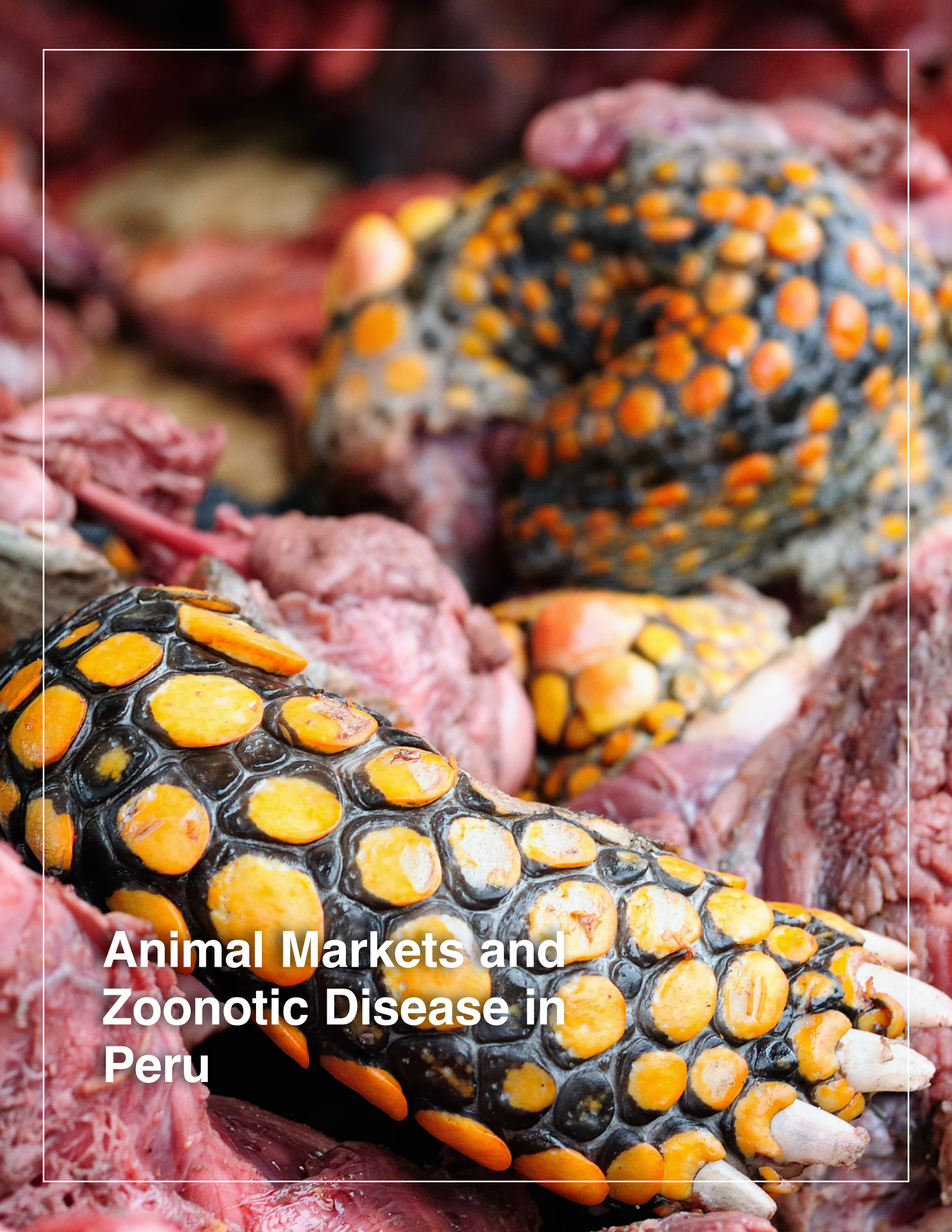

Animal Markets and Zoonotic Disease in Peru

COUNTRY SUMMARY: PERU

CULTURAL CONTEXT

Peru, with 31 million people, is divided across three regions— highlands, coast, and jungle—and known for rich biodiversity, particularly the jungle region which includes large portions of the Amazon rainforest. Though there is variance across regions, wildlife has long been considered a means of subsistence that provides food, clothing and economic benefits in local markets. Hunting has been an ancestral practice linked to rituals maintained today. In recent decades, an increase in internal displacement and migration have shifted consumption and trade patterns, accelerating development of national trade networks and the proliferation of local and regional animal markets where wildlife products and byproducts are offered. International demand for wildlife products has increased the emergence of trafficking routes. Along with this growth and consumption, interactions with wildlife and human exposure to zoonotic risks have increased. In its policymaking, the state seeks to preserve the continuity of these traditions.

ANIMAL MARKETS

Animal markets are common across Peru, selling live domestic animals, wildlife, wild meat, and other animal products, often from different stalls in the same market. Many markets serve important social functions. Some support and foster the illegal trade of wild animals. Animal parts and byproducts are sometimes offered for ritual use or witchcraft, while meat is available for direct consumption. Wild meat is sold primarily in the Amazon region. Domestic animals such as chicken, fish, beef, pork, guinea pig, alpaca, and eggs are also commonly traded at markets. Small animals can be stored in cages, slaughtered, and skinned either outside the market or in the same stalls. For larger animals, such as pigs and cows, whole pieces of the animal are displayed on shelves or hanging from meat hooks. A significant proportion of products traded in markets are from household economies: small plots of agricultural land, backyard poultry and pork, and subsistence-hunted bushmeat, along with crafts and traditional medicine. Communities that once hunted for subsistence are increasingly commercializing wild meat for income. There are wildlife breeding farms in Peru but information about practices, trading networks, and rates of disease at these facilities is limited. Livestock production primarily focuses on camelids (alpaca, llama) and guinea pigs. Poultry comprise more than half of Peruvian livestock and are raised intensively.

DRIVERS OF ZOONOTIC DISEASE RISKS

Animal markets in Peru generally have limited hygiene, inadequate handling practices, and poor infrastructure. In some cases, live animals are kept in cages that are small or crowded, causing interaction between different animals and different species held together in ways that facilitate disease spread. In many cases wildlife species are in constant contact with domestic species traded as pets,

and with animals such as chicken, guinea pigs, rabbits, and turkeys sold for direct human consumption. Waste management and sanitary control by local authorities is often wanting. Some markets pose a particularly high risk due to improper disposal of waste, which can attract other animals such as rodents. Some markets lack electricity, drinking water, or sewage services.

RISK MITIGATION AND RELEVANT CHALLENGES

Legal permits for breeding wildlife are often unaffordable, and hunters lack incentives to comply with regulatory requirements. Precarious wildlife management systems and limited surveillance have led to a lack of a comprehensive response and prevention mechanisms. More data is needed as there is insufficient knowledge regarding the impacts of growing demand for bushmeat on endemic ecosystems and how this imbalance could impact the proliferation of species such as rodents, mosquitoes, and other possible vectors that may transmit zoonotic disease to humans. A multicultural approach to the regulations governing subsistence hunting would contribute to designing adequate and responsive policies. Interventions must account for Peru's fragmented institutional and social arrangements, with special attention to local and Indigenous populations that face the highest risk.

AUTHORS

This report was written by Monica Nuñez Salas (Universidad del Pacífico, Perú) and Sayuri Andrade Toma (Universidad del Pacífico, Perú).

ACKNOWLEDGMENTS

This work was made possible thanks to the support of Diana Palacios and Nicole Nuñez, student researchers in the Environmental Management Clinic at Universidad del Pacífico Law School (Lima, Peru). The authors also wish to acknowledge those who contributed to our understanding of the issue with their time and knowledge: Oswaldo Cabanillas, Matthew Enriquez, Ana Elisa Lambert, Eder Lara, Yovana Murillo, Larissa Otero, Ibelice Pérez, Patricia Torres and Rubén Villacaqui.

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INTRODUCTION AND RELEVANT CONTEXT

Peru is a megadiverse country located on the West Coast of South America. Its topography is defined by three macroregions that cross the territory north to south, from west to east: the Coast, Highlands and Jungle. The relationship between human and nonhuman animals in each macroregion and consumption patterns is characterized by species diversity, traditional culture, and economic development.

Most of the country's population lives in the Coastal region, in cities that sprawled due to their proximity to ports, and that now host Peruvians from all three macroregions. The country's capital, the city of Lima, is located on the central Coast and is home to a third of the country's population (9,674,755 inhabitants).[1] Forty percent of these inhabitants were born elsewhere.[2] The Highlands region is characterized by the dramatic landscape of the Andean mountain range. Cities such as Cusco, the capital of the Incan Empire, stand at 3,300 meters above sea level (over 11,000 feet) and have traditionally relied on tourism as an important source of income, attracting considerable national and international migration. The Amazon macroregion covers most of the country's territory but hosts the smallest number of inhabitants, compared to the other two. Differences in altitude, humidity, and accessibility make this region all but a homogeneous ecosystem. Despite facing conservation threats such as extractive industries, agricultural expansion, and road infrastructure—all of which have attracted foreign capital and driven internal migration—the Peruvian side of the Amazon Basin hosts a large diversity of wildlife, many species endemic to the country and region. Perhaps more importantly, in addition to riverine and campesino communities of the rural Amazonian population, a significant number of Peruvians in the jungle macroregion identify as Indigenous and conserve many of their traditional consumption patterns. The area is also home to some of the world's last isolated peoples and Indigenous peoples who have only been in initial contact with others.

In the last few decades, an increase in internal displacement and migration has shifted consumption and trade patterns within the country. This has accelerated the development of national trade networks alongside increasing proliferation of local and regional wet markets where wildlife products and byproducts are offered. Along with this growth and consumption, interactions among wildlife species and human exposure to zoonotic risks have increased.

In addition, international demand for wildlife products has intensified routes for wildlife trafficking that often cross all three regions. Animal parts and products are transported mostly from the Amazon, through the Highlands, and into Coastal cities and ports before being exported to international markets.

The most frequent zoonosis outbreaks recorded by the Ministry of Health (MINSA) are urban rabies (present in the regions of Arequipa, Puno, and Cusco), wild rabies (in Loreto, Pasco, Ucayali, and Amazonas), fasciolosis (in the northern and southern highlands), plague (in Piura, Lambayeque,

1. "La Población de Lima Supera los Nueve Millones y Medio de Habitantes (The Population of Lima Exceeds Nine and a Half Million Inhabitants)," Instituto Nacional de Estadística e Informática, January 17, 2020, https://m.inei.gob.pe/prensa/noticias/la-poblacion-de-lima-supera-los-nueve-millones-y-medio-de-habitantes-12031/.
2. *"INEI y CELADE Presentan Estudio Sobre Migración Interna a Nivel Departamental, Provincial y Distrital* ("INEI and CELADE Present a Study on Internal Migration at the Departmental, Provincial and District Levels)," Instituto Nacional de Estadística e Informática Press Release, May 24, 2022, https://m.inei.gob.pe/media/MenuRecursivo/noticias/nota-de-prensa-no-087-2022-inei.pdf.

Cajamarca, and La Libertad), leptospirosis (at the national level) and anthrax (on the coast, northern highlands, and south of Lima).[3]

Other reported diseases that have generated concern in the health sector recently are hantavirus pulmonary syndrome (HPS) and the fungus *Batrachochytrium dendrobatidis* (Bd). Hantavirus is generally transmitted to humans by inhalation of aerosols produced by the feces and urine of infected rodents. In 2011, the first two cases of human HPS in the country were identified in the Amazonian city of Iquitos.[4] Iquitos is the largest city in the world not accessible by roadways.

On the other hand, the Bd fungus has radically decreased amphibian populations worldwide and was reported in animals seized in the capital city of Lima, as well as in wild *T. culeus* specimens inhabiting Lake Titicaca.[5] The amphibians likely reached wet markets in Lima due to the popular consumption of a beverage that is traditionally thought to remedy respiratory issues in the winter. An increase in sales of this traditional product has been reported by Peruvian media since 2015.[6] As many as 2,157 infected amphibians were seized in 2019 by SERFOR, after which the agency called on the general public to avoid consuming this beverage due to risk of zoonosis[7] though currently there is no known zoonotic potential.[8]

Three of the main human activities that explain the transmission of these pathogens in Peru, as has been documented throughout the research, are analyzed below: bushmeat consumption and trade, illegal trafficking of wild species, and species interaction through local trade. All these activities often converge in spaces of trade, such as wet markets, where both live animals and meat are offered to the public.

ANIMAL MARKETS AND MAIN ZOONOTIC RISKS

This assessment of risks addresses local consumption habits, taking into account the influence of internal migration and cultural consumption patterns. We also consider potential zoonotic risks identified by researchers in some of the main markets in the Coastal macro-region, and through a collaborative study led by the Wildlife Conservation Society (WCS) countrywide. We then present the main routes for wildlife trafficking and the institutional arrangements that rule over animal and human

3. Thanks to the timely detection of the National Epidemiology Network (RENACE), rabies and plague have been effectively controlled in recent years. Rabies is currently considered an endemic disease, with two main sources of transmission: urban (transmitted by dogs) and wild (transmitted mainly by the bite of hematophagous bats). Anna Maria Navarro, José Bustamante, and Alberto Sato, "Situación Actual y Control de la Rabia en el Perú (Current Situation and Control of Rabies in Peru)," Revista Peruana de Medicina Experimental y Salud Publica 24, no. 1 (2007): 46–50, http://www.scielo.org.pe/scielo.php?script=sci_arttext&pid=S1726-46342007000100008. Rabies is regulated under MINSA's Technical Standard for the Prevention and Control of Human Rabies (published in 2006), which establishes the actions to be taken in the event of suspected outbreaks in wildlife, especially in bats. Likewise, the incidence of anthrax has been controlled thanks to the joint work between MINSA and the National Agricultural Health Service (SENASA) (MINSA, 2019). See also "Zoonosis un Reto Para el CDC Perú (Zoonotic Disease Surveillance)," Ministerio de Salud Press Release, July 6, 2019, https://www.dge.gob.pe/portal/docs/notas_prensa/2019/notaprensa0222019.pdf.

4. The cause of infection was found to be Seoul orthohantavirus (SEOV). See also Martín Casapía *et al.,* "Síndrome Pulmonar por Hantavirus (Virus Río Mamoré) en la Amazonía Peruana (Hantavirus Pulmonary Syndrome (Río Mamoré Virus) in the Peruvian Amazon Region)," *Revista Peruana de Medicina Experimental y Salud Pública* 29, no. 3 (2012): 390–5, 10.17843/rpmesp.2012.293.375.

5. Roberto Elías et al., "Gestión y Vigilancia Sanitaria de la Fauna Silvestre en el Perú (Management and Health Surveillance of Wildlife in Peru)," *Salud y Tecnología Veterinaria* 8, no. 1(2020): 19–26, https://doi.org/10.20453/stv.v8i1.3788.
Lake Titicaca is located at 3,812 meters above sea level in the Highland region of Puno, on the border of Peru and Bolivia.
See also: Raul Berenguel et al., "Chytrid Fungus, Batrachochytrium dendrobatidis, in Wild Populations of the Lake Titicaca Frog, Telmatobius culeus, in Peru," *Journal of Wildlife Diseases* 52, no. 4 (2016): 973–5, https://doi.org/10.7589/2016-01-007.

6. "Frío Eleva Venta de Extracto de Rana en La Parada (Cold Increases Sales of Frog Extract in La Parada)" *El Comercio, June 10, 2014*, https://elcomercio.pe/lima/frio-eleva-venta-extracto-rana-parada-328452-noticia/.

7. "Decomisan 2,517 Ranas Gigantes de Puno que Tenían como Destino Lima (They Seize 2,517 Giant Frogs from Puno That Were Destined for Lima)," *Andina, June 24, 2019,* https://andina.pe/agencia/noticia-decomisan-2517-ranas-gigantes-puno-tenian-como-destino-lima-756446.aspx.

8. "Batrachochytrium," ScienceDirect, accessed September 21, 2023, https://www.sciencedirect.com/topics/immunology-and-microbiology/batrachochytrium.

health. This is followed by a description of the risks involved in transporting the species across different regions, through different geographies and, oftentimes, in boats and buses meant to transport people and not prepared to follow animal sanitation measures.

Wildlife in Peru, particularly in the Amazon, has historically been a means of subsistence that provides food, clothing (to a much lesser extent today), and economic benefits from selling wildlife parts and products in local markets.[9] Subsistence hunting has been an ancestral practice linked both to rituals and to provide food, a part of the Amazonian cosmovision that is still maintained today. One of the possible mechanisms of transmission of infectious diseases that is unlikely to be monitored is the consumption of bushmeat and/or the exposure of bushmeat and other types of meat to contaminating pathogens in the informal trade.

Bushmeat Consumption

Throughout the Andean Amazon, hunting is an ancestral practice carried out by native communities for subsistence purposes, which often sell the remnant bushmeat in local markets.[10] With the increase of internal migration toward bigger cities, a market for local bushmeat trade has been growing. Given the lack of livelihood alternatives and the low incomes obtained by the sale of agricultural products, communities that only used to hunt for subsistence purposes are increasingly adopting local commercialization as a viable source of income.[11]

Peruvian regulations allow hunting for subsistence and ritual use, as well as the consumption of forest or wildlife products for domestic use, self-consumption or subsistence activities that have been authorized by the communal authority.[12] In this way, the state seeks to preserve the continuity of these cultural traditions, as it recognizes the great contribution, beyond food and survival, that fauna provide to rural populations composed of either native communities or settlers.[13] Commercialization of bushmeat, wildlife products, and their byproducts is forbidden unless it comes from formally authorized breeding farms or community-management areas in which agrarian sanitary practices are supervised by SENASA.[14] A total of thirty-four breeding farms (*zoocriaderos*) are reported in the country.[15] Many

9. N. Badayan *Influencia Socioeconómica de la Fauna Silvestre como Recurso Alimentario* (Bachelor dissertation), Universidad Nacional de la Amazonía Peruana, Perú, 1991.

10. Nora Y. Bendayán Acosta, Julia Bardales García, and Lorgio A. Verdi Olivares, . "Catastro de Zonas de Extracción de Fauna Silvestre en Loreto, Perú (Cadastre of Wildlife Extraction Areas in Loreto, Peru)," in R. Bodmer (ed.), *MEMORIA VI Congreso sobre Manejo de Fauna Silvestre en Amazonia y Latinoamérica (Iquitos: Wildlife Conservation Society, 2004),* 499-503.

11. M. Cristina Espinosa, "What has Globalization to Do with Wildlife Use in the Remote Amazon? Exploring the Links Between Macroeconomic Changes, Markets and Community Entitlements," *Journal of Developing Societies* 24, no. 4 (2008): 489–521, https://doi.org/10.1177/0169796X0902400404; Antony C. Leberatto, "A Typology of Market Sellers of Protected Wildlife Across Peru," *Deviant Behavior* 38, no. 12 (2017): 1352–70, https://doi.org/10.1080/01639625.2016.1254963.

12. The right of Indigenous peoples to carry out subsistence activities, which is recognized in the following legal instruments: ILO Convention 169 (Art. 23), United Nations Declaration on the Rights of Indigenous Peoples (Art. 20) and the American Declaration on the Rights of Indigenous Peoples. See also: Article 121 - Law No. 29763, Forestry and Wildlife Law.

13. Marc J. Dourojeanni, *Amazonía ¿Qué hacer? (*Iquitos: Centros de Estudios Teológicos de la Amazonía [CETA], 1990).

14. According to Article 94 of Law No. 29763, Forestry and Wildlife Law, breeding farms are establishments for the *ex-situ* management of wildlife for commercial purposes and production of goods and services. They have adequate environments for animal welfare and are intended for the breeding, reproduction and maintenance of wildlife specimens in a controlled environment. In these establishments, the breeding of endangered species is not authorized. It's relevant to note that Peter Daszak, President of EcoHealth Alliance and a member of the World Health Organization commision that visited China in early 2021 to find evidence on the origins of the Covid-19 pandemic, stated that wildlife farms were a likely source of the virus (Michaeleen Doucleff, "WHO Points to Wildlife Farms in Southern China as Likely Source of Pandemic," NPR, March 15, 2021, https://www.npr.org/sections/goatsandsoda/2021/03/15/977527808/who-points-to-wildlife-farms-in-southwest-china-as-likely-source-of-pandemic). This finding may lead health, wildlife and conservation experts to reconsider the viability of wildlife farms. According to Article 89 of Law No. 29763, Forestry and Wildlife Law, wildlife management areas are natural areas in which the sustainable use of certain wildlife species is carried out under management plans.

15. The information is available online, through the wildlife management database of OSINFOR. See: https://zoobservatorio.osinfor.gob.pe/Home/ListFauna (Last visit: June 3, 2021).

of these function as tourist sites dedicated to recovering reptiles and practicing falconry but not raising animals for direct consumption. Information about breeding practices, trading networks, and final products is unclear, although an opportunity to improve rural livelihoods through the certification of peccary leather has been suggested by researchers in the Loreto region.[16] The lack of official information suggests that the trade in bushmeat is considerably informal.

For local and Indigenous communities, obtaining the legal permits to breed wildlife is expensive and often unaffordable.[17] Requirements include a technical report for the management of an area and applying for the approval of multiple administrative permits before the regional and national authorities. Hunters lack incentives to engage in formal and sustained activities and rely on the income obtained from daily sales, while intermediaries and formal traders with access to city markets are able to increase the prices.[18] As an example, the price per kilo of peccary meat ranges from 7 to 9 soles (about $2) in the *28 de Julio* Kichwa community but nearly doubles in Iquitos, where it is sold at approximately 20 soles ($5.5).[19] Restaurants in the city have been found to pay as much as 40 soles ($11) for the same meat.[20] The current legal framework does not address all of these production and trade configurations, which precludes us from understanding the real magnitude of the problem or a capacity to propose solutions that seek a dialogue across cultural traditions, economic and social needs, and the law.

A first successful case of sustainable bushmeat production is the case of the Pucacuro National Park in Nauta, Loreto region, an example of coordinated work between the State and local communities. A hunters' association called "Los Pumarunas," originally from a native community, is effectively implementing a wildlife management plan for the consumption of *huangana* (*Tayassu pecari*), sajino or peccary (*Pecari tajacu*), *majaz* (*Cuniculus paca*), and deer species within the National Reserve. This plan was designed based upon the socioeconomic and cultural realities of the Kichwa communities in the Tigre River, who are dedicated to ancestral hunting for consumption, and even won national recognition granted by the Ministry of the Environment (MINAM) for their conservation work.[21] This case is an exception to the rule, as the high administrative costs of performing this activity legally often scare people away and have turned the commercialization of bushmeat into a clandestine activity, pushing wildlife products to informal markets or online.

Illegal Species Trade

In many local agricultural communities (either Indigenous or settlers), hunters sell part of their take as meat in order to obtain an income, since poverty rates in rural areas are quite high compared to urban areas. The city of Iquitos has been found to be the biggest hub for wildlife trade. This city is

16. Tula G. Fang, Richard E. Bodmer, Pablo E. Puertas et al., *Certificación de Pieles de Pecaríes en la Amazonía Peruana:* Una Estrategia para la Conservación y Manejo de Fauna Silvestre en la Amazonía Peruana (Lima: Wust Ediciones, 2008), 18.
17. Joao Diego Freitas Cordova and Pedro Vasquez, "Diagnosis of International Marketing of Wildlife in Loreto, Peru," Folia Amazónica 27, no. 2 (2018): 203–13, http://revistas.iiap.org.pe/index.php/foliaamazonica/article/view/469.
18. Carlos Ganoza Durant,. and Andrea Stiglich Watson, *El Perú está Calato. El Falso Milagro de la Economía Peruana y las Trampas que Amenazan Nuestro Progreso, (*Lima: Editorial Planeta, 2015).
19. Servicio Nacional de Áreas Naturales Protegidas por el Estado (SERNANP), *Plan de Manejo de Animales de Caza en la Reserva Nacional Pucacuro: Realizado por Cazadores Kichwas de la Comunidad 28 de Julio, Alfonso Ugarte y Asociación de Cazadores de Intuto, 2014–2018* (Lima: SERNANP, 2014).
20. Annie Julissa Escobedo Grández et al., *Consumo de la Carne de Monte o "Carne Invisible" en Restaurantes Turísticos de Iquitos* (Iquitos: SERNANP, 2020).
21. The Antonio Brack Egg National Environmental Award (2016). See more: https://www.sernanp.gob.pe/noticias-leer-mas/-/publicaciones/c/experiencia-de-aprovechamiento-de-carne-de-monte-en-reserva-250653

the capital of Loreto, the northeasternmost region of Peru, near the shared border with Colombia and Brazil, and is accessible only by boat or airplane. More than 345 tons of wildlife products are reportedly traded annually, including reptiles, mammals, and birds.[22] The most commonly traded species include the peccary (*Pecari tajacu*), the *majaz* (*Cuniculus paca*), and the *huangana* (*Tayassu pecari*).[23]

There are different configurations through which wild species are captured. When hunters capture parrots, monkeys, or peccaries for their consumption, the species' young are often traded as pets. A second source of capture is bycatch: hunters look for a particular species but capture other wildlife in the process. As an example, boas and other reptiles are often entangled in fishing nets when searching for paiche (*Arapaima gigas*), a freshwater fish native to these areas. A third case is when the killing is carried out for self -defense, whether for the protection of community members, livestock, or crops. Conflicts with caimans, jaguars, and pumas end with these specimens being sold at market value, with jaguar parts the most sought after. Lastly, a fourth case of wildlife capture occurs when hunting or opportunistic trade of species is related to illegal logging or mining activities.

The next step in the supply chain is when local actors sell the specimens to supplement their low income. Trading products obtained by subsistence hunting is considered a criminal offense, but local communities often interpret this restriction as wrong given that the income they obtain from trading is used for subsistence. This may be due to the long Peruvian tradition of using these animals as pets or trading them for medicinal and ritual purposes.[24]

Wildlife products are then traded by offering the species to their neighbors in squares or markets operating with informal and unsanitary conditions or by selling these products to intermediaries who, in turn, transport them to markets in order to supply the demand in other cities or to sell them abroad.[25] These intermediaries acquire them in the communities themselves, in the local river ports (central points for wildlife trade), or in local markets. Their main roles are to facilitate the transport of animals to both buyers and sellers, obtain certain species of interest, and locate potential buyers, among others.

Shanee et al. point to the weak intervention of local authorities as the main factor for local people to become involved in trafficking.[26] Wildlife trade represents a disproportionate risk-benefit for those involved in trafficking: rural inhabitants capture and transport animals to local markets without being interfered with, while intermediaries and traders in the cities face only the unlikely risk of the confiscation of species they consider to be of little investment cost, relative to the economic benefits obtained in their sale.[27]

A case study of the primate trade drew the routes of wildlife trafficking in the country, contained

22. Pedro E. Pérez-Peña, Cristian Gonzales-Tanchiva, Marcial Trigoso-Pinedo, "Evaluación del Plan de Manejo de Animales de Caza en la Reserva Nacional Pucacuro," Folía *Amazónica* 25, no. 1 (2016): 1-16, http://revistas.iiap.org.pe/index.php/foliaamazonica/article/view/377.

23. K. Moya, *Monitoreo de la Comercialización de Carne de Monte en los Mercados de Iquitos y Estrategias para su Conservación.* (Bachelor dissertation). Universidad Nacional de la Amazonia Peruana, Perú, 2011.

24. Antony C. Leberatto, "A Typology of Market Sellers of Protected Wildlife Across Peru," Deviant Behavior 38, no. 12 (2017):,1352–1370, https://doi.org/10.1080/01639625.2016.1254963.

25. Barbara Fraser, "Tras el Rastro del Comercio de Carne de Monte en la Amazonía," *Los Bosques en las Noticias, February 21, 2016,* https://forestsnews.cifor.org/40221/tras-el-rastro-del-comercio-de-carne-de-monte-en-la-amazonia?fnl= .

26. Sam Shanee et al., "Distribution, Ecological Niche Modelling and Conservation Assessment of the Peruvian Night Monkey (Mammalia: Primates: Aotidae: Aotus miconax Thomas, 1927) in North-eastern Peru, with Notes on the Distributions of Aotus spp.," *Journal of Threatened Taxa* 7, no. 3 (2015): 6947–64, http://dx.doi.org/10.11609/JoTT.o4184.6947-64.

27. Stephen F. Pires, and Gohar A. Petrossian, "Understanding Parrot Trafficking Between Illicit Markets in Bolivia: An Application of the CRAVED Model," *International Journal of Comparative and Applied Criminal Justice* 40, no. 1 (2016): 63–77, https://doi.org/10.1080/01924036.2015.1028951.

in the National Strategy to reduce illegal wildlife trafficking (2014).[28] From the place of origin where they are captured, generally in rural areas, to the places of trade in cities such as Iquitos, the trip can take up to six days by boat. Loreto and Ucayali are the regions with the highest rate of wildlife trafficking. Lima and Tumbes are the coastal cities with the highest trafficking rates outside of the Amazon.[29]

The main trade routes are as follows:

Northeast zone

Iquitos - Santa María de Nieva - Bagua - Tumbes, Piura or Chiclayo

Iquitos - Santa Rosa - Colombia or Brazil

Iquitos - Yurimaguas - Chachapoyas – Trujillo

Central zone

Pucallpa - Tingo María - Huánuco - Cerro de Pasco - Lima

Pucallpa - Atalaya - Satipo - La Merced - La Oroya - Lima

Southern zone

Lima – Huancavelica – Ayacucho – Apurímac – Cusco – Puno – Bolivia or Chile

Junín – Cusco – Puno – Bolivia or Chile

Ica – Ayacucho – Cusco – Puno – Bolivia or Chile

Arequipa – Cusco – Puno – Bolivia or Chile

28. Noga Shanee, A. Patricia Mendoza, and Sam Shanee, "Diagnostic Overview of the Illegal Trade in Primates and Law Enforcement In Peru," *American Journal of Primatology* 79, no. 11 (2017): e22516, https://doi.org/10.1002/ajp.22516.

29. Noga Shanee, A. Patricia Mendoza, and Sam Shanee, "Diagnostic Overview of the Illegal Trade in Primates and Law Enforcement In Peru," American Journal of Primatology 79, no. 11 (2017): e22516, https://doi.org/10.1002/ajp.22516.

Border Area: the triple frontier linking Peru with Brazil, Ecuador and Colombia

Map 1. Adapted by the authors from the Peruvian National Strategy to Reduce Wildlife Trafficking (2017).

As shown in the map, the city of Iquitos is the central axis of the northeastern route, where most of the fauna captured in the Loreto region is concentrated either for sale in local markets or for shipment to other regions. Loreto is the only department in Peru that is not connected to the rest of the country by road, so travel is necessarily by river. The second most important city is Yurimaguas, which receives animals from the northeast but also from communities located in the Huallaga river basin.[30] From Loreto, the fauna are transported through high jungle cities in the San Martín and Amazonas regions, before reaching markets in the coast. Alternatively, the animals are transported by boat in the Marañón river, through the port of Saramiriza (Loreto), and into Bagua (Amazonas), before being transported to the coast.[31]

In the central zone, the city of Pucallpa, in the department of Ucayali, is the main hub for the fauna collected from the entire department and also from Loreto, which arrives via the Ucayali River. From this city, one can take the Jorge Basadre highway to the Fernando Belaúnde Terry highway, the main road connecting the Amazon with the north and center of the country. Another alternative route to Lima is from Pucallpa to the port of Atalaya, crossing the Ucayali River and then heading towards the coast.[32]

In the south, a network is built between the regions of Madre de Dios, Cusco, and Puno. The city of Puerto Maldonado (Madre de Dios), an access point to some of the most biodiverse areas in the world, presents high rates of wildlife capture. Cusco, a well connected and tourist city, is accessible by road. Amphibians (*Telmatobius culeus*) are the most trafficked species in the south, captured in Puno.

Because Peru is a very diverse territory with interconnecting routes that include highways, dirt (unpaved) roads, and river navigation, the conditions under which wild animals are transported are often extreme. The trips involve first navigating by boat or motorboat, then long hours in buses or trucks without any biosecurity measures or welfare standards, since, as shown in various photos published during police interventions, the animals are transported in very small cages or even in closed boxes. When they are taken from their natural habitat, they must adapt to different climates: from the tropical heat of the Amazon, then through a mountainous area, and finally to the coast, which has a dry, desert climate. During this journey, animals could carry potential pathogens that could be introduced into other areas. Taking into account the above, it is estimated that out of every ten wild animals that are captured and sold illegally, only one survives.[33]

Local Trade Through Wet Markets

Markets are the main public spaces where the illegal trade of wildlife takes place. According to a 2016 national market census, there are 2,612 markets in Peru, of which 87.8% (2,294) are located

30. Servicio Nacional Forestal y de Fauna Silvestre (SERFOR), *Estrategia Nacional para Reducir el Tráfico Ilegal de Fauna Silvestre en el Perú 2017-2027,* (Lima: SERFOR, 2017).
31. Servicio Nacional Forestal y de Fauna Silvestre (SERFOR), Estrategia Nacional para Reducir el Tráfico Ilegal de Fauna Silvestre en el Perú 2017-2027, (Lima: SERFOR, 2017).
32. Servicio Nacional Forestal y de Fauna Silvestre (SERFOR), Estrategia Nacional para Reducir el Tráfico Ilegal de Fauna Silvestre en el Perú 2017-2027, (Lima: SERFOR, 2017).
33. Johnny Salazar, "Noga Shanee: Perú Tiene Uno de los Niveles más Altos de Tráfico de Fauna Silvestre en América Latina," *SPDA Actualidad Ambiental, January 22, 2016,* https://www.actualidadambiental.pe/noga-shanee-peru-tiene-uno-de-los-niveles-mas-altos-de-trafico-de-fauna-silvestre-en-america-latina/#:~:text=Pucallpa%20ten%C3%ADa%20el%20mercado%20de,muertos%20como%20carne%20de%20monte.

in urban areas and 12.1% (318) in rural areas.[34] The Loreto region has 1.2% of the grand total.[35] An estimated 80% of the trafficking of wildlife species is concentrated in the markets of Lima, Tumbes, Loreto, and Ucayali.[36] Different stalls in the same building will offer live animals to customers as pets, or to traders for sale in other cities or abroad. Animal parts and byproducts are offered for ritual use or witchcraft, and meat is available for direct consumption. Bushmeat is offered mainly in the Amazon regions.[37]

In addition to the aforementioned products, domestic animals such as chicken, fish, beef, pork, guinea pig, and alpaca, and other nutritional products such as eggs, vegetables, fruits, and groceries, are offered inside the market buildings. Small animals such as chickens and guinea pigs may be stored in cages, slaughtered, and skinned either right outside the market or in the same stalls. For the bigger animals, such as pork and beef, whole pieces of the animal (most commonly the head, thighs, liver, and tripe) are commonly displayed on shelves or hanging from metal hooks surrounding each meat stall.

In general, it has been observed that the sale of wild animals in these markets is carried out in precarious conditions, with poor hygiene and inadequate handling practices. In some cases, live animals are kept in cages that are either too small or too crowded, with lack of adequate food, causing interaction between domestic and exotic species in the storage space.[38]

In the northeastern region, the Belén, Modelo, and Central markets located in the city of Iquitos (Loreto) have been identified as the main commercialization points.[39] The Belén market is located in the district of the same name, which has the particularity of being in a flood zone on the banks of the Itaya River and is therefore known as the "Amazonian Venice." The infrastructure of the market is made up of a central building, which was originally the market, and open-air stalls set up by street vendors who took over the surrounding streets. It is the main supply center of the city and is known for the enormous diversity of goods that are offered, such as live animals, animal parts, all kinds of meat, fish, vegetables, fruits, medicinal plants and plants for ritual use, restaurants, clothing, and medicine.

Meat, fowl, fish, and food is reportedly handled under unsanitary conditions in Belén market.[40] This poses a threat to the 413,000 people that live in the four districts served by the market. Inadequate

34. Instituto Nacional de Estadística e Informática, Censo Nacional de Mercados de Abastos 2016 (Lima: INEI, 2017), https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1448/libro.pdf.

35. Instituto Nacional de Estadística e Informática, Censo Nacional de Mercados de Abastos 2016 (Lima: INEI, 2017), https://www.inei.gob.pe/media/MenuRecursivo/publicaciones_digitales/Est/Lib1448/libro.pdf.

36. Ana Patricia Mendoza, N. Cavero, and Y. Murillo, "Comercio de Animales Silvestres en los Mercados de Tumbes," *Wildlife Conservation Society, Documento de Trabajo N° 23, August 2013,* https://programs.wcs.org/library/doi/ctl/view/mid/33065/pubid/DMX2744900000.aspx.
Patricia Mendoza, Nancy Cavero, and C. Rynaby, "Comercio de Animales Silvestres en la Región de Loreto, 2007–2012," *Wildlife Conservation Society, Documento de Trabajo N° 27, August 2014,* https://library.wcs.org/doi/ctl/view/mid/33065/pubid/DMX2745500000.aspx.
Patricia Mendoza and Nancy Cavero, "Comercio de Animales Silvestres en el Mercado de Bellavista (Pucallpa, Ucayali) 2007–2012, *Wildlife Conservation Society, Documento de Trabajo N° 26, May 2014,* https://library.wcs.org/doi/ctl/view/mid/33065/pubid/DMX2745200000.aspx.

37. Judith Figueroa, "Tráfico de Partes e Individuos del Oso Andino Tremarctos ornatus en el Perú," *Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales* 38, no. 147 (2014): 177–190, https://doi.org/10.18257/raccefyn.62.
R. S. R. Williams et al., "Trade in Andean Condor Vulture Gryphus Feathers and Body Parts in the City of Cusco and the Sacred Valley, Cusco Region, Peru," *Vulture News* 61 (2011): 17–26, http://dx.doi.org/10.4314/vulnew.v61i1.2.
Luis Ríos., Fabiola Riva., and Lyana Canaquire, Reporte Situacional del Tráfico Ilegal de Fauna Silvestre en la Región Nororiental del Perú (Lima: Humane Society International, 2008).
Melvin Gastañaga et al., "A Study of the Parrot Trade in Peru and the Potential Importance of Internal Trade for Threatened Species," *Bird Conservation International* 21, no. 1 (2010): 76–85,https://doi.org/10.1017/S0959270910000249.

38. Luis Ríos, Fabiola Riva, and Lyana Canaquire, Reporte Situacional del Tráfico Ilegal de Fauna Silvestre en la Región Nororiental del Perú (Lima: Humane Society International, 2008).

39. Servicio Nacional Forestal y de Fauna Silvestre (SERFOR), Estrategia Nacional para Reducir el Tráfico Ilegal de Fauna Silvestre en el Perú 2017-2027, (Lima: SERFOR, 2017).

40. United Nations Development Program (UNDP), "Documento de Proyecto entre el Ministerio de la Producción y el Programa de las Naciones Unidas para el Desarrollo," financing agreement for the renovation of Belén Market, December 28, 2020, https://cdn.www.gob.pe/uploads/document/file/1537968/CONVENIO.pdf.pdf.

normalization practices, quality handling, waste management, and sanitary control by local authorities are cited as some of the main problems in Belén and as justification for its reconstruction. The construction project of the "Gran Mercado de Belén" began in 2015.[41] This project seeks to relocate the merchants and provide better infrastructure.[42] The market was closed in 2020 and a large number of stalls destroyed during the pandemic, as the Loreto region was the most affected by the first wave of COVID-19 in the country, and authorities determined the market was a source of infections. The improved infrastructure was expected to start functioning by July 2021 (*See* Appendix I).

The coastal regions of Lambayeque and Lima are the main wildlife trading hubs for the central part of the country.[43] The capital has some of the biggest market centers, one of the main ones being La Parada market in the district of La Victoria. It has undergone several modifications because it was considered an unhealthy shanty zone, with precarious infrastructure and a large number of street vendors both inside and outside the building. As for the southern region, animal parts can be found in the Cusco region, in the town of Pisac, which has a well-known market where Andean condor parts and Humboldt penguin skins are sold.[44] In this part of the country, agricultural "fairs" in the main squares or esplanades on Thursdays and Sundays are the main site of the animal trade. This includes domestic animals, living exotic animals, and, to a lesser extent, animal parts. On these days, the villagers travel from nearby towns or villages to sell part of their livestock or harvest (*See* Appendix I).

Most of these markets are under supervision of local governments at the provincial and district levels, which oftentimes own the land upon which markets operate.[45] They are also responsible for ensuring the sanitary conditions and requirements that must be met by establishments, whether public or private, at the different stages of the food chain. Local governments must assign qualified personnel trained in sanitary surveillance to carry out the sanitary surveillance of food and beverages marketed in the supply markets and the verification of compliance with the provisions of national regulations. In short, supervision activities are expected to observe a risk assessment, good handling practices, and hygiene and sanitation programs. To this end, they must work in coordination with MINSA and SENASA, which must supervise the sanitary control of animals within the production chain, whether cattle or poultry.[46] Municipalities (cities) must ensure that commercial, legal, and food safety norms are observed in markets. They have staff in charge of food inspection, but this only covers domestic-animal meats, which are usually sold in more formal and clean settings within markets (e.g, meat areas are often inside the markets building, which is periodically sanitized and fumigated; bushmeat is more often in the open-street area, with no cold-chain or running water available). Next, offices of the Regional Government Directorate of Health also work in markets to prevent zoonotic risk (e.g., through rodent and vector

41. As reported in the press, the project was initiated in 2015. "*Ya se Inicia Construcción de Gran Mercado de Belén,"* Diario La Región, accessed September 22, 2023, https://diariolaregion.com/ya-se-inicia-construccion-de-gran-mercado-de-belen/. .

42. However, there are groups of traders who have spoken out against it. Even the mayor of Belén was the victim of an attack in June last year, reportedly apparently by organized mafias with the market traders in retaliation for having closed the establishment as part of the sanitary measures against COVID-19. See: "Iquitos: Alcalde del Distrito de Belén fue Baleado al Salir de su Vivienda," *TVPE Noticias*, June 4, 2020, https://www.tvperu.gob.pe/noticias/nacionales/iquitos-alcalde-del-distrito-de-belen-fue-baleado-al-salir-de-su-vivienda.

43. Luis Ríos, Fabiola Riva, and Lyana Canaquire, Reporte Situacional del Tráfico Ilegal de Fauna Silvestre en la Región Nororiental del Perú (Lima: Humane Society International, 2008).

44. Judith Figueroa, "Tráfico de Partes e Individuos del Oso Andino Tremarctos ornatus en el Perú," Revista de la Academia Colombiana de Ciencias Exactas, Físicas y Naturales 38, no. 147 (2014): 177–190, https://doi.org/10.18257/raccefyn.62.

45. According to Ministerial Resolution No. 282-2003-SA/DM, which approves the Sanitary Regulations for the Operation of Food Markets.

46. Roberto Elías et al., "Gestión y Vigilancia Sanitaria de la Fauna Silvestre en el Perú," *Salud y Tecnología Veterinaria* 8, no. 1 (2020): 19–26, https://doi.org/10.20453/stv.v8i1.3788.

control) and to safeguard public health (wastewater and trash). The Animal Health Service (SENASA) is in charge of prevention, surveillance, and control of domestic/production animal diseases, and thus oversees meat production operations, intervening in markets because of the presence of backyard poultry and other live animals sold as foodstuff. There is, in other words, ample coverage of health issues at markets, but none of them are currently covering wildlife or bushmeat.[47]

Mercado La Hermelinda, Trujillo, La Libertad

Field studies have been conducted to address sanitary conditions in some markets in the country. Rivière-Cinnamond et al. conducted a study of the permanence of the Yersinia pestis bacteria in the Mercado La Hermelinda (Trujillo, La Libertad).[48] Their results indicate that the bacterium's persistent presence is not only a technical problem but also a cultural and interinstitutional management problem. In 2013 and in 2019, the Regional Health Authority of La Libertad declared this establishment a "high sanitary risk" due to the accumulation of garbage and the proliferation of rodents that could transmit the plague.[49] In addition, it was noted that the merchants did not have electricity, drinking water, or sewage services, which aggravates the unhealthy conditions at the site. These conditions show how implementation of basic sanitary practices can be made impossible by poor infrastructure design. Moreover, the researchers found a large gap in local government management. The multisectoral nature of a potential plague should be addressed, accordingly, through a multisectoral approach, not only by health authorities. Other observations include weak implementation, lack of budget planning, and lack of sustainable practices, given that the authority's responses are basically focused on emergency situations. Despite all of this, Rivière-Cinnamond et al. note a low plague risk perception among traders, who maintain unhygienic lifestyles despite sanitation campaigns carried out by the GERSA. As the researchers point out, they maintain a "lifestyle in which economic incentives outweighed sanitary standards."[50] Most of them are low-income, rural migrant workers in precarious housing, lacking basic services. The study's comprehensive approach analyzes the factors involved in the potential threat of plague development, which exceed supervision and sanitary management issues. They identified three main determining factors for the market's conditions: 1. the location of the market in Trujillo, the third largest city in the country; 2. the high number of visitors to the market per day (more than 5,000); and 3. its proximity to the international sea port of Salaverry.[51]

47. "El Peruano Normas Legales," Pág 246762, June 27, 2003, https://www.senasa.gob.pe/senasa/descargasarchivos/2016/03/RM-282-2003-MINSA-Funcionamiento-mercados-de-abasto.pdf.

48. This bacterium causes plague and has 3 clinical presentations: bubonic, septicemic and pneumonic. It is transmitted from the bite of the flea of the rat Xenopsylla cheopis. When these rodents are infected and die, the fleas look for a new host and it is in these circumstances that humans can be bitten by them and become infected with the disease.
Trujillo is the third largest city in the country and is close to the second largest international port (the Salaverry maritime terminal) and extensive rural areas where extensive sugar cane agriculture is practiced. The market was founded in 1987 and is considered one of the largest farmers' supply centers in northern Peru. It has around 1,371 merchants and around 2,000 street vendors. See: Ana Rivière-Cinnamond et al., "A Qualitative Socio-ecological Characterization of the Plague Threat at Hermelinda Market, La Libertad, Peru," *Revista Panamericana de Salud Pública* 41 (2017): e107, https://iris.paho.org/handle/10665.2/34442.

49. Alan Benites Guillen, "*Mercado La Hermelinda de Trujillo es Declarado en Alerta Sanitaria,"* Perú21, April 23, 2019, https://peru21.pe/peru/mercado-hermelinda-trujillo-declarado-alerta-sanitaria-473942-noticia/.

50. Ana Rivière-Cinnamond et al., "A Qualitative Socio-ecological Characterization of the Plague Threat at Hermelinda Market, La Libertad, Peru," Revista Panamericana de Salud Pública 41 (2017): e107, https://iris.paho.org/handle/10665.2/34442.

51. Ana Rivière-Cinnamond et al., "A Qualitative Socio-ecological Characterization of the Plague Threat at Hermelinda Market, La Libertad, Peru," Revista Panamericana de Salud Pública 41 (2017): e107, https://iris.paho.org/handle/10665.2/34442.

Markets in Lima, Tumbes, and Tarapoto

A qualitative study conducted by Carnero et al. analyzed the potential risk of interspecies transmission of zoonotic pathogens in poultry and pork market processes.[52] It evaluated poultry processing practices in formal and informal markets and the handling given to pork leftovers in the cities of Lima, Tumbes (a coastal department bordering Ecuador), and Tarapoto (a city located in the Amazonian region of San Martin).[53] After making 80 direct observations in these markets and interviewing producers, the authors provided detailed descriptions of interspecies interactions during the preparation and sale of chicken and pig feed. They noted a low level of compliance with basic hygiene practices, such as hand-washing and food safety practices established by MINSA among chicken sellers. Above all, the researchers emphasize the recurrent practice of selling the viscera of these birds as feed for pigs, which in many cases are not cooked according to standards that eliminate the risk of viral or bacterial transmission. They maintain that this practice "could potentially result in the transmission of avian influenza to swine, and the emergence of a pandemic influenza strain."[54] As of the time of writing, no evidence of avian influenza infections has been found among formal poultry workers; however, the authors conclude that exposure to chicken in markets constitutes an occupational hazard for infection with zoonotic agents, as it exposes people to materials that are potentially infectious to humans. In the same sense, Sánchez Quispe notes that, in Peru, the risk for zoonotic infection in markets is particularly concerning considering that a large proportion of the poultry trade is informal.[55]

PREDICT PROGRAM IN PERU

The USAID PREDICT program has been one of the most important initiatives for research and monitoring of pathogens present at the wildlife-human interface in Peru. The objective of this project was to improve surveillance of various diseases present in wildlife in order to, in turn, improve the detection and prevention of zoonotic diseases of wild origin. To this end, the project was carried out jointly by the Wildlife Conservation Society (WCS), the National Agricultural Health Service (SENASA), and the Peruvian Health Institute (INS).

The project, "Study of diseases in the legal and illegal bird trade in Peru," serves as a first record of these kinds of studies. It was executed between 2007 and 2010 by the Tambopata Macaw Project and the US Navy Tropical Disease Research Institute (NAMRU-6), which was then continued by the project, "Study of Diseases in the Wildlife Trade in Peru," executed from 2010 to 2013 by WCS within the framework of the PREDICT program.[56]

52. A.M. Carnero et al., "Risk for Interspecies Transmission of Zoonotic Pathogens During Poultry Processing and Pork Production in Peru: A Qualitative Study," *Zoonoses and Public Health* 65, no. 5 (2018): 528–39, https://doi.org/10.1111/zph.12463.

53. Lima concentrates the largest poultry (286.9 million) and pork (673,445) production in the country, which means more than half of the total national poultry production and more than 40% of pork production. In 2010, Tumbes produced 71,445 chickens and 14,190 pigs. In 2010, Tarapoto produced more than 9 million chickens and just over 60 thousand pigs. Ministerio de Agricultura y Riego (MIDAGRI), Producción Pecuaria e Industria Avícola 2011 (Lima: MIDAGRI, 2012), https://www.slideshare.net/gonzalesmarlo/2011-produccionpecuaria.

54. A.M. Carnero et al., "Risk for Interspecies Transmission of Zoonotic Pathogens During Poultry Processing and Pork Production in Peru: A Qualitative Study," Zoonoses and Public Health 65, no. 5 (2018): 528–39, https://doi.org/10.1111/zph.12463.

55. George Sánchez Quispe, "Transmisión de Precios y Cointegración en la Industria Avícola Peruana," *Ecuador Debate: Política y Economía* 53 (2001): 163–84, https://repositorio.flacsoandes.edu.ec/bitstream/10469/4878/1/RFLACSO-ED53-13-Sanchez.pdf.

56. Ana Patricia Mendoza, N. Cavero, and Y. Murillo, "Comercio de Animales Silvestres en los Mercados de Tumbes," Wildlife Conservation Society, Documento de Trabajo N° 23, August 2013, https://www.researchgate.net/publication/287818150_Comercio_de_animales_silvestres_en_los_mercados_de_Tumbes.

During the implementation of the field phase of both studies, it was possible to monitor wildlife trade in 41 markets in 10 cities in the country. Some of the results obtained are shown in the following table, which shows the work carried out in markets in Tumbes, Lima, Loreto, and Ucayali, which are the regions with the greatest diversity of species found in the illegal trade:[57]

Regions	Markets that sell wild animals	Number of wildlife species identified (2007-2012)	Daily average of wild animal specimens (2007-2012)	Market with the highest sales of species (District, Province)
Tumbes	2	55	237	Mercado de Aguas Verdes (Aguas Verdes, Zarumilla)
Lima	18	82	89	Mercado "Ayacucho" (Lima, Lima)
Loreto	6	101	45	Mercado de Belén (Belén, Maynas)
Ucayali	1	76	98	Mercado "Bellavista" (Callería, Ucayali)

The project found that in all of the markets where studies were carried out, wildlife species were in constant contact with species traded as pets, and with animals sold for direct human consumption such as chicken, guinea pigs, rabbits, and turkeys. Precarious conditions such as lack of hygiene, poor nutrition, and overcrowding were prevalent, increasing the potential development of diseases in these establishments where the proximity to infected species constitutes a latent risk of infection.[58] Not all of the final reports that emerged from the PREDICT program have been made public, but the findings were shared with the relevant government authorities to inform their policymaking and articulation strategies.

Some of the researchers involved in the program, however, continued to carry on relevant research and share additional findings that could inform the status of animal handling in Peru. A notable study on primates focused on tuberculosis infections and interspecies propagation. Primates represent the largest part of live traded mammals in Peruvian markets, with as many as 28,000 New World monkeys trafficked annually across the Peru–Colombia border that are used as food, pets, bait, or for medicinal purposes or sport.[59] Poor transportation and caging conditions, along with unsanitary waste and wastewater management practices, create the right environment for wildlife feces to disperse and potentially reach water sources used by the local population, particularly in flood-prone regions. Rosenbaum et al. concluded that primates held in enclosures with other species, and exposed to humans

57. Preliminary results of the field work carried out in regions. Wildlife Conservation Society (WCS), Enfermedades Infecciosas en el Comercio de Animales Silvestres en el Perú (Lima: WCS, 2016), own translation.

58. Wildlife Conservation Society (WCS), Enfermedades Infecciosas en el Comercio de Animales Silvestres en el Perú (Lima: WCS, 2016), own translation.

59. Marieke Rosenbaum et al., "Detection of Mycobacterium tuberculosis Complex in New World Monkeys in Peru," *Ecohealth* 12 (2015): 288–97,. https://link.springer.com/content/pdf/10.1007/s10393-014-0996-x.pdf.

for near-life–long periods of time, presented a higher occurrence of tuberculosis.[60] The disease has not been contained in Peru, which would contribute to interspecies transmission.

The Amazon cities of Iquitos and Pucallpa have been identified as the main cities supplying wildlife, and Tumbes as the main port of exit by land. Researchers considered that the measures to control the wildlife trade in these markets have been insufficient to discourage criminal behaviors. They recommend that these measures be reformulated, encouraging citizen participation and developing permanent training for public officials. The main region-specific findings of the PREDICT project are as follows.

Loreto: The region ranks first in terms of trade diversity, with a total of 101 different species, and is considered the main supplier of wildlife at the national level. Field studies were conducted in the markets of Belén, Modelo, Nauta, Puerto Nanay, Central, and El Vado. The average number of publicly offered animals was lower than other regions, attributable to traders' caution or migration to online trading platforms. Traders in this region disregarded biosecurity measures and preventive sanitary management when handling animals, by discarding waste and carcasses on public roads or in the rivers. This behavior can be explained by the idea of animals as merely merchandise and considering mortality as a minimal collateral effect in the cost-benefit analysis of the illegal trade.

Tumbes: The Aguas Verdes market, located on the border between Peru and Ecuador, was identified as a hub of trade between the two countries. Fieldwork was also conducted in the Modelo market. The infectious agents identified in these two markets include *Campylobacter* sp., *Salmonella* sp., and Newcastle disease. Although the incidence rate of this disease in Tumbes markets is low, the sale of wild birds is a risk because they can become potential carriers of the virus and spread the disease.[61]

Ucayali: Commercial activity was verified in only one of the five markets evaluated. Bellavista market, in the city of Pucallpa, was rated as the third most diverse animal market. Live animals are sold on a constant basis, and the study found gastrointestinal bacteria such as *Escherichia coli*, *Aeromonas* sp., *Campylobacter* sp., *Shigella flexneri*, and *Salmonella* sp. In addition, three out of every 10 reptiles sampled were found to be carriers of Aeromonas sp., 27% of the birds were parasitized with *Capillaria* eggs, and monkeys presented with *Flavivirus*, *Coronavirus*, *Arenavirus*, *Bunyavirus*, *Henipavirus*, *Retrovirus* (which causes encephalitis and immunodeficiencies in primates), and tuberculosis mycobacteria.[62] This project was very ambitious, because there was no similar research in Peru, so this study meant "starting from scratch."

PREDICT's main objective was to contribute to capacity building in the country. Researchers found gaps in authority and unclear definitional and jurisdictional boundaries between and within the two relevant institutions: SENASA, whose competence is limited to domestic animals, and SERFOR, whose scope is the management and handling of wildlife as a resource. In terms of the project outputs, around 6,000 samples were collected, but only 2,000 were processed. Approximately 4,000 samples have since been kept in storage at the National Health Institute (INS), an institution allied with PREDICT.[63] In addition

60. Marieke Rosenbaum et al., "Detection of Mycobacterium tuberculosis Complex in New World Monkeys in Peru," Ecohealth 12 (2015): 288–97, https://link.springer.com/content/pdf/10.1007/s10393-014-0996-x.pdf.

61. Ana Patricia Mendoza, N. Cavero, and Y. Murillo, "Comercio de Animales Silvestres en los Mercados de Tumbes," Wildlife Conservation Society, Documento de Trabajo N° 23, August 2013, https://programs.wcs.org/library/doi/ctl/view/mid/33065/pubid/DMX2744900000.aspx.

62. Patricia Mendoza and Nancy Cavero, "Comercio de Animales Silvestres en el Mercado de Bellavista, (Pucallpa, Ucayali), 2007 – 2012, Wildlife Conservation Society, Documento de Trabajo N° 26, May 2014, https://library.wcs.org/doi/ctl/view/mid/33065/pubid/DMX2745200000.aspx.

63. Personal communication, 2020.

to sampling and visits, workshops were offered to public health institutions, and the project's results were used to inform the national strategy to reduce wildlife trafficking. However, the recommendations on sanitary surveillance and public health were left aside, and the project was not continued after its original end date.

POLICY RESPONSE AND ENFORCEMENT: REGULATORY FRAMEWORK

Competent Authorities and Relevant Agencies in Peru

National Level

Ministry of Health (MINSA): The highest authority in the health sector at the national level, its dependencies include the Directorate for the Prevention and Control of Metaxenic Diseases and Zoonoses, in charge of identifying and coordinating strategic interventions for the prevention, control, and risk reduction of these diseases that could affect the population.[64] However, they do not have the specialized research or sufficient coordination by which to carry out this work hand in hand with local authorities and other key actors.[65] MINSA has two other units in charge of permanently monitoring the main zoonoses in the country: the Alert, Response and Global Health of the National Center for Epidemiology, Prevention and Disease Control (CDC Peru) and the National Epidemiology Network (RENACE). The ministry is promoting updated regulations on zoonoses with the participation of the CDC.[66]

National Agricultural Health Service (SENASA): A specialized technical agency under the authority of MIDAGRI was created in 1992 as the country's national agricultural health authority.[67] It is responsible for conducting the country's Animal Health Epidemiological Surveillance System through the Subdirectorate of Risk Analysis and Epidemiological Surveillance, which is part of the Environmental Health Directorate. According to its own regulation, SENASA is responsible for the management, control and surveillance of animal health, mainly livestock (cattle, horses, goats, pigs, South American camelids, poultry, and bees).[68] In practice, SENASA's competencies are quite limited in issues related to the surveillance of diseases in wild animals and the issuance of animal import and export certification in order to prevent the entry of diseases in shipments for import and international transit.[69] The agency has two main bodies: the Directorate of Animal Health and the Subdirectorate of Risk Analysis and Epidemiological Surveillance. The first of these is compounded by 25 Executive Directorates, each in charge of animal surveillance actions in a separate region of the country. The Directorate of Animal Health is centrally responsible for establishing, conducting, and coordinating an animal health control and supervision system for both domestic and international trade of livestock products and by-products and

64. Contained in its Regulation of Organization and Functions (approved by Supreme Decree No. 008-2017-SA).

65. Raul Berenguel et al., "Chytrid Fungus, Batrachochytrium dendrobatidis, in Wild Populations of the Lake Titicaca Frog, Telmatobius culeus, in Peru," Journal of Wildlife Diseases 52, no. 4 (2016): 973–5, https://doi.org/10.7589/2016-01-007.

66. Ministerio de Salud, "Zoonosis un Reto para el CDC Perú," MINSA, Nota de Prensa, July 6, 2019, https://www.dge.gob.pe/portal/docs/notas_prensa/2019/notaprensa0222019.pdf.

67. Created through Legislative Decree No. 25902, and established by Legislative Decree No. 1059.

68. Roberto Elías et al., "Gestión y Vigilancia Sanitaria de la Fauna Silvestre en el Perú (Management and Health Surveillance of Wildlife in Peru)," Salud y Tecnología Veterinaria 8, no. 1 (2020): 19–26, https://doi.org/10.20453/stv.v8i1.3788.

69. Article 29 – Supreme Decree No. 008-2005-AG, which approves the Regulation of Organization and Functions of SENASA.

also for conducting disease risk analyses to predict levels of impact and sanitary risk, and establishing and supervising a national meat control and inspection system in slaughterhouses (*camales*), etc.[70]

On the other hand, the Sub-directorate of Risk Analysis and Epidemiological Surveillance develops passive and active surveillance. Passive surveillance is carried out upon notification of the suspected presence of diseases of animal origin.[71] Once the notification becomes effective, the agency is in charge of evaluating the premises and the animals under suspicion. If necessary, samples are taken. If the result is positive and the animal is on the List of Notifiable Diseases, control and/or quarantine actions are taken.[72] Active surveillance consists of epidemiological studies to determine the prevalence, presence, or absence of a zoonotic disease through sample collection. For this purpose, six programmed studies are carried out per year: four basic studies (i.e., avian influenza, mad cow disease, swine fever), and 2 studies with a focus on prevalent and exotic diseases, depending on the situation.[73] According to some SENASA specialists, there is a close relationship between this entity and SERFOR.[74] They recognize that SERFOR is responsible for wildlife health management, which includes the control of wildlife animal health. For this reason, they work in coordination when there is a risk of diseases that can be transmitted to livestock, as well as for the issuance of certificates that measure the health risk of a species.[75] SENASA is the agency responsible for annually reporting the status of 117 notifiable diseases to the World Organization for Animal Health (OIE).[76]

National Forestry and Wildlife Service (SERFOR): It is the national authority responsible for wildlife management, attached to the Ministry of Agrarian Development and Irrigation (MIDAGRI).[77] It became operational in 2014. It is the governing body of the National System of Forestry and Wildlife Management (SINAFOR), and its functions include issuing regulations, plans, strategies, and programs, among other tools related to the management and sustainable use of forest and wildlife resources. SERFOR shares authority in matters of forestry and wildlife with a number of regional governments that benefited from a functional transfer following the country's decentralization efforts in 2004.[78] Although SERFOR is competent in matters of management, control, and conservation of wildlife, the

70. Article 28 – Supreme Decree No. 008-2005-AG, which approves the Regulation of Organization and Functions of SENASA. Approved by Directorial Resolution No. 030-2010-AG-SENASA-DSA.

71. Article 9 of Legislative Decree No. 1059, General Law of Agrarian Health, establishes that every person is obliged to report to the National Authority of Agrarian Health the presence of pests and diseases of quarantine importance, as well as those that for the first time are determined to be present in the country. Thus, the notification of animal diseases is mandatory regardless of whether the animal is owned or not, or whether it is alive or dead.

72. Chief Resolution No. 271-2008-AG-SENASA, which approves the List of Notifiable Diseases for the different animal species in the national territory. While the test is being sent out and the results are awaiting, an epidemiological investigation is being carried out simultaneously to see if there are other farms affected by the possible presence of widespread infectious diseases.

73. Prevalent diseases present in a population: Prevalence studies are carried out to quantify the level of presence of the disease (baseline study) by department and/or province. The whole country has different levels of prevalence. Thus, the baseline is established, and the goal is to reduce prevalence levels. These prevalent diseases are also identified in the List of Notifiable Diseases.
Exotic diseases: Diseases that do not originate in Peru but that are at risk of entering the national territory, since our country is involved in permanent international trade exchanges. In this regard, SENASA establishes possible disease entry scenarios and even carries out simulations of possible outbreaks, trains personnel, and evaluates the impact of these diseases. See also: Clínica de Gestión Ambiental (CGA). (2020). *Una aproximación legal a la gestión y vigilancia sanitaria animal, prevención de enfermedades zoonóticas en el Perú. Working paper.* Lima: Universidad del Pacifico. Recuperado de: www.cgaup.pe

74. Private interviews were held in preparation for this case study (CGA, 2020).

75. Clínica de Gestión Ambiental (CGA). (2020). *Una aproximación legal a la gestión y vigilancia sanitaria animal, prevención de enfermedades zoonóticas en el Perú. Working paper.* Lima: Universidad del Pacifico. Recuperado de: www.cgaup.pe

76. The List of Notifiable Diseases for all animal species was established in 2008 by Resolution No. 271-2008-AG-SENASA in order to keep the national epidemiological surveillance system up to date and to collaborate with the international disease notification system.

77. Created by the Forestry and Wildlife Law (Law No. 29763).

78. The competent regional governments are: Amazonas, Huánuco, La Libertad, Loreto, Madre de Dios, San Martín, Tumbes and Ucayali. In these regions, wildlife functions are under the responsibility of the Regional Forestry and Wildlife Management Offices.

health surveillance of said species is under the authority of SENASA and carried out through disease surveillance procedures for wild animals.[79]

Ministry of Production (PRODUCE): The highest authority in the manufacturing and fisheries sector, PRODUCE is responsible for the management of aquatic fauna as the competent authority in aquaculture sectors. It shares some functions with regional and local governments, such as artisanal fishing, aquaculture of micro and small enterprises, and others. However, its range of action is limited to the promotion of business activities, and it is not empowered to manage the sanitary management of these species.

Ministry of Agrarian Development and Irrigation (**MIDAGRI):** The highest authority in agriculture, domestic animal farming, and soil health, it is responsible for passing the environmental standards applicable to activities under its sector in order to promote and ensure the conservation and sustainable use of renewable natural resources for the benefit of agricultural producers. (Organizationally, SERFOR and SENASA are entities within MIDAGRI.)

Agency for the Supervision of Forest Resources and Wildlife (OSINFOR): In charge of the monitoring, supervision, and sanction of forestry and wildlife activities carried out under administrative permits (authorizations, permits, concessions) by governmental and nongovernmental actors. These authorizations were previously granted by SERFOR or regional governments. OSINFOR does not supervise illegal or unauthorized activities. It does, however, oversee the functioning of captive facilities receiving confiscated animals. By mandate, OSINFOR must be informed when animals are deceased (and could thereby receive information and notification regarding epidemiological risks). It performs annual inspections, including animal health and facility observations, and is currently retrieving information about notifiable disease events. So even though OSINFOR cannot intervene in illegal/informal settings, it has a lot of potential to share information about disease occurrence in animals in market/wildlife trafficking supply chains.

Regional and Local Governments

The regional governments with forestry and wildlife functions are responsible for wildlife management, including evaluating permit applications, granting authorizations, and monitoring the development of productive activities in the wildlife sector. They are also responsible for the dissemination of environmental sanitation programs and the formulation of health development policies. Local authorities do not have specific responsibilities for wildlife health management or for the control and monitoring of zoonoses, but they do have public health functions, including the promotion of environmental sanitation and epidemic control campaigns.[80] They also supervise markets and the control of products sold therein.[81]

Gerencia Regional de Salud (GERESA): Regional health agencies responsible for the dissemination of environmental health programs, as well as formulation and execution of health

79. Directorial Resolution No. 030-2010-AG-SENASA-DSA, which approves the procedure, “Surveillance of diseases in wild animals.”

80. Carried out in coordination with the district municipalities and the relevant regional and national agencies in accordance with Articles 2 and 80 - Law No. 27972, Organic Law of Municipalities.

81. Articles 161, 4.1 - Law No. 27972, Organic Law of Municipalities.

development policies, the GERESA coordinate an orderly and informed implementation of health and safety standards by local authorities.

Regional Forest and Wildlife Authority: Forestry and wildlife management for regions in which functions have been transferred, they are often called Gerencia Forestal Regional. They grant administrative permits, monitor the status of forest and wildlife populations in their region, and supervise informal activities.

Provincial, Metropolitan, and District Municipalities: They are responsible for carrying out environmental sanitation and epidemic control campaigns in coordination with district municipalities and relevant regional and national agencies. In addition, they have functions in the control and supervision of businesses such as local and district wet markets. Household animal farming activities (backyard poultry, pork, guinea pigs) not large enough to fall under the scope of national-level authorities are under the supervision of local-level authorities. Municipalities are responsible for managing residential and business waste (trash pickup, transportation, landfills), and for the collection, treatment, and final disposal of wastewater.

Regulatory Processes and Interactions Between Agencies

The Peruvian government is responsible for monitoring, prevention, management of, and response to, zoonotic outbreaks. Current regulations split relevant competencies among too many different agencies, requiring public servants to be highly specialized within their fields and impeding inter-sectoral coordination in the field and at policy level. All administrative authorities relevant to public health work in the executive branch, and respond to at least one of 19 ministries. Some ministries involve more than one economic sector. For example, the Ministry of Production (PRODUCE) is the national authority for markets, fisheries, and timber transformation, but has no competencies over sanitary practices or animal health, and it does not carry out supervision of markets at the local level. Likewise, the forest and wildlife authority (SERFOR), the water authority (ANA), and the animal health agency (SENASA) are individual agencies with separate budgets and offices, far apart from each other. However, they all answer to the Ministry of Agriculture (MIDAGRI). This sector is also in charge of agricultural development and financing, domestic animal raising, land titling, soil classification, and irrigation. Initiatives that farm wildlife are authorized by regional governments or SERFOR, depending on the region where they are carried out, and supervised by OSINFOR, which is attached to the office of the President for the Council of Ministers. Farming of domesticated animals, including guinea pigs, llamas, and alpaca, is carried out under SENASA's animal health guidelines but supervised by local governments unless carried out on a large scale. Given their scope, these small-scale activities often escape supervision. Most human health competencies lie within the Ministry of Health (MINSA) and the regional governments' health directorates. The involvement of agencies such as the National Health Institute (INS) and similar research offices has relied on the individual capacity of their staff and not on institutional arrangements that would facilitate intersectoral coordination. There is a significant gap between wildlife and animal health authorities. Despite responding to the same ministry, issues of industrial animal health and wildlife health have been regarded as two very different matters, even in efforts to articulate intersectoral functions.

Multisectoral workspaces: In 2019, MINSA installed the Permanent Multisectoral Commission for the Prevention and Control of Zoonotic Diseases, which reports to MIDAGRI.[82] This space was promoted within the World Health Organization's One Health framework and aims to address the problem of zoonosis from a multisectoral approach and coordinated work between the various competent entities.[83] Despite this effort to maintain a multisectoral approach, it is striking that SERFOR—the leading authority for wildlife management in the country—is not a part of the commission, and neither are regional and local governments. These entities are responsible for supervising the sanitary conditions of markets, where a high risk of interspecies transmission of pathogens occurs. The absence of these institutions is explained by the commission's focus on the control of livestock animals, and not on the sanitary management of fauna, which includes subsistence hunting and the trade of wildlife products and byproducts. To reiterate, industrial animals are not the only threat to human and ecosystem health. Wildlife management and consumption practices in Peru pose an acute risk for the emergence and contagion of new zoonotic diseases. Therefore, it is of utmost importance that similar platforms are made available to the authorities tasked with preventing and responding to these risks.

Interactions between institutions: These institutions share responsibilities for the control and prevention of zoonotic diseases, particularly regarding information sharing for early warning systems and disaster response scenarios. Findings of notifiable diseases are communicated from SENASA to MINSA so that the latter can respond by implementing the functions of its directorates. Two infectious diseases are of particular concern to these institutions due to the public health risks they pose: anthrax and rabies (the latter transmitted by the common vampire bat, *Desmodus rotundus*). If SENASA inspections find animals suspected to have either disease, the two institutions start working together, especially in executing sanitary campaigns.[84] For example, in the case of control and surveillance of rabies among wildlife, the response would involve SENASA, SERFOR, and the regional forestry authorities, which authorize sanitary measures such as specimen extraction for population control. SERFOR and regional forestry authorities are responsible for tracking animal health among wild populations and reporting abnormalities to health agencies. And when it comes to the (legal) commercialization of bushmeat for human consumption, the regional forestry authority and SENASA are responsible for supervising extraction and commercialization conditions, respectively. Those intending to farm wildlife for human consumption must obtain health authorization from SENASA before applying for a farming concession from the regional government, and then they are under the supervision of OSINFOR. Any kind of meat that makes it into a market must follow SENASA guidelines, with farming authorized by either local governments, SENASA, or OSINFOR. Meat from animals that have not been farmed, but instead have been hunted or captured, is unlikely to make it to the markets lawfully. Capture and hunting of wildlife are ruled by SERFOR and implemented through regional authorities with local nuances that characterize bushmeat consumption in the country.

82. Article 3 – Supreme Decree No. 002-2019-MINAGRI, which creates the Permanent Multisectoral Commission for the Prevention and Control of Zoonotic Diseases.

83. The Multisectoral Commission convenes representatives from MINSA (through the Director General of the General Directorate of Epidemiology), a representative of the Presidency of the Council of Ministers (PCM) and representatives of the Ministries of Defense, Interior, Foreign Trade, Agriculture, Production, Environment, Foreign Affairs and Transport and Communications.

84. Clínica de Gestión Ambiental (CGA). (2020). *Una aproximación legal a la gestión y vigilancia sanitaria animal, prevención de enfermedades zoonóticas en el Perú. Working paper.* Lima: Universidad del Pacifico. Recuperado de: www.cgaup.pe

CONCLUSION AND PROSPECTIVE REFORMS

Wet markets are prevalent throughout Peru. Along with bodegas, kiosks, and small businesses, they comprise the traditional retail channels in Peru and account for about 70% of the domestic retail market before the pandemic.[85] While they function at a local level as individual businesses and not as a single industry, the management challenges and health risks they pose are shared among most of the regions. A sense of familiarity with market vendors and affordable prices are some of the reasons why Peru has such a strong attachment to traditional markets and the consumers have been hesitant to adopt supermarkets as a substitute.[86] However, the health risks of poor sanitation practices and inadequate infrastructure design have increased with internal migration and shifts in demand for wildlife products.

Rather than substituting traditional markets for supermarkets or incentivizing consumers to switch their consumption habits, health and safety conditions within the existing markets that drive local economies should be improved. In this sense, renovation of the Belén market in Loreto has encountered local opposition because relocating the building would affect their local economy.

Moreover, the precarious institutional framework related to wildlife management and surveillance, as of the time of writing, has led to a lack of a comprehensive response and prevention mechanisms. On the institutional side, the main opportunities rely on strengthening communication and coordination between national government institutions and local governments (municipalities at the provincial and district levels). An evaluation of existing capacities would be necessary to determine clear institutional needs and gaps such as insufficient budgets or a lack of human resources to carry out assigned functions.

Similarly, a comprehensive approach to supply chains would inform better management and conservation efforts. There is insufficient knowledge regarding the impacts of growing demand for bushmeat on endemic ecosystems and how this imbalance could impact the proliferation of infection-bearing species like rodents, mosquitoes, and other vectors. A multicultural approach to the regulations governing subsistence hunting, as well as human-carnivore conflict, would contribute to designing adequate and responsive policies.

In order to achieve all of the above, a multisectoral effort to understand the phenomenon of potential zoonotic infections would be the first step towards designing an approach that is strategic and preventative of another possible pandemic.

It is relevant to note that Peruvian wet markets, and possibly others in the Andean Amazon, have some particularities that set them apart from markets in different developing regions. A significant proportion of the products traded in Peruvian markets originate from household economies: small plots of agricultural land, backyard-raised poultry and pork, and subsistence-hunted bushmeat, along with crafts and traditional medicine. Animal products are rarely imported across the border, but wildlife products make their way from Indigenous communities to Amazon cities, and from there to the Coast. (Two examples of cross-border trade, where it does exist, include the market of Aguas Verdes in the Ecuadorian–Peruvian region, involving backyard poultry, fighting cocks, and Amazonian wildlife, as

85. BBVA Research, Perú Situación Retail Moderno 2018, Powerpoint presentation, https://www.bbvaresearch.com/wp-content/uploads/2018/11/Peru-Retail-Moderno.pdf.

86. "Canal Tradicional: Oportunidades y Retos en el Mercado Peruano," Perú Retail, October 4, 2019, https://www.peru-retail.com/canal-tradicional-retos-oportunidades-mercado-peruano/.

well as the market of Desaquadero at the Bolivian border, which trades intensively in animal foodstuff including both domestic species and wildlife.)

In Peru, local communities play a vital role in keeping wet markets alive. Sellers and buyers go by the name "*casera*" or "*caserita*" and build trust relationships upon which their livelihood relies. Demand for bushmeat and traditional animal products in bigger coastal cities is driven by migrants, who share a sense of familiarity. Demand for wildlife products follows different patterns, with the main trading hubs located in fluvial ports and, increasingly, online (though to be sure, the largest wet markets, strictly speaking, are in Lima, Trujillo, and Chiclayo—the largest cities in Peru). Local trading of animal products and wildlife trafficking exchanges both pose their own risks to public health, and they should not be confused as the same phenomenon. Wet markets are also embedded in communities, and their health and safety standards follow those to which the locals have access. Social, cultural, and legal variables determine the level of risk that authorities allow—either by negligence or lack of capacity— people to coexist with. A community that has no access to sanitation and wastewater treatment at home will likely source their food in markets that lack adequate infrastructure. Similarly, communities that have been historically disenfranchised will face the highest risks, sourcing their meat from farms and hunters that operate at the edges of the law.

Peru has been deemed a high-risk country, prone to zoonotic outbreaks, but its public health challenges do not stem from bushmeat consumption, illegal trafficking, and inter-species exposure alone. In order to understand and prevent zoonotic risks, interventions will need to take into account Peru's fragmented institutional and social arrangements, with special attention to local and Indigenous populations that face the highest risk.

IMAGES

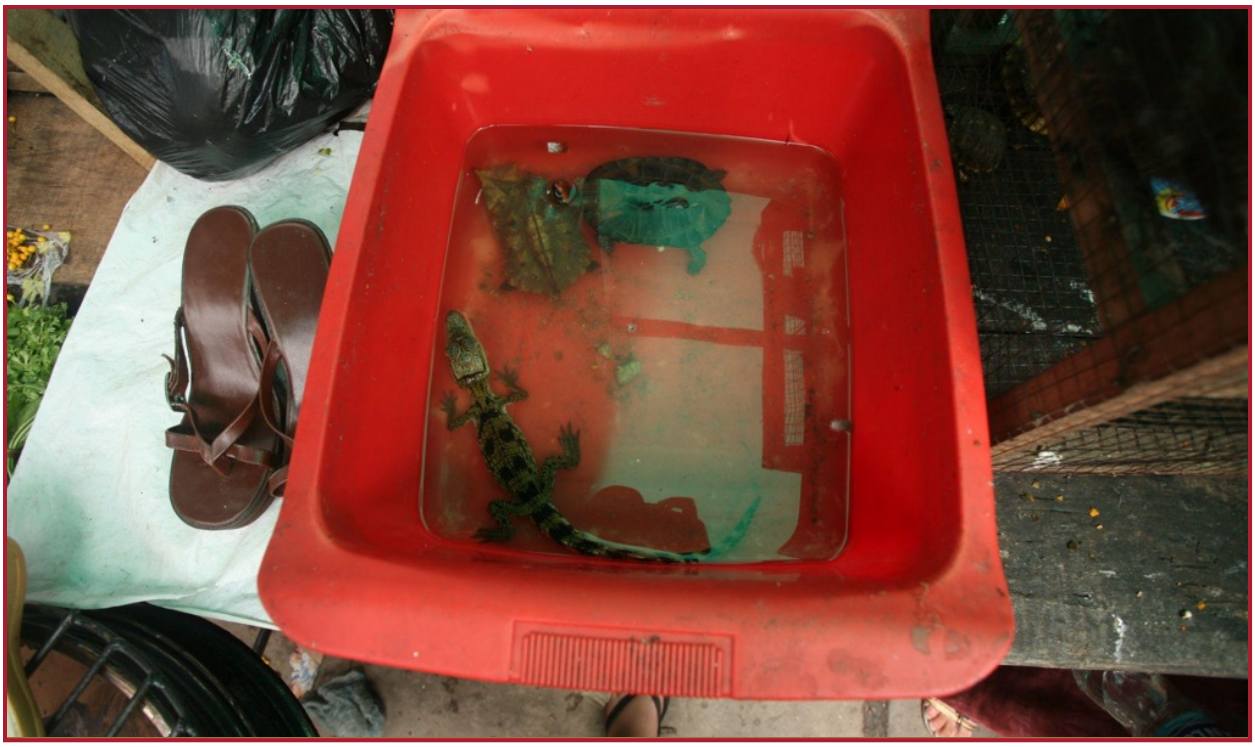
Some of the following images contain graphic content. All pictures were taken by Vania Milanovitch in March 2008, and obtained by the authors while mobility restrictions for the Covid-19 pandemic were still in force. The images were taken in the Belen market, located in the city of Iquitos, capital of the Loreto region. The market has since been renovated. While the pictures may not show the exact state of the infrastructure at the time of publication, they represent the conditions under which food and other consumption goods are commercialized throughout Peru. The traditional products, packaging, and infrastructure (or lack thereof) here shown, can all be found in the three distinctive regions of Peru.

Two women sit next to their stall of fresh fish outside of Belen Market, reading and eating a plate of yucca. The fish are displayed on top of two tables, unrefrigerated: some are cut in half, some lay whole next to flaked off fish meat. The species are Boquichico (*Prochilodus nigricans)*, Sábalo (*Prochilodus lineatus*), Paco (*Piaractus brachypomus*).

Sellers often spend all day at the stalls, and take their meals where they eviscerate, flake off and sell the meat: increasing the risk of cross-contamination. Two buckets are observed on the stalls, possibly containing water that is used to wash their products before a final sale. The floor is muddy and with small pieces of trash, showing that there may not be enough cleaning staff for the market.

A market stall selling fruit and live wildlife on the street outside of Belen Market. In the center, a small cage contains Taricayas (*Podocnemis unifilis*) on the bottom level, and a Majaz (*Cuniculus paca*) on the top level. A restrained Leoncito monkey (*Cebuella pygmaea*) sits on top of the cage, eating. To its left, a red bucket with water holds a turtle and a small lizard, positioned directly under two green parrots (*Psittacoidea*) that perch above it. Five other parrots are held inside a second cage, hanging from the perch in between the birds and the reptiles.

To the right of the table, a woman is placing bananas and papaya for sale. Both wildlife and fruit could belong to different stalls, but there is no real division between the two, which may indicate a lack of zoning within the market.



From the previous market stall: a grimy red bucket halfway filled with water contains two turtles and a lizard: Taricaya (*Podocnemis unifilis*), Mata Mata (*Chelus fimbriata*) and possibly a baby Cayman (*caiman sp.*). The water in the container its dirty with excrement, food and feathers. A pair of women's sandals sit next to the bucket.

A stall selling Sajino (*Dicotyles tajacu*) bushmeat, either salt-cured or raw. Pieces of meat are exhibited on top of a wooden table, unrefrigerated. The saleswoman in the stall is not wearing personal protection equipment and the stall does not have a space for appropriate handwashing. Temperatures in Iquitos can reach 31°C (89°F) in the month of March, increasing the risk of transmissible diseases.

A stall selling Motelo (*Chelonoidis denticulata*) meat and eggs. This turtle meat is the main ingredient in a popular soup, an Amazonian delicacy. The animal products are arranged over a layer of banana leaves, unrefrigerated and uncovered. Animal parts are easily identifiable and in direct contact with chicken meat, offered in the neighboring stall.

A woman stands behind a display of upside-down Motelo turtles (*Chelonoidis denticulata*), Churo snails (*Hexaplex radix*) and snail roe. The animal products lie on top of a red plastic cover, with no physical barrier to differentiate them from the neighboring stalls. It is unclear if the turtles are alive, but one of them is held inside their shell by a wooden stick.

Market stall offering a hanging skin of Otorongo (*Panthera onca*), jarred products and traditional ointments. Two women and a child are seen in the vicinity, snacking.

Signage for a market stall called “The little jaguar” and, behind it, “The little jungle”: both offering natural remedies. Potions and medicinal plants are sold in repurposed glass jars, juice bottles and plastic bags. Many of these are marketed to people with reproductive and sexual health concerns.

Main entrance to the Belen market in Iquitos, in 2008. Local authorities stand guard outside the building, where children, nuns, and tourists shop at makeshift sales stalls. The Belen market was reopened in 2020 under a new name, “*La Casona de Belén*”: with two floors. The first-floor stalls carry general edible products, and the second floor ones carry traditional medicine.

A group of adults and children watch the demonstration of a street vendor. They all stand around an improvised sales table in the middle of the market's walkway, eating *curichi* and selling Macambo (*Theobroma bicolor*), a type of walnut.

ACRONYMS

National Agricultural Health Service *Servicio Nacional de Sanidad Agraria*	SENASA
Ministry of Agrarian Development and Irrigation *Ministerio de Desarrollo Agrario y Riego*	MIDAGRI
Ministry of Health *Ministerio de Salud*	MINSA
Ministry of Production *Ministerio de la Producción*	PRODUCE
National Institute of Health *Instituto Nacional de Salud*	INS
National Forest and Wildlife Service *Servicio Nacional Forestal y de Fauna Silvestre*	SERFOR
National System of Forestry and Wildlife Management *Sistema Nacional Forestal y de Fauna Silvestre*	SINAFOR
Regional Health Authority *Gerencia Regional de Salud*	GERESA
National Epidemiology Network *Red Nacional de Epidemiología*	RENACE
Wildlife Conservation Society *Sociedad para la Conservación de la Vida Silvestre*	WCS
World Organization for Animal Health *Organización Mundial de Sanidad Animal*	OIE

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