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Original Article

Thailand's online reptile market decreases but shifts toward native species during COVID-19



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ABSTRACT

The recent COVID-19 pandemic presented the world with a crisis of incredible scale and made wildlife markets the focal point of authorities. Scientific literature on COVID-19 and wildlife trade overwhelmingly focused on the zoonotic risks of wildlife markets. As many physical marketplaces for wildlife were faced with closure or restrictions to curb the spread of COVID-19, alternative sale platforms were sought. I monitored social media platforms in Thailand during the pandemic and compared this with data obtained in 2016. I found a significant reduction of lizards and snakes offered for sale on social media, compared with before the pandemic. Although the quantity decreased, I found that the number of species almost doubled in snakes, of which unprotected native species increased by 245%. Transport restrictions would limit the mobility of harvesters and interrupts trade chains, and thus could explain the reduced number of snakes and lizards for sale. However, the increase in native species for sale shows that the impact of this international trade disruption could shift focus from international trade to what is locally available. Potentially having serious consequences for the conservation of local species and in line with previous studies documenting increased poaching rates and wildlife crime incidents.

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Introduction

The COVID-19 pandemic (caused by the virus SARS-CoV-2) has presented the world with a crisis of a scale unknown to current generations. Besides the loss of life, the pandemic had unprecedented social and economic ramifications around the globe (Hafiz et al. 2020). It has been suggested that the first intermediate animal hosts of SARS-CoV-2 were found among wildlife sold at a local live animal market in Wuhan, China (Xiao et al. 2021). Consequently, wildlife markets and the (legal and illegal) trade of wildlife are more and more considered public health risks (Bueno et al. 2016; Halbwx 2020; Bezerra-Santos et al. 2021). Placing the trade in wildlife at the focal point of authorities and relevant organizations to curb the spread of SARS-CoV-2 (Mallapaty 2020) and prevent future pandemic (Aguirre et al. 2020).

Scientific literature on COVID-19 and wildlife trade overwhelmingly focused on the zoonotic risks of wildlife markets (Bueno et al. 2016; Greateorex et al. 2016; Borsky et al. 2020; Aguirre et al. 2021), advocating for, or opposing of, wildlife trade

bans (Borzée et al. 2020; Eskew and Carlson 2020; Roe et al. 2020; Booth et al. 2021) or how the next pandemic can be prevented (Aguirre et al. 2020; Kolby 2020). Both the illegal and legal wildlife trade are more and more considered a public health risk. Several studies (Cherkaoui et al. 2020; Koju et al. 2021) predicted that measures taken to halt the pandemic might have grave consequences for wildlife with a primary focus on illegal harvesting or trade in wildlife for human consumption. Illegal harvesting of wildlife was expected to increase due to the impact of long-term lockdowns and travel restrictions on livelihoods in combination with reduced monitoring of wild populations (Kideghesho et al. 2021; Rahman et al. 2021). Rahman et al. (2021) reported that in Bangladesh the number of animal killings increased by 28 times during a COVID-19 lockdown. In addition, studies reported increased illegal harvesting of bushmeat due to reduced income from tourism activities (Akinsorotan et al. 2021; Henseler et al. 2022). Similar results were reported from Morocco, Nepal and India with an increase in wildlife crime incidents and illegal harvesting of wildlife (Cherkaoui et al. 2020; Koju et al. 2021). Yet, little research is available on how the pandemic impacted the live animal trade for the purpose of pets.

Despite the fact that several online social media platforms (e.g. Facebook, Instagram) do not allow the sale of wildlife as per their terms of service (https://www.facebook.com/policies_center/)

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commerce/animals), trade of these species via online platforms has been gaining in popularity (Krishnasamy and Stoner 2016; Siriwat and Nijman 2020). As many physical marketplaces for wildlife were faced with closure or restrictions to curb the spread of COVID-19, alternative sale platforms are most likely sought. This manuscript aims to add to the literature on the impact of the COVID-19 pandemic on wildlife trade by focusing on live animals (snakes and lizards) for sale on online platforms and comparing observed species with data obtained prior to the pandemic. I hypothesize that due to the closure of physical markets, online platforms should see an increased number of live animals offered for sale. In addition, due to transport restrictions (e.g. on new wildlife imports) during the pandemic, species composition is expected to shift toward more easily obtainable species (e.g. native species or species for which breeding stock is available).

Material and methods

I focused here on online trade in live reptiles in Thailand. Thailand has been the focal point for numerous wildlife trade studies (Nijman and Shepherd 2007, 2010, 2015; Chng 2014; Siriwat and Nijman 2018) and is known as a hub for wildlife trade, with a particular focus on physical markets like Chatuchak Market (Shepherd and Nijman 2008). I used data collected in 2016 (TRAFFIC, unpublished) and collected data for this study in 2022. Methodology was kept as similar as possible to facilitate easier comparison.

Data methodology 2016

Data from 2016 was obtained from TRAFFIC (unpublished) and was also collected by the author. Nine Facebook groups were monitored for 8 weeks in May and June 2016. These nine groups had an initial total of 71, 244 members. The Facebook groups selected were previously identified as groups where exotic wildlife, and in particular reptiles, was offered for sale and included both public groups (advertisements visible for everyone) and private groups (advertisements only visible for members). All groups were in the Thai language. Group members were not informed a priori of the data collection. Advertisements were documented based on date of placement. For all advertisements, the minimum number of individuals was recorded based on what was indicated in the text or attached photos. Duplicates were removed or not recorded. Posts were translated by a native Thai speaker where required.

Data methodology 2022

As not all the Facebook groups monitored in 2016 were still active, a new selection of Facebook groups was made, which included 12 groups that were created after the survey in 2016. Data was gathered once a week in January and February 2022. Thirteen Facebook groups, of which one was included in 2016, with a total of 66, 400 members, were selected. These groups were previously identified as groups where exotic wildlife and in particular reptiles were offered for sale. This included both public groups (advertisement visible for everyone) and private groups (advertisements only visible for members). All groups were in the Thai language. Although technological advances would allow the use of automated techniques to systematically scrape these pages, to keep methodology as similar as possible, similar methodology was used compared with 2016. In addition, unauthorized scraping violates the terms of service of Facebook. Group members were not informed a priori of the data collection. A priori informing group members of data collection was not desirable as it could have influenced what wildlife was offered for sale. Posts showing personal collections of animals or videos were ignored, only posts that showed an indication that the animal

was for sale were included. For all advertisements, the minimum number of individuals was recorded based on what was indicated in the text or attached photos. Collected data included: species, quantity, price, and if advertisements were coded or not (e.g. “rehoming” instead of “for sale”). No personal data were collected, ensuring ethical data collection and compliance with the Personal Data Protection Act (“PDPA”) Thailand.

Both datasets were analyzed using RStudio 2022.07.1 Build 554 (Allaire 2012) to gain an overview of traded species, their legality and compliance with national and international legislation. I used Chi-squared tests to investigate any temporal changes between both datasets.

National Legislation

Within Thailand, the main legislation governing the protection of species varied between 2016 and 2022. In 2016, the main legislation was the Wildlife Preservation and Protection Act, B.E. 2535 (1992) (WARPA). A revised version of the Wildlife Conservation and Protection Act B.E. 2562 (2019) (WARPA) came into effect in 2019.

Under both the 1992 and 2019 WARPA legislation, 14 snake species and 47 lizard species were/are protected. It is illegal to hunt, possess or trade in protected wildlife and their derivatives (section 16-20), unless it comprises protected wildlife which has been designated under Section 17 of WARPA as approved type of propagated wildlife. Under Ministry Regulation B.E. 2546 (2003), four species of snakes are listed as approved species for exemption of the prohibitions listed under Section 16-20.

1. Reticulated python: *Malayopython reticulatus*
2. Burmese python: *Python bivittatus*
3. Indo-Chinese rat snake: *Ptyas korros*
4. Oriental rat snake: *Ptyas mucosus*

These four snake species are popular in the global skin and meat trade (Magnino et al. 2009; Suzuki et al. 2015). In addition to WARPA, the Thai Government issued a Cabinet Resolution on October 9, 1999, suspending all export of live snakes to protect snakes and control the rat population but the Cabinet Resolution does not cover snake products (e.g. skins), which can be exported regardless. This Cabinet Resolution also prohibits the export of all non-protected snake species, but no restrictions are placed on the import of snake species. The Supreme Court however, ruled (14/2546) that no attempt has been made to enact or revoke the resolution. Therefore, the Cabinet Resolution is technically not law, but Governmental Agencies are expected to follow the resolution.

In 1983, Thailand became a Party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). The obligations from the CITES Convention are also implemented in WARPA.

Results

In 2016, a total of 3, 207 reptiles were observed, of which 2, 660 were lizards (83%) and 547 were snakes (17%), compared with 564 reptiles in 2022, of which 371 were lizards (65.7%) and 193 were snakes (34.2%), constituting a significant reduction in total numbers of 64% ($X^2(N = 25) = 36.067, p = <0.001$). However, the differences in quantity did not differ significantly between lizards and snakes ($X^2(24, N = 25) = 20.847, p = >0.05$).

Snakes

In 2016, 547 snakes consisting of 20 species were documented for sale, comprising 485 Pythonidae (5 species) and 62 Colubridae

(15 species). In 2022, however, only 193 snakes were observed for sale, consisting of 51 species of 11 families (Table 1). In 2016, Pythonidae were the most observed snake family, but this was reduced to merely 59 Pythonidae in 2022. Colubridae (19 species) accounted for 87 of the 193 snakes observed in 2022 and were the most encountered snake family. In 2016, *Python regius* was the most frequently documented snake species with 278 documented individuals, followed by *Python bivittatus* ($n = 166$). Although the Ball Python was still the most frequently documented species in 2022, only 39 individuals were observed. Of all the species observed, only 9 species were observed during both 2016 and 2022, 11 species were only in 2016, and 42 species were only observed in 2022.

Of all the 20 species observed in 2016, 11 species were native to Thailand, of which six are protected under WARPA. In 2022, 27 native species were observed (245% increase), of which only two are protected under WARPA. Of all the 20 species observed for sale in 2016, 11 were listed on the CITES Appendices (6 in 2016, 9 in 2022), all in Appendix II. Most snake species ($n = 47$) were listed on the IUCN Red List as Least Concern, except for five species, which were listed as Vulnerable (3), or Near Threatened (2).

Lizards

In 2016, 2660 lizards (46 species) were documented for sale, consisting primarily of Iguanidae ($n = 1863$, 4 species) and Agamidae ($n = 538$, 12 species). In contrast, in 2022 only 364 lizards (26 species) were offered for sale (Table 2). Although Iguanidae remained the dominant lizard family offered for sale, only 251 lizards belonging to this family were documented. Where the diversity in snake species increased from 2 families to 11 in 2022, the number of lizard families documented for sale was relatively similar with 10 and 11 in 2016 and 2022 respectively. In both 2016 and 2022, the *Iguana iguana* was most observed with respectively 1836 and 246 animals observed. Only 14 species were observed during both 2016 and 2022 surveys, 32 species only in 2016, and 12 species were only observed in 2022.

Of all 46 lizard species observed in 2016, 14 species were native to Thailand, and of which six are protected under WARPA. In 2022, only two native lizard species were observed, both unprotected under WARPA. Of all lizard species observed during both surveys, 32 are listed on the CITES Appendices (26 in 2016, 17 in 2022), of which 2 are listed on CITES Appendix I (*Varanus nebulosus* and *Cyclura cornuta*) and the remaining species on Appendix II. Of all species offered for sale during both surveys, 54 are listed on the IUCN Red List, of which 35 were considered Least Concern, followed by Vulnerable ($n = 8$), Data Deficient ($n = 4$), Endangered ($n = 3$) and Near Threatened ($n = 3$). One species (*Iguana delicatissima*) offered for sale was considered Critically Endangered on the IUCN Red List.

Legality of observed trade

Several species (33 lizards and 11 snakes; Tables 1 and 2) observed in 2016 and 2022 are listed in CITES, but there were no CITES import records for 6 lizard species and 2 snake species. For several species, advertisements were observed in 2016, with species not being listed until 2017 (*Abronia deppii*) or 2019 (*Goniurosaurus lichtenfelderi*, *Gekko gecko*, *Ctenosaurus* sp.). Several species were observed for which the nomenclature used by CITES has not been updated yet, for example, *Heloderma alvarezii* or *Boa imperator*, which could be traded under previously recognized names, that is, *Heloderma horridum* and *Boa constrictor imperator*. Two species (*Varanus nebulosus* and *Ptyas mucosus*) listed in CITES were also native to Thailand, and thus lack of trade records does not provide a direct indication of illegal trade. It is important to note that for one

species observed, endemic to the Philippines, (*Varanus olivaceus*), there is no reasonable explanation to the lack of import records. It is likely that these specimens observed in 2016 have an illegal origin, as there are no import records into Thailand, nor has this species been exported from range state the Philippines to Thailand or other Parties.

Six lizard species were observed that are both native and protected under Thai legislation, all observations were made in 2016. No observations of native and protected lizards were made in 2022. Similar observations were made for snakes, where in 2016, five protected snake species were offered for sale, only one protected species was found in 2022.

Discussion

In contrast to my hypothesis, a significant reduction of the number of snakes and lizards was observed between 2016 and 2022. The number of snakes offered for sale on social media decreased by 64% between both study periods. However, the number of species observed more than doubled (62 vs. 128). The number of native snake species was 245% higher in 2022 compared with 2016. Such a pattern was not visible in the lizards offered for sale, where not only the quantity decreased over time, but also the number of species offered for sale.

With travel and transport restrictions in place, it can be expected that wildlife offered for sale might shift toward native species as their availability is not as much influenced by travel restrictions to the same extent as international travel. Native species might be harvested in people's gardens or nearby forests. This confirmed our hypothesis that species composition shifted during the pandemic. However, it is unclear why this pattern is not observed in lizards. Although the trade in reptiles for pets affects more species than any other form of trade (Janssen 2021), it is dominated by a small number of species which make up the bulk of the reptiles traded (Valdez 2021). These are often considered inexpensive, charismatic and relatively easy to keep (Valdez 2021). It could well be possible that this points toward different motivations of drivers fuelling the trade in lizards versus snakes. It might also reflect the availability of species in the domestic Thai market or simply a reflection of changing trends in what species are desired by consumers (Valdez 2021). Historically, demand has continuously shifted and frequently toward rarer species (Lyons and Natusch 2013; Robinson et al. 2015; Chen 2016). Travel restrictions could have reduced opportunities to obtain species from abroad, increasing desirability of domestic species or previously less desired alternatives. This could be the underlying reason as to why the number of CITES listed species reduced from 26 to 17 in lizard advertisements. Lucas (2022) reported a decrease in poaching and trafficking of wildlife for international markets due to the disruption of transport routes. This disruption also affected the legal (CITES) trade. Additionally, the decrease in CITES-listed species for lizards could reflect what species are kept by hobbyists in, and what is bred in captivity in, the Thai domestic market. For species in Thailand that are less frequently bred in captivity supply might be more reliant on import. The hypothetical link between COVID-19 and wildlife trade could have reduced demand for these species (Morcatty et al. 2021), despite reptiles not being considered host species (Lam et al. 2020).

Although Morcatty et al. (2021) did not find evidence that the online wildlife trade decreased during the pandemic, this is the case for this study. Several other studies have also reported that disease outbreaks did not stop wildlife trade (Leroy et al. 2004; Ordaz-Németh et al. 2017), although differences were observed between disease outbreaks among wild animals versus domesticated animals (Rassy and Smith 2013). Another potential

Table 1. Overview of live snakes offered for sale on social media in Thailand in 2016 and 2022.

Scientific name	Common name	IUCN	CITES	Native	Protected in Thailand	Quantity	
						2016	2022
Acrochordidae							
<i>Acrochordus javanicus</i>	Elephant trunk snake	Least Concern		Yes			5
Boidae							
<i>Boa imperator</i>	Central American boa constrictor	Least Concern	II				3
<i>Gongylophis colubrinus</i>	Kenyan sand boa	Least Concern	II				4
Colubridae							
<i>Ahaetulla prasina</i>	Gunther's whip snake	Least Concern		Yes		2	10
<i>Boiga cynodon</i>	Dog-toothed cat snake	Least Concern		Yes			5
<i>Boiga dendrophila</i>	Mangrove cat snake	Least Concern				4	
<i>Boiga dendrophila gemmicincta</i>	Sulawesi cat snake						2
<i>Boiga siamensis</i>	Gray cat snake	Least Concern		Yes		1	
<i>Chrysopelela ornata</i>	Ornate flying snake	Least Concern		Yes		3	2
<i>Coelognathus radiatus</i>	Copperhead racer	Least Concern		Yes	Yes	1	
<i>Dasyplectis gansi</i>	Gan's egg eater	Least Concern					1
<i>Dendrelaphis cyanochloris</i>	Wall's Bronzeback	Least Concern		Yes			1
<i>Dendrelaphis pictus</i>	Common Bronzeback	Least Concern		Yes		2	
<i>Dryophiops rubescens</i>		Least Concern		Yes			1
<i>Elaphe taeniura ridleyi</i>	Ridley cave racer			Yes	Yes	2	
<i>Fowlea piscator</i>	Checkered keelback	Least Concern		Yes		2	
<i>Gonyosoma oxycephalum</i>	Red-tailed racer	Least Concern		Yes	Yes	3	
<i>Heterodon nasicus</i>	Western Hognose	Least Concern					2
<i>Lampropeltis abnorma</i>		Least Concern					6
<i>Lampropeltis californiae</i>	California kingsnake	Least Concern					16
<i>Lampropeltis californiae hybrid</i>							1
<i>Lampropeltis getula</i>	Common kingsnake	Least Concern				3	3
<i>Lampropeltis leonis</i>							2
<i>Lampropeltis polyzona</i>	Atlantic Central American milksnake	Least Concern				2	
<i>Lampropeltis triangulum</i>	Eastern milksnake	Least Concern					4
<i>Lycodon laoensis</i>	Laotian wolf snake	Least Concern		Yes			1
<i>Oligodon purpurascens</i>	Purple kukri snake	Least Concern		Yes		2	
<i>Pantherophis guttatus</i>	Red cornsnake	Least Concern				26	18
<i>Pantherophis hybrid</i>							1
<i>Pantherophis obsoletus lindheimeri</i>	Texas rat snake						7
<i>Ptyas korros</i>	Javan rat snake	Near Threatened		Yes	Yes	8	4
<i>Ptyas mucosus</i>	Oriental rat snake		II	Yes	Yes	1	
Elapidae							
<i>Bungarus candidus</i>	Malayan krait	Least Concern		Yes			1
<i>Bungarus fasciatus</i>	Banded krait	Least Concern		Yes			2
<i>Bungarus flaviceps</i>	Red-headed krait	Least Concern		Yes			1
<i>Naja siamensis</i>	Indo-Chinese spitting cobra	Vulnerable	II	Yes			2
Homalopsidae							
<i>Cerberus rhynchops</i>	South Asian bockadam	Least Concern		Yes			2
<i>Enhydris enhydris</i>	Rainbow mud snake	Least Concern		Yes			1
<i>Enhydris plumbea</i>	Boie's mud snake	Least Concern		Yes			1
<i>Erpeton tentaculatum</i>		Least Concern		Yes			1
<i>Homalopsis buccata</i>	Dog-face water snake	Least Concern		Yes			2
Lamprophiidae							
<i>Boaedon fuliginosus</i>	African house snake	Least Concern					1
<i>Psammodynastes pulverulentus</i>	Common mock viper	Least Concern		Yes			3
Natricidae							
<i>Rhabdophis subminiatus</i>	Red-necked keelback	Least Concern					1
Pareidae							
<i>Pareas carinatus</i>	Keeled slug-eating snake	Least Concern		Yes			2
<i>Pareas margaritophorus</i>	White-spotted slug snake	Least Concern		Yes			1
Pythonidae							
<i>Leiopython albertisii</i>	Northern white-lipped python	Least Concern	II				1
<i>Malayopython reticulatus</i>	Reticulated python	Least Concern	II	Yes		33	9
<i>Morelia viridis</i>	Green tree python	Least Concern	II			4	2
<i>Python bivittatus</i>	Burmese python	Vulnerable	II	Yes		166	2
<i>Python brongersmai</i>	Brongersma's short-tailed python	Least Concern	II			4	
<i>Python curtus</i>	Sumatran short-tailed python	Least Concern	II	Yes			6
<i>Python regius</i>	Ball python	Near Threatened	II			278	39
Viperidae							
<i>Trimeresurus albolabris</i>	White-lipped pit viper	Least Concern		Yes			2
<i>Trimeresurus insularis</i>	Sunda Island pit viper	Least Concern					2
<i>Trimeresurus macrops</i>	Large-eyed pit viper	Least Concern		Yes			2
<i>Trimeresurus popeiorum</i>	Pope's pit viper	Least Concern		Yes			2
<i>Trimeresurus venustus</i>	Brown-spotted pit viper	Vulnerable		Yes			2
Xenopeltidae							
<i>Xenopeltis unicolor</i>	Sunbeam snake	Least Concern		Yes	Yes		4

Table 2. Overview of live lizards offered for sale on social media in Thailand in 2016 and 2022.

Scientific name	Common name	IUCN	CITES	Native	Protected in Thailand	Quantity	
						2016	2022
Agamidae							
<i>Calotes emma</i>	Emma Gray's forest lizard	Least Concern		Yes	Yes	1	
<i>Calotes mystaceus</i>	Blue crested lizard	Least Concern		Yes		2	
<i>Calotes versicolor</i>	Oriental garden lizard	Least Concern		Yes		3	
<i>Draco</i> spp.				Yes	Yes	2	
<i>Hydrosaurus amboinensis</i>	Amboina sail fin lizard	Least Concern					1
<i>Hydrosaurus weberi</i>	Weber's sail fin lizard	Vulnerable				3	3
<i>Leiolepis belliana</i>	Common butterfly lizard	Least Concern		Yes		21	
<i>Leiolepis guttata</i>	Spotted butterfly lizard	Data Deficient				12	
<i>Physignathus cocincinus</i>	Chinese water dragon	Vulnerable		Yes	Yes	16	
<i>Pogona vitticeps</i>	Central bearded dragon	Least Concern				439	23
<i>Uromastyx aegyptia</i>	Egyptian spiny-tailed lizard	Vulnerable	II			10	
<i>Uromastyx geyri</i>	Geyr's spiny-tailed lizard	Near Threatened	II			7	
<i>Uromastyx ornata</i>	Ornate spiny-tailed lizard	Least Concern	II			22	
Anguidae							
<i>Abronia deppii</i>	Deppe's arboreal alligator lizard	Endangered	II			4	
Chamaeleonidae							
<i>Chamaeleo calytratus</i>	Veiled chameleon	Least Concern	II			8	5
<i>Furcifer pardalis</i>	Panther chameleon	Least Concern	II			1	
Cordylidae							
<i>Cordylus tropidosternum</i>	East African spiny-tailed lizard	Least Concern	II				2
Corytophanidae							
<i>Basiliscus plumifrons</i>	Green basilisk	Least Concern				16	
Crotaphytidae							
<i>Crotaphytus collaris</i>	Eastern collared lizard	Least Concern					2
Diplodactylidae							
<i>Correlophus ciliatus</i>	Crested gecko	Vulnerable					1
<i>Rhacodactylus leachianus</i>	New Caledonia giant gecko	Least Concern				1	
Eublepharidae							
<i>Eublepharis macularius</i>	Leopard gecko	Least Concern				71	3
<i>Goniurosaurus lichtenfelderi</i>	Lichtenfelder's gecko	Vulnerable	II				1
<i>Hemitheconyx caudicinctus</i>	Fat-tail gecko	Least Concern				3	
Gekkonidae							
<i>Dixonius siamensis</i>	Siamese leaf-toed gecko	Least Concern		Yes		44	
<i>Gekko gekko</i>	Tokay	Least Concern	II	Yes		27	1
<i>Hemidactylus platyurus</i>	Flat-tailed house gecko	Least Concern		Yes		2	
<i>Phelsuma grandis</i>	Giant Madagascar day gecko	Least Concern	II			1	
<i>Gekko lionotum</i>	Smooth-backed flying gecko	Least Concern		Yes	Yes	1	
Helodermatidae							
<i>Heloderma alvarezi</i>	Chiapan beaded lizard	Vulnerable	II			2	
<i>Heloderma suspectum</i>	Gila monster	Near Threatened	II			7	
Iguanidae							
<i>Cachryx defensor</i>	Yucatán spiny-tailed iguana	Vulnerable	II			2	
<i>Ctenosaura pectinata</i>	Western spiny-tailed iguana	Least Concern	II			21	
<i>Ctenosaura similis</i>	Black spiny-tailed iguana	Least Concern	II				2
<i>Cyclura cornuta</i>	Rhinoceros rock iguana	Endangered	I			4	1
<i>Iguana delicatissima</i>	Lesser antillean iguana	Critically Endangered	II				2
<i>Iguana iguana</i>	Green iguana	Least Concern	II			1836	246
Phrynosomatidae							
<i>Phrynosoma asio</i>	Giant horned lizard	Least Concern				35	
Scincidae							
<i>Eutropis</i> spp.				Yes		1	
<i>Tiliqua gigas</i>	Giant bluetongue skink	Least Concern				7	8
<i>Tiliqua scincoides chimaera</i>	Tanimbar bluetongue skink						3
<i>Tribolonotus gracilis</i>	Red-eyed crocodile skink	Least Concern					23
Teiidae							
<i>Dracaena guianensis</i>	Northern caiman lizard	Least Concern	II			1	
<i>Salvator merianae</i>	Argentine black and white tegu	Least Concern	II			1	16
<i>Salvator rufescens</i>	Red tegu	Least Concern	II			1	4
Varanidae							
<i>Varanus albigularis albigularis</i>	White-throated monitor	Least Concern	II			1	
<i>Varanus beccarii</i>	Black tree monitor	Data Deficient	II				1
<i>Varanus dumerilii</i>	Dumeril's monitor	Data Deficient	II	Yes	Yes	1	
<i>Varanus exanthematicus</i>	Savannah monitor	Least Concern	II			54	4
<i>Varanus indicus</i>	Mangrove monitor	Least Concern	II			2	2
<i>Varanus melinus</i>	Quince monitor	Endangered	II			2	1
<i>Varanus nebulosus</i>	Clouded monitor	Near Threatened	I	Yes	Yes	5	
<i>Varanus olivaceus</i>	Gray's monitor	Vulnerable	II			2	
<i>Varanus prasinus</i>	Green tree monitor	Least Concern	II			1	
<i>Varanus reisingeri</i>	Reisinger's tree monitor	Data Deficient	II				2
<i>Varanus salvadorii</i>	Crocodile monitor	Least Concern	II				1
<i>Varanus salvator</i>	Water monitor	Least Concern	II	Yes		55	6

alternative explanation for the reduction in wildlife offered for sale online as during this study could be increased efforts by social media companies to reduce wildlife sales. For instance, Facebook does not allow the sale of live animals on their platforms, and actively counters this by removing groups used for this practice.

The largest Facebook group was dismantled during the study period (May 2016) after a hornbill chick was offered for sale on one of the monitored groups (Samart 2016). This led to a new growth of different groups selling wildlife, however, this time under “secret” privacy settings instead of as a closed group, which operated like a private group, except they were undiscoverable by searching, and new members could only join the group if invited by current members. Currently, Facebook now has only two categories of groups, Public and Private, with Private groups having the option of being Visible or Hidden. A similar situation occurred in 2022, where two of the monitored Facebook groups were dismantled during the survey period. Disrupting trade by removing the platforms has the potential to push the trade even more underground (Patel et al. 2015).

Algorithms are trained to detect posts that mention common terms like “for sale,” forcing advertisers to use codewords. The use of codewords is increasingly common practice in wildlife trade and has been observed in several studies (D’Cruze et al. 2018; Alfino and Roberts 2020). This was also the case for this study, where terms were used as “ready to fly,” “rehome,” and even the use of airplane emoji to signal that the animal was for sale. In addition to using code words, information provided in the advertisements is reduced to provide as little opportunity as possible for algorithms to detect the post, price was for instance only mentioned for 24 animals total in 2022. Frequent removal of social media platforms frequently merely displaces trade instead of reducing opportunities to trade (J. Janssen, pers. obs.), resulting in a game of cat and mouse between the platforms and advertisers. This could have caused or contributed to the reduced number of animals offered for sale, yet not for the increase in species and shift toward native species as observed.

Conclusion

I hypothesized that due to the closure of physical markets, online platforms should see an increased number of live animals offered for sale. Yet, I observed a significant reduction of the number of live snakes and lizards offered for sale. One could argue that transport restrictions would limit the mobility of harvesters and interrupts trade chains, and thus could explain the reduced number of animals for sale. However, the increase in native species for sale (this study) shows that the impact of this international trade disruption could shift focus from international trade to what is locally available, potentially having serious consequences on the conservation of local species. This is in line with what has been observed in other studies that observed increased poaching rates and other wildlife crime incidents (Cherkaoui et al. 2020; Koju et al. 2021).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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