



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



## COVID-19 impacts, opportunities and challenges for wildlife farms in Binh Duong and Ba Ria Vung Tau, Vietnam

Thuy Thu Pham<sup>a,\*</sup>, Hong Thi Kim Tang<sup>b</sup>, Nuong Thi Kieu Nguyen<sup>b</sup>,  
Phuong Hai Dang<sup>b</sup>, Anh Thi Van Nguyen<sup>c</sup>, Anh Thi Thuy Nguyen<sup>d</sup>,  
Hoa Ngoc My Tran<sup>a</sup>, Long Tuan Hoang<sup>a</sup>, Duyen Nhat Lam Tran<sup>e</sup>, Quang  
Nhat Nguyen<sup>b</sup>

<sup>a</sup> Center for International Forestry Research, Bogor 16115, Indonesia

<sup>b</sup> Nong Lam University, Ho Chi Minh City 700000, Viet Nam

<sup>c</sup> University of Economics and Business, Vietnam National University, Hanoi 100000, Viet Nam

<sup>d</sup> Diplomatic Academy of Vietnam, Hanoi 100000, Viet Nam

<sup>e</sup> Vietnam National University, Hanoi 100000, Viet Nam

### ARTICLE INFO

#### Keywords:

COVID-19 impacts  
Wildlife farming  
Wildlife policy  
Vietnam wildlife

### ABSTRACT

The wildlife trade is a major cause of species loss and can trigger disease transmission. While the COVID-19 pandemic sparked public interest in eliminating the wildlife trade, a better understanding is needed of the economic repercussions of COVID-19 on those who rely on wildlife farming for their livelihoods. Using the case studies of Ba Ria Vung Tau and Binh Duong provinces in Vietnam – a country seen as Asia's wildlife trade hotspot – this paper explores COVID-19's impacts on wildlife farms and their owners. Understanding these impacts is important, both in order to design appropriate interventions to support local people in mitigating COVID-19's impacts as well as to inform effective policymaking around wildlife conservation in Vietnam. In this study, we adopted mixed research methods (including a literature and policy review, stakeholder consultation with government agencies and NGOs engaged in designing and monitoring wildlife conservation policies, a wildlife farming household survey, and research validation workshop) to understand the status of Vietnamese wildlife farms, as well as the impacts of COVID-19, and any opportunities and challenges for wildlife conservation and management in Vietnam. Our paper shows that, across the two studied provinces, numbers of wildlife farms and farmed wildlife animals have both declined since the pandemic, with declining market demand and wildlife farm owners experiencing difficulties accessing markets due to travel restrictions. Although this affected wildlife-related income, this represented less than 30 % of families' overall income on average, and thus households were able to maintain their livelihoods through other sources. Most wildlife is raised as an additional food source for farming families and plays an important role in the diets of surveyed households. Findings also highlighted that most surveyed households' post-pandemic recovery strategies involved expanding their wildlife farms in scope and scale; these households perceived a stable domestic market and high prices for wildlife products in future.

\* Corresponding author.

*E-mail addresses:* [t.pham@cgiar.org](mailto:t.pham@cgiar.org) (T.T. Pham), [tangkimhong@hcmuaf.edu.vn](mailto:tangkimhong@hcmuaf.edu.vn) (H.T.K. Tang), [ntknuong@hcmuaf.edu.vn](mailto:ntknuong@hcmuaf.edu.vn) (N.T.K. Nguyen), [Danghaiphuong@hcmuaf.edu.vn](mailto:Danghaiphuong@hcmuaf.edu.vn) (P.H. Dang), [Kloudanh2002@gmail.com](mailto:Kloudanh2002@gmail.com) (A.V. Nguyen), [Chichthuyanh1012@gmail.com](mailto:Chichthuyanh1012@gmail.com) (A.T.T. Nguyen), [hoatranngocmy1408@gmail.com](mailto:hoatranngocmy1408@gmail.com) (H.N.M. Tran), [L.Hoang@cgiar.org](mailto:L.Hoang@cgiar.org) (L.T. Hoang), [trannhatlamduyen@gmail.com](mailto:trannhatlamduyen@gmail.com) (D..L. Tran), [nnquangwoodtech@gmail.com](mailto:nnquangwoodtech@gmail.com) (Q.. Nguyen).

<https://doi.org/10.1016/j.gecco.2022.e02314>

Received 20 January 2022; Received in revised form 17 September 2022; Accepted 25 October 2022

Available online 26 October 2022

2351-9894/© 2022 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Our study found several opportunities for sustainable wildlife farming practices, including greater political commitment, an increasing number of wildlife conservation policies, and stronger law enforcement mechanisms. Challenges remain, however; including an unclear and inconsistent policy framework, the presence of an illegal market, and wildlife farm owners' limited knowledge and understanding of wildlife policies. Our paper also shows a lack of comprehensive data and understanding around actual wildlife transactions during the pandemic, leading to challenges in confirming whether COVID-19 had any real impact on wildlife trade. Further research is required to address this knowledge gap.

## 1. Introduction

The wildlife trade is a major cause of species loss and is one of the main causes of disease transmission (Liew et al., 2021; Wikramanayake et al., 2021). COVID-19 has thus been seen as an alarm call, raising public and policymakers' awareness and commitment to addressing this challenge (Lin, 2021). Previous studies have found COVID-19 to have multiple and multifaceted impacts on wildlife trading and farming, both positive and negative. The pandemic has led to a decline in financial and human resources devoted to wildlife conservation in many places, posing a significant threat to animal welfare, and challenging government agencies and conservation communities alike in the post-pandemic period (Neupane, 2020; Baptista et al., 2021; Smith et al., 2021).

The COVID-19 outbreak also intensified an unsettled debate on whether governments should legalize or criminalize the commercial trade of wildlife (D'cruze et al., 2020; Bennett et al., 2021; Borzée et al., 2021). Banning wildlife trade, as China has done, can translate political will to address illegal wildlife farming and trade by strengthening existing monitoring and law enforcement mechanisms and enhancing legislation and regulation around wildlife farming practices, thereby galvanizing rapid, widespread knock-on actions and impacts (Koh et al., 2021). This is necessary to promote improvements in wildlife management, for example updating protected species lists, revising laws, strengthening existing but poorly implemented wildlife policies, and changing consumption behaviors (Yang et al., 2020; Xiao et al., 2021).

However, while conservation communities advocate for banning the wildlife trade (Lindsey et al., 2020; Roe et al., 2020), several scholars propose that policymakers and conservationists could take a policy-based approach instead, considering species-specific attributes of biological productivity as well as the management context (Shi et al., 2020; Bennett et al., 2021). This is because a ban might not fully acknowledge and address key drivers of emerging infectious diseases, such as: habitat destruction, which largely driven by agricultural expansion and industrial livestock production (Roe et al., 2020); wildlife consumption and animal-based food systems (Shi and Hu, 2008; Murray et al., 2016); international wildlife trade and crime (Bell et al., 2004); and larger trends of deforestation, defaunation, and environmental exploitation (Gatti, 2020, IPBES, 2020, van Uhm and Zaitch 2021). As COVID-19 has negatively affected local livelihoods (Rahman et al., 2021) and millions worldwide are wildlife-dependent for food security and income (Montgomery and Macdonald, 2020), there is also concern that a wildlife trade ban could undermine human rights and undermine sustainable development longer term (Roe et al., 2020). Scholars highlighting the merits of the wildlife trade, like Yang et al. (2020), Koh et al. (2021) and Xiao et al. (2021), flagged blanket ban weak spots, including how to reduce harm to wildlife farm owners, and ensure policies and measures are in place to support farmers' livelihoods. As wildlife breeding and trade are big businesses, seen by many countries as a poverty reduction tool, solutions must address both conservation and development concerns (You, 2020). Yet limited empirical evidence exists on the pandemic's economic repercussions for those depending on wildlife farming for their livelihoods (Mcnamara et al., 2020) to inform such solutions.

This paper's objective is thus to examine impacts of the COVID-19 pandemic on wildlife farms and discuss implications for future wildlife policies in Vietnam. Vietnam is an Asian wildlife trade hotspot (Nash, 2019; Dinh, 2020; Nguyen and Dinh, 2020). Reported cases, both of illegal wildlife trading and of wildlife animals being rescued, have increased sharply over the last five years (Vietnam News, 2021; Vietnam News Agency, 2021, VietNamNet Global 2021). And while the government perceives wildlife farming to contribute significantly to local livelihoods and rural development (Nguyen et al., 2007), it also acknowledges the threat illegal wildlife trading poses to degrading national biodiversity. The COVID-19 pandemic has also intensified national debate around wildlife trading, with civil society organizations pressing the government to strengthen policies as they advocate to ban wildlife farming and trading (The Guardian, 2020). On 23 July 2020, the Prime Minister of Vietnam issued Directive 29/CT-TTg, outlining urgent measures to tighten wildlife management; this included suspending wildlife imports, strengthening law enforcement, and stricter local-level monitoring of wildlife farming activities (Prime Minister of Vietnam, 2020). This regulation stirred new hope for conservation communities wishing to reduce the wildlife trade (Nguyen, 2020a), despite concerns about the potential for it to turn into an empty promise (Environmental Investigation Agency, 2020). While various media outlets report the pandemic's limited impact on slowing or reducing wildlife trading activities (Bui and Quan, 2021; Nguyen, 2021b), there is scant scientific evidence to support this; understanding these impacts is key, both to design appropriate interventions to support local people to mitigate such impacts, and to inform effective policymaking around wildlife conservation in Vietnam.

## 2. Methods

### 2.1. Site selection

We began by reviewing relevant literature to identify areas with large numbers of wildlife farms, before interviewing two central government agencies and three NGOs engaged in designing and monitoring wildlife conservation policies, to identify potential sites and knowledge gaps. From this we identified four potential research sites in the provinces of Thanh Pho Ho Chi Minh, Binh Duong, Ba Ria Vung Tau and Dong Nai. Over 70 % of Vietnamese wildlife farms are in the Southern region (Vietnam News, 2020), and these four provinces see large numbers of wildlife farming activities (Dard, 2007; Nguyen, 2010; Luong, 2018, Pannature, 2020, Le, 2021, Nguyen, 2021a, Sang, 2021). The research team then visited these four provinces to validate reported data, consult stakeholders and obtain research approval. Based on this, the research team chose Binh Duong and Ba Ria Vung Tau as the locations for the study sites. This was partly due to research approval by local government offices. As such, future research in the remaining two provinces would provide a more comprehensive regional overview and ensure site selection has not impacted results; for example, governmental willingness to participate may reflect differing local perspectives, compared with those of locations more reticent to be surveyed.

### 2.2. Data collection

We reviewed national and provincial policies on wildlife management, as well as reports by government, donor, international NGO and academic bodies, on the impacts of the COVID-19 pandemic and implications for implementing wildlife management policies.

We then interviewed 11 government officers in Binh Duong and 12 government officers in Ba Ria Vung Tau engaged in wildlife policy design and implementation. These interviews aimed to understand the status of Vietnamese wildlife farms, the impacts of COVID-19, and any opportunities and challenges for wildlife conservation and management in these two provinces. These interviews were transcribed and analyzed using a thematic coding approach.

We then conducted a household survey of 92 wildlife farm owners in Ba Ria Vung Tau and Binh Duong provinces to understand local people's perceptions on current policies concerning wildlife conservation and management, as well as COVID-19 impacts (Table 1). These households were randomly selected from the list of total households engaged in wildlife farming activities, as provided by the provincial authorities.

## 3. Results

### 3.1. Overview of wildlife farms in Binh Duong and Ba Ria Vung Tau provinces

#### 3.1.1. Binh Duong province

Most wildlife farms in this province function for food and economic purposes, operating at household scale with less than five species per farm, and less than 10 animals in total (Binh Duong government agencies interviewed, and Table 2).

The most commonly-raised species (i.e., more than 500 animals) in Binh Duong are *Trionyx sinensis* (ba ba tròn), *Crocodylus siamensis* (cá sấu nước ngọt), *Python molurus bivittatus* (trăn đất), *Hystrix brachyura* (nhím) and *Ptyas mucosus* (rắn ráo trâu). Farmed numbers of all these animals declined significantly between 2016 and 2020 (Fig. 1 and Fig. 2).

#### 3.1.2. Ba Ria Vung Tau province

In this province, the most common species raised for economic purposes are *Crocodylus siamensis* (cá sấu nước ngọt), *Rhizomys pruinosus* (dúi), *Hystrix brachyura* (nhím), *Paradoxurus hermaphroditus* (cầy vòi hương), *Ptyas Mucosus* (Rắn ráo trâu), *Naja trou* (rắn hổ mang thường), *Cervus unicolor* (nai) and *Phasianus colchicus* (Trĩ đỏ khoang cổ) (Table 3). Overall, this province has 32 farms with 1681 individuals of more commonly-found forest animals listed in Table 3.

Many farmed species are raised for multiple purposes; however, most are raised for meat, breeding and tourism purposes. Provincial government officers reported that wildlife trade here targets both domestic and Chinese markets; their belief was that the decline in farm numbers was due to declining demand, mostly from China. Illegal wildlife trading activities and weak compliance with legislation are still widely reported in the province, however (ThienNhiem.Net 2020, Phuc, 2021); this could point to another possibility – that wildlife farming has gone underground since the pandemic linked its origins with wildlife trade.

**Table 1**  
Number of wildlife farms in Binh Duong and Ba Ria Vung Tau provinces in 2021.

Province	Total number of wildlife farm owners in the province	Number of households taking part in the study
Binh Duong	90	42 (46.7 %)
Ba Ria Vung Tau	97	50 (51.5 %)
Total	187	92 (49.2 %)

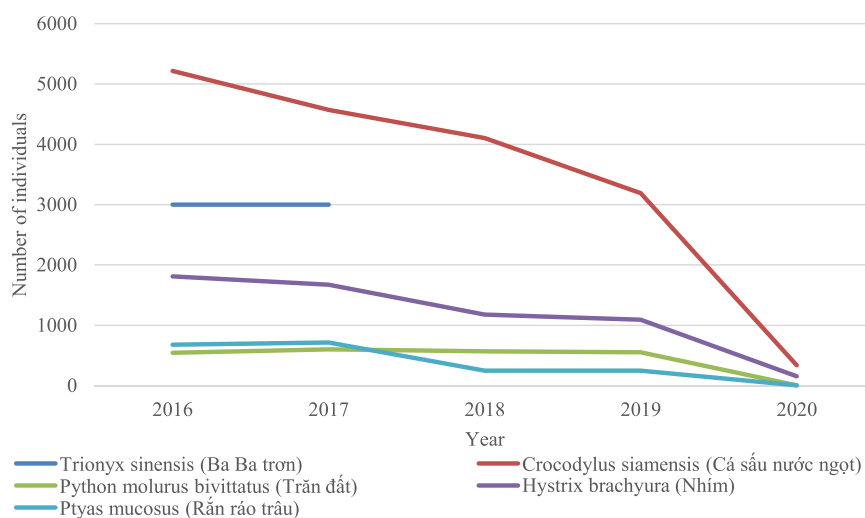
Source: Binh Duong Forest Protection Department (2020) and Ba Ria Vung Tau Forest Protection Department (2021).

**Table 2**

Purpose of wildlife farms in Binh Duong province (Unit: Number and % of individual animals).

Species	Selling animals for meat	Selling animals for breeding	Keeping animals for tourism	Selling processed wildlife products	Other (e.g., food for family, pets)
<i>Rusa/Cervus unicolor</i> (Nai)	20 (57 %)	21 (60 %)	15 (43 %)	4 (12 %)	14 (40 %)
<i>Hystrix brachyura</i> (Nhím)	318 (100 %)	288 (91 %)	4 (1.3 %)	50 (16 %)	52 (16 %)
<i>Crocodylus siamensis</i> (Cá sấu nước ngọt)	311 (56 %)	11 (2 %)	n/a	311 (56 %)	240 (43 %)
<i>Paradoxurus hermaphroditus</i> (Cây vòi hương)	65 (94 %)	55 (80 %)	n/a	41 (59 %)	2 (3 %)
<i>Ptyas mucosus</i> (Rắn ráo trâu)	165 (100 %)	n/a	n/a	165 (100 %)	n/a
<i>Tragulus javanicus</i> (Cheo)	n/a	n/a	n/a	n/a	14 (100 %)
<i>Pavo cristatus</i> (Công Ấn Độ)	n/a	8 (73 %)	2 (18 %)	8 (73 %)	1 (9 %)
<i>Ursus thibetanus</i> (Gấu ngựa)	n/a	n/a	n/a	10 (91 %)	3 (27 %)
<i>Cervus nippon</i> (Hươu sao)	5 (19 %)	5 (19 %)	n/a	5 (19 %)	21 (81 %)
<i>Giraffa camelopardalis</i> (Hươu)	68 (96 %)	71 (100 %)	71 (100 %)	n/a	n/a
<i>Pavo muticus</i> (Công)	n/a	1 (14 %)	2 (29 %)	1 (14 %)	4 (57 %)
<i>Rhizomys pruinosus</i> (Dúi mốc lớn)	57 (74 %)	77 (100 %)	n/a	n/a	n/a
<i>Python molurus bivittatus</i> (Trăn đất)	20 (27 %)	n/a	n/a	75 (100 %)	55 (73 %)
<i>Amyda cartilaginea</i> (Ba be Nam Bộ)	88 (100 %)	88 (100 %)	n/a	n/a	n/a
<i>Phasianus colchicus</i> (Trĩ đỏ khoang cổ)	12 (100 %)	12 (100 %)	n/a	n/a	n/a

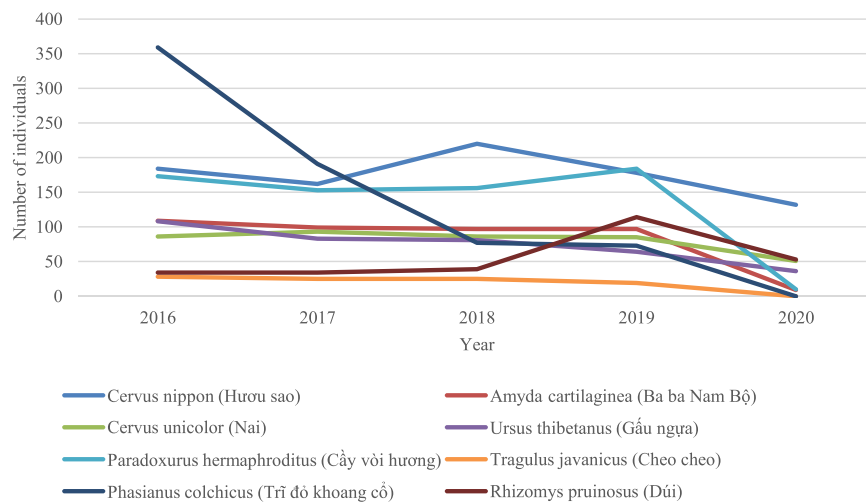
Source: Surveyed households in Binh Duong province.

**Fig. 1.** Number of common species (i.e., more than 500 individuals) animals in Binh Duong province.

Source: Binh Duong Forest Protection Department (2020).

### 3.1.3. Weak monitoring and evaluation of wildlife farms

While most wildlife farms surveyed in Ba Ria Vung Tau were formally registered (94 %), this figure was just 17 % in Binh Duong. Government officers and households gave two reasons for this: (i) provinces were changing to a new registration system, and previously-registered farms now required licenses and registration numbers to be reissued for IIB group species under Decree 06/2019; and (ii) many wildlife farmers refused to renew their registration as they did not understand why they were suddenly illegal. Provincial



**Fig. 2.** Number of uncommon species (i.e., less than 500 individuals) animals in Binh Duong province.  
Source: Binh Duong Forest Protection Department (2020).

**Table 3**

Purpose of wildlife farms in Ba Ria Vung Tau province (Unit: Number and % of individual animals).

Species	Selling animals for meat	Selling animals for breeding	Keeping animals for tourism	Selling processed wildlife products
<i>Crocodylus siamensis</i> (Cá Sấu nước ngọt)	3143 (100 %)	3143 (100 %)	686 (22 %)	686 (48 %)
<i>Paradoxurus</i> (Cây vòi hương)	318 (100 %)	314 (98 %)	n/a	n/a
<i>Pavo cristatus</i> (Cồng Ấn Độ)	4 (100 %)	4 (100 %)	4 (100 %)	4 (100 %)
<i>Tragulus javanicus</i> (Cheo Cheo)	27 (100 %)	27 (100 %)	n/a	n/a
<i>Phasianus colchicus</i> (Chim trĩ đỏ)	92 (100 %)	92 (100 %)	92 (100 %)	92 (100 %)
<i>Rhizomys pruinosus</i> (Dúi)	946 (100 %)	938 (99 %)	n/a	n/a
<i>Sus scrofa x Sus scrofa domesticus</i> (Heo rừng lai)	62 (46 %)	62 (46 %)	n/a	135 (100 %)
<i>Naja nana</i> (Hồ mang thường)	65 (100 %)	60 (92 %)	n/a	n/a
<i>Varanus bengalensis</i> (Kỳ đà vàng)	1 (100 %)	1 (100 %)	n/a	n/a
<i>Rusa/Cervus unicolor</i> (Nai)	38 (69 %)	38 (69 %)	20 (36 %)	55 (100 %)
<i>Hystrix brachyura</i> (Nhím)	219 (100 %)	214 (98 %)	n/a	n/a
<i>Ptyas Mucous</i> (Rắn ráo trâu)	526 (100 %)	513 (98 %)	n/a	n/a

Source: Surveyed households in Ba Ria Vung Tau province.

government actors also shared challenges in monitoring unlicensed farms, highlighting households' difficulties completing government-required forms. Although 50 % of households in Binh Duong and 96 % in Ba Ria Vung Tau said they were aware of government policies, for example, that they required certificates and licenses from forest rangers to sell wildlife commercially, they had limited understanding of what paperwork they needed to submit to rangers. Just 14 % of households interviewed in each province understood the need to submit records of wildlife origins and proof of human/animal safety standards to obtain their certificates.

In Ba Ria Vung Tau, government officers undertake two annual inspections, mostly focused on rare and endangered species. Government agencies in both provinces highlighted challenges identifying the origins of wildlife specimens, due to poor household recordkeeping and previously-unregulated policies. Weak monitoring and law enforcement, as Ba Ria Vung Tau government officers explained, are also due to insufficient funding for biodiversity assessments and studies, coupled with an outdated database on species and their preferred habitats, both in natural and farmed conditions.

### 3.2. How the COVID-19 pandemic impacted wildlife farms

#### 3.2.1. Few wildlife farms affected by the pandemic

Just 12 % of households interviewed in Ba Ria Vung Tau and 40 % in Binh Duong claimed their businesses had been negatively impacted by the pandemic. Those who were explained it was because the pandemic meant they were unable to sell their products, as markets closed (25 %), tourists were unable to visit their facilities (25 %), restaurants could not open due to lockdowns (50 %) and there had been increased costs for hiring laborers (75 %), without profit being generated. Households in both provinces shared that many brokers had forced small-scale farms to sell them their wildlife at low cost, so they could make more profit post-pandemic. Lockdowns and stricter wildlife conservation policies meant households were unable to sell wildlife products overseas and to other provinces, so they resorted to trading illegally within their provinces without informing government officers.

However, the majority of households across both provinces (60 % in Binh Duong and 88 % in Ba Ria Vung Tau) claimed the pandemic had a minor impact on them as wildlife farming was not their primary income source (less than 30 % of the household budget); their main income sources were other businesses, like hostel services and restaurants (Fig. 3). These households highlighted that the scale at which they operated was relatively small (less than 10 individual animals), and they mostly supplied domestic, rather than international markets.

The number of surveyed households claiming to be affected in Ba Ria Vung Tau was much less than in Binh Duong province (12 % compared with 40 %). This was for three reasons. First, some survey respondents in Ba Ria Vung Tau had moved to online sales through social media platforms like Zalo and Facebook, meaning they were not seriously affected by COVID-19 lockdowns. Second, as Binh Duong was a COVID-19 hotspot in the South (Phuoc, 2021) its lockdown was longer than that of Ba Ria Vung Tau (Hoang, 2021). Third, most Ba Ria Vung Tau wildlife farmers targeting domestic markets also had restaurants, so they could continue selling meat products during the pandemic; in contrast Binh Duong farm owners rely on selling to other provinces, notably Ho Chi Minh City, which was another COVID-19 hotspot with a lengthy lockdown period.

#### 3.2.2. Slight decline in wildlife farms and farm-raised wildlife animals

Differing from Binh Duong, which has robust recordkeeping of wildlife farms over time, Ba Ria Vung Tau province lacks systematic monitoring and evaluation to show the progressive status of wildlife farms over time. However, available data shows that the number of wildlife farms and the number of species on these farms has slightly reduced in both provinces since COVID-19, with a reduction of more than 55 % in the total number of farm-raised wildlife animals in Ba Ria Vung Tau (Table 4).

While acknowledging the pandemic’s partial contribution to the decline in wildlife farms, both central and provincial government interviewees highlighted that this decline was also partly due to the accumulative impacts of a declining Chinese market (which began long before the pandemic), as well as stricter policies and law enforcement around wildlife trading and farm expansion. Although Binh Duong government officers shared that farm owners were no longer informing officials of their wildlife sales since the pandemic, they also acknowledged insufficient data on wildlife trade transactions to confirm their hypothesis. A Ba Ria Vung Tau government officer also added that weak law enforcement around illegal wildlife trade provided little disincentive to prevent local people from committing crimes.

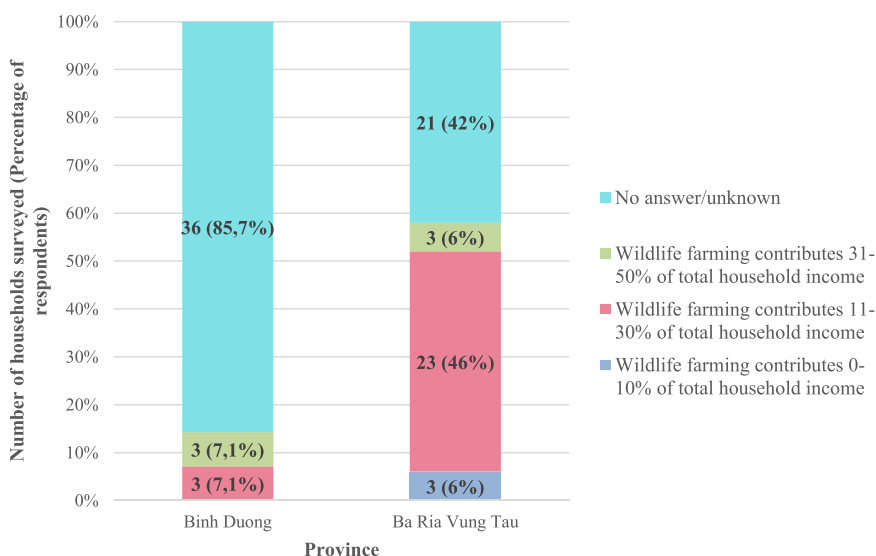


Fig. 3. Contribution of wildlife farming to total household income ( % of respondents). Source: Surveyed households in Ba Ria Vung Tau province and Binh Duong province.



**Table 4**  
Status of wildlife farms between 2016 and 2020.

Year	Total number of farms per province		Total number of species per province		Total number of individual animals per province	
	Binh Duong	Ba Ria Vung Tau	Binh Duong	Ba Ria Vung Tau	Binh Duong	Ba Ria Vung Tau
<b>Before COVID-19</b>						
2016	179	300	79	n/a	15,189	n/a
2017	150	n/a	87	n/a	12,608	n/a
2018	116	113	86	n/a	8072	n/a
<b>After COVID-19</b>						
2019	104	97	84	n/a	7759	8253
2020	90	40	81	12	6110	4830

Source: Ba Ria Vung Tau Forest Protection Department (2021) and Binh Duong Forest Protection Department (2021)

### 3.3. Opportunities, challenges and post-pandemic strategies for wildlife farmers in Vietnam

#### 3.3.1. Opportunities

Reflecting the evolving political context, government agencies in both provinces acknowledged increasing political attention on wildlife issues. This presents opportunities for provincial government agencies to obtain more central government funding for law enforcement and more international funding to provide technical support around monitoring and capacity building so wildlife farm owners can carry out their farming practices sustainably.

Ba Ria Vung Tau government officers highlighted other opportunities, for example that many involved in wildlife farming activities had extensive knowledge of how to treat diseases and increase the successful breeding of rare and endangered species; knowledge that forest rangers did not have. This could be beneficial in terms of increasing the population of certain rare and endangered species. Interviewed government officers in both provinces also flagged an increasing interest in the opening of eco-resorts, in which companies had large-scale safari areas to raise wildlife, veterinary staff, and operational staff trained in wildlife conservation. Most wildlife farm owners surveyed in Binh Duong and Ba Ria Vung Tau provinces believed this was easy to do, and that it remained easy to sell wildlife because there was stable market demand.

#### 3.3.2. Wildlife farmers' post-pandemic strategies

We applied the Chi-square test of independence to test for significant differences in responses, for example perceptions around future opportunities for wildlife farming and trade, and wildlife farm owners' post-pandemic strategies.

Wildlife farm owners' decisions regarding their future in wildlife farming are based on their perceptions of post-pandemic opportunities for the wildlife trade (Table 5). Statistically significant differences were noted between Binh Duong and Ba Ria Vung Tau when looking at households' perceptions around future opportunities. In Binh Duong, stakeholders anticipated opportunities for future wildlife farming and trade would include government support to increase the sustainability of wildlife farm practices, and further guidelines and support for wildlife farm owners. Meanwhile, the majority of Ba Ria Vung Tau respondents felt the most significant opportunities were the potential of having sustainable, high income from wildlife farming, and the fact that wildlife farms are already legalized in Vietnam.

These differing responses can be explained by various factors. Most surveyed households in Binh Duong are small-scale operators reliant on government support for technical training and guidance; this has increased over time due to stronger wildlife management policies. Their perceptions of future opportunities are duly influenced by this government support. In contrast, Ba Ria Vung Tau households operate at a larger scale, targeting both domestic and oversea markets; their perceptions of opportunities therefore relate to market opportunities and income potential. According to most stakeholders interviewed, the fact that commercial wildlife farms are legalized provides households with the confidence to invest.

**Table 5**  
Wildlife farming households' perceptions around future opportunities for wildlife farming and trade by province.

Wildlife farming households' perceptions	Binh Duong (% of respondents replying 'yes')	Ba Ria Vung Tau (% of respondents replying 'yes')	Pearson $\chi^2$
Wildlife farmers will receive support from government agencies	9.52 %	0.00 %	4.98**
It will be easy to farm wildlife	33.33 %	52.00 %	3.24*
Wildlife farmers will receive guidance on raising animals	21.43 %	0.00 %	11.88***
Income will be stable	7.14 %	40.00 %	13.14***
There will be high numbers of tourists and restaurant customers	0.00 %	6.00 %	2.60
Farmed wildlife will have high economic value and can be exported	0.00 %	46.00 %	25.76***
There will be future market price increases	0.00 %	4.00 %	1.72
Wildlife farming will remain legal	2.38 %	54.00 %	28.73***
Wildlife farming will provide more food	0.00 %	8.00 %	3.51*

Note: \*, \*\*, and \*\*\* indicate a statistical significance of 10 %, 5 % and 1 %, respectively. No. of respondents: Binh Duong = 42 and Ba Ria Vung Tau = 50. Source: Households surveyed in Binh Duong and Ba Ria Vung Tau provinces



The study also found both similarities and differences between the two provinces in terms of wildlife farm owners' post-pandemic strategies (Table 6). Based on their perceptions, the majority of wildlife farmers in Binh Duong intended to scale down (33.33 %) or maintain their existing farms (21.43 %), while farm owners in Ba Ria Vung Tau were more likely to expand (32.00 %) or maintain their existing farms (52 %); just a few planned to scale down (4.00 %) following the COVID-19 pandemic. Rather than expanding individual numbers of specific species, however, these households planned to increase the overall number of animals raised.

The difference here could be explained by several factors. As wildlife farming households in Binh Duong operate at a smaller scale, most have limited capital to invest in large-scale farming. The pandemic's impact on household income has thus led several households to have weaker capacity and interest in maintaining and expanding their operations. In contrast, many Ba Ria Vung Tau households were able to continue sales of wildlife products in the domestic market, and few were affected by the COVID-19 pandemic; expansion is thus seen as strategy to overcome any setbacks experienced due to the pandemic and improve future income.

### 3.3.3. Challenges

Despite this optimism, both households and government agencies highlighted numerous challenges for current and future wildlife farming practices in Vietnam. In both provinces, 98 % of households were unaware of human and animal diseases associated with farming wildlife animals. An overwhelming majority of Ba Ria Vung Tau households (46 households – 92 %) highlighted their insufficient veterinary knowledge, and 48 households (96 % of households surveyed) in Ba Ria Vung Tau admitted that their knowledge around environmental standards was insufficient to meet national requirements. Surveyed households shared that such knowledge was determined by their access to government programs, ranger support, and social networks among wildlife farmers, all of which varied significantly. In Binh Duong, 27 households (64.3 %) said government agencies proactively guided and supervised wildlife farming activities; this figure was just 4 households (8 %) in Ba Ria Vung Tau. A small number of households surveyed (8 households (16 %) in Ba Ria Vung Tau and 4 households (10 %) in Binh Duong) highlighted the risk of uncertain markets and prices for wildlife products, while others flagged more competition, caused by increasing numbers of new wildlife farms, as a challenge.

## 4. Discussion

The Government of Vietnam argues that captive breeding and artificial propagation contribute to local income and employment (Nguyen et al., 2007). Wildlife farming continues to prove an economically attractive option for households in our studied sites, with new farms being established even after the COVID-19 pandemic. While previous studies show COVID-19 lockdowns affected the incomes of similar wildlife businesses elsewhere in the world (Mcginlay et al., 2020, Abeli Shoo et al., 2021, Cahyadi and Newsome, 2021, Rahman et al., 2021, Spenceley et al., 2021), in Vietnam just a few surveyed wildlife farms believed COVID-19 had seriously affected their businesses; wildlife-related income contributing less than 30 % to most households' income in Ba Ria Vung Tau and Binh Duong provinces. This minor impact has several implications for future wildlife conservation policies.

First, our paper supports previous studies, which highlight that effective wildlife conservation policies and projects need to prioritize the diversification of livelihood options (Cherkaoui et al., 2020; Abeli Shoo et al., 2021; Mcelwee et al., 2020) to reduce financial dependence on wildlife farming. Second, our paper flags a significant data gap when it comes to legal and illegal operations. The current monitoring and evaluation system relies on reported numbers of registered wildlife farms. However, this monitoring indicator does not give a comprehensive understanding of the scope and scale of operations. A reduced number of farms does not necessarily indicate less wildlife farming; such a decline could mean a local shift from offline to online markets, as our study found, or that wildlife farming has become more secretive since the pandemic. This would explain the increasing number of reported violations around illegal trade in Binh Duong province (Dinh, 2019; Le, 2019), and flags the further challenges policymakers now face in monitoring the wildlife trade. When animals are bred for human consumption and local people want to expand the scale of this enterprise, this raises a flag of alarm for biodiversity conservation.

Stakeholders' concerns around the government's limited ability to oversee and monitor wildlife farms have led to some conservationists advocating for a wildlife trade ban in Vietnam (Nguyen, 2020b). However, both the banning and sustainable management of wildlife trading remain controversial (Bennett et al., 2021). A ban could reduce the risk of emerging infectious diseases (Aguirre et al., 2020), and prevent the biodiversity destruction that results from wildlife farms 'laundering' wild animals to sell onto other farms (Brooks et al., 2010). On the other hand, the fact that some households raise wildlife for food and felt wildlife farming was their best plan post-pandemic highlights that a blanket ban could both be logistically challenging to implement, and negatively impact development and human rights (Roe et al., 2020). With farmers determined to expand and maintain their farms to respond to continued demand, our paper shows that addressing the wildlife trade nationally depends on a major shift in global wildlife consumption patterns (Li et al., 2021).

Several studies emphasize that policymakers will need to adopt a participatory approach to decision making, to ensure that future use and trade of wildlife is safe, environmentally sustainable and socially equitable (Booth et al., 2021, 2021). Our paper reveals a critical concern around wildlife farming – farmers' lack of knowledge and awareness around veterinary requirements, animal health and human safety. Households surveyed in both provinces are currently raising diverse species in their farms, with weak understanding around human and animal health implications. Further research is needed to understand how species differences in terms of legality and welfare might impact human health, local incomes and people's responses to government policies.

Our study showed domestic restaurants are a key market for many Vietnamese wildlife farm owners, yet there remains limited understanding around consumer segmentation, with a corresponding lack of appropriate behavioral interventions (Olmedo et al., 2021). Previous studies meanwhile show an influx of coronaviruses from the wildlife supply chain into Vietnamese restaurants, suggesting risk for end-consumers, since this likely underpins zoonotic spillover to people (Huong et al., 2020). This further

**Table 6**  
Wildlife farm owners' post-pandemic strategies by province.

Wildlife farm owners' post-pandemic strategies	Binh Duong (% of respondents replying 'yes')	Ba Ria Vung Tau (% of respondents replying 'yes')	Pearson $\chi^2$
Farm expansion	0.00 %	32.00 %	16.27***
Scaling down operations	33.33 %	4.00 %	13.67***
Maintaining existing operations	21.43 %	52.00 %	9.05***

Note: \* \*\* indicates a statistical significance at a level of 1 %. No. of respondents: Binh Duong = 42 and Ba Ria Vung Tau = 50. Source: Households surveyed in Binh Duong and Ba Ria Vung Tau provinces

emphasizes the need to increase local access to veterinary services and knowledge on veterinary standards (Gortázar and de la Fuente 2020). There are limited studies and analysis to uncover these risks, however, nor policies in place to address them. As well as strengthening policies and law enforcement, government agencies must also conduct awareness campaigns and undertake appropriate policy interventions so as to reduce consumer demand for wildlife products domestically. Rigorous research and impact evaluation on the effectiveness of these campaigns is equally essential (Nuno et al., 2018; Verissimo and Wan, 2019; Thomas-Walters et al., 2021). For government agencies focused on public health and wildlife, it is critically important to assess diverse wildlife trade situations for the risk of potentially serious zoonotic diseases, so as to inform policy design and ensure appropriate policy interventions (Wikramanayake et al., 2021).

## 5. Conclusion

This paper examined the various impacts of the COVID-19 pandemic on Vietnamese wildlife farms, as well as wildlife farm owners' strategies in response to the pandemic. Our findings show that although COVID-19 did affect local incomes, the extent of this impact depended on how diversified household income streams were, the scale of farming operations, and whether farm owners were able to adapt their business models (for example, by moving from offline to online trade). Our paper also highlights some key challenges for implementing a wildlife trade ban, particularly when most wildlife farmers intend to maintain or expand their wildlife farms post-pandemic. As many farmers raise wildlife for family food, any future ban would also affect their dietary requirements. A particular challenge for wildlife management in Vietnam is weak understanding among wildlife farmers around wildlife policies, human-animal health risks, and how to implement environmental safeguards and human health measures so as to prevent risks. Addressing these challenges requires policy commitment, as well as participatory decision-making processes and capacity building among wildlife farm owners. Future research is also needed to document both the longer-term impacts of the pandemic on Vietnamese wildlife farms, and how government and farm owners respond to COVID-19 and wildlife conservation policies, so as to inform appropriate policy interventions.

## Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Pham Thu Thuy reports financial support was provided by CGIAR-COVID-19 Hub. Pham Thu Thuy reports financial support was provided by United States Agency for International Development (USAID). Pham Thu Thuy reports financial support was provided by CGIAR Research Program on Forests, Trees and Agroforestry (FTA). Pham Thu Thuy reports was provided by CGIAR Research Program on Forests, Trees and Agroforestry (FTA).

## Data Availability

The data that has been used is confidential.

## Acknowledgements

We would like to thank the CGIAR-COVID-19 Hub, the United States Agency for International Development (USAID), the CGIAR Research Program on Forests, Trees and Agroforestry (FTA) and the Norwegian Agency for Development Cooperation (NORAD) (grant number QZA-21/0124) for supporting this study.

## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at [doi:10.1016/j.gecco.2022.e02314](https://doi.org/10.1016/j.gecco.2022.e02314).

## References

- Abeli Shoo, R., Kamili Mtui, E., Modest Kimaro, J., Robert Kinabo, N., Joseph Lendii, G., Kideghesho, J., 2021. Wildlife management areas in Tanzania: Vulnerability and survival amidst COVID-19. In: KIDEGHESHO, J. (Ed.), *Managing Wildlife in A Changing World*. IntechOpen. <https://doi.org/10.5772/intechopen.97396>.
- Aguirre, A.A., Catherina, R., Frye, H., Shelley, L., 2020. Illicit wildlife trade, wet markets, and COVID-19: preventing future pandemics. *World Med. Health Policy* 12 (3), 256–265. <https://doi.org/10.1002/wmh3.348>.
- Ba Ria Vung Tau Forest Protection Department, 2021. *Official letter No 349/CKKL-TTPC on 25 May 2021 from BRVT FPD to DARD of BRVT. Ba Ria Vung Tau Forest Protection Department, Ba Ria Vung Tau, Vietnam*.
- Baptista, J., Blache, D., Cox-Witton, K., Craddock, N., Dalziel, T., Graaff, D.E., Fernandes, N., Green, J., Jenkins, R., Kahn, H., Kelly, S., Lauber, D., Maloney, M., Peachey, S.K., Rodger, B., Skuse, I., Tilbrook, J., Walker, A.J., Wall, F.R., Zito, S. K., 2021. Impact of the COVID-19 pandemic on the welfare of animals in Australia. *Front. Vet. Sci.* 7, 1219. <https://doi.org/10.3389/fvets.2020.621843>.
- Bell, D., Robertson, S., Hunter, P.R., 2004. Animal origins of SARS coronavirus: possible links with the international trade in small carnivores. *Philos. Trans. R. Soc. Lond. Ser. B: Biol. Sci.* 359 (1447), 1107–1114. <https://doi.org/10.1098/rstb.2004.1492>.
- Bennett, E.L., Underwood, F.M., Milner-Gulland, E.J., 2021. To trade or not to trade? Using Bayesian belief networks to assess how to manage commercial wildlife trade in a complex world. *Front. Ecol. Evol.* 9, 123. <https://doi.org/10.3389/fevo.2021.587896>.
- Binh Duong Forest Protection Department, 2020. *Annual report 2016-2020 on the management of raising, planting and exploiting endangered, precious and rare wild fauna and flora and fauna and flora belong to CITES's appendix and common wildlife 2016-2020. Binh Duong Forest Protection Department, Binh Duong, Vietnam*.
- Binh Duong Forest Protection Department, 2021. *Annual report on wildlife violation, Binh Duong, Vietnam*.
- Booth, H., Arias, M., Brittain, S., Challender, D.W.S., Khanyari, M., Kuiper, T., Li, Y., Olmedo, A., Oyanedel, R., Pienkowski, T., Milner-Gulland, E.J., 2021. Saving lives, protecting livelihoods, and safeguarding nature: risk-based wildlife trade policy for sustainable development outcomes post-COVID-19. *Front. Ecol. Evol.* 9, 99. <https://doi.org/10.3389/fevo.2021.639216>.
- Borzée, A., Kielgast, J., Wren, A., Angulo, A., Chen, S., Magellan, K., Messenger, K.R., Hansen Hendrikx, C.M., Baker, A., Dos Santos, M.M., Kusriani, M., Jiang, J., Malsova, I.R., Das, I., Park, D., Bickford, D., Murphy, R.W., Che, J., Do, T.V., Nguyen, T.Q., Chuang, M.F., Bishop, P.J., 2021. Using the 2020 global pandemic as a springboard to highlight the need for amphibian conservation in Eastern Asia. *Biol. Conserv.* 225, 108973. <https://doi.org/10.1016/j.biocon.2021.108973>.
- Brooks, E.G., Robertson, S.I., Bell, D.J., 2010. The conservation impact of commercial wildlife farming of porcupines in Vietnam. *Biol. Conserv.* 143 (11), 2808–2814. <https://doi.org/10.1016/j.biocon.2010.07.030>.
- Bui, T., Quan, L., 2021. Vietnam's wildlife traffickers in the age of COVID-19. *Earth Journal*. (<https://earthjournalism.net/node/5361>) (Accessed 8.22.21).
- Cahyadi, H.S., Newsome, D., 2021. The post COVID-19 tourism dilemma for geoparks in Indonesia. *Int. J. Geoheritage Parks* 9 (2), 199–211. <https://doi.org/10.1016/j.ijgeop.2021.02.003>.
- Cherkaoui, S.I., Boukherout, M., Lakhali, T., Aghzar, A., El Youssfi, L., 2020. Conservation amid COVID-19 pandemic: Ecotourism collapse threatens communities and wildlife in Morocco. *E3S Web Conf*, 183, p. 01003. <https://doi.org/10.1051/e3sconf/202018301003>.
- D'cruze, N., Green, J., Elwin, A., Schmidt-Burbach, J., 2020. Trading tactics: time to rethink the global trade in wildlife. *Animals* 10 (12), 2456. <https://doi.org/10.3390/ani10122456>.
- Dard] DEPARTMENT OF AGRICULTURE AND RURAL DEVELOPMENT, 2007. *Situation of management of wild animals and plants in Ho Chi Minh City*. (<http://www.songsonghiep.hochiminhcity.gov.vn/tintuc/Lists/Posts/Post.aspx?List=f73cebc3%2D9669%2D400e%2Db5fd%2D9e63a89949f0&ID=1755>) (Accessed 8.22.21).
- Dinh, H., 2020. Vietnam bans wildlife imports, markets amid new health fears. *Washington Post*. ([https://www.washingtonpost.com/world/asia\\_pacific/vietnam-bans-wildlife-imports-markets-amid-new-health-fears/2020/07/25/0d4c28dc-ce2d-11ea-99b0-8426e26d203b\\_story.html](https://www.washingtonpost.com/world/asia_pacific/vietnam-bans-wildlife-imports-markets-amid-new-health-fears/2020/07/25/0d4c28dc-ce2d-11ea-99b0-8426e26d203b_story.html)) (Accessed 8.22.21).
- Dinh, T., 2019. Review of some cases of captive tigers attacking people in Binh Duong. *Lao dong tre*. (<https://laodongtre.laodong.vn/doi-song/diem-lai-mot-so-vu-ho-nuoi-nhot-tan-cong-nguoi-o-binh-duong-737483.ldo>) (Accessed 8.22.21).
- Environmental Investigation Agency, 2020. *Vietnam's new wildlife trade crackdown is a positive step but must not be another empty promise*. (<https://eia-international.org/news/vietnams-new-wildlife-trade-crackdown-is-a-positive-step-but-must-not-be-another-empty-promise/>) (Accessed 8.22.21).
- Gatti, R.C., 2020. The pangolin's revenge: SARS-CoV-2 did not emerge from a lab but from wildlife exploitation. *GAIA-Ecol. Perspect. Sci. Soc.* 29 (2), 79–82. <https://doi.org/10.14512/gaia.29.2.3>.
- Gortazar, C., De La Fuente, J., 2020. COVID-19 is likely to impact animal health. *Prev. Vet. Med.* 180, 105030. <https://doi.org/10.1016/j.pvetmed.2020.105030>.
- Hoang, M., 2021. More cases of COVID-19 in the community: Ba Ria-Vung Tau is proactive in all situations. *Online newspaper Communist Party of Vietnam*. (<https://dangcongsan.vn/xa-hoi/them-nhieuc-ca-mac-covid-19-ngoai-cong-dong-ba-ria-vung-tau-chu-dong-voi-moi-tinh-huoc-595627.html>) (Accessed 4.14.22).
- Huong, N.Q., Nga, N.T.T., Van Long, N., Luu, B.D., Latinne, A., Pruvot, M., Phuong, N.T., Quang, L.T.V., Van Hung, V., Lan, N.T., Hoa, N.T., Minh, P.Q., Diep, N.T., Tung, N., Ky, V.D., Robertson, S.I., Thuy, H.B., Van Long, N., Gilbert, M., Wicker, L., Mazel, J.A.K., Johnson, C.K., Goldstein, T., Tremereau-Bravard, A., Ontiveros, V., Joly, D.O., Walzer, C., Fine, A.E., Olson, S.H., 2020. Coronavirus testing indicates transmission risk increases along wildlife supply chains for human consumption in Viet Nam, 2013-2014. *PLoS One* 15, e0237129. <https://doi.org/10.1371/journal.pone.0237129>.
- Ipbes, 2020. *Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services*. Daszak, P., Amuasi, J., das Neves, C. G., Hayman, D., Kuiken, T., Roche, B., Zambrana-Torrel, C., Buss, P., Dunderova, H., Feferholtz, Y., Foldvári, G., Igbinoza, E., Junglen, S., Liu, Q., Suzan, G., Uhart, M., Wannous, C., Woolaston, K., Mosig Reidl, P., O'Brien, K., Pascual, U., Stoett, P., Li, H., Ngo, H. T., IPBES secretariat, Bonn, Germany. <https://doi.org/10.5281/zenodo.4147317>.
- Koh, L.P., Li, Y., Lee, J.S.H., 2021. The value of China's ban on wildlife trade and consumption. *Nat. Sustain.* 4 (1), 2–4. <https://doi.org/10.1038/s41893-020-00677-0>.
- Le, A., 2019. ENV ordered Binh Duong province to end pilot tiger farming. *Ho Chi Minh Phap Luat Online News*. (<https://plo.vn/xa-hoi/env-de-nghi-binh-duong-cham-dat-viec-nuoi-ho-thi-diem-838823.html>) (Accessed 8.22.21).
- Le, A., 2021. There are more than 900 wildlife breeding facilities. *DongNai Online News*. (<http://baodongnai.com.vn/kinhte/202106/hon-900-co-so-gay-nuoi-dong-vat-hoang-da-3060460/index.htm>) (Accessed 8.22.21).
- Li, H., Daszak, F., Chmura, A., Zhang, Y., Terry, P., Fielder, M., 2021. Knowledge, attitude, and practice regarding zoonotic risk in wildlife trade, Southern China. *EcoHealth* 18 (1), 95–106. <https://doi.org/10.1007/s10393-021-01532-0>.
- Liew, J.H., Kho, Z.Y., Lim, R., Dingle, C., Bonebrake, T.C., Sung, Y.H., Dudgeon, D., 2021. International socioeconomic inequality drives trade patterns in the global wildlife market. *Sci. Adv.* 7 (19), 7679. <https://doi.org/10.1126/sciadv.abf7679>.
- Lin, J., 2021. Reflection: an update on China's wild meat consumption since COVID-19. *Explor. Hist. Cult. Hum. Nourishment* 29 (2), 213222. <https://doi.org/10.1080/07409710.2021.1901391>.
- Lindsey, P., Allan, J., Brehony, P., Dickman, A., Robson, A., Begg, C., Bhammar, H., Blanken, L., Breuer, T., Fitzgerald, K., Flyman, M., Gandiwa, P., Giva, N., Kaelo, D., Nampindo, S., Nyambe, N., Steiner, K., Parker, A., Roe, D., Thomson, P., Trimble, M., Caron, A., Tyrrell, P., 2020. Conserving Africa's wildlife and wildlands through the COVID-19 crisis and beyond. *Nat. Ecol. Evol.* 4, 13001310. <https://doi.org/10.1038/s41559-020-1275-6>.
- Luong, X., 2018. Dong Nai: 14 wild animals "wait" to cook". *VOV online*. (<https://vov.vn/tin-nong/dong-nai-14-ca-the-dong-vat-hoang-da-cho-len-ban-nhau-794389.vov>) (Accessed 8.22.21).
- Mcelwee, P., Turnout, E., Chiroleu-Assouline, M., Clapp, J., Isenhour, C., Jackson, T., Kelemen, E., Miller, D.C., Rusch, G., Spangenberg, J.H., Waldron, A., Baumgartner, R.J., Bleys, B., Howard, M.W., Mungatana, E., Ngo, H., Ring, I., Santos, R., 2020. Ensuring a post-COVID-19 economic agenda tackles global biodiversity loss. *One Earth* 3 (4). <https://doi.org/10.1016/j.oneear.2020.09.011>, 448–46.
- Mcginlay, J., Gkoumas, V., Holtvoeth, J., Fuertes, R.F.A., Bazhenova, E., Benzoni, A., Botsch, K., Martel, C.C., Sánchez, C.C., Cervera, I., Chaminade, G., Doerstel, J., García, C.J.F., Jones, A., Lammertz, M., Lotman, K., Odar, M., Pastor, T., Ritchie, C., Santi, S., Smolej, M., Rico, F.S., Waterman, H., Zwijacz-Kozica, T.,

- Kontoleon, A., Dimitrakopoulos, P.G., Jones, N., 2020. The impact of COVID-19 on the management of European protected areas and policy implications. *Forests* 11, 1–15. <https://doi.org/10.3390/f11111214>.
- Mcnamara, J., Robinson, E.J.Z., Abernethy, K., Midoko Ipong, D., Sackey, H.N.K., Wright, J.H., Milner-Gulland, E., 2020. COVID-19, systemic crisis, and possible implications for the wild meat trade in Sub-Saharan Africa. *Environ. Resour. Econ.* 76, 1045–1066. <https://doi.org/10.1007/s10640-020-00474-5>.
- Montgomery, R.A., Macdonald, D.W., 2020. COVID-19, health, conservation, and shared wellbeing: Details matter. *Trends Ecol. Evol.* 35, 748–750. <https://doi.org/10.1016/j.tree.2020.06.001>.
- Murray, K.A., Allen, T., Loh, E., Machalaba, C., Daszak, P., 2016. Emerging viral zoonoses from wildlife associated with animal-based food systems: risks and opportunities. In: Jay-Russell, M., Doyle, M.P. (Eds.), *Food Safety Risks from Wildlife*. Springer, Cham, pp. 31–57. [https://doi.org/10.1007/978-3-319-24442-6\\_2](https://doi.org/10.1007/978-3-319-24442-6_2).
- Nash, S., 2019. Vietnam's empty forests. *New York Times*. (<https://www.nytimes.com/2019/04/01/travel/vietnam-wildlife-species-ecotravel-tourism.html>) (Accessed 8.22.21).
- Neupane, D., 2020. How conservation will be impacted in the COVID-19 pandemic. *Wildl. Biol.* 2020, 2. <https://doi.org/10.2981/wlb.00727>.
- Nguyen, D., 2021a. Proposing Dong Nai cultural nature reserve to be an ASEAN heritage park. *Dan sinh*. (<https://thanhvien.vn/thoi-su/de-xuat-khu-bao-ton-thien-nhien-van-hoa-dong-nai-la-vuon-di-san-asean-1399690.html>) (Accessed 8.22.21).
- Nguyen, D.C., 2010. Raising wild animals in Ho Chi Minh City: A new profession brings high income for people. *Forest Protection Department*. ([http://www.kiemlam.org.vn/PortletBlank.aspx/AB643F9FDB734E16AE8A3AF613D6ADC9/Voi/So-2/Nuoi\\_dong\\_vat\\_hoang\\_da\\_o\\_thanh\\_pho\\_Ho\\_Chi\\_Minh\\_Nghe\\_moi\\_dem\\_Jai\\_thu\\_nhap\\_cao\\_cho\\_nguoi\\_dan/?print=4132018](http://www.kiemlam.org.vn/PortletBlank.aspx/AB643F9FDB734E16AE8A3AF613D6ADC9/Voi/So-2/Nuoi_dong_vat_hoang_da_o_thanh_pho_Ho_Chi_Minh_Nghe_moi_dem_Jai_thu_nhap_cao_cho_nguoi_dan/?print=4132018)) (Accessed 8.22.21).
- Nguyen, D.H., Dinh, T.M., 2020. Impacts of wildlife trade and sustainable development in Vietnam. *E3S Web Conf.* 157: p. 03001. <https://doi.org/10.1051/e3sconf/202015703001>.
- Nguyen, H.T., 2020b. Vietnam to ban wildlife trade following conservationists' demand. *PanNature*. (<https://www.nature.org.vn/en/2020/03/vietnam-to-ban-wildlife-trade/>) (Accessed 8.22.21).
- Nguyen, H.T., 2021b. Illegal wildlife trade does not show any decline in Vietnam. *PanNature*. (<https://www.nature.org.vn/en/2021/06/illegal-wildlife-trade-does-not-show-any-decline-in-vietnam/>) (Accessed 8.22.21).
- Nguyen, M.H., Dung, V.Van, Song, N.Van, Thang, H.Van, Dung, N.H., Tuan, P.N., Hoa, T.T., Canh, D., 2007. Report on the review of Vietnam's wildlife trade policy. *CRES/FPD/UNEP/CITES/UEED*, Hanoi, Vietnam.
- Nguyen, T., 2020a. Vietnam's new ban on illegal wildlife trade and consumption welcomed by international community. *Vietnam Times*. (<https://vietnamtimes.org.vn/vietnams-new-ban-on-illegal-wildlife-trade-and-consumption-welcomed-by-international-community-22762.html>) (Accessed 8.22.21).
- Nuno, A., Blumenthal, J.M., Austin, T.J., Bothwell, J., Ebanks-Petrie, G., Godley, B.J., Boderick, A.C., 2018. Understanding implications of consumer behavior for wildlife farming and sustainable wildlife trade. *Conserv Biol.* 32 (2), 390–400. <https://doi.org/10.1111/cobi.12998>.
- Olmedo, A., Verissimo, D., Challender, D.W.S., Huong, T.T.D., Milner-Gulland, E.J., 2021. Who eats wild meat? Profiling consumers in Ho Chi Minh City, Vietnam. *People Nat.* 3 (3), 700–710. <https://doi.org/10.1002/pan3.10208>.
- Pannature. 2020. Gây nuôi động vật hoang dã ở Việt Nam. *PanNature*. ([https://nature.org.vn/vn/wp-content/uploads/2020/10/2\\_FACT-Sheet-wildlife-farming\\_FAO-1.pdf](https://nature.org.vn/vn/wp-content/uploads/2020/10/2_FACT-Sheet-wildlife-farming_FAO-1.pdf)) (Accessed 8.22.21).
- Phuc, H., 2021. Strengthening inspection and management on breeding wildlife. *Bà Rịa - Vũng Tàu Online News*. (<http://www.baoriavungtau.com.vn/kinh-te/202104/tang-cuong-kiem-tra-quan-ly-gay-nuoi-dong-vat-hoang-da-923457/index.htm>) (accessed 8.22.21).
- Phuoc, T., 2021. Binh Duong expects 120,000 coronavirus cases in next two weeks. *VnExpress*. (<https://e.vnexpress.net/news/news/binh-duong-expects-120-000-coronavirus-cases-in-next-two-weeks-4346035.html>) (accessed 4.18.22).
- Prime Minister Of Vietnam, 2020. Directive No. 29/CT-TTg dated 23 July 2020 of the Prime Minister on a number of urgent solutions for wildlife management. Prime Minister of Vietnam, Hanoi, Vietnam.
- Rahman, Md. S., Alam, Md. A., Salekin, S., Belal, Md. A.H., Rahman, Md. S., 2021. The COVID-19 pandemic: a threat to forest and wildlife conservation in Bangladesh? *Trees*. *People* 5, 100119. <https://doi.org/10.1016/j.tfp.2021.100119>.
- Roe, D., Dickman, A., Kock, R., Milner-Gulland, E.J., Rihoy, E., Sas-Rolfes, M., 2020. Beyond banning wildlife trade: COVID-19, conservation and development. *World Dev.* 136, 105121. <https://doi.org/10.1016/j.worlddev.2020.105121>.
- Sang, T., 2021. Ho Chi Minh City directs to strengthen wildlife management. *Phap luat online news*. (<https://m.plo.vn/thoi-su/tphcm-chi-dao-tang-cuong-quan-ly-dong-vat-hoang-da-967860.html>) (Accessed 8.22.21).
- Shi, X., Zhang, X., Xiao, L., Li, B.V., Liu, J., Yang, F., Zhao, X., Cheng, C., Lü, Z., 2020. Public perception of wildlife consumption and trade during the COVID-19 outbreak. *Biodivers. Sci.* 28, 630–643. <https://doi.org/10.17520/biods.2020134>.
- Shi, Z., Hu, Z., 2008. A review of studies on animal reservoirs of the SARS coronavirus. *Virus Res.* 133 (1), 74–87. <https://doi.org/10.1016/j.virusres.2007.03.012>.
- Smith, M.K.S., Smit, I.P.J., Swemmer, L.K., Mokhatla, M.M., Freitag, S., Roux, D.J., Dziba, L., 2021. Sustainability of protected areas: vulnerabilities and opportunities as revealed by COVID-19 in a national park management agency. *Biol. Conserv.* 255, 108985. <https://doi.org/10.1016/j.biocon.2021.108985>.
- Spenceley, A., Mccool, S., Newsome, D., Bæz, A., Barborak, J.R., Blye, C.J., Bricker, K., Cahyadi, H.S., Corrigan, K., Halpenny, E., Hvenegaard, G., King, D.M., Leung, Y.F., Mandić, A., Naidoo, R., Riede, D., Sano, J., Sarhan, M., Santamaria, V., Sousa, T.B., Zschiegener, A.K., 2021. Tourism in protected and conserved areas amid the COVID-19 pandemic. *Parks* 27, 103–118. <https://doi.org/10.2305/IUCN.CH.2021.PARKS-27-SIAS.en>.
- The Guardian, 2020. Billion-dollar wildlife industry in Vietnam under assault as law drafted to halt trading. *The Guardian*. (<https://www.theguardian.com/environment/2020/mar/18/billion-dollar-wildlife-industry-in-vietnam-under-assault-as-law-drafted-to-halt-trading>) (Accessed 8.22.21).
- Thiennhien.Net, 2020. Attack on billion-dollar line of wildlife trade. *Thiennhien.Net*. (<https://www.thiennhien.net/2020/03/25/tan-cong-vao-duong-day-ti-do-buon-ban-dong-vat-hoang-da/>) (Accessed 8.22.21).
- Thomas-Walters, L., Hinsley, A., Bergin, D., Burgess, G., Doughty, H., Eppel, S., Macfarlane, D., Meijer, W., Lee, T.M., Phelps, J., Smith, R.J., Wan, A., Verissimo, D., 2021. Motivations for the use and consumption of wildlife products. *Conserv. Biol.* 35 (2), 483–491. <https://doi.org/10.1111/cobi.13578>.
- Tylianakis, J.M., Herse, M.R., Malinen, S., Lyer, P.O.B., 2021. Pandemic prevention should not victimize indigenous peoples and local communities. *Conserv. Lett.* e12813. <https://doi.org/10.1111/conl.12813>.
- Van Uhm, D., Zaitch, D., 2021. Defaunation, wildlife exploitation and zoonotic diseases: a green criminological perspective. In: Siegel, D. (Ed.), *Notes from Isolation: Global Criminological Perspectives on Coronavirus Pandemic*. Eleven International Publishing, Netherlands, pp. 11–30.
- Verissimo, D., Wan, A., 2019. Characterizing efforts to reduce consumer demand for wildlife products. *Conserv. Biol.* 33 (3), 623–633. <https://doi.org/10.1111/cobi.13227>.
- Vietnam News, 2020. Thousands of wildlife farms in Viet Nam threaten biodiversity. *Vietnam News*. (<https://vietnamnews.vn/environment/813707/thousands-of-wildlife-farms-in-viet-nam-threaten-biodiversity.html>) (Accessed 8.22.21).
- Vietnam News, 2021. Illegal wildlife trade cracked down nationwide. *Vietnam News*. (<https://vietnamnews.vn/environment/988680/illegal-wildlife-trade-cracked-down-nationwide.html>) (Accessed 8.22.21).
- Vietnam News Agency, 2021. Wildlife trafficking in Vietnam remains complex. Report. *VietnamPlus*. (<https://en.vietnamplus.vn/wildlife-trafficking-in-vietnam-remains-complex-report/203280.vnp>) (Accessed 8.22.21).
- Vietnamnet Global, 2021. Over 1,130 wild animals rescued in VN in 2020. *Vietnamnet Global*. (<https://vietnamnet.vn/en/sci-tech-environment/over-1-130-wild-animals-rescued-in-viet-nam-in-2020-712765.html>) (Accessed 8.22.21).
- Wikramanayake, E., Pfeiffer, D.U., Magouras, I., Conan, A., Ziegler, S., Bonebrake, T.C., Olson, D., 2021. A tool for rapid assessment of wildlife markets in the Asia-Pacific region for risk of future zoonotic disease outbreaks. *One Health* 13, 100279. <https://doi.org/10.1016/j.onehlt.2021.100279>.
- Xiao, L., Lu, Z., Li, X., Zhao, X., Li, B.V., 2021. Why do we need a wildlife consumption ban in China. *Curr. Biol.* 31 (4), R168–R172. <https://doi.org/10.1016/j.cub.2020.12.036>.
- Yang, N., Liu, P., Li, W., Zhang, L., 2020. Permanently ban wildlife consumption. *Science* 367 (6485). <https://doi.org/10.1126/science.abb1938>, 1434.
- You, M., 2020. Changes of China's regulatory regime on commercial artificial breeding of terrestrial artificial breeding of terrestrial wildlife in time of COVID-19 outbreak and impacts on the future. *Biol. Conserv.* 250, 108756. <https://doi.org/10.1016/j.biocon.2020.108756>.