Retrospective and current trend of wild-cat trade in Peru

José Luis Mena¹² | Rosa Vento¹ | Jorge Luis Martínez¹ | Ana Gallegos¹

¹Wildlife Conservation Society-Peru, Lima, Peru
²Museo de Historia Natural “Vera Alleman Haeghebaert”, Universidad Ricardo Palma, Lima, Peru

Correspondence
José Luis Mena, Museo de Historia Natural “Vera Alleman Haeghebaert”, Universidad Ricardo Palma, Lima 33, Peru.
Email: menaa.jl@gmail.com

Abstract
Several species of wild cats are threatened with extinction due to habitat loss, persecution or retaliatory killing by humans as a result of real or perceived livestock depredation, and illegal trade. The trade of individuals or their parts has been a recurring threat over the years, especially prior to the establishment of CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) in 1975. We assessed the extent of trade of wild cats in Peru (eight species) using export records available from 1946 to 1973, before the establishment of CITES and after the implementation of CITES using confiscation data available for 2001–2020. The ocelot and the jaguar were the most exploited species for their skins in the pre-CITES period, with 228,376 and 17,301 individuals, respectively; as well as post-CITES, although at significantly lower levels, with 67 individuals and 107 body parts, and 27 individuals and 99 body parts, respectively. Post-CITES trade, however, shows an increasing trend for the jaguar and all wild cat species. Currently in Peru, the illegal wildlife trade is considered opportunistic, but its impact on wild populations has not been properly documented. We recommend improving knowledge regarding population status of wild cats to inform conservation status, and to increase efforts to reduce illegal trade at both national and regional level.

Keywords
felines, illegal, jaguar, ocelot, Peru, wildlife trade, wildlife trade CITES

Wild feline populations, especially those of large-bodied species (≥15 kg), have been decreasing in recent years, in some cases with up to 95% of range contraction (e.g., tigers or lions; Ripple et al., 2014; Wolf & Ripple, 2017). This decrease is associated with threats such as the loss and degradation of habitat, persecution or retaliatory killing by humans as a result of real or perceived livestock depredation, human use (e.g., traditional medicine, skins, and trophies), and population declines of their natural prey species (Ripple et al., 2014).

A recurring threat to wild cats is the illegal trade in body parts. This is a primary cause of population decline for tigers (Panthera tigris) due to the demand from China, South Korea, and other Asian countries for body parts and derivatives for traditional medicine and decorative purposes, especially high during the 1980s and 1990s (Dinerstein et al., 2007; Jackson, 2010; Loveridge, Wang, Frank, & Seidensticker, 2010). Currently, this threat has been recognized as a major concern for lions and other large cats (Everatt, Kokes, & Lopez Pereira, 2019; Loveridge et al., 2010; Williams, Loveridge, Newton, & Macdonald, 2017). The trafficking of body parts has also been recognized as a conservation problem for the jaguar, the largest feline in the Americas (Morcatty et al., 2020).

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2021 The Authors. Conservation Science and Practice published by Wiley Periodicals LLC on behalf of Society for Conservation Biology.
Several spotted-cat species populations in Latin America, including the ocelot (*Leopardus pardalis*), margay (*Leopardus wiedii*), and jaguar (*Panthera onca*) have been impacted due to the international trade of skins, especially for the fashion industry in Europe and North America in the 1960s and 1970s (Loveridge et al., 2010). This trade resulted in an annual removal of ~80,000 ocelots and ~15,000 jaguars in the Brazilian Amazon during 1960s (Smith, 1976), and up to ~800,000 ocelots and margays, and ~180,000 jaguars between 1904 and 1969 (Antunes et al., 2016). That level of overexploitation of Neotropical wild cats motivated their listing in Appendix I of the Convention on International Trade in Endangered Species (CITES) in 1975, prohibiting international commercial trade. In 1986 the European Union banned all imports of body parts of Latin American cats, while several smaller cat species were listed as Appendix I between 1989 and 1992 (Loveridge et al., 2010). Due to trade controls at both national and international levels and a resultant decreasing demand of spotted cat skins, trade in cat products decreased (Broad, 1987b). Furthermore, Graham (2017) reviewed the CITES trade database (1980–2016) and found that the ocelot trade decreased after the legal fur-trade period. Confiscations during that time included live wild-born and captive-bred individuals as well as body parts. Nevertheless, illegal trade in ocelot skins and other body parts still persists (Graham, 2017). The same situation applies to jaguars (Morcatty et al., 2020). In fact, both species show decreasing population trends, mainly due to habitat loss, persecution, and illegal trade of body parts (de la Torre, González-Maya, Zarza, Ceballos, & Medellín, 2017; Paviolo et al., 2015).

Peru has a large diversity of felines, with eight species (Felidae) (Pacheco et al., 2020), one of them considered threatened (*Leopardus jacobita*), two are near threatened (*Panthera onca* and *Puma concolor*) and three are data deficient (*Leopardus garleppi*, *Leopardus tigrinus*, and *Leopardus wiedii*) (SERFOR, 2018). In 1970 the Peruvian government banned trade and exportation of jaguar skins (Ministerial Resolution No 5056-70-AG) and in 1973 declared an indefinite prohibition on Amazonian wildlife trade (Veda de Caza, 934-73-AG), including spotted-cats (Broad, 1987a, 1987b). In 2017 the Peruvian government published the national strategy to reduce illegal wildlife trafficking (SERFOR, 2017), whose implementation is hoped to reduce illegal trade. Peru also has the second-largest population of jaguars (~22,200 individuals) after Brazil (Jędrzejewski et al., 2018). Unfortunately, wild felids have been poorly studied in Peru and large knowledge gaps exist regarding population ecology, distribution, and conservation issues, among others (Cossios et al., 2012), making an accurate assessment of threats to these species difficult.

In this paper, we assessed trends in trade of spotted cats in Peru prior to the implementation of CITES. We reviewed records on legal exports from the city of Iquitos from 1946 to 1973 available in Grimwood (1969) and Broad (1987a). These records provided the number of skins for spotted cat species exported per year during that period. Export records from Iquitos were utilized because it was the main export location for wildlife skins during that time (Broad, 1987a; Grimwood, 1969). In addition to reviewing these legal exports, we assessed trends for all wild cat body-parts and living individuals (hereafter referred as specimens) seized between 2001 and 2020, using data provided by national authorities such as the National Forest and Wildlife Service (SERFOR) and Regional Governments of Loreto, Ucayali, and Madre de Dios (GOREs). Following Heinrich et al. (2020), we considered specimens seized as examples of illegal wildlife trade. Specimen confiscations were generally planned, and intelligence driven, but also sometimes complaint-driven and occurred in markets, airports, bus station terminals, and custom posts. Using both past legal export data and more recent seizures of illegally traded specimens allow for an updated assessment on the current illegal trade of wild cats in Peru within the context of past population impacts due to historical trade. Thus, we believe that this approach allows us to better assess the effect of current threats (e.g., habitat loss, illegal trade, and human-wildlife conflicts) on previously impacted populations.

We used generalized additive models (GAM) to estimate trends over time for the number of exported spotted-cat skins from 1946 to 1973 (pre-CITES period). GAM is a kind of general linear model (GLM) where the linear predictor depends linearly on smooth functions of predictor variables and also allows the potential temporal autocorrelation to be incorporated into the structure of the models (Wood, 2017). The number of exported spotted-cat skins by each species was used as the response variable: *spotted-cat skins* = *f*(Year), where year was the predictor variable, modeled using the GAM framework to fit a smooth function (*f*). We treated time (Year) as a continuous variable, which allows annual patterns to be visualized more easily (Heinrich et al., 2020). The model was fitted using a log link function under a Poisson distribution (Model 1) and a negative binomial variance function (Model 2), which are recommended when there are over-dispersion problems in the data (Zuur, Ieno, & Elphick, 2010). We fitted GAM models for the species with the highest number of traded skins (ocelots and jaguars).

In addition, we fitted GAM models to estimate the temporal trend in the total number of wild cats seized from 2001 to 2020. We also ran GAM models to analyze
trends for the two species with the highest number of specimens seized (ocelot and jaguar). Skins, skulls, teeth, legs, and claws were considered body parts (specimens) because records did not identify these to individuals. We considered the number of specimens by year as the variable response “number of wild cat specimens seized”. As the total number of confiscation incidents (“confiscation effort”) was not evenly distributed across the years, it was included as an offset in modeling (Zuur, Hilbe, & Ieno, 2013). The average number of wild cat specimens seized by each confiscation incident was 1.5 ± 0.58. The comparison of the models was based on the Akaike information criterion corrected for small samples (AICc), and subsequent inferences were made from the model with the lowest AICc value when the difference with the next best model was ΔAICc < 2 (Burnham & Anderson, 2002).

All data were analyzed in R (R Core Team, 2020). The best model was run using the “mgcv” package (Wood, 2011) and the selection of the models was made using the “MuMIn” package (Barton, 2020).

The commercialization of spotted cats prior to the implementation of CITES showed an increase related to the international demand present at that time. Between 1946 and 1973, an estimated 228,376 ocelots and 17,301 jaguars were commercially harvested for their skins, with ~8156 (95% CI: 6226–10,087) and ~618 (95% CI: 461–774) individuals hunted per year, respectively. During the same period, 9607 margay skins were traded. Based on the most supported GAM model, trade steadily increased until 1968 and 1963 for ocelots and jaguars, respectively, but decreased until 1973 for both species (Figure 1). In 1946, the estimated number of traded ocelot skins was 1,261 (95% CI: 883–1801); in 1968 trade increased to 13,390 (95% CI: 10,931–16,402) but by 1973 it decreased to 11,460 (95% CI: 8033–16,351) (Figure 1). Similarly, in 1946 the estimated number of traded jaguar skins went from 284 (95% CI: 107–758) to 812 (95% CI: 472–1,396) in 1963 and decreased to 483 by 1973 (95% CI: 181–1,288) (Figure 1).

Between 2001 and 2020, 184 living individuals and 302 body parts of wild cats (486 in total) were confiscated in 279 incidents recorded by government authorities. Specimens seized included the northern pampas cat, *Leopardus garleppi* (seven individuals, seven body parts), the Andean cat, *Leopardus jacobi*ta (2, 4), the ocelot, *L. pardalis* (67, 107), the oncilla, *L. tigrinus* (14, 4), the margay, *L. wieddi* (21, 4), the jaguar, *P. onca* (27, 99), the puma, *Puma concolor* (24, 13), and the jaguarundi, *Puma yagouaroundi* (14, 1). Based on the most supported GAM model, the estimated number of specimens seized increased for jaguar and all wild cat species but decreased for ocelots (Figure 2). In 2001, the estimated number of wild cat specimens seized was 14 (95% CI: 10–20) increasing to 20 in 2020 (95% CI: 15–25). Similarly, the estimated number of ocelots seized was 11 in 2001 (95% CI: 6–18), and four in 2020 (95% CI: 2–6) (Figure 2), and the estimated number of jaguars seized was three in 2001 (95% CI: 1–8), increasing to up to six in 2020 (95% CI: 3–12) (Figure 2). The department of Lima had the highest number of wild cat specimens seized (31.89%), followed by Amazonian departments such as Loreto (20.16%) and Ucayali (13.17%), and Junín (8.64%).

Based on current density data for jaguars in Peru, 3.00 (2.41 ± 3.62) individuals/100 km² as suggested by Jędrzejewski et al. (2018), the annual loss of ~618 jaguars prior to the establishment of CITES implied the annual local extirpation of jaguar individuals in an approximate area of 20,167 (15,900–24,433) km². This area is the equivalent in size to protected areas such as the Pacaya Samiria National Reserve or the Sierra del Divisor National Park. Grimwood (1969) pointed out that during the 60s, jaguars disappeared from areas surrounding human settlements and were considered rare throughout the Peruvian amazon. Due to the jaguar’s biological characteristics, including slow reproduction rate and long generation time (Kantek et al., 2021; van de Kerk, de Kroon, Conde, & Jongejans, 2013), it would seem that this level of exploitation was unsustainable. Nevertheless, Antunes et al. (2016) considered that a refuge-harvestable area model (i.e., source-sink dynamics) was the only reasonable way to explain increasing or continued commercial-scale harvest for Amazonian wildlife species in Brazil, including jaguars and ocelots. It is possible that

---

**FIGURE 1** The fitted smoother curves obtained with GAM depicting the effect of time (years) on commercial harvest (skins) by both ocelot and jaguar (solid line) and 95% confidence interval (shaded) based on data from Grimwood (1969) and (Broad, 1987a). The grey dotted line indicates the year of the hunting band (Veda de Caza, 934-73-AG)
jaguar dispersal patterns may have allowed them to recon-olize previously harvested territories. Studies have shown that jaguar dispersal is mostly male-biased, while females are more philopatric, remaining close to each other (Kantek et al., 2021; Lorenzana et al., 2020). In addition, jaguar home-ranges are estimated at 35–2915 km² for males and 13–1155 km² for females, and are related to habitat productivity, forest cover and road density (Morato et al., 2016; Thompson et al., 2021). These biological characteristics, in combination with the availability of unexploited and undisturbed habitats, possibly allowed for the existence of source-sink dynamics and prevented a population collapse during pre-CITES levels of overexploitation and explains the current persistence of jaguars in previously hunted areas. Likewise, the high dispersal potential of jaguars has also probably resulted in high levels of gene flow among populations. In that sense, Lorenzana et al. (2020) showed no evidence of recent genetic bottlenecks for Amazonian populations; instead, jaguars show high levels of genetic diversity. As Antunes et al. (2016) pointed out, if hunting of wild cat populations in Brazil during the trade period included adequate source populations, felines may be resilient since high-levels of commercial harvest failed to extirpate them during that period. This likely also occurred for jaguars and ocelots in Peru during the pre-CITES period, and also the 2001–2020 period.

Broad (1987b) pointed out that CITES annual reports showed that the number of cats skins traded in Peru was drastically reduced (zero in 1985). However, illegal trade in wild cat body parts, although not at pre-CITES levels, seems to be widespread in several locations throughout the Peruvian Amazon (Graham, 2017; Morcatty et al., 2020; Shanee, 2012). In Peru, the wild cat trade for medicinal and mystical utilization is considered opportunistic and, although illegal, it is not recognized as a criminal act due to cultural legacy reasons (Arias et al., 2021; Braczkowski et al., 2019; Leberatto, 2016; Leberatto, 2017). A recent study showed evidence of illegal trade of jaguar body parts in the main cities of the Peruvian Amazon, where skins and teeth are sold as handicrafts in markets (SERFOR and WCS, 2020) (Figure 3), with Iquitos (Loreto) being the most important city for this type of trade. These findings are in agreement with the data regarding specimen seizures, which showed the Amazonian departments of Loreto and Ucayali as having the highest number of seizures after Lima, which is the main departure location for international destinations.

The trade of tiger body parts, mainly associated with medicinal attributes, has had repercussions for other big cats as tiger populations have decreased and regulation of tiger trade has increased. Species such as leopards, lions, and jaguars may be considered as tiger substitutes (Morcatty et al., 2020; Villalva & Moracho, 2019).
Fortunately, in Peru, there does not yet seem to be a relationship of illegal trade with the demand for wild cat parts for the Asian market, as it is for other Latin American countries (Morcatty et al., 2020). However, data on the relationship between the Asian markets and illegal wildlife trade in Peru is lacking. The recent increase in jaguars and other species of wild cats seized is a wake-up call to increase measures to determine the drivers of the illegal wildlife trade and reduce wildlife trafficking. As ‘t Sas-Rolfes, Challender, Hinsley, Veríssimo, and Milner-Gulland (2019) has pointed out, seizure data at the national level are subject to the enforcement or reporting capacity, so the extent of the illegal wildlife trade is probably underestimated.

Currently, jaguar populations are being strongly threatened by land-use change, which leads to deforestation, forest fragmentation and the replacement of original forests by crops, (Oliveira et al., 2007; Sánchez-Cuervo et al., 2020). Between 2001 and 2020 Peru lost 33,900 km² of primary forest equivalent to 4.3% of its forest cover, and 3.1% of its primary forest (Global Forest Watch, 2021), which equals approximately 1000 individual jaguars lost based on Jedrzejewski et al. (2018) density estimates. In addition to land use change, persecution and population decline of their natural prey base are considered important threats in Peru. However, these threats have not been fully assessed. Therefore, even if biological and ecological factors favored the survival of spotted cat populations during past commercial harvests when trade was legal, the current illegal trade which is likely underestimated, in combination with the aforementioned main threats, pose a significant challenge to wild cat conservation.

The reduction of big cat populations has repercussions not only for prey dynamics but also for ecosystem functioning, due to the role of large cats as top predators (Hoeks et al., 2020; Ripple et al., 2014). Unfortunately, information on the population ecology of wild cats is limited in Peru, with a few exceptions for ocelots (Kolowski & Alonso, 2010) and jaguars (Mena et al., 2020; Tobler et al., 2018; Tobler, Carrillo-Percastegui, Zúñiga Hartley, & Powell, 2013). We recommend improving knowledge regarding population status of wild cats to inform conservation status and efforts to reduce illegal trade in alignment with Peru’s national strategies. We also recommend improving public education campaigns for potential suppliers and purchasers of wildlife products as well as government authorities regarding the illegality of trade, its criminal repercussions, and the importance of conserving wild cats.

ACKNOWLEDGMENTS
We thank the National Forest and Wildlife Service (SERFOR) and the GOREs (Regional Governments of
Loreto, Ucayali, and Madre de Dios) for providing data about wildlife seized. We are grateful to Catherine Sahley for reviewing previous versions of the manuscript.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS
José Luis Mena: designed the study, collated, analyzed, and interpreted the data and wrote the manuscript. Rosa Vento, Jorge Luis Martinez and Ana Gallegos: supervised the development of the manuscript, and assisted with the study design, analysis, and editing.

DATA AVAILABILITY STATEMENT
All data are freely available from the referenced sources.

ORCID
José Luis Mena https://orcid.org/0000-0002-3716-598X

REFERENCES
Antunes, A. P., Fewster, R. M., Venticinque, E. M., Peres, C. A., Levi, T., Rohe, F., & Shepard, G. H. (2016). Empty forest or empty rivers? A century of commercial hunting in Amazonia. Science Advances, 2(10), e1600936. https://doi.org/10.1126/sciadv.1600936

Arias, M., Hinsley, A., Nogales-Ascarrunz, P., Negroes, N., Glikman, J. A., & Milner-Gulland, E. J. (2021). Prevalence and characteristics of illegal jaguar trade in North-Western Bolivia. Conservation Science and Practice, 3(7), e444. https://doi.org/10.1111/csp2.444

Barton K (2020) MuMIn: Multi-Model Inference. R Package Version 1.43.17. https://CRAN.R-project.org/package=MuMIn.

Braczkowski, A., Ruzo, A., Sanchez, F., Castagnino, R., Brown, C., Guynup, S., Winter, S., Gandy, D., & O’Bryan, C. (2019). The ayahuasca tourism boom: An undervalued demand driver for jaguar body parts? Conservation Science and Practice, 1(12), e126. https://doi.org/10.1111/csp2.126

Broad, S. (1987a). The harvest of and trade in Latin American spotted cats (Felidae) and otters (Lutrinae). Wildlife Trade Monitoring Unit, IUCN Conservation Monitoring Centre.

Broad, S. (1987b). International trade in skins of Latin American spotted cats. Traffic Bulletin, 9(2/3), 56-63.

Burnham, K. P., & Anderson, D. R. (2002). Model selection and multimodal inference: A practical information-theoretic approach. Springer.

Cossios, E. D., Alcázar, P., Fajardo, U., Chávez, K., Alfaro-Shigueto, J., Cárdenas-Alayza, S., Valqui, J., Montero, F. G., Lescano, J., & Quevedo, M. (2012). El Orden Carnivora (Mammalia) en el Perú: estado del conocimiento y prioridades de investigación para su conservación. Revista Peruana de Biología, 19(1), 17–26.

de la Torre, J. A., González-Mayá, J. F., Zarza, H., Ceballos, G., & Medellín, R. A. (2017). The jaguar’s spots are darker than they appear: Assessing the global conservation status of the jaguar Panthera onca. Oryx, 52(2), 300–315. https://doi.org/10.1017/S0030605316001046

Dinerstein, E., Loucks, C., Wikramanayake, E., Ginsberg, J., Sanderson, E., Seidensticker, J., Forrest, J., Bryja, G., Heydlauff, A., Klenzendorf, S., Leimgruber, P., Mills, J., O’Brien, T. G., Shrestha, M., Simons, R., & Songer, M. (2007). The fate of wild tigers. Bioscience, 57(6), 508–514. https://doi.org/10.1641/B570608

Everatt, K. T., Kokes, R., & Lopez Pereira, C. (2019). Evidence of a further emerging threat to lion conservation; targeted poaching for body parts. Biodiversity and Conservation, 28(14), 4099-4114. https://doi.org/10.1007/s10531-019-01866-w

Global Forest Watch (2021) https://www.globalforestwatch.org/dashboards/country/PER/

Graham, K. (2017). International intent and domestic application of the convention on international trade in endangered species of wild Fauna and Flora (CITES): The case of the ocelot (Leopardus pardalis). Journal of International Wildlife Law & Policy, 20(3–4), 253–294. https://doi.org/10.1080/13880292.2017.1403797

Grimwood, I. (1969). Notes on the distribution and status of some Peruvian mammals, 1968. Special publication No 21. American Committee for International Wildlife Protection and New York Zoological Society.

Heinrich, S., Ross, J. V., Gray, T. N. E., Delean, S., Marx, N., & Cassey, P. (2020). Flight of the commons: 17 years of wildlife trafficking in Cambodia. Biological Conservation, 241, 108379. https://doi.org/10.1016/j.biocon.2019.108379

Hoeks, S., Huijbregts, M. A. J., Busana, M., Harfoot, M. B. J., Svenning, J.-C., & Santini, L. (2020). Mechanistic insights into the role of large carnivores for ecosystem structure and functioning. Ecography, 43(12), 1752–1763. https://doi.org/10.1111/ecog.05191

Jackson, P. (2010). Chapter 1: Fifty years in the Tiger world—An introduction. In R. Tilson & P. J. Nyhus (Eds.), Tigers of the world (2nd ed., pp. 1–15). William Andrew Publishing. https://doi.org/10.1080/02981431.2015.1134663

Kantek, D. L. Z., Trinca, C. S., Tortato, F., Devlin, A. L., de Azevedo, F. C. C., Cavalcanti, S., Silveira, L., Miyazaki, S. S., Junior, P. G. C., May-Junior, J. A., Frugoso, C. E., Sartorello, L. R., Rampim, L. E., Haberfeld, M. B., de Araujo, G. R., Morato, R. G., & Eizirik, E. (2021). Jaguars from the Brazilian Pantanal: Low genetic structure, male-biased dispersal, and implications for long-term conservation. Biological Conservation, 259, 109153. https://doi.org/10.1016/j.biocon.2021.109153

Kolowski, J. M., & Alonso, A. (2010). Density and activity patterns for long-term conservation. Biological Conservation, 143, 917–925.

Leberatto, A. C. (2016). Understanding the illegal trade of live wildlife species in Peru. Trends in Organized Crime, 19(1), 42–66.

Leberatto, A. C. (2017). A typology of market sellers of protected wildlife across Peru. Deviant Behavior, 38(12), 1352–1370.
Lorenzana, G., Heidtmann, L., Haag, T., Ramalho, E., Dias, G., Hrbeck, T., Farias, I., & Eizirik, E. (2020). Large-scale assessment of genetic diversity and population connectivity of Amazonian jaguars (Panthera onca) provides a baseline for their conservation and monitoring in fragmented landscapes. *Biological Conservation*, 242, 108417. https://doi.org/10.1016/j.biocon.2020.108417

Loveridge, A. J., Wang, S. W., Frank, L., & Seidensticker, J. (2010). People and wild felids: Conservation of cats and management of conflicts. In W. Macdonald David & A. J. Loveridge (Eds.), *Biology and conservation of wild felids* (pp. 161–195). Oxford University Press.

Mena, J. L., Yagui, H., Tejeda, V., Cabrera, J., Pacheco-Esquível, J., Rivero, J., & Pastor, P. (2020). Abundance of jaguars and occupancy of medium- and large-sized vertebrates in a trans-boundary conservation landscape in the northeastern Amazon. *Global Ecology and Conservation*, 23, e01079. https://doi.org/10.1016/j.gecco.2020.e01079

Morato, R. G., Stabach, J. A., Fleming, C. H., Calabrese, J. M., De Paula, R. C., Ferraz, K. M. P. M., Kantek, D. L. Z., Miyazaki, S. S., Pereira, T. D. C., Araujo, G. R., Paviolo, A., De Angelo, C., Di Bitetti, M. S., Cruz, F., Lima, F., Cullen, L., Sana, D. A., Ramalho, E. E., Carvalho, M. M., ... Leimgruber, P. (2016). Space use and movement of a Neotropical top predator: The endangered jaguar. *PLoS One*, 11(12), e0168176. https://doi.org/10.1371/journal.pone.0168176

Morcatty, T. Q., Bausch Macedo, J. C., Nekaris, K. A.-I., Ni, Q., Durigan, C. C., Svensson, M. S., & Nijman, V. (2020). Illegal trade in wild cats and its link to Chinese-led development in central and South America. *Conservation Biology*, 34, 1525–1535. https://doi.org/10.1111/cobi.13498

Oliveira, P. J. C., Asner, G. P., Knapp, D. E., Almeida, A., Galvan-Gildemeister, R., Keene, S., Raybin, R. F., & Smith, R. C. (2007). Land-use allocation protects the Peruvian amazon. *Science*, 317, 1233–1236. https://doi.org/10.1126/science.1146324

Pacheco, V., Graham-Angeles, L., Peña, S. R. D., Hurtado, C. M., Ruelas, D., Zevallos, O. K. C., & Villavicencio, J. E. S. (2018). Land-use allocation protects the Peruvian amazon. *International Journal of Biodiversity* (8), e70354. https://doi.org/10.1371/journal.pone.0070354

Paviolo, A., Crawshaw, P., Caso, A., de Oliveira, T., Lopez-Gonzalez, C. A., Kelly, M., De Angelo, C., & Payan, E. (2015). *Leopardus pardalis* (errata version published in 2016). The *IUCN Red List of Threatened Species*, e.T11509A97212355. https://doi.org/10.2305/IUCN.UK.2015-4.RLTS.T11509A97212355.en

R Core Team. (2020). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Ripple, W. J., Estes, J. A., Beschta, R. L., Wilmers, C. C., Ritchie, E. G., Hobbie, M., Berger, J., Elmhagen, B., Letnic, M., Nelson, M. P., Schmitz, O. J., Smith, D. W., Wallach, A. D., & Wirsing, A. J. (2014). Status and ecological effects of the world’s largest carnivores. *Science*, 343(6176), 1241484. https://doi.org/10.1126/science.1241484

Sánchez-Cuervo, A. M., de Lima, L. S., Dallmeier, F., Garate, P., Bravo, A., & Vanthomme, H. (2020). Twenty years of land cover change in the southeastern Peruvian Amazon: Implications for biodiversity conservation. *Regional Environmental Change*, 20(1), 8. https://doi.org/10.1007/s10113-020-01603-y

SERFOR. (2017). Estrategia nacional para reducir el tráfico ilegal de fauna silvestre en el Perú 2017–2027 y su plan de acción 2017-2022. Serfor (Servicio Nacional Forestal y de Fauna Silvestre).

SERFOR. (2018). *Libro Rojo de la Fauna Silvestre Amenazada del Perú. Primera edición*. Serfor (Servicio Nacional Forestal y de Fauna Silvestre).

SERFOR, WCS (2020) Documento de Trabajo 31. Evidencias del tráfico de partes del jaguar en la Amazonía peruana: 2018–2019, Lima Shannee, N. (2012). Trends in local wildlife hunting, trade and control in the tropical Andes biodiversity hotspot, northeastern Peru. *Endangered Species Research*, 19(2), 177–186.

Smith, N. J. H. (1976). Spotted cats and the Amazon skin trade. *Oryx*, 13(4), 362–371. https://doi.org/10.1017/S0003065300014095

'St-Rolfs, M., Challender, D. W., S. Hinsley, A., Verissimo, D., & Milner-Gulland, E. J. (2019). Illegal wildlife trade: Scale, processes, and governance. *Annual Review of Environment and Resources*, 44(1), 201–228. https://doi.org/10.1146/annurev-environ-011718-033253

Thompson, J. J., Morato, R. G., Niebuhr, B. B., Alegre, V. B., Oshima, J. E. F., de Barros, A. E., Paviolo, A., de la Torre, J. A., Lima, F., McBride, R. T., Jr., Cunha de Paula, R., Cullen, L., Jr., Silveira, L., Kantek, D. L. Z., Ramalho, E. E., Maranhão, L., Haberfeld, M., Sana, D. A., Medellin, R. A., ... Ribeiro, M. C. (2021). Environmental and anthropogenic factors synergistically affect space use of jaguars. *Current Biology*, 31, 3457–3466. e4. https://doi.org/10.1016/j.cub.2021.06.029

Tobler, M. W., Carrillo-Percastegui, S. E., Zúñiga Hartley, A., & Powell, G. V. N. (2013). High jaguar densities and large population sizes in the core habitat of the southwestern Amazon. *Biological Conservation*, 159, 375–381. https://doi.org/10.1016/j.biocon.2012.12.012

Tobler, M. W., Garcia Anleu, R., Carrillo-Percastegui, S. E., Ponce Santizo, G., Polisar, J., Zúñiga Hartley, A., & Goldstein, I. (2018). Do responsibly managed logging concessions adequately protect jaguars and other large and medium-sized mammals? Two case studies from Guatemala and Peru. *Biological Conservation*, 220, 245–253. https://doi.org/10.1016/j.biocon.2018.02.015

van de Kerk, M., de Kroon, H., Conde, D. A., & Jongejeans, E. (2013). Carnivora population dynamics are as slow and as fast as those of other mammals: Implications for their conservation. *PLoS One*, 8(8), e70354. https://doi.org/10.1371/journal.pone.0070354

Villalva, P., & Moracho, E. (2019). Tiger trade threatens big cats worldwide. *Science*, 364(6442), 743–744. 7474. https://doi.org/10.1126/science.aax5200

Williams, V. L., Loveridge, A. J., Newton, D. J., & Macdonald, D. W. (2017). Questionnaire survey of the pan-African trade in lion body parts. *PLoS One*, 12(10), e0187060. https://doi.org/10.1371/journal.pone.0187060

Wolf, C., & Ripple, W. J. (2017). Range contractions of the world’s large carnivores. *Royal Society Open Science*, 4(7), 170052. https://doi.org/10.1098/rsos.170052

Wood, S. N. (2011). Fast stable restricted maximum likelihood and marginal likelihood estimation of semiparametric generalized linear models. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, 73(1), 3–36. https://doi.org/10.1111/j.1467-9868.2010.00749.x
Wood, S. N. (2017). Generalized additive models: An introduction with R (2nd ed.). CRC Press. https://doi.org/10.1201/9781315370279
Zuur, A. F., Hilbe, J. M., & Ieno, E. N. (2013). A beginner’s guide to GLM and GLMM with R: A Frequentist and Bayesian perspective for ecologists. Highland Statistics Newburgh.
Zuur, A. F., Ieno, E. N., & Elphick, C. S. (2010). A protocol for data exploration to avoid common statistical problems. Methods in Ecology and Evolution, 1(1), 3–14. https://doi.org/10.1111/j.2041-210X.2009.00001.x

How to cite this article: Mena, J. L., Vento, R., Martínez, J. L., & Gallegos, A. (2021). Retrospective and current trend of wild-cat trade in Peru. Conservation Science and Practice, 3(12), e558. https://doi.org/10.1111/csp2.558