters of meat in the world, accounting for roughly 25% of the global export market for beef.⁶ Cattle alone account for 8.5% of the nation’s gross domestic product (GDP).⁷ The desire to raise and feed large numbers of livestock has placed increasing pressure on the country’s native and fragile ecosystems, in particular, the Amazon rainforest and the Cerrado.⁸ Since 1990, over 780,000 square kilometers (192,000,000 acres) have been lost to deforestation,

1. “The World Factbook: Brazil,” *Central Intelligence Agency*, accessed April 27, 2022, <https://www.cia.gov/the-world-factbook/countries/brazil/>.
2. Brazilian Institute of Geography and Statistics (IBGE) 2020 report, “Estimativas da População Residente no Brasil e unidades da federação com data de referência em 1 de julho de 2020,” accessed April 4, 2021, https://ftp.ibge.gov.br/Estimativas_de_Populacao/Estimativas_2020/estimativa_dou_2020.pdf.
3. Brazilian Institute of Geography and Statistics (IBGE) 2020 report, “Estimativas da População Residente no Brasil e unidades da federação com data de referência em 1 de julho de 2020,” accessed April 4, 2021, https://ftp.ibge.gov.br/Estimativas_de_Populacao/Estimativas_2020/estimativa_dou_2020.pdf.
4. Yewande Alimi et al., “Report of the Scientific Task Force On Preventing Pandemics,” *Harvard Global Health Institute*, August 2021, <https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2343/2021/08/PreventingPandemicsAug2021.pdf>.
5. Thomas M. Lewinsohn and Paulo Inácio Prado, “How Many Species Are There in Brazil?” *Conservation Biology* 19 no. 3 (June 2005), <https://doi.org/10.1111/j.1523-1739.2005.00680.x>.
6. “Livestock and Poultry: World Markets and Trade,” United States Department of Agriculture Foreign Agricultural Service, July 12, 2023, https://apps.fas.usda.gov/psdonline/circulars/livestock_poultry.pdf.
7. Guilherme Cunha Malafaia et al., “The Brazilian Beef Cattle Supply Chain in the Next Decades,” *Livestock Science* 253 (2021): 104704, <https://www.ufrgs.br/nepro/wp-content/uploads/2021/10/10.-The-brazilian-beef-cattle-supply-chain.pdf>.
8. Marin Elisabeth Skidmore et al., “Cattle Ranchers and Deforestation in the Brazilian Amazon: Production, Location, and Policies,” *Global Environmental Change* 68 (2021): 102280, <https://doi.org/10.1016/j.gloenvcha.2021.102280>.

and with it, roughly 2,000 species of animals.⁹ The primary driver of this loss was the expansion of pastureland for cattle, which accounted for an estimated 80% of deforestation.^{10 11}

Brazil's size, diversity, and population pose significant regulatory challenges, while at the same time, its vast quantities of both domestic animals and wildlife carry substantial zoonotic risk. This report attempts to assess the country's preparedness to address and prevent the emergence and transmission of zoonotic diseases resulting from legal and illegal uses of livestock and wildlife animals as food, medicine, and pets in Brazil. A country-wide overview will be given regarding the status of production and consumption of those animals in Brazil, in addition to a discussion of Brazil's legal framework and its implementation, with an eye toward understanding how the country's current regulation maps onto disease risk. Regarding some aspects, namely the sale of live animals and animal products in public markets, this report will focus on the northern region of the country. The decision to spotlight this region results from the fact that the city of Belem in Pará is where the largest public market in Latin America is located.

LEGAL FRAMEWORK

Overview

The Brazilian legal system is structured in statutes such as the Civil Code, the Penal Code, the Commercial Code, the Customer Protection Code, and normative policy instruments issued by regulatory agencies. The Federal Constitution, adopted in 1988, covers a wide range of topics across 250 plus articles and is the highest law in the country. Brazil has a federalist governance system, with power divided among three levels of government: Union, States, and Municipalities. Of relevance to this report are the competence division of legislative and administrative powers over food safety and environmental protection. Accordingly, the Union has the exclusive power to legislate on a broad range of subjects from international trade to agrarian laws. The Union, the States, and the Federal District share the power to legislate on production and consumption, forest, hunting, fishing, fauna, and liability for damages to the environment and consumers. Municipalities have the power to legislate solely upon matters of local interest, though they might supplement federal and state legislations. The administrative power to enforce and regulate national law is assigned to all levels of governments and shared across different agencies as described in the next sections.

The Federal Constitution of Brazil has specific provisions regarding the protection of animals and the health of the population. According to article 196, health is a right of all people and a duty of the State and shall be guaranteed by means of social and economic policies aimed at reducing the risk of illness and other hazards. In addition to other duties, as set forth by the law, the Constitution states in article 200 that the health system needs to carry out actions of sanitary and epidemiologic vigilance and supervise

9. Cassiano Messias et al., "Analysis of Deforestation Rates and Their Drivers in the Brazilian Legal Amazon During the Last Three Decades," *RA'E GA - O Espaço Geográfico em Análise* 52 (Sept. 2021): 18–41, https://www.researchgate.net/profile/Cassiano-Gustavo-Messias/publication/354321510_Analise_das_taxas_de_desmatamento_e_seus_fatores_associados_na_Amazonia_Legal_Brasileira_nas_ultimas_tres_decadas_Analise_of_deforestation_rates_and_their_drivers_in_the_Brazilian_Legal_Amazon_during/links/6130d3e7c69a4e4879745574/Analise-das-taxas-de-desmatamento-e-seus-fatores-associados-na-Amazonia-Legal-Brasileira-nas-ultimas-tres-decadas-Analysis-of-deforestation-rates-and-their-drivers-in-the-Brazilian-Legal-Amazon-during.pdf.

10. Global Forest Atlas, 2016; J. B. Veiga et al., "Cattle Ranching in the Amazon Rainforest," *Proceedings of the Australian Society of Animal Production* 24 (2002): 253–6, https://www.researchgate.net/publication/228451423_Cattle_ranching_in_the_Amazon_rainforest.

11. J. B. Veiga et al., "Cattle Ranching in the Amazon Rainforest," *XII World Forestry Congress* (2003), <https://www.fao.org/3/xii/0568-b1.htm>.

and control foodstuffs, including their nutritional contents. Further, in article 225, the Constitution provides that all have the right to an ecologically balanced environment, which is an asset of common use and essential to a healthy quality of life, and both the government and the community shall have the duty to defend and preserve it for present and future generations. To ensure the effectiveness of this right, it is incumbent upon the government to protect the fauna and flora, with prohibition, in the manner prescribed by law, of all practices that represent a risk to their ecological function, cause the extinction of species, or subject animals to cruelty.

The following sections on wildlife and livestock will provide further information about the rules governing environmental protection and food safety. In reading those sections it is important to keep in mind that under the Brazilian legislation “wild animals” are all animals of native, migratory, or other species of aquatic or terrestrial fauna whose life cycle takes part wholly or partially within the limits of the Brazilian territory or waters. “Livestock animals” are bovines, buffaloes, equidae, suidae, ovines, caprines, lagomorphs, domestic birds, as well as wild animals raised in captivity that are slaughtered in establishments under veterinary inspection as per article 10 of the Decree 9.013/2017 that provides for the industrial and sanitary inspection of products of animal origin. Legislation has also defined as “wild pets” those animals of wild fauna species, born in a legally established commercial breeding facility and kept in captivity at home, without the purpose of slaughter, reproduction, or scientific and laboratory use (Resolution CONAMA n. 394/2007).

The Regulatory Landscape for Wildlife Protection

To oversee the protection of the environment and wildlife, Brazil established the National Environmental System (SISNAMA), which is composed of authorities from the three levels of government and representatives of relevant agencies. The Ministry of the Environment (MMA) is the central body within this system coordinating environmental policies for the entire country, whereas the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), and the Chico Mendes Institute for Biodiversity Conservation (ICMBio) are the executing agencies at the federal level. Each state and municipality have supplemental regulations and law enforcement authorities.

Brazil has a long-standing law that regulates the commercial trade in wildlife specimens as well as products and objects used for their hunting, pursuit, destruction, or capture. Adopted in 1967, law n. 5.197 is one of the first of its kind introduced in Latin America that has established an express prohibition against commercial hunting in a national territory.^{12 13} This law, which remains partially in force, also limits the trade in wildlife specimens and products to those that originated from legalized breeding sites. The passing of federal law 9.605 in 1998 expanded the legal framework for environmental protection by specifying several harmful actions as punishable crimes. Key provisions from this law include the following:

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12. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil*, (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
 13. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil*, (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

Art. 29. Killing, chasing, hunting, capturing, using specimens of wild fauna, native or on a migratory route, without the proper permission, license, or authorization of the competent Authority, or in disagreement with the obtained:

Penalty: Imprisonment from six months to one year, and fine.

§ 1 Incurs the same penalties:

- I. Who prevents the procreation of fauna, without a license, authorization, or in disagreement with the one obtained;
- II. Whoever modifies, damages, or destroys a nest, shelter, or natural breeding;
- III. Whoever sells, exposes for sale, exports or acquires, keeps, has in captivity or deposits, uses or transports eggs, larvae or specimens of wild fauna, native or on a migratory route, as well as products and objects originating therefrom, from breeding sites unauthorized or without proper permission, license or authorization from the competent authority.

[...]

Art. 30: To export unfinished skins and hides of amphibians and reptiles without the authorization of the competent environmental authority; Penalty - imprisonment, from one to three years, and fine.

Art. 31: To introduce animal species in the country without a favorable official technical report and a license given by the competent authority; Penalty - imprisonment, from three months to one year, and fine.

Art. 32: Practicing an act of abuse, ill treatment, injuring or mutilating wild, domestic or domesticated animals, native or exotic. Penalty - imprisonment, from three months to one year, and fine.

Regarding the killing of animals, Law 9.605/1998 makes exceptions when killing is done, including the following:

1. In a state of need, to satisfy the agent's or his family's hunger;
2. To protect crops, orchards, and herds from the predatory or destructive action of animals, provided that it is legally and expressly authorized by the competent authority;
3. To harmful animals characterized as such by the competent authority.

IBAMA is the competent authority to make determinations as to whether killings are justified by these exemptions based on technical studies. For instance, under the premise of population control, IBAMA has authorized the hunting of wild boar (*Sus scrofa*), which is an exotic species with no local predator that is considered harmful to the Brazilian fauna.

Concerning captive breeding facilities, several rules have been issued based upon specific taxa, conservation status, and breeding purposes (commercial, amateur, scientific, educational, etc.) under the overarching framework of IBAMA normative instruction 07/2015 that specifies the following uses and management facilities of captive wild fauna:

1. Wildlife screening center;
2. Native wildlife rehabilitation center;
3. Trader of live wildlife animals;

4. Trader of parts, products, and by-products of wild fauna;
5. Scientific breeding for conservation purposes;
6. Scientific breeding for research purposes;
7. Commercial breeding;
8. Wild fauna maintainer;
9. Slaughterhouse, and
10. Zoo.

All these facilities must be registered in the National Fauna Management System (SisFauna). The commercialization of live wild animals or their products is further regulated by ordinance 117/1997 of IBAMA, which requires registration of all legal entities and individuals that sell live animals, slaughtered animals, parts, and products. Additionally, this ordinance requires that receipts are issued with display of the registration number provided by IBAMA and other relevant information such as specie and value. Finally, the transport of animals, including wildlife, across Brazilian states must be accompanied by the Animal Transit Guide (GTA) issued by the Ministry of Agriculture, Livestock, and Supply for the control of the spread of animal diseases within the national territory.

The Regulatory Landscape for Food Safety of Animal Origin

Since 1915, Brazil has had an official government service responsible for the *ante-mortem* and *post-mortem* sanitary inspection of animals destined for human consumption.¹⁴ Over the past century, to strengthen the health of the population, new regulatory measures have been adopted. Two norms that are still in force and that stand out as historical landmarks are Law 1.283/1950 and Decree-Law 986/1969. The first introduced the mandatory inspection of all products from animal origin, edible and non-edible, before marketing, whereas the latter established the requirement that all food intended for sale be registered with the local government health authority.¹⁵ Also important is Law 7.889/1989 that further establishes the division of competence among sanitary inspection government services across the three levels of governance. Accordingly, the municipal branch of government regulates and inspects slaughterhouses and establishments processing products of animal origin that are distributed only at the local level. These products are identified by a label with the initials SIM (Sistema de Inspeção Municipal). If a slaughterhouse and/or processing establishment aims to sell its products across different municipalities, it needs to seek registration under the state inspection service, abbreviated as SIE (Sistema de Inspeção Estadual). The federal inspection service, known as SIF (Sistema de Inspeção Federal), is responsible for overseeing the inspection of slaughterhouses and processing establishments that market their products across different states of Brazil and internationally. The federal inspections are performed by inspectors of the Ministry of Agriculture, Livestock, and Supply (MAPA). Each State and municipal government also has its own inspection authorities.

14. The first sanitary inspection service for animal-derived food was established in 1915. "Industrial Inspection," *Avicultura Industrial*, July 28, 2008, <https://www.aviculturaindustrial.com.br/imprensa/inspecao-industrial/20080728-112608-3269>.

15. The sanitary inspection of animals and animal products are the sole competence of veterinary professionals as per Law No. 5,517 of October 23, 1968. The sanitary inspection of animals slaughtered includes the ante- and post-mortem analysis at all levels. Federal inspection standards on sanitary control also incorporate the evaluation of welfare conditions for the animals, as per Decree 9013 of March 29, 2017.

The rules detailing the procedures for sanitary inspections and overall requirements for slaughtering and processing livestock animals are established in decree 9013/2017. Included in this decree are provisions covering: 1) the verification of the hygienic and sanitary conditions of the facilities, 2) equipment and operation of food establishments and food handlers, 3) evaluation of information inherent to primary production with implications for animal health and public health or information that is part of international agreements with importing countries, 4) classification of products and derivatives according to the types and standards set out in specific legislation or registered formulas, 5) verification of the means of transport of live animals and derived products and their raw materials intended for human consumption, 6) control of residues and contaminants in products of animal origin, and, lastly, 7) assessment of the welfare of animals destined for slaughter. Decree 9013/2017 also determines that animals may only be slaughtered using humane methods, with prior stunning, based on scientific principles, and followed by immediate bleeding. A religious exemption is allowed, provided that the byproducts from this type of slaughter are destined entirely or partially for the consumption of the religious community. Individuals and establishments that fail to comply with the sanitary regulatory framework may incur fines and/or have the product seized and/or destroyed, and the establishment can be temporarily or permanently closed. The specific penalty depends upon which provision has been breached. In addition to administrative sanctions, some forms of non-compliance might also fall within the scope of criminal and/or civil liability. The latter cases would depend upon the outcome of a judicial case.

It is important to clarify that the competence of MAPA (and the equivalent livestock inspection service at the state and municipal level) in the matters of food safety is restricted to foods derived from animals (meat, milk, eggs, honey, fish, crustaceans, mollusks, and related derivatives), beverages in general (non-alcoholic, alcoholic, and fermented), and fresh vegetables. All remaining foods fall under the sanitary control of the National Health Surveillance Agency (ANVISA), which is an agency linked with the Ministry of Health (MS) that coordinates the National Health Surveillance System (SNVS).¹⁶ The other important competence distinction refers to the stage of the food supply. MAPA (and the other equivalent state and municipal authorities) is responsible for the oversight of food of animal origin from the farm level up to the later stages of processing and export. ANVISA (and equivalent state and municipal health authorities) holds the responsibility to carry sanitary controls at the point of sale (e.g., retailers, street fairs, public markets, restaurants).

Animal Use

Overview

Brazil is home to more than 120,000 species of invertebrates and approximately 8,930 vertebrate species (734 mammals, 1,982 birds, 732 reptiles, 973 amphibians, 3,150 freshwater fish, and 1,358 marine fish), of which 1,173 are listed as threatened with extinction.¹⁷ It is estimated that Brazil hosts between 15%-20% of the world's biological diversity.¹⁸ It also has one of the largest livestock populations

16. In Portuguese the agency is titled Sistema Nacional de Vigilância Sanitária.

17. "Chico Mendes Institute for Biodiversity Conservation (ICMBio)," gov.br, accessed September 16, 2023, <https://www.gov.br/icmbio/pt-br>.

18. "Brazil: Main Details," Convention on Biological Diversity, accessed September 16, 2023, <https://www.cbd.int/countries/profile/?country=br>.

in the world. According to the Brazilian Institute of Geography and Statistics (IBGE) livestock survey in 2019, the country has 214.7 million cattle, 249.1 million chickens, 40.6 million pigs, 19.7 million sheep, 17.4 million quail, 11.3 million goats, as well as other livestock.¹⁹

Wildlife

Uses

The use of wild animals in Brazil encompasses both legal and illegal practices across a wide variety of taxa, including several invertebrate phyla (e.g., *Annelida*, *Mollusca*, *Arthropoda*, *Cnidaria*) and all current vertebrate groups.²⁰ The demand for these animals (either wild or captive-bred) comes from zoos and aquariums, private collectors, commercial breeders, scientific institutions, amateur breeders, the wild animal pet market, the fashion industry, ornamental home products producers, the food industry, traditional medicine providers, and adherents of traditional religions.²¹ Depending on the use, the animal might be kept alive or killed, and its parts might be consumed either raw or processed.

The use of animals (or their derived products) as ingredients in the preparation of popular remedies form an integral part of local cultures in some areas of Brazil, with information about the preparation passed from generation to generation.²² The use of certain animals for medicinal purposes may also provide an alternative to conventional medicine in rural communities where access to the formal health system is limited, though treatments using animals have generally not been shown to be medically effective and, in fact, may expose the patient to zoonotic risk.^{23 24 25 26} In Northeast Brazil, 100 or more different species are used for medicinal purposes.²⁷ Treatments involve a wide range of animal parts and products including feathers, flesh, teeth, tongue, stomach, milk, liver, head, bone, and other

19. IBGE, *Production of Municipal Livestock 2019*, (Rio de Janeiro: IBGE, 2019), https://biblioteca.ibge.gov.br/visualizacao/periodicos/84/ppm_2019_v47_br_informativo.pdf.
20. Wedson Medeiros Silva Souto et al., "Zootherapeutic Uses of Wildmeat and Associated Products in the Semiarid Region of Brazil: General Aspects and Challenges for Conservation," *Journal of Ethnobiology and Ethnomedicine* 14, no. 1 (2018): 60, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0259-y>;
Rômulo Romeu Nóbrega Alves, Tacyana Pereira Ribeiro Oliveira, and Irecê Lucena Rosa, "Wild Animals Used as Food Medicine in Brazil," *Evidence-based Complementary and Alternative Medicine* 2013 (2013): 670352, <https://doi.org/10.1155/2013/670352>;
Ana Carla Astora El-Deir et al., "Ichthyofauna Used in Traditional Medicine in Brazil," *Evidence-based Complementary and Alternative Medicine*, 2012 (2012): 474716, doi: 10.1155/2012/474716;
Flávio B. Barros et al., "Medicinal Use of Fauna by a Traditional Community in the Brazilian Amazonia," *Journal of Ethnobiology and Ethnomedicine* 8 (2012): 37, <https://ethnobiomed.biomedcentral.com/articles/10.1186/1746-4269-8-37>;
Rômulo Romeu Nóbrega Alves et al., "A Zoological Catalogue of Hunted Reptiles in the Semiarid Region of Brazil," *Journal of Ethnobiology and Ethnomedicine* 8 (2012): 27, <https://ethnobiomed.biomedcentral.com/articles/10.1186/1746-4269-8-27>;
Wedson MS Souto et al., "Medicinal Animals Used in Ethnoveterinary Practices of the 'Cariri Paraibano,' NE Brazil," *Journal of Ethnobiology and Ethnomedicine* 7 (2011): 30, doi: 10.1186/1746-4269-7-30-.
21. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
22. In some studies, it is named popular medicine, whereas in others it is named traditional or folk medicine.
23. Wedson Medeiros Silva Souto et al., "Zootherapeutic Uses of Wildmeat and Associated Products in the Semiarid Region of Brazil: General Aspects and Challenges for Conservation," *Journal of Ethnobiology and Ethnomedicine* 14, no. 1 (2018): 60, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0259-y>; Patricia de Moraes Mello Boccolini and Cristiano Siqueira Boccolini, "Prevalence of Complementary and Alternative Medicine (CAM) Use in Brazil," *BMC Complementary Medicine and Therapies* 20, no. 1 (2020): 51, doi:10.1186/s12906-020-2842-8 2020.
24. Wedson Medeiros Silva Souto et al., "Zootherapeutic Uses of Wildmeat and Associated Products in the Semiarid Region of Brazil: General Aspects and Challenges for Conservation," *Journal of Ethnobiology and Ethnomedicine* 14, no. 1 (2018): 60, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0259-y>.
25. F. S. Ferreira et al., "Vertebrates as a Bactericidal Agent," *EcoHealth* 15, no. 3 (2018): 619–26, <https://doi.org/10.1007/s10393-018-1345-2>.
26. Rômulo R. N. Alves and Irecê L. Rosa, "From Cnidarians to Mammals: The Use of Animals as Remedies in Fishing Communities in NE Brazil," *Journal of Ethnopharmacology* 107, no. 2 (2006): 259–76, <https://doi.org/10.1016/j.jep.2006.03.007>.
27. Rômulo R. N. Alves and Irecê L. Rosa, "From Cnidarians to Mammals: The Use of Animals as Remedies in Fishing Communities in NE Brazil," *Journal of Ethnopharmacology* 107, no. 2 (2006): 259–76, <https://doi.org/10.1016/j.jep.2006.03.007>.

body secretions.²⁸ Though the process of collecting and processing animals as well as the use of animal-based remedies may carry risk of zoonotic disease, only a small percentage (5%) of respondents in Bahia who used traditional medicine believed there could be adverse side effects from such treatments, according to a recent study.^{29 30}

The consumption of meat from the wild is also part of local cultures in some areas of Brazil. Wildlife consumption in these regions often spans a wide sociocultural spectrum including traditional communities, indigenous peoples, and small rural communities.³¹ Wildlife consumption is more common among older generations in lower income groups, and especially among traditional communities and members of the rural migratory communities in urban centers.³² For these people and others, activities such as hunting and fishing can also be an important source of income and a more accessible source of dietary protein.³³ However, even among traditional communities, wild meat rarely acts as the primary source of animal protein, with 94% of hunters reporting that domestic livestock animals formed the larger share of their family's diet.³⁴ For years, rural and riverine communities have relied on hunting and fishing as a subsistence source of protein, and more recently as a source of income when they sell products to third parties (though such sales are illegal if they are carried out without the proper authorization from the environmental authorities).

Subsistence hunting is allowed by law, but the commercial trade of wild meat is illegal.³⁵ Still, studies suggest that only 15% of wild meat is consumed by the hunter and their family, while the rest is offered for sale.³⁶ By contrast, 80% of wild meat is bought from local markets.^{37 38} In these street markets, wild meat is widely available, with thousands of pounds sold across the Amazonian states, while some wild meat is also moved across the border for sale in Peru, Columbia, and elsewhere.³⁹ A large majority of inhabitants of the central Amazon region consume wild meat regularly, comprising over 20 different

28. Rômulo R. N. Alves and Irecê L. Rosa, "From Cnidarians to Mammals: The Use of Animals as Remedies in Fishing Communities in NE Brazil," *Journal of Ethnopharmacology* 107, no. 2 (2006): 259–76, <https://doi.org/10.1016/j.jep.2006.03.007>.
29. Rômulo R. N. Alves and Irecê L. Rosa, "From Cnidarians to Mammals: The Use of Animals as Remedies in Fishing Communities in NE Brazil," *Journal of Ethnopharmacology* 107, no. 2 (2006): 259–76, <https://doi.org/10.1016/j.jep.2006.03.007>.
30. Joanison Vicente dos Santos Teixeira et al., "Uses of Wild Vertebrates in Traditional Medicine by Farmers in the Region Surrounding the Serra do Conduru State Park (Bahia, Brazil)," *Biota Neotropica* 20, no. 1 (2020), <https://doi.org/10.1590/1676-0611-BN-2019-0793>.
31. João Vitor Campos-Silva et al., "Community-Based Management of Amazonian Biodiversity Assets," in Christina Baldauf (ed.), *Participatory Biodiversity Conservation* (Cham: Springer Nature Switzerland AG, 2020), 99–111, https://doi.org/10.1007/978-3-030-41686-7_7.
32. Rômulo R. N. Alves et al., "Commercialization of Animal-derived Remedies as Complementary Medicine in the Semi-arid Region of Northeastern Brazil," *Journal of Ethnopharmacology* 124, no. 3 (2009): 600–8, <https://doi.org/10.1016/j.jep.2009.04.049>; Maine V. A. Confessor et al., "Animals to Heal Animals: Ethnoveterinary Practices in Semiarid Region, Northeastern Brazil," *Journal of Ethnobiology and Ethnomedicine* 5 (2009): 37, <https://ethnobiomed.biomedcentral.com/articles/10.1186/1746-4269-5-37>; Felipe S. Ferreira et al., "Animal-Based Folk Remedies Sold in Public Markets in Crato and Juazeiro do Norte, Ceará, Brazil," *BMC Complementary and Alternative Medicine* 9 (2009): 17, <https://bmccomplementmedtherapies.biomedcentral.com/articles/10.1186/1472-6882-9-17>; Daniel Garcia, Marcus Vinicius Domingues, and Eliana Rodrigues, "Ethnopharmacological Survey Among Migrants Living in the Southeast Atlantic Forest of Diadema, São Paulo, Brazil," *Journal of Ethnobiology and Ethnomedicine* 6 (2010): 29, <https://ethnobiomed.biomedcentral.com/articles/10.1186/1746-4269-6-29>.
33. Rômulo Romeu Nóbrega Alves et al., "A Zoological Catalogue of Hunted Reptiles in the Semiarid Region of Brazil," *Journal of Ethnobiology and Ethnomedicine* 8 (2012): 27, <https://ethnobiomed.biomedcentral.com/articles/10.1186/1746-4269-8-27>; Vanessa Moura dos Santos Soares et al., "Local Knowledge, Use, and Conservation of Wild Birds in the Semi-Arid Region of Paraíba State, Northeastern Brazil," *Journal of Ethnobiology and Ethnomedicine* 14, no. 1 (2018): 77, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0276-x>.
34. Éverton Renan de Andrade Melo et al., "Diversity, Abundance and the Impact of Hunting on Large Mammals in Two Contrasting Forest Sites in Northern Amazon," *Wildlife Biology* 21, no. 5 (2015): 234–45, <https://doi.org/10.2981/wlb.00095>.
35. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
36. Hani R. El Bizri et al., "Urban Wild Meat Consumption and Trade in Central Amazonia," *Conservation Biology* 34, no. 2 (2020): 438–48, doi: 10.1111/cobi.13420.
37. Hani R. El Bizri et al., "Urban Wild Meat Consumption and Trade in Central Amazonia," *Conservation Biology* 34, no. 2 (2020): 438–48, doi: 10.1111/cobi.13420.
38. Nathalie van Vliet et al., "Ride, Shoot, and Call: Wildlife Use Among Contemporary Urban Hunters in Três Fronteiras, Brazilian Amazon." *Ecology and Society* 20, no. 3 (2015): 8, <http://www.jstor.org/stable/26270228>.
39. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

taxa, with mammals being by far the most common (71.6%).⁴⁰ Capybara, tapir, lowland paca, peccary, deer, and primates are among the most frequently traded species.⁴¹

Central Amazonia alone is estimated to consume well over 10,000 tons (2,000,000 pounds) of wild meat annually at a value of more than \$35,000,000 USD.⁴² Wild meat consumption remains a primary driver of the illegal wildlife trade, both for its lower price and for its ease of access, while cultural traditions and tastes determine the local consumer market, leading to regional variation in terms of what species are sold.⁴³ The consumption of meat from the wild is also gradually becoming a delicacy for wealthier urban individuals, who enjoy exotic tastes of meat from species like the giant river turtle from Amazonas (*Podocnemis expansa*).

The exotic pet trade provides additional demand for native wildlife. Brazil's fauna supply both domestic and international markets for exotic pets, exporting hundreds of species of reptiles, amphibians, birds, mammals, and other wildlife for sale in the U.S., Europe, and Asia.⁴⁴ While some of these animals are legally traded, others are not. Brazil is a source country for the global trade in illegal wildlife, with many of these animals funneled into the exotic pet trade.⁴⁵ Within Brazil, songbirds and primates are popular pets, especially in the Amazon region.⁴⁶ Still, studies suggest that infectious disease is the leading cause of death for songbirds illegally trafficked for the pet trade in Brazil.⁴⁷ The trade in live wildlife, along with wild meat, and other animal parts and products presents ample opportunities for zoonotic spillover across the supply chain.

Sources

Wild animals are derived from both legal and illegal sources. According to a 2017-2018 report on captive wildlife production, there are over 420 registered commercial wildlife breeders in Brazil encompassing roughly half a million animals.⁴⁸ In addition, there are 47 butchering facilities that process captive wildlife registered in Brazil, with the largest farms and abattoirs located in the states of Mato

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40. Hani R. El Bizri et al., "Urban Wild Meat Consumption and Trade in Central Amazonia," *Conservation Biology* 34, no. 2 (2020): 438–48, doi: 10.1111/cobi.13420.
41. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
42. Hani R. El Bizri et al., "Urban Wild Meat Consumption and Trade in Central Amazonia," *Conservation Biology* 34, no. 2 (2020): 438–48, doi: 10.1111/cobi.13420.
43. Willandia A. Chaves et al., "Market Access and Wild Meat Consumption in the Central Amazon, Brazil," *Biological Conservation* 212, Part A (2017): 240–8, <https://doi.org/10.1016/j.biocon.2017.06.013>; Vanessa Moura dos Santos Soares et al., "Local Knowledge, Use, and Conservation of Wild Birds in the Semi-Arid Region of Paraíba State, Northeastern Brazil," *Journal of Ethnobiology and Ethnomedicine* 14, no. 1 (2018): 77, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0276-x>; Wedson Medeiros Silva Souto et al., "Zootherapeutic Uses of Wildmeat and Associated Products in the Semiarid Region of Brazil: General Aspects and Challenges for Conservation," *Journal of Ethnobiology and Ethnomedicine* 14, no. 1 (2018): 60, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0259-y>; Willandia A. Chaves, Martha C. Monroe, and Kathryn E. Sieving, "Wild Meat Trade and Consumption in the Central Amazon, Brazil," *Human Ecology* 47, no. 5 (2019): 733–46, <https://www.jstor.org/stable/45238569>.
44. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
45. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
46. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
47. Silvia Neri Godoy and Eliana Reiko Matushima, "A Survey of Diseases in Passeriform Birds Obtained From Illegal Wildlife Trade in São Paulo City, Brazil," *Journal of Avian Medicine and Surgery* 24, no. 3 (2010): 199–209, <https://doi.org/10.1647/2009-029.1>.
48. Marcela de Castro Trajano and Larissa Pereira Carneiro, *Diagnóstico da Criação Comercial de Animais Silvestres no Brasil (Diagnosis of the Commercial Breeding of Wild Animals in Brazil)*, (Brasília: IBAMA, 2019), <https://www.ibama.gov.br/phocadownload/fauna/faunasilvestre/2019-ibama-diagnostico-criacao-animais-silvestres-brasil.pdf>.

Grosso do Sul (25.2%), São Paulo (16.5%), Paraná (14.3%), and Minas Gerais (13%).⁴⁹ These facilities slaughter approximately 380,000 individuals from 14 different species, though the Caiman (*Caiman yacare*) and Arrau turtle (*Podocnemis expansa*) are the largest captive populations. Additionally, the demand for wild pet species is also increasing significantly in the country, with approximately 36 million BRL/year in the legal market alone.⁵⁰ Registered operations breeding wild animals for sale in the pet trade span 532 different species.⁵¹

Next to this growing legal market for wild animals, there is a large illegal wildlife trade in Brazil that is estimated to remove over 38 million individual animals from the wild, with 40%-70% of these animals destined for international markets.^{52 53 54} Brazil's thriving illegal wildlife trade is fostered by both the relatively mild criminal penalties for trafficking and the opportunity for substantial profit, set against a background of lackluster law enforcement.⁵⁵ Despite the low survival rate of animals from capture to end-buyer (less than 10% in some cases), it is speculated that this parallel market generates annually over \$2.5 billion in revenue.^{56 57 58} Currently, the maximum sentence available is just 12 months' detention.⁵⁹ The main regions for illegal wildlife trade are rural areas, particularly the impoverished states in the northeast (namely Bahia, Pernambuco, Paraíba, Piauí, and Ceará), the Amazon region in the north, as well as the states of Mato Grosso, Mato Grosso do Sul and Goiás in the midwest.⁶⁰

Legal and illegal wildlife markets are closely connected. Underscoring this problem is a legal trade in captive-bred wildlife that provides cover for the illegal market, allowing poached animals, captured from the wild, to be laundered and passed off as legal sales.⁶¹ A 2020 report by the NGO TRAFFIC documented "widespread fraud and malpractice" on the part of amateur and commercial breeders who mislabel species declarations, forge permits, and tamper with government identifications

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49. Marcela de Castro Trajano and Larissa Pereira Carneiro, Diagnóstico da Criação Comercial de Animais Silvestres no Brasil (Diagnosis of the Commercial Breeding of Wild Animals in Brazil), (Brasília: IBAMA, 2019), <https://www.ibama.gov.br/phocadownload/fauna/faunasilvestre/2019-ibama-diagnostico-criacao-animais-silvestres-brasil.pdf>.
50. Tanya Wyatt et al., "Wildlife Trafficking via Social Media in Brazil," *Biological Conservation* 265 (2022): 109420, <https://doi.org/10.1016/j.biocon.2021.109420>.
51. Marcela de Castro Trajano and Larissa Pereira Carneiro, Diagnóstico da Criação Comercial de Animais Silvestres no Brasil (Diagnosis of the Commercial Breeding of Wild Animals in Brazil), (Brasília: IBAMA, 2019), <https://www.ibama.gov.br/phocadownload/fauna/faunasilvestre/2019-ibama-diagnostico-criacao-animais-silvestres-brasil.pdf>.
52. Renctas (Rede Nacional de Combate ao Tráfico de Animais Silvestres), *First National Report on Wildlife Trafficking*, (Brasília: RENCTAS, 2014), https://www.renctas.org.br/wp-content/uploads/2014/02/REL_RENCTAS_pt_final.pdf.
53. Victor Lima et al., "Zoonotic Parasites in Wild Animals Such as Carnivores and Primates That are Traded Illegally in Brazil," *Brazilian Journal of Veterinary Medicine* 43, no. 1 (2021): e113720, <http://dx.doi.org/10.29374/2527-2179.bjvm113720>.
54. Tanya Wyatt et al., "Wildlife Trafficking via Social Media in Brazil," *Biological Conservation* 265 (2022): 109420, <https://doi.org/10.1016/j.biocon.2021.109420>.
55. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
56. Giulia Bucheroni, "Onda Está a Fauna Brasileira? Panorama do Tráfico de Animais Revela Futuro Preocupante (Where is the Brazilian Fauna? Panorama of Animal Trafficking Reveals Worrying Future)," *globo.com*, June 24, 2019, <https://g1.globo.com/sp/campinas-regiao/terra-da-gente/noticia/2019/06/24/onde-esta-a-fauna-brasileira-panorama-do-traffic-de-animais-revela-futuro-preocupante.ghtml>; Duda Menegassi, "Espécie Exótica de Lagarto é Registrada em Noronha e Liga Alerta de Biólogos (Exotic Species of Lizard is Registered in Noronha and Raises Awareness Among Biologists)," *(o)eco*, April 6 2020, <https://oeco.org.br/noticias/especie-exotica-de-lagarto-e-registrada-em-noronha-e-liga-alerta-de-biologos/>; Natália Menuzzi, "Tráfico de Espécies Silvestres Ameaça a Biodiversidade da Fauna Brasileira (Trafficking in Wild Species Threatens the Biodiversity of Brazilian Fauna)," *Revista Arco*, August 27, 2020, <https://www.ufsm.br/midias/arco/traffic-animais-silvestres>; Rodrigues 2020.
57. Victor Lima, et al., "Zoonotic Parasites in Wild Animals Such as Carnivores and Primates That are Traded Illegally in Brazil," *Brazilian Journal of Veterinary Medicine* 43, no. 1 (2021): e113720, <http://dx.doi.org/10.29374/2527-2179.bjvm113720>.
58. Tanya Wyatt et al., "Wildlife Trafficking via Social Media in Brazil," *Biological Conservation* 265 (2022): 109420, <https://doi.org/10.1016/j.biocon.2021.109420>.
59. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
60. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
61. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

in order to sell illegally obtained animals.⁶² In the report, interviewees from IBAMA, a division of the Brazilian Ministry of the Environment, estimated that as many as 75% of all songbirds registered in their system—an estimated 3 million animals—were the result of forgery and false declarations.⁶³ These accounts support previous studies that found 67.5% of bird ring identifiers were forged.⁶⁴ The influx of wild birds into captive-bred populations along with the inability to effectively trace the origins of these animals carries implications for zoonotic disease risk, as some of these birds have been found to carry viruses or antibiotic-resistant bacterial strains that can be passed to humans.⁶⁵

Supply Chains

Wildlife supply chains vary in length and direction depending on use. Often, wild meat is either consumed for subsistence or sold illegally in local and regional markets. Less frequently, it is moved longer distances for domestic or international sale.⁶⁶ Shelf life and the availability of cold storage also play a role in determining how far animal parts and products travel: items that demand refrigeration such as meat, eggs, milk, viscera, and blood are usually obtained based on immediate demand, while dry, durable materials such as teeth and bones, claws, horns, feathers, and snake rattles, are stored for longer periods until sold. That is the case also of leather, stuffed animals, lard, suet, and some medicinal products as well as whole animals or parts kept in alcohol bottles for preservation.

While wild meat is often consumed closer to its source, much of the trade in live wildlife flows from the Northeast, Amazon, and Central-West regions of the country into population centers in the Southeast region such as São Paulo and Rio de Janeiro.⁶⁷ Though airplanes are sometimes used, more often animals are transported along roadways or, in the case of the Amazon, floated down rivers.⁶⁸ Animals change hands several times throughout this journey.

There are many stakeholders and touchpoints involved in the transportation and sale of illegal wildlife and wildlife products.⁶⁹ Beyond the subsistence scale, there are also “professional” hunters (people whose main source of income comes from hunting activities) who are usually local inhabitants.⁷⁰ Often, their participation is partially or wholly financed by middlemen who provide loans for hunters to buy supplies and to pay their expenses.⁷¹ Indigenous peoples and impoverished youth are sometimes

62. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

63. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

64. Rodrigo Ribeiro Mairynk, “Expert Examination to Detect Fraud in Official Passerine Bands: A Tool to Combat the Trafficking of Wild Animals,” (MA diss., Federal University of Santa Catarina, 2016), https://1library-co.translate.google/document/q5rje5jz-pericial-deteccao-oficiais-passeriformes-ferramenta-combate-traffic-silvestres.html?_x_tr_sl=pt&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=sc/.

65. Marcos Bezerra-Santos et al., “Illegal Wildlife Trade: A Gateway to Zoonotic Infectious Diseases,” *Trends in Parasitology* 37, no. 3 (2021): P181–4, <https://doi.org/10.1016/j.pt.2020.12.005>.

66. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

67. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

68. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

69. Willandia A. Chaves, Martha C. Monroe, and Kathryn E. Sieving, “Wild Meat Trade and Consumption in the Central Amazon, Brazil,” *Human Ecology* vol. 47, no. 5 (2019): 733–46, <https://www.jstor.org/stable/45238569>.

70. Tanya Wyatt et al., “Wildlife Trafficking via Social Media in Brazil,” *Biological Conservation* 265 (2022): 109420, <https://doi.org/10.1016/j.biocon.2021.109420>.

71. Willandia A. Chaves, Martha C. Monroe, and Kathryn E. Sieving, “Wild Meat Trade and Consumption in the Central Amazon, Brazil,” *Human Ecology* vol. 47, no. 5 (2019): 733–46, <https://www.jstor.org/stable/45238569>.

used by wildlife traffickers to gather animals, which are then resold for up to 1,000 times the cost at which they are obtained.⁷² Animals are collected from suppliers by small-scale traffickers, usually on bicycle or motorcycle, before being handed off to middle-men, who house the animals until they can be collected by large-scale traffickers that move the animals long distances to Southeastern Brazil or across the border.⁷³ While trafficking is sometimes carried out entirely by individuals whose sole income is derived from smuggling, these individuals may also enlist professionals who work in long-distance travel occupations, such as truck drivers and migrant rural workers, as measures to avoid police scrutiny.⁷⁴ Once animals arrive in urban centers, animals may be sold either in person or through online sales.⁷⁵ Sales can take place at street fairs, public markets (both itinerant and established), at a client's home, or other pre-arranged discrete meeting spots.⁷⁶

From a disease standpoint, street markets are an important node in wildlife supply chains, bringing a host of species, both alive and dead, together in one place.⁷⁷ In some cases, the medicinal trade, wild meat trade, and exotic pet trade operate side-by-side in these venues.⁷⁸ ⁷⁹ In addition, these animals are handled by vendors and customers as well, providing opportunities for zoonotic transmission. One study of eight such street markets in Northeastern Brazil found that 55 different species of birds were offered for sale, often displayed in small cages and sometimes housed together with multiple other species.⁸⁰ Over 80% of the birds showed signs of stress or abnormal behavior brought about by close confinement, overcrowding, lack of water, and handling of the birds by humans.⁸¹ None of the animals underwent sanitary checks or health inspections prior to sale.⁸² The authors estimated that roughly 50,000 wild birds pass through those eight street markets annually, along with dozens of other types of wildlife, concluding that “Th[ese] values indicate that street markets are wildlife sinks, with a large and frequently ignored impact on the regional biodiversity that must be taken into account in the control and conservation of biodiversity, not just in Brazil but elsewhere. The impact of such sites on the removal of live animals from nature to supply both pet markets as well as traditional medicine and the bushmeat market cannot be ignored.”⁸³ At these markets, sellers were not concerned about the

72. Tanya Wyatt et al., “Wildlife Trafficking via Social Media in Brazil,” *Biological Conservation* 265 (2022): 109420, <https://doi.org/10.1016/j.biocon.2021.109420>.

73. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

74. Willandia A. Chaves, Martha C. Monroe, and Kathryn E. Sieving, “Wild Meat Trade and Consumption in the Central Amazon, Brazil,” *Human Ecology* vol. 47, no. 5 (2019): 733–46, <https://www.jstor.org/stable/45238569>.

75. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

76. Willandia A. Chaves, Martha C. Monroe, and Kathryn E. Sieving, “Wild Meat Trade and Consumption in the Central Amazon, Brazil,” *Human Ecology* vol. 47, no. 5 (2019): 733–46, <https://www.jstor.org/stable/45238569>.

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78. Rodrigo Farias Silva Regueira and Enrico Bernard, “Wildlife Sinks: Quantifying the Impact of Illegal Bird Trade in Street Markets in Brazil,” *Biological Conservation* 149, no. 1 (2012): 16–22, <https://doi.org/10.1016/j.biocon.2012.02.009>.

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80. Rodrigo Farias Silva Regueira and Enrico Bernard, “Wildlife Sinks: Quantifying the Impact of Illegal Bird Trade in Street Markets in Brazil,” *Biological Conservation* 149, no. 1 (2012): 16–22, <https://doi.org/10.1016/j.biocon.2012.02.009>.

81. Rodrigo Farias Silva Regueira and Enrico Bernard, “Wildlife Sinks: Quantifying the Impact of Illegal Bird Trade in Street Markets in Brazil,” *Biological Conservation* 149, no. 1 (2012): 16–22, <https://doi.org/10.1016/j.biocon.2012.02.009>.

82. Rodrigo Farias Silva Regueira and Enrico Bernard, “Wildlife Sinks: Quantifying the Impact of Illegal Bird Trade in Street Markets in Brazil,” *Biological Conservation* 149, no. 1 (2012): 16–22, <https://doi.org/10.1016/j.biocon.2012.02.009>.

83. Rodrigo Farias Silva Regueira and Enrico Bernard, “Wildlife Sinks: Quantifying the Impact of Illegal Bird Trade in Street Markets in Brazil,” *Biological Conservation* 149, no. 1 (2012): 16–22, <https://doi.org/10.1016/j.biocon.2012.02.009>.

possibility of inspection by law enforcement, noting that such inspections were infrequent and when they did take place, occurred later in the day, allowing vendors to sell their animals early in the morning without fear of enforcement.⁸⁴

Environmental authorities and police forces are regularly trying to combat the illegal trade of wild animals; however, their efforts are limited due to a lack of resources, lack of reliable data, and corruption.^{85 86} The state level police force seizes between 30,000–50,000 animals each year in São Paulo state alone.⁸⁷ Still, estimates suggest that authorities successfully apprehend less than 1 in 200 animals in the illegal trade.⁸⁸ Where possible, animals are released back into the wild at the point of seizure; however, others are brought to IBAMA-managed wildlife reception centers, which take in roughly 72,000 wild animals annually.⁸⁹ These facilities, which are often overcrowded and under-funded, struggle to keep pace with the flourishing illegal wildlife trade and to manage their own zoonotic risks.⁹⁰

The Brazilian wildlife trade is both domestic and international. Brazil's borders are expansive and porous, in particular those it shares with eight other countries in the Amazonian region.⁹¹ Animals are trafficked across these borders uncontrolled or with very little oversight.^{92 93} These problems are aggravated in part by policies of neighboring countries, such as Guyana and Suriname, that, unlike Brazil, allow for the commercial sale of wild caught animals.^{94 95} In other areas, including the borders with Colombia and Peru, animals are trafficked alongside other illegal materials.^{96 97 98 99} Border towns seem to play a key role in facilitating the illegal wildlife trade.¹⁰⁰

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84. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
85. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
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87. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
88. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
89. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
90. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
91. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.
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93. Angela M. Maldonado, Vincent Nijman, and Simon K. Bearder, "Trade in Night Monkeys *Aotus* spp. in the Brazil–Colombia–Peru Tri-Border Area: International Wildlife Trade Regulations are Ineffectively Enforced," *Endangered Species Research* 9, no. 2 (2009): 143–9, <https://doi.org/10.3354/esr00209>.
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Social media and other online communication tools such as Facebook and WhatsApp are increasingly used to facilitate wildlife trafficking in Brazil as animals move along these channels.¹⁰¹ Social media fosters a thriving exotic pet market in Brazil, supplied by a large-scale, domestic trade in illegal wildlife.¹⁰² These online “market spaces” give several advantages to the traffickers as they avoid conspicuous gatherings that may catch the attention of law enforcement authorities while allowing for direct communication to potential buyers without the interference of middlemen.¹⁰³ There are also exclusive online communities and privacy protections that make policing more difficult, i.e., Facebook groups with strict entry criteria or conversations with end-to-end encryption in instant messengers that allow users to erase conversations without leaving a trace.^{104 105}

Despite growing research efforts, a great deal remains unknown about illegal wildlife supply chains in Brazil.¹⁰⁶ They are better understood in relation to species with high demand such as the case of *Podocnemis* turtles in the Amazon.¹⁰⁷ The commerce of wild songbirds in public markets is also relatively well understood, with profits estimated at \$30 USD (at 2018 exchange rates) per animal and more coveted species reaching over \$170 USD in value.¹⁰⁸ However, most wildlife supply chains remain opaque, undermining both conservation and enforcement efforts.

Zoonotic Risk

High-risk human-animal interactions as well as inadequate hygiene practices and food preservation conditions are present at various stages of both legal and illegal supply chains of wild animals.^{109 110} With respect to hunting, the capture and killing of the animals are often made by

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101. Tanya Wyatt et al., “Wildlife Trafficking via Social Media in Brazil,” *Biological Conservation* 265 (2022): 109420, <https://doi.org/10.1016/j.biocon.2021.109420>.
102. Tanya Wyatt et al., “Wildlife Trafficking via Social Media in Brazil,” *Biological Conservation* 265 (2022): 109420, <https://doi.org/10.1016/j.biocon.2021.109420>.
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107. The significant consumption trends for these turtles allows for a detailed account of the extraction chain and for consumption and revenue estimations. Jackson Pantoja-Lima et al., “Chain of Commercialization of *Podocnemis* Spp. Turtles (Testudines: *Podocnemididae*) in the Purus River, Amazon Basin, Brazil: Current Status and Perspectives,” *Journal of Ethnobiology and Ethnomedicine* 10 (2014): 8, <https://ethnobiomed.biomedcentral.com/articles/10.1186/1746-4269-10-8>.
108. Vanessa Moura dos Santos Soares et al., “Local Knowledge, Use, and Conservation of Wild Birds in the Semi-Arid Region of Paraíba State, Northeastern Brazil,” *Journal of Ethnobiology and Ethnomedicine* 14, no. 1 (2018): 77, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-018-0276-x>.
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110. Victor Lima et al., “Zoonotic Parasites in Wild Animals Such as Carnivores and Primates That are Traded Illegally in Brazil,” *Brazilian Journal of Veterinary Medicine* 43, no. 1 (2021): e113720, <http://dx.doi.org/10.29374/2527-2179.bjvm113720>.

rudimentary techniques using simple tools. For instance, wild animals may be captured with traps, snares, firearms, or dogs.¹¹¹ Each of these techniques allows for the spread of pathogens, and hunters come into contact with live or freshly killed animals as well as their bodily fluids.¹¹² There are well-known zoonotic risks associated with the hunting, consumption, and processing of wild animals in Brazil, with hunters generally unable to monitor complex epidemiological aspects such as potential spillover, while also being the parties most likely to encounter such risks.¹¹³ Hunting activities present exposure risks to humans, not only in the direct hunting and animal processing activities, but also indirectly by driving human populations into areas favorable to pathogen transmission.¹¹⁴ In local communities it is common for most or all of the animal to be used as food or medicine, which exacerbates the risk of zoonotic transmission as a wider array of tissues and organs are manipulated and consumed, increasing the variety of risk exposures (i.e., exposure to bacterial, viral, or protist pathogens in blood and other fluids, helminths from the viscera and muscle tissue, and arthropod vectors from skinning and manipulating the carcass).¹¹⁵

Consumption of mammal species is of special concern, given that phylogenetic proximity is a facilitating factor for parasite and pathogen spillover, likely due to similarities in physiology and immunology.¹¹⁶ Animal consumption is thus a strong potential source of mammal-to-mammal zoonotic infection.¹¹⁷ For example, armadillos may transmit *Mycobacterium leprae*, *Trypanosoma sp.*, *Paracoccidioides brasiliensis*, and *Leishmania sp.* to humans, while consumption of wild game meat has been linked to at least thirty-two confirmed cases of *Trypanosoma cruzi* infection in Brazil.^{118 119} Likewise, tuberculosis contamination from feral pigs has also been documented.¹²⁰

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The trade in primates is of particular concern because of the acute zoonotic risks they pose to humans, in part, because of their similar genetics.^{121 122 123 124 125} Primates are kept as pets in the Amazon region, where they are owned by one in 30 households.¹²⁶ At the same time, they are also common fixtures in the wild meat trade.¹²⁷ A frequently cited 2000 study estimated that 3.8 million primates are consumed each year in the Brazilian Amazon alone.^{128 129} Studies indicate that more than half of primates and carnivores moved through the illegal trade carry harmful parasitic pathogens, though most animal dealers remain unaware of this risk.¹³⁰ One study found that 57% of primates seized from the illegal wildlife trade in Brazil tested positive for *Leptospiras*, a disease that, though usually mild in humans, becomes severe in 5%–10% of cases and can result in renal failure, severe pulmonary hemorrhagic syndrome, and sometimes death.¹³¹ Other research confirms that primates are transmitting such diseases to humans. For instance, one study found that 18% of those working with primates in Brazil had been infected with simian foamy virus, a retrovirus of the same viral family as HIV, suggesting a zoonotic risk for owners, traffickers, and hunters of new world monkeys, where close contact between humans and primates presents an ideal nexus for disease spillover.^{132 133}

In addition, recent cases of bird-to-human transmission of zoonotic disease have also been detected in the pet bird trade.¹³⁴ Wild parrots and songbirds carry pathogens from *Salmonella* to psittacosis or parrot fever, which can be fatal in humans.^{135 136} One recent study found that 80% of wild

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birds seized from the wildlife trade carried bacterial pathogens capable of infecting humans.¹³⁷ The sheer volume of the wildlife trade and diversity of species involved make Brazil at particular risk for zoonotic spillover events.¹³⁸ The close animal–animal interactions as well as human–animal interactions, both along the supply chain and after the animals are purchased at pet stores, offer manifold opportunities for disease spillover and spread.¹³⁹ The emerging industry of captive wildlife breeding may only amplify these dangers by adding its own zoonotic risks, while at the same time providing cover for the illegal trade.¹⁴⁰ Public education may play a key role in mitigating zoonotic risks posed by the pet trade.¹⁴¹

Livestock

Meat consumption in Brazil has nearly doubled since 1990, outpacing almost all developed countries.¹⁴² On average, Brazilians consume between 78.6 to 96 kilos of livestock meat per year per capita; approximately 45 kilograms is chicken, while 37 kilograms is beef and 14 kilograms is pork.¹⁴³ The consumption pattern of meat has varied over the years across regions and growth has not been uniform. For example, according to a food survey carried out by IBGE in the Northeastern part of Brazil, beef consumption fell from 11% between the 2008–2009 and 2017–2018 surveys.¹⁴⁵ In turn, pork increased its frequency of consumption among Northeasterners by 2.5 % in this same period.¹⁴⁶ For poultry, there was an increase in the North, Northeast, and Southeast, with a reduction in the South and Midwest.¹⁴⁷ However, the Covid-19 pandemic reduced purchasing power and drove down total meat consumption in Brazil.¹⁴⁸

Brazil is also among the world's top meat producers in terms of both production and export figures. Meat production is a major industry in Brazil, accounting for 10% of the country's GDP.^{149 150} In the first quarter of 2020, around 7.9 million cattle, 11.9 million pigs, and 1.5 billion chickens were slaughtered

137. Carlos Alexandre Rey Matias et al., "Frequency of Zoonotic Bacteria Among Illegally Traded Wild Birds in Rio de Janeiro," *Brazilian Journal of Microbiology* 47, no. 4 (2016): 882–8, <https://doi.org/10.1016/j.bjm.2016.07.012>.

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147. Lais Oliveira, "IBGE: Northeast is the Second Region with the Highest Frequency of Coffee Consumption in the Country," *Opovo*, Aug. 21, 2020, <https://www.opovo.com.br/noticias/brasil/2020/08/21/ibge--nordeste-e-segunda-regiao-com-maior-frequencia-de-consumo-de-cafe-no-pais.html>.

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149. Guilherme Cunha Malafaia, et al., "The Brazilian Beef Cattle Supply Chain in the Next Decades," *Livestock Science* 253 (2021): 104704, <https://www.ufrgs.br/nespro/wp-content/uploads/2021/10/10.-The-brazilian-beef-cattle-supply-chain.pdf>. See also "2020 Should be Marked as a New Year of Records in Brazil," *CEPEA*, September 16, 2020, <https://www.cepea.esalq.usp.br/en/brazilian-agribusiness-news/2020-should-be-marked-as-a-new-year-of-records-in-brazil.aspx>.

150. Mehmet A. Sahinli and M. M. Abdul-Kareem, "Competitive Analysis: Chicken Meat Sector in Brazil and Turkey," *Food Science and Nutrition Technology* 3, no. 3 (2018): 000153, <https://medwinpublishers.com/FSNT/FSNT16000153.pdf>.

for human consumption.¹⁵¹ The Brazilian beef sector, in particular, has impressive numbers and is second only to the United States in terms of cattle production.¹⁵² Per year the country produces 10.32 million tons of beef; 73.93% remains in the national market, and 26.07% is exported to dozens of countries around the world.¹⁵³ The country produces approximately 4.436 million tons of pork, and 77% is destined for the domestic market while 23% is exported.¹⁵⁴ This makes Brazil the fourth-largest producer and exporter of pork in the world.¹⁵⁵ Similarly, Brazil produces approximately 13.845 million tons of chicken meat, of which 69% is destined for the internal market and 31% for exports, making it one of the world's largest suppliers of chicken meat along with the United States and China, exporting more than each.^{156 157}

Swine and chicken herds are concentrated in the South of the country, with 50% and 45%, respectively, followed by the Southeast region with 17% and 27%, respectively.¹⁵⁸ For cattle, this pattern changes, with the Midwest responsible for 34% of Brazil's cattle herd, followed by the North region with 22%.¹⁵⁹ JBS S.A., the largest meat processing company in the world, is headquartered in Brazil. The size and power of the corporation has raised concerns of regulatory capture, which were borne out in 2017 when the parent company of JBS pled guilty to bribing more than 1,900 officials and politicians in Brazil and agreed to pay more than \$1,400,000,000 USD in fines.¹⁶⁰

There is a diversity of livestock production systems in Brazil, ranging from simple, subsistence practices to highly modern and technological production systems.¹⁶¹ Eighty percent of cattle rearing takes place on pastured-based systems.¹⁶² Pigs as well as broiler chickens and laying hens are primarily kept indoors in highly intensive systems of production.

Health Control for Livestock Products

The sanitary controls of livestock processing establishments under the Brazilian Ministry of Agriculture federal inspection service (SIF) are the strictest in the country. These establishments are also regularly audited by foreign official veterinary services of importing countries. There are 3,320 establishments of animal products covering the areas of meat and meat products, milk and dairy

151. Brazilian Institute of Geography and Statistics (IBGE). Livestock Production Statistics: Complete Results (2020). See also Roberto Guedes et al. 2020

152. Erasmus K. H. J. zu Ermgassen et al., "The Origin, Supply Chain, and Deforestation Risk of Brazil's Beef Exports," *Proceedings of the National Academy of Sciences of the United States of America* 117, no. 50 (2020): 31770–9, <https://doi.org/10.1073/pnas.2003270117>.

153. "Our Beef Accessible to All Around the World," *ABIEC Brazilian Beef Exporters Association*, accessed on May 3, 2022, <http://abiec.com.br/>.

154. "Brazil Breaks Pork Export Record in 2023," *Pig Progress*. <https://www.pigprogress.net/the-industrymarkets/market-trends-analysis-the-industrymarkets-2/brazil-breaks-pork-export-record-in-2023/>

155. "Pork," *BrazilianFarmers.com*, accessed on May 3, 2022, <https://brazilianfarmers.com/pork/#:~:text=This%20has%20helped%20make%20Brazil,the%20country's%20south%20and%20southeast>.

156. Joao F. Silva, Poultry and Products Annual Report: Brazil, United States Department of Agriculture Foreign Agricultural Service, Report No. BR2019-0068, August 28, 2020, https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Poultry%20and%20Products%20Annual_Brasilia_Brazil_09-01-2019.

157. Camila Aquino, *Poultry and Products Semi-Annual Report*, United States Department of Agriculture Foreign Agricultural Service, Report No. BR2019-0069 February 26, 2021, https://apps.fas.usda.gov/newgainapi/api/Report/DownloadReportByFileName?fileName=Poultry%20and%20Products%20Semi-annual_Brasilia_Brazil_03-01-2019.

158. "The Brazilian Meat Sector," FGV Projetos. https://agro.fgv.br/sites/default/files/2023-03/Trigo_EN.pdf

159. "The Brazilian Meat Sector," FGV Projetos. https://agro.fgv.br/sites/default/files/2023-03/Trigo_EN.pdf

160. "J&F Investimentos SA. Pleads Guilty and Agrees to Pay Over \$256 Million to Resolve Criminal Foreign Bribery Case," *Office of Public Affairs, United States Department of Justice*, October 14, 2020, <https://www.justice.gov/opa/pr/jf-investimentos-sa-pleads-guilty-and-agrees-pay-over-256-million-resolve-criminal-foreign>.

161. Guilherme Cunha Malafaia et al., *Beef Supply Chain: Context and Future Challenges (Cadeia produtiva da carne bovina: contexto e desafios futuros)* (Campo Grande: Embrapa Gado de Corte, 2021), <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/232238/1/DOC-291-Final-em-Alta.pdf>.

162. Guilherme Cunha Malafaia et al., *Beef Supply Chain: Context and Future Challenges, (Cadeia produtiva da carne bovina: contexto e desafios futuros)* (Campo Grande: Embrapa Gado de Corte, 2021), <https://ainfo.cnptia.embrapa.br/digital/bitstream/item/232238/1/DOC-291-Final-em-Alta.pdf>.

products, honey and bee products, eggs and fish, and their by-products, which are eligible for national and foreign sale.¹⁶³ The sanitary controls of slaughterhouses under state and municipal inspection services are often less stringent, with the latter often linked with severe deficiencies in food safety and humane handling. To raise the sanitary standards of state and municipal establishments, MAPA is encouraging the standardization and harmonization of inspection procedures countrywide. If the procedures of SIM and SIE are proven to be equivalent to those hygienic-sanitary levels of inspection carried out by SIF, then states and municipalities (or public consortia of municipalities) can apply to join the Sisbi-POA.¹⁶⁴ This enables establishments under these inspections to widen their geographical outreach of the sale of their animal products within Brazil's territory (animal products aimed at foreign markets remain the sole competence of SIF).

The number of federal inspectors in the country, however, is not enough to keep pace with the growth of the meat industry. This has prompted MAPA to propose changes to the inspection system to reduce the number of random inspections as well as the permanent presence of official inspectors at industrial plants.¹⁶⁵ This proposal allows the private sector to assume some of the food safety responsibilities that were previously carried out by federal inspectors. Bill 1293/2021, which outlines the proposal, is currently under review in the national congress.¹⁶⁶ The livestock sector supports this proposal in hopes of reducing bureaucratic oversight and speeding up the inspection process. The National Association of Federal Health Inspectors opposes the proposal, however, and believes that allowing industry to assume control of the inspection process would represent a serious risk to food safety.¹⁶⁷

The slaughter of cattle without veterinary inspection is estimated to account for 3.83% to 14.1% of the total meat consumed in the country. This data was calculated by the Center for Advanced Studies in Applied Economics in 2015 by comparing official slaughter data released by the IBGE, which includes federal (SIF), state (SIE), and municipal (SIM) data, and data on the number of animals available for slaughter from the Brazilian Confederation of Agriculture and Livestock (CNA).¹⁶⁸ A wide range of animal products in breach of hygienic and sanitary legislation for the production and marketing of animal-derived products were found on electronic marketplaces (e-commerce), with a greater concentration of offers in the Southeast region.¹⁶⁹

163. "Brazil Enables 136 Animal Products Establishments for Export in the First Quarter," *Brazilian Ministry of Agriculture and Livestock*, updated November 3, 2022, <https://www.gov.br/agricultura/pt-br/assuntos/noticias/brasil-habilita-136-estabelecimentos-de-produtos-de-origem-animal-para-exportacao-no-primeiro-trimestre>.

164. In Portuguese: Sistema Brasileiro de Inspeção de Produtos de Origem Animal. As of December 2020, the Sisbi-POA had 19 states (AL, BA, CE, ES, GO, MA, MT, MS, MG, PA, PR, PE, PI, RJ, RN, RS, RO, SC e TO), the Federal District, 4 municipality consortia (Cidema/SC, Cisama/SC, Consad/SC e Codevale/MS) and 28 individual municipalities (Araguari, Arroio do Meio, Alegrete, Cascavel, Caxias do Sul, Chapecó, Engenho Velho, Erechim, Fernandópolis, Florianópolis, Glorinha, Guarapuava, Ibiúna, Itapetininga, Itu, Joanópolis, Marau, Miraguai, Mossoró, Rio Claro, Rosário do Sul, Salvador do Sul, Santa Cruz do Sul, Santa Maria, Santana do Livramento, Santo Antônio da Platina, São Pedro do Butiá e Uberlândia). The requirements and procedures for joining the Sisbi-POA are established in Decree 5.741/2006 and in MAPA Normative Instruction 17/2020.

165. "Self-control Bill Gains New Version and Meets Demands of the Productive Sector," *Canal Rural*, accessed September 19, 2023, <https://www.canalrural.com.br/noticias/projeto-autocontrole-nova-versao-atende-demandas-setor-productivo/>.

166. "Commission Debates Project That Replaces Agricultural Inspection with Self-control Programs," *Câmara Dos Deputados*, June 14, 2021, <https://www.camara.leg.br/noticias/770987-comissao-debate-projeto-que-substitui-fiscalizacao>.

167. Tatiane Correia, "Quality of Food Consumed in Brazil and Exported Will be Affected by Bolsonaro Government Decision," *JGGN*, July 18, 2020, <https://jornalggn.com.br/noticia/qualidade-dos-alimentos-consumidos-no-brasil-e-exportados-sera-afetada-por-decisao-do-governo-bolsonaro/>.

168. "Livestock/CEPEA: Unsupervised Slaughter in the Country Corresponds to 3.83% to 14.1% of the Total," *CEPEA*, April 25, 2019, <https://www.cepea.esalq.usp.br/br/releases/pecuaria-cepea-abate-nao-fiscalizado-no-pais-corresponde-de-3-83-a-14-1-do-total.aspx>.

169. Izadora Souza Trindade da Silva et al., "Non-compliance with Sanitary Standards in the Offer of Animal Products in E-commerce and the Risks to Public Health," *Vigilância Sanitária em Debate: Sociedade, Ciência & Tecnologia (Health Surveillance in Debate: Society, Science & Technology)* 9, no. 2 (2021): 98–103, https://www.redalyc.org/journal/5705/570569642012/570569642012_2.pdf.

Environmental Impacts of Animal Industry

Many critics see a direct link between agribusiness profit and environmental degradation in Brazil. In recent decades, roughly 20% of the Amazon rainforest was cleared— much of it to make way for pasture land for cattle.¹⁷⁰ Cattle ranches occupy between 75%–80% of deforested areas of Amazonia.^{171–172} In the last few years, this trend has rapidly accelerated.¹⁷³ In 2019, an area of forest roughly the size of Lebanon was felled and burned, the largest loss in more than a decade.¹⁷⁴ In 2020, however, the area lost was even larger.¹⁷⁵ These changes have coincided with a surge in the global demand for beef, driving up Brazilian beef exports by 35% in just three years.¹⁷⁶ Over 50% of Brazilian beef exports go to China and Hong Kong.¹⁷⁷

At the same time, the political landscape has also changed, with a push towards deregulation, along with firings and a reduction in funding for agencies tasked with preventing unauthorized forest clearing.¹⁷⁸ While Brazilian law prohibits raising beef on illegally cleared forestland, these regulations are nearly impossible to enforce with no effective system in place to track a herd's origins.^{179–180} Cattle are frequently moved from illegal pastureland into the legal supply chain, without reliable mechanisms for consumers to distinguish between legally-produced and illegally-produced meat.^{181–182–183–184}

The livestock industry is a major interest of political and business groups that lobby for legislation that would further loosen control of deforestation and conservation units and remove protections for

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170. Cassiano Messias et al., "Analysis of Deforestation Rates and Their Drivers in the Brazilian Legal Amazon During the Last Three Decades," *RA'E GA - O Espaço Geográfico em Análise* 18, no. 52 (2021): 18–41, https://www.researchgate.net/profile/Cassiano-Gustavo-Messias/publication/354321510_Analise_das_taxas_de_desmatamento_e_seus_fatores_associados_na_Amazonia_Legal_Brasileira_nas_ultimas_tres_decadas_Analise_of_deforestation_rates_and_their_drivers_in_the_Brazilian_Legal_Amazon_during/links/6130d3e7c69a4e4879745574/Analise-das-taxas-de-desmatamento-e-seus-fatores-associados-na-Amazonia-Legal-Brasileira-nas-ultimas-tres-decadas-Analysis-of-deforestation-rates-and-their-drivers-in-the-Brazilian-Legal-Amazon-during.pdf. See also J. B. Veiga et al., "Cattle Ranching in the Amazon Rainforest," XII World Forestry Congress (2003), <https://www.fao.org/3/xii/0568-b1.htm>.
171. Marin Elisabeth Skidmore et al., "Cattle Ranchers and Deforestation in the Brazilian Amazon: Production, Location, and Policies," *Global Environmental Change* 68 (2021): 102280, <https://doi.org/10.1016/j.gloenvcha.2021.102280>.
172. Sergio Margulis, *Causes of Deforestation of the Brazilian Amazon*, World Bank Working Paper 22 (Washington, DC: The World Bank, 2004), <https://documents1.worldbank.org/curated/en/758171468768828889/pdf/277150PAPER0wbwp0no1022.pdf>.
173. Ralph Trancoso, "Changing Amazon Deforestation Patterns: Urgent Need to Restore Command and Control Policies and Market Interventions," *Environmental Research Letters* 16, no. 4 (2021): 041004, <https://iopscience.iop.org/article/10.1088/1748-9326/abee4c/meta>.
174. Celso H. L. Silva Jr. et al., "The Brazilian Amazon Deforestation Rate in 2020 is the Greatest of the Decade," *Nature Ecology & Evolution* 5 (2021): 144–5, <https://doi.org/10.1038/s41559-020-01368-x>.
175. Celso H. L. Silva Jr. et al., "The Brazilian Amazon Deforestation Rate in 2020 is the Greatest of the Decade," *Nature Ecology & Evolution* 5 (2021): 144–5, <https://doi.org/10.1038/s41559-020-01368-x>.
176. "Beef Report 2020," *ABIEC Brazilian Association of Meat Exporting Industries*, accessed May 5, 2022, <http://abiec.com.br/publicacoes/beef-report-2020/>.
177. Other leading consumers include Egypt and Russia, along with smaller countries like the UAE. "Beef Report 2020," *ABIEC Brazilian Association of Meat Exporting Industries*, accessed May 5, 2022, <http://abiec.com.br/publicacoes/beef-report-2020/>.
178. Xiao Feng et al., "How Deregulation, Drought and Increasing Fire Impact Amazonian Biodiversity," *Nature* 597 (2021): 516–21, <https://doi.org/10.1038/s41586-021-03876-7>.
179. Marin Elisabeth Skidmore et al., "Cattle Ranchers and Deforestation in the Brazilian Amazon: Production, Location, and Policies," *Global Environmental Change* 68 (2021): 102280, <https://doi.org/10.1016/j.gloenvcha.2021.102280>.
180. Ritaumaria Pereira et al., "Extensive Production Practices and Incomplete Implementation Hinder Brazil's Zero-Deforestation Cattle Agreements in Pará," *Tropical Conservation Science* 13, no.1 (2020), <https://doi.org/10.1177/1940082920942014>.
181. Marin Elisabeth Skidmore et al., "Cattle Ranchers and Deforestation in the Brazilian Amazon: Production, Location, and Policies," *Global Environmental Change* 68 (2021): 102280, <https://doi.org/10.1016/j.gloenvcha.2021.102280>.
182. Ritaumaria Pereira et al., "Extensive Production Practices and Incomplete Implementation Hinder Brazil's Zero-Deforestation Cattle Agreements in Pará," *Tropical Conservation Science* 13, no.1 (2020), <https://doi.org/10.1177/1940082920942014>.
183. Fanny Moffette and Holly K. Gibbs, "Agricultural Displacement and Deforestation Leakage in the Brazilian Legal Amazon," *Land Economics* 97, no. 1 (2021): 155–79, muse.jhu.edu/article/806367.
184. While much of Brazil's agricultural output does not rely on deforestation, those that do have an outsized impact. Roughly 20% of Brazilian soy exports and 17% of Brazilian beef exports to the EU from the Amazon and Cerrado regions were found to come from illegally cleared land. Raoni Rajão, "The Rotten Apples of Brazil's Agribusiness," *Science* 369, no. 6501 (2020): 246–8, DOI: 10.1126/science.aba6646.

indigenous peoples' lands.^{185 186} A recent declaration by the former Minister of the Environment of Brazil underscored this connection, as he was accused by some of using the pandemic as an opportunity to, “deixar a boiada passar” (literally, “let the cattle get in”) and to reduce regulation.^{187 188} Legislative acts aimed at weakening environmental protection accelerated during the COVID-19 pandemic and, despite a surge in illegal deforestation during this period, environmental fines dropped by 72% due to lack of enforcement.¹⁸⁹

Zoonotic Risks

These environmental changes carry public health implications as well. Land use change has been identified as a primary driver of zoonotic disease emergence.¹⁹⁰ There is mounting evidence to suggest that deforestation increases the likelihood of zoonotic outbreaks. This is especially true in tropical regions with a wide diversity of species where disease emergence is closely tied to land clearing for agricultural purposes.^{191 192} There are a variety of factors underpinning this increased risk.

Changes in land use can provoke other ecosystem changes in terms of the types and numbers of animals present and the ways in which they interact with humans.¹⁹³ Displaced wild animals come in more frequent contact with humans encroaching into their habitat.^{194 195} For example, studies have found an increase in rabies transmission in Brazil in areas where bats have been displaced by deforestation.¹⁹⁶ This is especially concerning given the wide range of other viral species that Brazil's 178 species of bats are reservoir hosts for.¹⁹⁷ To take another example: in 2020, Southern Brazil observed 881 probable cases of yellow fever, which is transmitted by mosquito vectors from primates to humans.¹⁹⁸ Forest loss

185. Eder Johnson de Area Leão Pereira et al., “Brazilian Policy and Agribusiness Damage the Amazon Rainforest,” *Land Use Policy* 92 (2020): 104491, <https://doi.org/10.1016/j.landusepol.2020.104491>.

186. Denis Abessa, Ana Famá, and Lucas Buruaem, “The Systematic Dismantling of Brazilian Environmental Laws Risks Losses on All Fronts,” *Nature Ecology & Evolution* 3 (March 2019), 510–1, <https://doi.org/10.1038/s41559-019-0855-9>.

187. Mariana M. Vale et al., “The COVID-19 Pandemic as an Opportunity to Weaken Environmental Protection in Brazil,” *Biological Conservation* 255 (2021): 108994, <https://doi.org/10.1016/j.biocon.2021.108994>.

188. The pandemic has also been capitalized upon to harvest illegal wood and forest-poached animal products for export to the USA. See investigation in the “Operação Akuanduba.” “PF Make Search and Seizure Against Salles and Ministry of the Environment,” *Poder 360*, updated May 22, 2021, <https://www.poder360.com.br/justica/pf-cumpra-mandato-de-busca-e-apreensao-contra-salles/>.

189. Mariana M. Vale et al., “The COVID-19 Pandemic as an Opportunity to Weaken Environmental Protection in Brazil,” *Biological Conservation* 255 (2021): 108994, <https://doi.org/10.1016/j.biocon.2021.108994>.

190. Elizabeth H. Loh et al., “Targeting Transmission Pathways for Emerging Zoonotic Disease Surveillance and Control,” *Vector-Borne and Zoonotic Diseases* 15, no. 7 (2015): 432–7, DOI: 10.1089/vbz.2013.1563.

191. Yewande Alimi et al., “Report of the Scientific Task Force On Preventing Pandemics,” Harvard Global Health Institute, August 2021, <https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2343/2021/08/PreventingPandemicsAug2021.pdf>.

192. Toph Allen et al., “Global Hotspots and Correlates of Emerging Zoonotic Diseases,” *Nature Communications* 8 (2017): 1124, DOI: 10.1038/s41467-017-00923-8.

193. Raina K. Plowright et al., “Land Use-Induced Spillover: A Call to Action to Safeguard Environmental, Animal, and Human Health,” *Lancet Planet Health* 5, no. 4 (2021): E237–45, [https://www.thelancet.com/journals/lanph/article/PIIS2542-5196\(21\)00031-0/fulltext](https://www.thelancet.com/journals/lanph/article/PIIS2542-5196(21)00031-0/fulltext).

194. Christina L. Faust et al., “Pathogen Spillover During Land Conversion,” *Ecology Letters* 21, no. 4 (2018): 471–83, DOI: 10.1111/ele.12904.

195. Laura S. P. Bloomfield, Tyler L. McIntosh, and Eric F. Lambin, “Habitat Fragmentation, Livelihood Behaviors, and Contact Between People and Nonhuman Primates in Africa,” *Landscape Ecology* 35 (2020): 985–1000, DOI:10.1007/s10980-020-00995-w.

196. Fernanda A. G. de Andrade et al., “Geographical Analysis for Detecting High-Risk Areas for Bovine/Human Rabies Transmitted by the Common Hematophagous Bat in the Amazon Region, Brazil,” *PLoS One* 11, no. 7 (2016): e0157332, <https://doi.org/10.1371/journal.pone.0157332>.

197. Samuel Cibulski, Francisco Esmail Sales de Lima, and Paulo Michel Roehle, “Coronaviruses in Brazilian Bats: A Matter of Concern?” *PLoS Neglected Tropical Diseases* 14, no. 10 (2020): e000820, <https://doi.org/10.1371/journal.pntd.000820>.

198. Roberto C. Ilacqua et al., “Reemergence of Yellow Fever in Brazil: The Role of Distinct Landscape Fragmentation Thresholds,” *Journal of Environmental and Public Health* 2021 (2021): 8230789, <https://doi.org/10.1155/2021/8230789>.

and fragmentation was found to be predictive in determining human yellow fever outbreaks.¹⁹⁹ In addition, deforestation allows wild animals to be more easily hunted as a result of increased human access to previously inaccessible protected habitat.²⁰⁰ At the same time, wildlife may be more likely to come into contact with domestic livestock species in a way that could facilitate zoonotic spread.^{201 202} Finally, as the health of the ecosystem degrades and biodiversity is lost, the species that remain tend to be those more likely to spread pathogens to humans.^{203 204} It is estimated that as many as half of global zoonotic infectious diseases in humans have been the result of changes in land use, wildlife hunting, as well as changes in agricultural or food production practices.^{205 206} Brazil is widely considered to possess each of these three risk factors.

Areas of high biodiversity experiencing forest fragmentation and increased presence of livestock are likely to create conditions favorable to zoonotic disease emergence.^{207 208} The sheer magnitude of animal production in Brazil, combined with the proximity between domestic animal production and the country's thousands of species of native wildlife, presents serious and substantial opportunities for zoonotic spillover. This is, in part, why many experts consider Brazil a potential "hotspot" for emerging infectious disease.²⁰⁹

In addition to land use change, livestock production carries its own set of inherent zoonotic risks. For example, the transport and slaughter of livestock may entail techniques that are not only problematic from an animal welfare perspective but also highly risky from a food safety standpoint.²¹⁰ Pathogens such as those that cause brucellosis and leptospirosis, as well as viruses such as rabies and vaccinia virus,

199. Roberto C. Ilacqua et al., "Reemergence of Yellow Fever in Brazil: The Role of Distinct Landscape Fragmentation Thresholds," *Journal of Environmental and Public Health* 2021 (2021): 8230789, <https://doi.org/10.1155/2021/8230789>. See also Christian Devaux et al., "Infectious Disease Risk Across the Growing Human-Non Human Primate Interface: A Review of the Evidence," *Frontiers in Public Health* 7 (2019): 305, DOI:10.3389/fpubh.2019.00305.

200. Thierry Bonaudo et al., "The Effects of Deforestation on Wildlife Along the Transamazon Highway," *European Journal of Wildlife Research* 51 (2005): 199–206, DOI: 10.1007/s10344-005-0092-1.

201. Nathan D. Wolfe et al., "Bushmeat Hunting, Deforestation, and Prediction of Zoonotic Disease," *Emerging Infectious Diseases* 11, no. 12 (2005):1822–7, doi:10.3201/eid1112.040789.

202. See, for example, the emergence of Nipah virus: Bryony A. Jones et al., "Zoonosis Emergence Linked to Agricultural Intensification and Environmental Change," *Proceedings of the National Academy of Sciences U.S.A.* 110, no. 21 (2013): 8399–404, <https://doi.org/10.1073/pnas.1208059110>.

203. Frédéric Baudron and Florian Liégeois, "Fixing our Global Agricultural System to Prevent the Next COVID-19," *Outlook on Agriculture* 49, no. 2 (2020): 111–8, <https://doi.org/10.1177/0030727020931122>.

204. Bryony A. Jones et al., "Zoonosis Emergence Linked to Agricultural Intensification and Environmental Change," *Proceedings of the National Academy of Sciences U.S.A.* 110, no. 21 (2013): 8399–404, <https://doi.org/10.1073/pnas.1208059110>.

205. Yewande Alimi et al., "Report of the Scientific Task Force On Preventing Pandemics," Harvard Global Health Institute, August 2021, <https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2343/2021/08/PreventingPandemicsAug2021.pdf>.

206. Felicia Keesing et al., "Impacts of Biodiversity on the Emergence and Transmission of Infectious Diseases," *Nature* 468, no. 7324 (=2010): 647–52, DOI: 10.1038/nature09575.

207. Jason R. Rohr et al., "Emerging Human Infectious Diseases and the Links to Global Food Production," *Nature Sustainability* 2 (2019): 445–56, DOI: 10.1038/s41893-019-0293-3.

208. For example, studies have shown that species such as horseshoe bats, a reservoir of some coronaviruses, are more likely to inhabit areas with greater forest fragmentation and those adjacent to livestock farms.

Maria Rulli et al., "Land-use Change and the Livestock Revolution Increase the Risk of Zoonotic Coronavirus Transmission from Rhinolophid Bats," *Nature Food* 2 (2021): 409–16, <https://doi.org/10.1038/s43016-021-00285-x>. See also: Yewande Alimi et al., "Report of the Scientific Task Force On Preventing Pandemics," Harvard Global Health Institute, August 2021, <https://cdn1.sph.harvard.edu/wp-content/uploads/sites/2343/2021/08/PreventingPandemicsAug2021.pdf>.

209. Kevin J. Olival et al., "Host and Viral Traits Predict Zoonotic Spillover from Mammals," *Nature* 546 (2017): 645–50, <https://www.nature.com/articles/nature22975>.

210. Engidaw Abebe, Getachew Gugsu, and Meselu Ahmed, "Review on Major Food-Borne Zoonotic Bacterial Pathogens," *Journal of Tropical Medicine* 2020 (2020): 4674235, <https://doi.org/10.1155/2020/4674235>.

continue to cause concern in the Brazilian livestock industry.^{211 212 213 214} Livestock production may also heighten the risk of viruses of “pandemic potential” such as influenzas. Pigs in particular provide ideal mixing-vessels for the generation of new and dangerous strains of influenza virus that may become transmissible to humans, and, in fact, novel strains of influenza A virus have been discovered in Brazil, including a version of H1N2v isolated from a pig farmer in the Southeastern part of the country.^{215 216 217} One study found that 9% of pigs slaughtered in a Brazilian abattoir tested positive for influenza A virus, though the animals displayed no visible sign of illness.²¹⁸

The processing of meat from livestock can provide opportunities for pathogen spread, especially when carried out clandestinely without regulatory oversight.²¹⁹ Contamination of “clean” tissue (such as muscle or fat) by microorganisms from the excretory system, skin, gut, and even from the environment can pose serious health risks for humans who come into contact with these animal-derived products.²²⁰

Zoonotic disease has the potential to cause severe economic impacts for Brazil’s vast livestock production industry. In 2021, when two cases of atypical bovine spongiform encephalopathy (known as “BSE” or “mad cow disease”) were detected in Brazil, it triggered a temporary embargo on Brazilian beef exports to China, resulting in substantial economic concern.^{221 222 223 224} Prior outbreaks have had more long-term effects. For example, China suspended Brazilian beef imports from 2012-2015 after another BSE case was reported.²²⁵ Though these cases were found to be the result of atypical rather

211. Erna Geessiem Kroon et al., “Zoonotic Brazilian *Vaccinia* Virus: From Field to Therapy,” *Antiviral Research* 92, no. 2 (2011): 150–63, <https://doi.org/10.1016/j.antiviral.2011.08.018>.

212. Maria Cosate et al., “Molecular Typing of *Leptospira interrogans* Serovar Hardjo Isolates from Leptospirosis Outbreaks in Brazilian Livestock,” *BMC Veterinary Research* 13, (2017): 177, <https://doi.org/10.1186/s12917-017-1081-9>.

213. Ana J. S. Alves et al., “Economic Analysis of Vaccination to Control Bovine Brucellosis in the States of Sao Paulo and Mato Grosso, Brazil,” *Preventive Veterinary Medicine* 118, no. 4 (2015): 351–8, <https://doi.org/10.1016/j.prevetmed.2014.12.010>.

214. Elane A. Andrade et al., “Livestock Rabies in Pará state, Brazil: A Descriptive Study (2004 to 2013),” *Pesquisa Veterinária Brasileira* 40, no. 4 (2020): 234–41, <https://doi.org/10.1590/1678-5150-PVB-6307>.

215. Paola Cristina Resende et al., “Whole-Genome Characterization of a Novel Human Influenza A(H1N2) Virus Variant, Brazil,” *Emerging Infectious Diseases* 23, no. 1 (2017): 152–4, doi:10.3201/eid2301.161122.

216. Ariane Ribeiro Amorim et al., “Influenza A Virus Infection of Healthy Piglets in an Abattoir in Brazil: Animal–Human Interface and Risk for Interspecies Transmission,” *Memórias Do Instituto Oswaldo Cruz* 108, no. 5 (2013): 548–53, doi: 10.1590/0074-0276108052013003.

217. Tatiane T. N. Watanabe et al., “Histopathological and Immunohistochemical Findings of Swine with Spontaneous Influenza A Infection in Brazil, 2009–2010,” *Pesquisa Veterinária Brasileira* 32, no. 11 (2012): 1148–54, <https://doi.org/10.1590/S0100-736X2012001100013>.

218. Araine Amorim et al., “Influenza A Virus Infection of Healthy Piglets in an Abattoir in Brazil: Animal–Human Interface and Risk for Interspecies Transmission,” *Memórias Do Instituto Oswaldo Cruz* 108, no. 5 (2013): 548–53, doi: 10.1590/0074-0276108052013003.

219. Leonardo Hermes Dutra et al., “The Prevalence and Spatial Epidemiology of Cysticercosis in Slaughtered Cattle from Brazil,” *Semina: Ciências Agrárias* 33, no. 5 (2012): 1887–96, DOI:10.5433/1679-0359.2012v33n5p1887.

220. Engidaw Abebe, Getachew Gugsa, and Meselu Ahmed, “Review on Major Food-Borne Zoonotic Bacterial Pathogens,” *Journal of Tropical Medicine* 2020 (2020): 4674235, <https://doi.org/10.1155/2020/4674235>.

221. “Brazil Confirms Mad Cow Disease Cases; Suspends China Beef Export,” *Aljazeera*, Sept. 5, 2021, <https://www.aljazeera.com/news/2021/9/5/brazil-confirms-mad-cow-disease-cases-suspends-china-beef-export>.

222. “Despite Ban From China, Brazilian Beef Exports Continue High,” *CEPEA*, Sept. 17, 2021, <https://cepea.esalq.usp.br/en/brazilian-agribusiness-news/despite-ban-from-china-brazilian-beef-exports-continue-high.aspx>.

223. Tatiana Freitas, “Brazil’s Meatpackers Curb Output as China Beef Ban Lingers,” *Bloomberg*, Oct. 8, 2021, <https://www.bloomberg.com/news/articles/2021-10-08/brazil-s-meatpackers-curb-production-as-china-beef-ban-lingers>.

224. For further explanation on the differences between classical and atypical BSE, see World Organisation for Animal Health’s Disease Information Fact Sheet, “Bovine Spongiform Encephalopathy,” World Organisation for Animal Health, last updated May 30, 2023, <https://www.oie.int/en/disease/bovine-spongiform-encephalopathy/>.

225. Huan Zhu, “Brazil-China Beef Trade Held Up Due to Mad Cow Cases,” *China Trade Monitor*, October 19, 2021, <https://www.chinatradermonitor.com/brazil-china-beef-trade-held-up-due-to-mad-cow-cases/>.

than classic BSE, outside of Brazil some have expressed concern over perceived delays in disease reporting.^{226 227 228 229 230}

Public Food Markets

Overview

One common sales outlet for animals and animal products is public markets. Public markets and open street fairs (feira livre) are ubiquitous in Brazil, throughout the country in most cities and towns. The precise number of fairs and markets currently in place in Brazil is unknown, but in 2014, the Interministerial Chamber of Food and Nutritional Security (Portuguese acronym CAISAN) coordinated a voluntary mapping effort that identified over 6,000 fairs and 951 markets across 1,176 municipalities.²³¹ Street food fairs and indoor markets date back to the colonial era; however, in the nineteenth century, driven by both hygienic considerations and a push towards urban development, Brazil moved to construct iron buildings to house these public markets.^{232 233 234 235 236} Many of these markets sell only vegetables, eggs, and dairy; however, some carry raw meat as well. Fewer still offer wild meat, wildlife, or wildlife products for sale.

The number and size of public markets and street fairs varies from region to region, and so too does the type of products on display for sale. In general, however, it is possible to describe local public markets as being a relatively large structure that houses several stands roughly divided into sectors that might include fruits, meat, and arts and crafts.²³⁷ At some commercial sites, alongside the multitude of wares and foods for sale, are domestic and wild animals as well as their byproducts. Larger

226. "Despite Ban From China, Brazilian Beef Exports Continue High," CEPEA, (Sept. 17, 2021), <https://cepea.esalq.usp.br/en/brazilian-agribusiness-news/despite-ban-from-china-brazilian-beef-exports-continue-high.aspx>.

227. World Trade Organization, Committee on Sanitary and Phytosanitary Measures, *Summary of the Meeting of 16-17 October 2013*, January 15, 2014, 8, <https://docs.wto.org/dol2fe/Pages/SS/directdoc.aspx?filename=q:/G/SPS/R73.pdf&Open=True>.

228. Meredith Lee Hill, "Biden Administration Resists Calls from Lawmakers to Suspend Brazilian Beef," *PoliticoPro*, December 6, 2021, <https://subscriber.politicopro.com/article/2021/12/biden-administration-resists-calls-from-lawmakers-to-suspend-brazilian-beef-2098834>.

229. United States Animal Plant Health Inspection Service, "Concurrence With OIE Risk Designations for Bovine Spongiform Encephalopathy," *United States Federal Register*, October 1, 2014, <https://www.federalregister.gov/documents/2014/10/01/2014-23407/concurrence-with-oie-risk-designations-for-bovine-spongiform-encephalopathy>.

230. "OIE Scientific Commission Maintains Brazil BSE Status as Negligible and Recommends Strong Monitoring," World Organisation for Animal Health (September 26, 2022), <https://www.woah.org/en/oie-scientific-commission-maintains-brazil-bse-status-as-negligible-and-recommends-strong-monitoring/>.

231. "Mapping of Food and Nutrition Security in States and Municipalities (Mapeamento de segurança alimentar e nutricional nos estados e municípios)," *MapaSAN*, accessed September 20, 2023, https://www.mds.gov.br/webarquivos/publicacao/seguranca_alimentar/mapa_san_resultados_preliminares.pdf.

232. Leonardo Danielli and Vanderli Machado Mackmillian, "Public Market: Typologies and Sociability of the Urban Environment," *National Symposium on Geography and Territorial Management and Academic Geography Week at the State University of Londrina 1* (2018): Annals of the I SINAGGET and XXXIV SEMAGEO, https://anais-uel-br.translate.goog/portal/index.php/sinagget/article/view/478?_x_x_tr_sch=http&_x_x_tr_sl=pt&_x_x_tr_tl=en&_x_x_tr_hl=en&_x_x_tr_pto=sc.

233. Clarice Barbieri Shinyashiki, Érica Christina Rodrigues Souza, and Ivone Salgado, "Public Works in the City of São Paulo in the Mid-Nineteenth Century: Hygiene and the Construction of the Public Cemetery, the Public Market and the Public Slaughterhouse," *National History Association – ANPUH XXIV National History Symposium – 2007*, <http://snh2007.anpuh.org/resources/content/anais/Clarice%20Barbieri%20Shinyashiki.pdf>.

234. Jorge Fleury and Aline Ferreira, "The Market and the City: The Influence of Meat Consumption on the Urban History of Belém in the Second Half of the 19th Century," *National Association of History – ANPUH*, São Paulo, July 2011.

235. Silvana Maria Pintaúdi, "Public Markets: Metamorphoses of a Space in Urban History," *Electrónica Magazine of Geography and Social Sciences* 218, no. 81 (2006), <http://www.ub.edu/geocrit/sn/sn-218-81.htm>.

236. Leonardo Danielli and Vanderli Machado Mackmillian, "Public Market: Typologies and Sociability of the Urban Environment," *National Symposium on Geography and Territorial Management and Academic Geography Week at the State University of Londrina 1* (2018): Annals of the I SINAGGET and XXXIV SEMAGEO, https://anais-uel-br.translate.goog/portal/index.php/sinagget/article/view/478?_x_x_tr_sch=http&_x_x_tr_sl=pt&_x_x_tr_tl=en&_x_x_tr_hl=en&_x_x_tr_pto=sc.

237. Erika de Sousa et al., "Prospecção Socioeconômica em Feiras Livres: O Caso do Complexo do Ver-o-Peso, Belém, Pará, Brasil (Socioeconomic Prospection in Open Markets: The Case of the Ver-o-Peso Complex, Belém, Pará, Brazil)," *Revista Espacios* 38, no. 36 (2017): 5, <https://www.revistaespacios.com/a17v38n36/a17v38n36p05.pdf>.

municipalities in particular may feature different sectors of the fair selling different types of animals and animal products. For example, one sector may sell animals for food, while another may sell animals for medicinal or magic/religious uses, while a third may sell live animals as pets. The profile of attendees and vendors in street fairs and public markets varies greatly from region to region, and from place to place within Brazil's large territory.

Municipal legislation defines the rule for the functioning of local public markets, including whether it is possible to sell products of animal origin. Food of animal origin must be inspected by the veterinary service by one of the government levels (SIF, SIE, or SIM) before making it available for sale. Overseeing compliance with this and other health regulations at the marketplace falls into the competence of the local health surveillance governmental entity and representatives of the public prosecutor. In addition to meat and other food products derived from livestock species (cattle, goats, chickens, and pigs) in some public markets, where demand exists, it is possible to find legal and illegal sellers of live wild animals for pets, for medicinal and magic/religious uses, and bushmeat.²³⁸ Most species of wild animal traded in public markets are native to the area in which they are sold.²³⁹ However, there is also demand for some species of non-local taxa. Meeting such demand requires longer and more extensive supply chains whose transport covers wide distances across the country, often from the seashore to the countryside, or from the Amazon region to southern states, crossing several state lines.²⁴⁰

Illegally hunted or captive wild animals might be found alongside other food and artifacts from other types of animals, though normally, due to their unlawful status, they are not always put on display, but rather shown directly to the individual customer.²⁴¹ This is the case, for instance, in markets in the capital cities of the Northern and Northeastern Brazilian states where whole animals used for medicinal purposes are commonly stored in cages or plastic bags in hidden spots.²⁴² Animals (or their parts) used for Afro-Brazilian religious rituals can also be hidden alongside other religious items or sold in stores that cater to religious practices.²⁴³ In some regions of Brazil, markets for illegally hunted animals may operate instead as a parallel or semi-parallel market.²⁴⁴ Precise data on the volume of wild animals sold

238. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

239. Rômulo R. N. Alves et al., "Animal-based Remedies as Complementary Medicines in the Semi-arid Region of Northeastern Brazil," *Evidence-based Complementary and Alternative Medicine* 2011 (2011): 179876, doi:10.1093/ecam/nep134; Wedson M. S. Souto et al., "Medicinal Animals Used in Ethnoveterinary Practices of the 'Cariri Paraibano', NE Brazil," *Journal of Ethnobiology and Ethnomedicine* 7, no. 30 (2011): 30, <https://doi.org/10.1186/1746-4269-7-30>; Flávio Barros et al., "Medicinal Use of Fauna by a Traditional Community in the Brazilian Amazonia," *Journal of Ethnobiology and Ethnomedicine* 8 (2012): 37, doi: 10.1186/1746-4269-8-37; Rômulo Romeu Nóbrega Alves et al., "Game Mammals of the Caatinga Biome," *Ethnobiology and Conservation* 5 (July 2016): 5, <https://www.ethnobiococonservation.com/index.php/ebc/article/view/90/79>; Wallisson Syllas Luna de Oliveira et al., "Illegal Trade of Songbirds: An Analysis of the Activity in an Area of Northeast Brazil," *Journal of Ethnobiology and Ethnomedicine* 16, no. 1 (2020): 16, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-020-00365-5>.

240. Rômulo R. N. Alves et al., "Animal-based Remedies as Complementary Medicines in the Semi-arid Region of Northeastern Brazil," *Evidence-based Complementary and Alternative Medicine* 2011 (2011): 179876, doi:10.1093/ecam/nep134; Wedson M. S. Souto et al., "Medicinal Animals Used in Ethnoveterinary Practices of the 'Cariri Paraibano', NE Brazil," *Journal of Ethnobiology and Ethnomedicine* 7, no. 30 (2011): 30, <https://doi.org/10.1186/1746-4269-7-30>; Flávio B. Barros et al., "Medicinal Use of Fauna by a Traditional Community in the Brazilian Amazonia," *Journal of Ethnobiology and Ethnomedicine* 8 (2012): 37, <https://ethnobiomed.biomedcentral.com/articles/10.1186/1746-4269-8-37>; Rômulo Romeu Nóbrega Alves et al., "Game Mammals of the Caatinga Biome," *Ethnobiology and Conservation* 5 (July 2016): 5, <https://www.ethnobiococonservation.com/index.php/ebc/article/view/90/79>; Wallisson Syllas Luna de Oliveira et al., "Illegal Trade of Songbirds: An Analysis of the Activity in an Area of Northeast Brazil," *Journal of Ethnobiology and Ethnomedicine* 16, no. 1 (2020): 16, <https://ethnobiomed.biomedcentral.com/articles/10.1186/s13002-020-00365-5>.

241. Willandia A. Chaves, Martha C. Monroe, and Kathryn E. Sieving, "Wild Meat Trade and Consumption in the Central Amazon, Brazil," *Human Ecology* vol. 47, no. 5 (2019): 733–46, <https://www.jstor.org/stable/45238569>.

242. Rômulo R. N. Alves and Ierecê L. Rosa, "From Cnidarians to Mammals: The Use of Animals as Remedies in Fishing Communities in NE Brazil," *Journal of Ethnopharmacology* 107, no. 2 (2006): 259–76, <https://doi.org/10.1016/j.jep.2006.03.007>; Rômulo R. N. Alves and Ierecê L. Rosa, "Zootherapeutic Practices Among Fishing Communities in North and Northeast Brazil: A Comparison," *Journal of Ethnopharmacology* 111, no. 1 (2007): 82–103, <https://doi.org/10.1016/j.jep.2006.10.033>.

243. Rômulo Romeu Nóbrega Alves and Ierecê L. Rosa, "Trade of Animals Used in Brazilian Traditional Medicine: Trends and Implications for Conservation," *Human Ecology* 38 (2010): 691–704, <https://link.springer.com/article/10.1007/s10745-010-9352-0>.

244. See, for example, jaguars. Vincent Nijman et al., "Illegal Wildlife Trade – Surveying Open Animal Markets and Online Platforms to Understand the Poaching of Wild Cats," *Biodiversity* 20, no. 1 (2019): 58–61, DOI: 10.1080/14888386.2019.1568915.

in these markets is unknown, but law enforcement seizures may confiscate several tons of illegal wild meat per market per year across the Amazonian states.²⁴⁵ Species such as paca, tapirs, deer, peccaries, and others are widely poached and sold in these markets, especially those located near the triple border of Brazil, Peru, and Colombia.²⁴⁶ A study conducted in the public markets in the city of Santa Cruz do Capibaribe, Pernambuco State, found that some animal species sold for medicinal purposes were included on lists of endangered species.²⁴⁷

Ver-o-Peso (Belém, Pará)²⁴⁸

The largest market complex in Latin America is located in the north of Brazil, in the city of Belém. The market complex is called “Ver-o-Peso,” a name that refers to the activity of verifying weight, which derives from its origin as a checkpoint for goods and tax collection in 1625. The expansion of the checkpoint started around 1860 when local authorities decided to build a more robust, indoor meat market at the site to facilitate the growing number of people and products circulating in the region.²⁴⁹ As such, the Municipal Meat Market was built between 1860-1870. It was expanded in 1890 due to insufficient space, as merchants had begun trading on the sidewalks around the building, and was renamed the Bolonha Meat Market in honor of the engineer responsible for the expansion. The need to organize a space for the sale and exchange of other types of meat, and to improve hygiene and reduce contamination, also led to the inauguration of a Fish Market in 1901 next to the Bolonha Meat market. This new space was built using iron, a construction type commonly used in European markets and that had arrived in Brazil just a few decades before.²⁵⁰ In 1977, the market was declared a national historical and artistic heritage site, and it has been added to UNESCO’s tentative list for world heritage status designation.^{251 252}

The market complex Ver-o-Peso currently spreads across an area of more than 26,000 square meters, where the Meat Market (the Bolonha Market), Fish Market (the Iron Market), Fisherman’s Square, Clock Square, Açaí Square, and Bolonha Palace are all housed.^{253 254, 255} The rules governing the

245. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

246. Sandra Charity and Juliana Machado Ferreira, *Wildlife Trafficking in Brazil* (Cambridge, UK: TRAFFIC International, 2020), <https://www.traffic.org/publications/reports/brazils-widespread-wildlife-trafficking/>.

247. Rômulo R. N. Alves et al., “Animal-based Remedies as Complementary Medicines in Santa Cruz do Capibaribe, Brazil,” *BMC Complementary Medicine and Therapies* 8 (2008): 44, <https://doi.org/10.1186/1472-6882-8-44>.

248. See pictures at Luciana Carvalho, *Ver-o-Peso*, (Belém: IPHAN, 2011), https://casadopatrimoniopa.files.wordpress.com/2013/12/guia_imprescc3a3o.pdf.

249. Jorge Nassar Fleury and Aline Alves Ferreira, “O Mercado e a Cidade: a Influência do Consumo de Carne na História Urbana de Belém na Segunda Metade do Século XIX (The Market and the City: The Influence of Meat Consumption in the Urban History of Belém in the Second Half of the 19th Century),” *Anais do XXVI Simpósio Nacional de História – ANPUH (Proceedings of the XXVI National History Symposium)*, São Paulo, July 2011, <https://docplayer.com.br/7278331-O-mercado-e-a-cidade-a-influencia-do-consumo-de-carne-na-historia-urbana-de-belem-na-segunda-metade-do-seculo-xix.html>.

250. The first iron structure used in Brazil was in the market São José, located in Recife (state of Pernambuco) and inaugurated in 1875. The structure was based on the European style, mainly the Grenelle Market architecture, in Paris. “Recife: Mercado de São José,” *Brazilian National Historic and Artistic Heritage Institute (IPHAN)*, accessed September 20, 2023, http://portal.iphan.gov.br/uploads/publicacao/9_rota_patrimonio_mercado_sao_jose_recife_pe.pdf.

251. “Ver-o-Peso,” IPHAN, accessed September 20, 2023, <http://portal.iphan.gov.br/pagina/detalhes/828>.

252. “Ver-o-Peso,” UNESCO, accessed September 20, 2023, <https://whc.unesco.org/en/tentativelists/5879/>.

253. The fish market has an infrastructure that hosts 60 stands exclusively for the sale of fish, and seven stands for other seafood. All stands are equipped with electricity, piped water, stainless steel table, sink, drain, and a space for a freezer and scale. The stands in the other areas of the complex are not standardized given the variety of products for sale.

254. “Ver-o-Peso,” IPHAN, accessed September 20, 2023, <http://portal.iphan.gov.br/pagina/detalhes/828>.

255. Instituto Brasileiro de Geografia e Estatística (IBGE), Catálogo, ID 2416, <https://biblioteca.ibge.gov.br/biblioteca-catalogo.html?id=42416&view=detalhes>.

functioning of the market are laid out in the municipal decree 26.580/1994, and it is administered by joint efforts of the Municipal Secretariats of Economy (SECON), Urbanism (SEURB), Environment (SEMMA), and Health (SESMA). There are approximately 1,200 people registered at SECON with a permit to hold trade activities in the Ver-o-Peso market. These activities include the sale of fruits, vegetables, herbs, fish, seafood, livestock meat, flour, handicrafts, Afro-Brazilian religious items, as well as serving food in restaurants.²⁵⁶ It is estimated that between 15 and 20 thousand people circulate in the Complex per day and, depending on the time of year, this number can double. Permit holders are most commonly 40 years or older, with low levels of education.^{257 258} By contrast, the profile of customers varies greatly as the market is regularly attended by local consumers as well as national and international tourists. The volume of products sold at the Ver-o-Peso complex generates up to one million Brazilian reais daily for the economy of Pará, per Inter-Union Statistics Department data (Dieese-PA).²⁵⁹

Despite the existing regulatory framework and surveillance, noncompliance and illegalities have been observed in the Ver-o-Peso market complex regarding the sale of animals (livestock and wildlife) and derived products. While there is no official data on illegal wild animals (or parts) traded at the Ver-o-Peso complex, online information sources report that live snakes, live birds, dolphin oil, porpoises' sex organs, dry seahorses, and other illegal items can be found there.²⁶⁰ With regard to sanitary conditions, field research conducted in early January of 2020 by Rosa and Seixas concluded that the conditions at the Bolonha Meat Market can be classified as at the lower end of "good," at least with respect to legally required food market conditions.^{261 262} Despite this relatively positive evaluation, the authors make two important remarks. The first is that the nonconformities found in relation to water, the cleanliness of counters, and door-seal conditions result in a risk of contamination and foodborne diseases. Second, they note that this classification is not the norm in studies that analyze public markets and popular fairs in Brazil. Indeed, several other studies of the Ver-o-Peso marketplace and of similar markets have noted inadequate hygienic and sanitary conditions.²⁶³ Studies also confirm that these markets are significant vectors of contamination and the spread of foodborne diseases, due to the unsatisfactory conditions of hygiene and sanitary measures.²⁶⁴

256. Mercado Ver-o-Peso, *Jornal do Mercado*, May 29, 2019, <https://jornaldomercado.com.br/mercado-ver-o-peso/>.

257. Erika de Sousa et al., "Prospecção Socioeconômica em Feiras Livres: O Caso do Complexo do Ver-o-Peso, Belém, Pará, Brasil (Socioeconomic Prospection in Open Markets: The Case of the Ver-o-Peso Complex, Belém, Pará, Brazil)," *Revista Espacios* 38, no. 36 (2017): 5, <https://www.revistaespacios.com/a17v38n36/a17v38n36p05.pdf>.

258. Bruno Pedroso da Silva, Evelyn Rafaele de Oliveira Souza, and Altem Nascimento Pontes, "Aspectos Socioeconômicos dos Comerciantes de Peixes do Mercado de Ferro do Ver-o-Peso no Município de Belém, Pará, (Socioeconomic Aspects of Fish Traders in the Ver-o-Peso Iron Market in the Municipality of Belém, Pará)," *Revista Contribuciones a las Ciencias Sociales* (2019), <https://www.eumed.net/rev/ccss/2019/12/comerciantes-peixes-para.html>.

259. "Ver-o-peso completes 392 years with pulsating commercialization", *Romananews.com*, accessed April 20, 2021 at <https://www.romanews.com.br/cidade/ver-o-peso-completa-392-anos-com-comercializacao-pulsante/34457/>.

260. For example, Janaina Vidal, "Ibama Carries Out an Operation Against 'Moda Triste,'" *Peludinhos Carentes*, February 19, 2010, <http://peludinhoscarentes.blogspot.com/2010/02/ibama-faz-operacao-contra-moda-triste.html>; and João Lara Mesquita, "Dolphins and Small Whales: 100,000 are Killed per Year," *ESTADÃO*, April 16, 2021, <https://marsemim.com.br/golfinhos-e-pequenas-baleias-100-mil-sao-mortos-por-ano/>.

261. Checklist based on Resolution RDC 216/2004, RDC 275/ 2002, of the National Health Surveillance Agency. Full research can be found at Matheus Yuri de Oliveira Rosa and Vitória Nazaré Costa Seixas, "Risco Sanitário na Comercialização de Carne: Condições Estruturais do Mercado Francisco Bolonha, Belém (PA) (Health Risk in the Meat Marketing: Structural Conditions of the Francisco Bolonha Market, Belém (PA))," *Congresso Internacional da Agroindústria, Ciência Tecnologia e Inovação: do campo à mesa, CIAGRO 2020*, September 25–27, 2020, DOI:10.31692/ICIAGRO.2020.0014.

262. Their scale was of three categories: bad for compliance lower than 50%, good for compliance between 51 to 74%, and excellent for compliance above 75%.

263. Several studies reporting precarious conditions on the sale of meat products in fairs and markets have been found. These studies describe one or more of the following inadequacies: lack of hygiene, lack of correct infrastructure, lack of refrigeration, exposure of products to dust and sun, and presence of cats and dogs in the surroundings.

264. Johnata da Cruz Matos et al., "Hygienic-sanitary Conditions of Street Markets: Integrative Review," *Revista Eletrônica Gestão & Saúde* 6, no. 3 (2015): 2884–93, <https://pdfs.semanticscholar.org/d0df/9aad941cb2d3acd5068e75455e720c3e223b.pdf>. The Matos study employed a mix of data collection methods (checklist, interviews, and structured questionnaires), concluding that the scenario was in breach of health legislation.

These studies and those of similar markets also indicated inadequate knowledge and training on best practices and legal requirements. For example, one study in the southern region of the State of Pernambuco found that 60.4% of interviewees working in the meat trade were unaware of the contamination risks in meat handling, and 61.5% were unaware that displaying meat on hooks, without refrigeration, is inadequate from both the sanitary and legal points of view.²⁶⁵ This study also found that 33% of the traders slaughtered the animals (mainly pigs and poultry) at their own home, clandestinely.²⁶⁶ The rest of the traders have the animals slaughtered at the municipal slaughterhouses. The transportation of carcasses of animals slaughtered at home and in municipal slaughterhouses generally occurs without adequate refrigeration systems.²⁶⁷ Another study conducted in the same region found that consumers were aware of the hygiene deficiencies throughout the supply chain, from obtaining the raw material, packaging, handling, and transportation of the products.²⁶⁸ Despite being made aware of these issues, all 50 consumers interviewed expressed a willingness to continue attending the fair. In the far southern state of Santa Catarina, a study involving 17 establishments that sell meat products showed that training activities improve food safety conditions.²⁶⁹ The nonconformities that remained were related to structural facility limitations and individual attire preferences such as wearing accessories (collars, rings, bracelets, watches, and/or earrings) while handling food.

Ver-o-Peso restaurants were closed by state and municipal decree in March 2020 when the city of Belém had only five confirmed cases of COVID-19.²⁷⁰ By June 2020, the city had 32,913 people who had tested positive for COVID-19, but the closure of restaurants and other facilities was no longer mandatory.²⁷¹ A COVID-19 test was mandatory for all permit holders working at Ver-o-Peso, however.²⁷² Further guidance on personal hygiene and enhanced safety practices for food handling in fairs, markets,

265. The study was carried out in the micro-region of Garanhuns, Pernambuco, covering five municipalities. Data was collected via semi-structured interviews of 109 meat traders at local markets. The study found that traders have an average time in the activity of 13 years, and that 48% of them count on the participation of the family to help run the business. It was also observed that 65% of the boxes at the market sold beef cattle, followed by chicken and pork. Meat from fish, goats, and giblets was less frequently commercialized. The full study can be found at W. J. da Silva Diniz et al., "Hygienic Aspects of Sale of Meat in Street Markets: The Perception of Trader," *Acta Veterinaria Brasilica, Rio Grande do Norte* 7, no. 4 (2013): 294–9.

266. A recent study published by Centro de Estudos Avançados em Economia Aplicada (CEPEA) estimates that uninspected beef cattle slaughter accounts for between 3.83% and 14.1% of all slaughter in Brazil. (#148). According to an interview with a federal inspector of MAPA, this illegal activity occurs throughout the country. Driving factors include local availability of animals, tax and tax evasion, low investments in facilities, low operating cost, deficiency in inspection at all stages of the production chain, ease of placing the product on the local retail market, consumer misinformation, lack of strict punishment for offenders, and socioeconomic and political competitiveness. (#161)

267. The hygienic and sanitary conditions of municipal slaughterhouses are often poor. See for instance, Narjara Cristine Tavares Oliveira, "Avaliação Higiênico-sanitária de Abatedouros com Sistema de Inspeção Municipal no Semiárido Nordestino (Hygienic-sanitary Evaluation of Slaughterhouses with Municipal Inspection System in the Northeastern Semi-arid Region)," Master's Diss., Postgraduate Program in Animal Science, Center for Rural Health and Technology, Federal University of Campina Grande - Patos - Paraíba - Brazil, 2017 (Dissertação de Mestrado em Zootecnia, Programa de Pós-graduação em Zootecnia, Centro de Saúde e Tecnologia Rural, Universidade Federal de Campina Grande - Patos - Paraíba - Brasil, 2017).

268. Antonio Brito da Silva Filho et al., "Percepção do consumidor sobre a higiene na comercialização de carnes em feira livre da cidade de Garanhuns – PE (Consumer Perception of Hygiene When Selling Meat at a Street Market in the City of Garanhuns - PE)," *Revista Brasileira de Higiene e Sanidade Animal* 12, no. 4 (2018): 428–36.

269. The study evaluated 17 establishments that commercialize products of animal origin inspected by the Municipal Inspection System (SIM). These are: 15 supermarkets, 2 meat processing establishments and 1 fish processing establishment. Eriane de Lima Caminotto et al., "Impactos do Curso de Capacitação para os Manipuladores de Produtos de Origem Animal (Impacts of the Training Course for Animal Product's Handlers)," *Brazilian Journal of Development* 6, no. 9 (2020): 64044–52, <https://doi.org/10.34117/bjdv6n9-001>.

270. "Ver-o-Peso Restaurants are Closed to Prevent the New Coronavirus in Belém," *globo.com*, March 24, 2020, <https://g1.globo.com/pa/para/noticia/2020/03/24/restaurantes-do-complexo-do-ver-o-peso-sao-fechados-como-prevencao-ao-contagio-do-novo-coronavirus-em-belem.ghtml>.

271. Carlos Molinari, "Belém Lives 'New Normal', Despite High Contamination by COVID-19," *Agência Brasil*, June 11, 2020, <https://agenciabrasil.ebc.com.br/geral/noticia/2020-06/belem-vive-novo-normal-apesar-de-contaminacao-alta-por-covid-19>.

272. Dilson Pimentel, "Ver-o-Peso Stallholders take Covid-19 Tests This Monday," *OLIBERAL.COM*, June 29, 2020, <https://www.oliberal.com/belem/feirantes-do-ver-o-peso-fazem-testes-de-covid-1.280996>.

and slaughterhouses was drafted and distributed by MAPA in partnership with ANVISA.^{273 274} It is worth noting that places at Ver-o-Peso were falsely advertising a combination of herbs as a cure for COVID-19.²⁷⁵

Conclusion

Brazil has a longstanding legal framework for addressing both environmental protection and food safety that encompasses all three levels of government—federal, state, and municipal. This system alone is not sufficient for mitigating zoonotic risks to human health, however. Disease risks arise in both the wildlife sector and the livestock sector, and each of these types of risk is amplified by ongoing environmental changes and habitat degradation.

The degree of risk and the frequency of illegal practices reported in Brazil suggest that further efforts are needed to protect the health and welfare of humans and animals. In this context, policymakers should adopt an educational approach to inform consumers about the importance of hygienic-sanitary control during the production of animal products, and to diminish demand for high-risk products. Investments in resources for law enforcement institutions are also crucial at all levels of government to ensure countrywide protection. Finally, addressing the underlying drivers of disease transmission— in particular deforestation, habitat loss, and land use change—is critical to reducing the likelihood of future zoonotic outbreaks.

273. “The Marketing of Food Products in Street Markets, Grocery Stores and Retailers (in Partnership with MS and ANVISA),” www.gov.br, March 18, 2021, <https://www.gov.br/agricultura/pt-br/campanhas/mapacontracoronavirus/documentos/recomendacoes-comercializacao-produtos-alimenticios-feiras-livres-sacoloes-varejistas.pdf>.

274. Brazil Ministry of Agriculture, Livestock and Supply. General Guidelines for Refrigerators Due to the COVID-19 Pandemic. (2020), <https://www.gov.br/agricultura/pt-br/campanhas/mapacontracoronavirus/documentos/manual-orientacoes-gerais-para-frigorificos-em-razao-da-pandemia-da-covid-19/view>.

275. Gram Slattery, “Aspirin in Honey: Dubious COVID-19 ‘Cures’ fSpread in Brazil,” Reuters, June 17, 2020, <https://www.reuters.com/article/us-health-coronavirus-brazil-fakenews/aspirin-in-honey-dubious-covid-19-cures-spread-in-brazil-idUSKBN23O2VA>; Victor Furtado, “It’s Rumor: ‘Corona Kit’ from Belém Fairs,” OLIBERAL.COM, May 7, 2020, <https://www.oliberal.com/belem/e-boato-kit-corona-das-feiras-de-belem-1.264788>.

Images



Figure 1. Zootherapeutic products exposed at urban vendors in Belém, State of Pará: yacare leather, rostral expansion on *Pristis perotteti* and an exemplar of *Oreaster reticulatus*. Photo: Rômulo Alves.



Figure 2. Different populations in Brazil have hunting as a source of animal protein. (A) trap made by hand for hunting small mammals; (B) specimen of *Didelphis albiventris* being prepared by the hunter for consumption and (C) specimen of *Nasua nasua* packaged and without skin ready for consumption. Photo: Ianei Carneiro.



Figure 3. Mammals and reptiles are the most hunted species for consumption. (A) specimen of *Kerodon rupestris*, a rodent found in the Caatinga biome e (B) lizard of the genus *Tupinambis* sp. hunted and sold at an open market in a Brazilian city. Photo: Ianei Carneiro (left) and Poliana Mascarenhas (right).