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Research

Immediate effects of the COVID-19 pandemic on the use of wildlife as food among indigenous people and local communities in South America

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ABSTRACT. The COVID-19 pandemic has had a range of effects on the environment and particularly on wildlife, through diverse and sometimes contradictory impact pathways. In this study, based on data collected among indigenous people and local communities from South America (Colombia, Ecuador, Guyana, and Peru), we investigated changes in the use of wildlife resources for food during the first months of the COVID-19 pandemic. Our study generated unique data collected from 756 households in 60 communities and nine sites. We confirm the hypothesis that wildlife use increased as a short-term response to food insecurity during the pandemic, and fish played a more significant role than wild meat in that endeavor. The increase in wild-meat consumption as a response to food insecurity was conditioned by prices and availability (unsuccessful hunts). Wildlife use did not increase as an alternative means to generate income, because communities were cut off from the market economy for several months. Also, whereas the reliance on wildlife emerged as an immediate solution during the first months of the crisis, longer-term strategies prioritized at household level involved diversifying food sources through domestic meat and crop production. Among all available animal-based proteins, local chicken came just after fish as the animal-based source of protein whose consumption increased the most during the first months of the crisis, as a response to food insecurity. We caution that relying on wildlife as a safety net may constitute a poverty trap in cases where the resource is depleted. Although not specifically studied here, access to land and the transmission of traditional knowledge/skills are possible additional determinants of the role that wildlife may play in times of crisis, and this is proposed as an area for future research. Results also attest to local communities expecting more support from their respective national governments, and confirm results from Walters et al. (2021) that governments were generally absent or unable to react quickly during the pandemic, leaving households (or their local leaders) with the responsibility to innovate with local solutions and pro-actively adapt to the rapid impacts of the crisis.

Key Words: *adaptation strategies; binary logistic regression; COVID-19; food security; IPLCs; South America; wildlife use*

INTRODUCTION

Since the onset of the global spread of COVID-19 in spring 2020, the unprecedented measures put in place across the world to reduce the spread of the disease have had severe impacts on people's lives, including on income, food security, and physical and mental health (Aristovnik et al. 2020, Bakar and Rosbi 2020, De Vos 2020, Duan and Zhu 2020, Dubey et al. 2020, Gudmundsson et al. 2020, Mayasari et al. 2020, Mogaji 2020, Pitoyo et al. 2020, Ratten 2020, Kesar et al. 2021, Mahmud and Riley 2021). These measures also brought about a diverse range of effects on the environment and particularly on wildlife, through multiple and sometimes contradictory impact pathways. First, the COVID-19 pandemic triggered calls from the scientific community to stop wildlife use (Borzée et al. 2020, Shi et al. 2020) and prompted governments to enact blanket or targeted bans on wildlife consumption (Booth et al. 2021). Second, narratives linking COVID-19 and human destruction of nature have generated more support for conservation (Shreedhar and Mourato 2020). Third, the reduction of human activities, such as vehicle traffic, has translated into an increase in wildlife populations, and/or a decline in wildlife mortality (Manenti et al. 2020, Neupane 2020, Rutz et al. 2020, Shilling et al. 2021, Silva-Rodríguez et al. 2021). On the other hand, speculation that wildlife was linked to the outbreak of coronavirus stimulated the killing of some target species in retaliation, e.g., the critically endangered Chinese pangolin (*Manis pentadactyla*; Neupane 2020). In addition, the COVID-19 crisis prompted a reduction of tourism revenues normally invested in conservation (Neupane 2020), the cancellation of anti-poaching operations (Karmakar 2020), and the postponement of management actions to control alien species (Manenti et al. 2020) or to monitor vulnerable ones (Neupane 2020).

In a recent study, McNamara et al. (2020) hypothesized that COVID-19 may have led to increased use of wildlife as a safety net during the crisis in sub-Saharan Africa. Drawing a parallel with other economic crises (such as wars), Rondeau et al. (2020) also conjectured that the pandemic may have translated into an increased burden on wildlife being sought for food, because of the migration of urban dwellers who found themselves without jobs. In addition, Walters et al. (2021) suggested that the increased labour time available in rural areas during the crisis may have been invested in the harvesting of natural resources for traditional medicines, and to meet subsistence and nutritional requirements. Mendiratta et al. (2021) showed that hunting increased during the crisis in India, because of a reduction in enforcement efforts, as well as to the disruption of food supplies and heightened demand for recreational activities. However, no study has as yet addressed the immediate effects of the COVID-19 crisis on the use of wildlife for food in South America.

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With the aim of helping to bridge this knowledge gap, and with support from a wide network of local researchers who are part of the International Union of Conservation of Nature's (IUCN) Sustainable Use and Livelihoods Specialist Group (SULi), we developed a research protocol to understand how COVID-19 and the related restrictions affected the way indigenous people and local communities (IPLCs) used wildlife for food during the first months of the pandemic. Based on data collected in indigenous and local communities from South America (Colombia, Ecuador, Guyana, and Peru), we investigated changes in the use of wildlife during the first months of the COVID-19 outbreak through semi-structured questionnaires at the household level and framed the changes observed within the wider local context of food security. Our research was guided by the following questions: Did the use of wildlife (wild meat and fish) for food change during the first months of the pandemic? Were those changes determined by households' socio-economic variables and geographical location? How were those changes framed in relation to the consumption of other animal-based sources of protein from domestic or industrial origin? Were changes in wildlife consumption explained by changes in food security and changes in income? What adaptation strategies were adopted to reduce the impacts of COVID-19 on household food security?

METHODS

Study sites

Semi-structured questionnaires at household level were conducted among 60 IPLCs in Colombia, Ecuador, Guyana, and Peru. The choice of the study sites was made based on the following criteria: (1) communities located in tropical ecosystems; (2) communities encompassing a diversity of socio-economic contexts with regard to dependency on wildlife, access to markets, and ethnicity; and (3) the physical presence of one of the co-authors in the communities or, alternatively, the presence of a trusted local researcher based in the communities who could conduct the interviews. This was particularly important at a time when no international travel was allowed and heavy restrictions on national travel were in place. Some communities were still in lockdown at the time of the survey. Household ethnicity was almost entirely indigenous, except for respondents at sites in the Chocó, i.e., Pacific, region of Colombia, where the majority were Afro-descendants (Table 1).

All communities were located in tropical forest ecosystems, except in Guyana, where communities live in tropical savannah landscapes. Local economies in all study sites were mostly based on food-crop production, fishing, and hunting, but in some sites tourism or mining were also important. Afro-descendant communities surveyed in the Pacific region of Colombia were all located within the Chocó department, where the economy is mainly based on agriculture, fishing, hunting, forest harvesting, and, to a lesser extent, tourism and mining. In the Colombian Amazon, surveys were conducted in Puerto Nariño, home to an indigenous community whose livelihoods depend mainly on tourism, agriculture, fishing, and hunting.

In Ecuador, we worked in indigenous communities distributed along the Amazonian provinces of Napo and Pastaza. In the Napo province, where communities have road connections, they have lost much land to settlers, and rely mainly on cash crops, and to a lesser degree on hunting, fishing, and timber extraction. In the Pastaza province, communities in the Arajuno area also have road connections, but have lost little land to settlers, so hunting, fishing, and timber harvesting remain important, in addition to agriculture. Toñampare and Sarayaku have no road connection and the economy is based on hunting, fishing, and subsistence agriculture, with tourism as a minor component. In Guyana, indigenous communities from the Rupununi region live off agriculture, hunting, and fishing, but generate income through tourism and extensive cattle production. In Peru, communities surveyed were part of the Loreto department, located within the Peruvian Amazon, along the Amazon and the Marañon Rivers, within the Pebas and Parinari districts, respectively. These communities generate income from trade in crops and natural resources to the nearest town of Iquitos (Fig. 1).

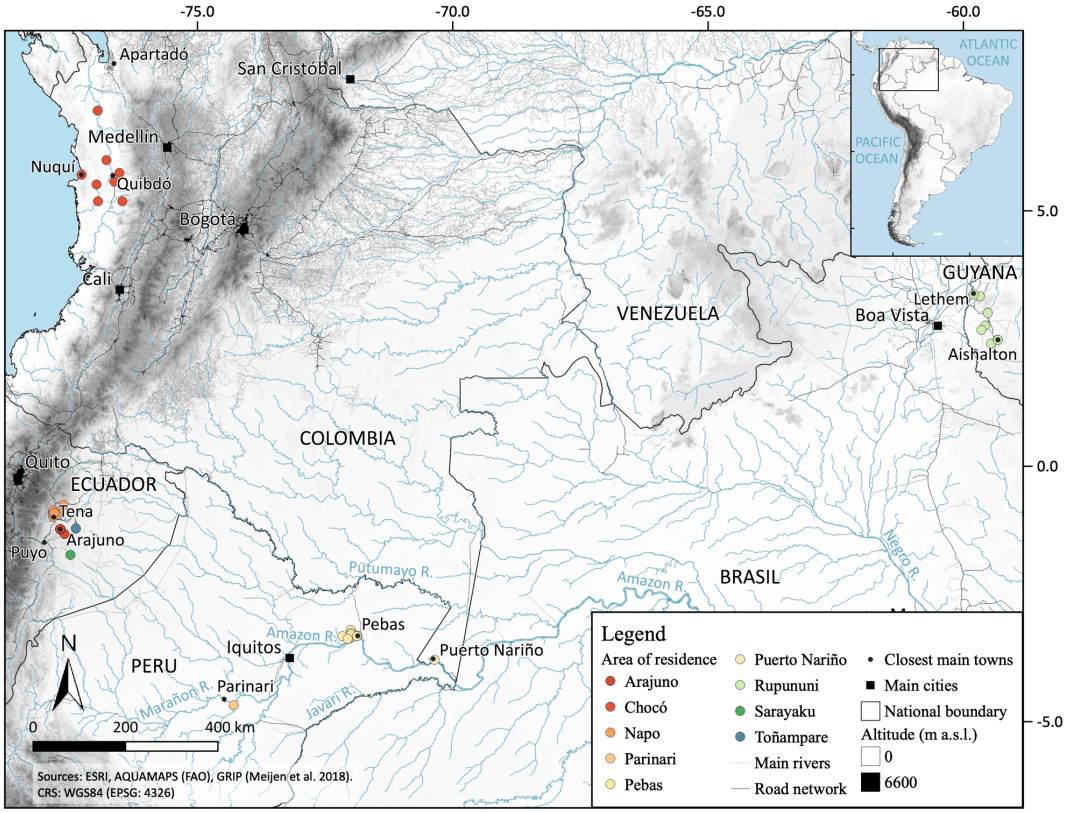
Data collection

A total of 756 interviews were conducted from October 2020 to January 2021. To reduce the number of categories and increase the sample size within each location, the 60 communities were divided into nine sites based on country and geographical proximity, as follows: in Colombia, (1) Chocó and (2) Puerto Nariño; in Ecuador, (3) Napo, (4) Arajuno, (5) Toñampare, and (6) Sarayaku; in Guyana, (7) Rupununi; and, in Peru, (8) Pebas and (9) Parinari. This grouping took into account similarities in relation to COVID-19 national-level restrictions and site accessibility during the pandemic (Fig. 1).

One person per household was surveyed, and questions were intended to gather information at the household level. After being offered a thorough explanation of the objectives of this study, participants were requested to give their consent before being asked to complete the questionnaire. The interviews were conducted at a time of day, such as evening, when no other household activity needed to be undertaken, to ensure that the respondents had enough time and could concentrate on the responses. The interviews lasted for a maximum of between a half and one hour, depending on how much additional information was given by the respondent during the conversation. In each community, households were chosen following a convenient sampling strategy, given the following logistical constraints: (1) restricted movement of interviewers within communities; (2) sparse distribution of houses in some communities; and (3) limited personnel available to carry out the interviews. In Colombia and Peru, interviews took place in Spanish. In Ecuador, some interviews were carried out in Spanish and others in Kichwa, whereas in Guyana, interviews were conducted in Wapishana and English.

The questionnaire included a first section that aimed to describe the socio-economic characteristics of the household. The main categories for economic activities were employed, self-employed, farmer, forest-dependent, and other. The employed category referred to those who relied on a fixed and stable income from a formal job or pension, such as civil servants, people employed in mining, by tourism operators, etc. Self-employed referred to those who sell (such as shop owners), manufacture goods (such as craftspeople and carpenters), provide services (such as tourist guides), and for whom the nature of their activity often translates into a variable monthly income. Farmers referred to those dedicated to farming activities, whose main income is generated

Fig. 1. Geographic location of the 60 villages where the survey was carried out. These were pooled into nine sites for posterior analysis (see text for details).



by the sale of crops or livestock in local markets. Forest-dependents were those whose main income depends on selling and trading wildlife (such as fishers and hunters) or non-timber forest products. Finally, other referred mostly to housewives and single women who were in neither of the previous categories (Table 1).

A second section of the questionnaire asked about restrictions during the pandemic, e.g., Did your community experience lockdown? How long did it last? Could people come into the community? Or leave the community? How long did those restrictions last? It also asked about the implications of such restrictions on income, e.g., Did your household experience any changes in income during the first months of the COVID-19 pandemic? As well, it asked about perceived food security, e.g., During the first months of the COVID-19 pandemic, did you worry about not having sufficient food for you (and your family)?

A third section of the questionnaire included questions about changes in wild-meat and fish consumption and shifts in the consumption of other available animal-based sources of protein. Where changes in wildlife use were mentioned, we inquired about whether these were because of changes in hunting/fishing effort, changes in the number of household members engaging in hunting/fishing, changes in wild-meat/fish prices, changes in the amount of fish/wild meat purchased in the community, or other.

The last section of the questionnaire was based on an open discussion about the adaptation strategies that households may have prioritized during the first months of the pandemic. To facilitate the analysis, responses were grouped into seven adaptation strategies: (1) start breeding livestock; (2) increase crops or the extent of farming area; (3) start breeding wildlife; (4) request government support; (5) engage in sustainable wildlife initiatives; (6) use/enhance local and traditional knowledge related to fishing and hunting; and (7) buy locally grown food supplies. These categories were not mutually exclusive, and respondents could mention more than one strategy. All response variables were binary coded for posterior statistical analysis.

Data analysis

We used discriminant analysis to understand the determinants for changes in wild-meat and fish consumption, separately. We computed a discriminant analysis between the perceived change in wild-meat consumption as the dependent variable and a set of explanatory variables of a quantitative nature, e.g., number of children and adults per household, or of a qualitative nature, e. g., gender (categorical), ethnic group (categorical), household's economic activity site (categorical), perceived change in food security (categorical), and perceived change in income (binary). Subsequently, to assess the main reasons for the observed changes in wild-meat consumption, we computed a discriminant analysis with change in wild-meat consumption as the dependent variable

Table 1. Proportion of households in each category of ethnicity and main economic activity, and average number of youth and adult members per site.

	Ethnicity[†]			Main economic activity[‡]						
Country/area of residence	Afro.	Indig.	Other	Emp.	S. emp.	Farm.	F. dep.	Other	Average no. of children (SD)	Average no. of adults (SD)
Colombia (169)	0.69	0.30	0.02	0.15	0.27	0.15	0.43	0.00	2 (1.5)	1 (2.7)
Chocó (123)	0.93	0.05	0.02	0.07	0.31	0.11	0.51	0.00	2 (1.4)	1 (2.3)
Puerto Nariño (46)	0.02	0.96	0.02	0.39	0.17	0.24	0.20	0.00	2 (1.7)	2 (3.7)
Ecuador (288)	0.00	1.00	0.00	0.21	0.13	0.30	0.36	0.01	3 (2.2)	2 (3.0)
Arajuno (63)	0.00	1.00	0.00	0.16	0.06	0.68	0.08	0.02	3 (1.7)	2 (3.5)
Napo (89)	0.00	1.00	0.00	0.34	0.08	0.43	0.16	0.00	3 (2.4)	2 (3.5)
Sarayaku (104)	0.00	1.00	0.00	0.13	0.06	0.03	0.78	0.00	4 (2.4)	2 (2.7)
Toñampare (32)	0.00	1.00	0.00	0.19	0.59	0.06	0.09	0.06	3 (1.4)	1 (2.0)
Guyana (188)	0.00	1.00	0.00	0.20	0.20	0.59	0.01	0.00	2 (1.8)	2 (3.2)
Rupununi (188)	0.00	1.00	0.00	0.20	0.20	0.59	0.01	0.00	2 (1.8)	2 (3.2)
Peru (111)	0.00	0.96	0.04	0.04	0.30	0.32	0.24	0.11	3 (1.7)	2 (2.5)
Parinari (39)	0.00	0.90	0.10	0.03	0.15	0.26	0.26	0.31	4 (2.0)	2 (2.1)
Pebas (72)	0.00	1.00	0.00	0.04	0.38	0.35	0.24	0.00	2 (1.4)	1 (2.7)
Total (756)	0.15	0.84	0.01	0.17	0.20	0.34	0.27	0.02	3 (2.0)	2 (2.9)

[†] Afro-descendant (Afro.), Indigenous (Indig.).
[‡] Employed (Emp.), Self-employed (S. emp), Farmer (Farm.), Forest-dependent (F. dep.).

and reasons for change as quantitative explanatory variables of binary nature (yes/no). A similar analysis was conducted for fish consumption. In order to assess the correlation between perceived food insecurity and consumption of different animal-based proteins, we then computed a discriminant analysis with perceived food insecurity as the dependent variable and consumption of each type of animal-based source of protein as quantitative binary explanatory variables. Significant differences between groups were tested with the Wilks Lambda test ($P < 0.0001$), Pillai's trace ($P < 0.0001$), and Hotelling-Lawley trace ($P < 0.0001$). Data analysis was conducted with XLSTAT 2022.

RESULTS

All surveyed communities were subject to lockdown and curfew for several months, with starting dates and durations that generally covered the period from March to August 2021. In Colombia, Ecuador, and Peru, mobility restrictions were strictly enforced by national government, whereas in Guyana, village leaders voluntarily placed their communities in lockdown to avoid contagion. In cases where enforcement was performed by national authorities, access to markets and hunting/fishing grounds was restricted and carefully controlled, as were movements in and out the communities. In Guyana, where the voluntary lockdown was set in place, community members could freely move within their territory, but outsiders were not allowed to come into the community, and this was enforced by local leaders. Based on the direct responses from 310 households, the main implications of COVID-19 on households' economy were a considerable decline in sales, including tourism, because of mobility restrictions and lack of access to local and regional markets (54%), reduced job, i.e., informal, opportunities (14%), increased cost of food supplies (5%), and loss of jobs (3%).

When asked about the changes in wildlife use, 34% of all respondents indicated an increase in wildlife-consumption frequency during the pandemic. Among these, 79.4% and 30.6% indicated an increase in consumption of fish and wild meat, respectively, but contrasting patterns were observed across sites. Whereas households in Parinari, Puerto Nariño, and Sarayaku showed a significant probability of increased fish consumption ($P < 0.0001$), households from Arajuno ($P = 0.005$), Chocó ($P < 0.0001$), and Napo ($P < 0.0001$) were likely to experience no change. Indigenous households ($P < 0.0001$), those dependent on forest-related activities ($P < 0.0001$), and those who worried more often about food security during the pandemic ($P = 0.002$), were more likely to increase fish consumption. The increase in fish consumption was largely explained by increased fishing frequency ($P < 0.0001$), more purchase of fish within the community ($P = 0.001$), or more household members engaging in fishing ($P = 0.05$). Households in Rupununi ($P < 0.0001$) were more likely to have reduced fish consumption during the first months of the pandemic. The odds of consuming less fish or not changing their fish consumption patterns during the pandemic increased for households that were never worried about food security ($P = 0.0001$), had experienced no change in income ($P = 0.03$), or were female-headed households ($P < 0.0001$).

Changes in wild-meat consumption also varied according to geographical location. Whereas Sarayaku showed significant probability ($P < 0.0001$) of reducing wild-meat consumption, in Arajuno, Pebas, and Puerto Nariño the odds of increasing wild-meat consumption were high ($P = 0.019$, $P < 0.0001$ and $P < 0.0001$, respectively). Increased wild-meat consumption was significantly correlated with male-headed households ($P = 0.0001$) and the number of adults in the family ($P = 0.003$), but neither ethnicity nor occupation had any impact on changes in wild-meat consumption. The increased frequency of wild-meat consumption was significantly explained by a higher hunting frequency during the pandemic ($P < 0.0001$), more non-hunter household members engaging in hunting ($P < 0.0001$), increased purchasing of wild meat within the community ($P < 0.0001$), or because there was no other option ($P < 0,0001$). The odds of not experiencing any change in wild-meat consumption increased among Afro-descendants ($P = 0.001$) and the self-employed ($P = 0.001$).

Moreover, households that did not experience a decline in income during the pandemic or did not worry about their food security were more likely to experience no change in their consumption of wild meat during the pandemic ($P = 0.0001$ and $P = 0.0004$, respectively). The decrease in wild-meat consumption (observed mostly in Sarayaku) was highly correlated to feeling food insecure ($P < 0.0001$), to the number of children in the household ($P = 0.04$), and to being a forest-dependent household ($P < 0.0001$). Reasons for not consuming more wild meat during the pandemic were unsuccessful hunts ($P < 0.0001$) and high prices ($P = 0.05$). A reduction in income was not significantly correlated to wild-meat or fish consumption.

Among the 740 households, 37% always worried about not having enough food during the pandemic and 41% only worried about it sometimes. The rest never worried about their food security during the first months of the pandemic. Households that were always worried about not having enough food were more likely to have consumed more fish ($P < 0.0001$) during the pandemic and more likely to have reduced their consumption of wild meat ($P < 0.0001$). Households that worried from time to time were more likely to have increased their consumption of local chicken ($P = 0.001$). Those that never worried about food security did not increase fish ($P < 0.0001$) or wild-meat consumption ($P < 0.0001$). All other associations were insignificant, meaning that no significant correlation was observed between perceived food security and the consumption of pork, imported chicken, canned meats, and beef.

Among the 728 households that mentioned any strategy to cope with the impacts of the COVID-19 pandemic, breeding livestock (particularly chicken) and increasing the amount of crop production on farmed lands were mentioned as top strategies by 72.5% of the respondents. Other strategies mentioned by the households interviewed included buying locally grown food supplies (22.6%), asking for government support (21%), starting wildlife farming (14%, restricted to Chocó), engaging in sustainable wildlife management initiatives (13%), and using/enhancing traditional knowledge for fishing and hunting (9%).

DISCUSSION

Our study generates unique ground data collected just after the COVID-19 outbreak from nine sites in South America about the impacts of the pandemic on the use of wildlife among indigenous peoples and local communities.

Although the trends observed and impact pathways differ according to each local context, the study confirms the hypothesis of McNamara et al. (2020) and Rondeau et al. (2020), which suggests that when rural income falls and labor-time availability increases, the number of harvesters rises. Indeed, we show that wildlife consumption increased in 34% of the households interviewed, mostly because of people investing more time in hunting and fishing, or because of new household members engaging in those activities. We also demonstrate that engaging in hunting or fishing was more of a response to food insecurity than one to a reduction of income. Although hunting and fishing can be practiced interchangeably for subsistence or income (Brown and Williams 2003), there is no evidence to show that households engaged in those activities as a source of income. Hunting and fishing constitute readily available alternative activities that act as safety nets for food security or simply as a way of spending spare time, given that they require little investment (Nielsen et al. 2018, Pitoyo et al. 2020).

Our results suggest that not all wildlife served an equal purpose as a safety net and that fish played a more significant role than wild meat during the pandemic. Whereas in other studies the role of hunting as a safety net during periods of shortage or shock has been widely documented (Arnold et al. 2011, Schulte-Herbrüggen et al. 2013, Vinceti et al. 2013, Wunder et al. 2014, Reyes-García et al. 2015, Vasco and Sirén 2016, van Vliet et al. 2018), our study evidences the greater importance of fish compared with wild meat and any other animal-based source of meat. The role that wild meat played as a safety net was limited, either by high prices or by lack of availability (unsuccessful hunts). Various authors have shown that resource depletion hinders the adaptation capacity of communities in times of crisis and caution about the possible impacts of wildlife depletion on the food security of millions of forest dwellers (Cawthorn and Hoffman 2015, Begossi et al. 2018, Paumgarten et al. 2018). Besides, households that do not have a hunter in the family are alienated from this traditional resource because they cannot afford its price, which is increasingly conditioned by its rarity value and market demand as delicacy food across South America (van Vliet et al. 2014, El Bizri et al. 2020).

Where wild-meat consumption increased, this was mainly in response to restrictions on mobility, most of which were described as imposed by the central government. In fact, restrictions of mobility during the COVID-19 crisis mimicked the effects of conflict, by disrupting access to markets (to sell and purchase commodities) and by increasing the reliance on locally available sources of protein (van Vliet et al. 2017, 2018). Wild-meat consumption increased more specifically in larger households, and in those headed by a man. The gender of the household head potentially played a role in households' choice of increased wild-meat consumption as a response to food insecurity, in that men are traditionally the family members who maintain the skills and knowledge required for hunting. Although not specifically studied in this research, the maintenance and transmission of traditional knowledge and skills may determine the capacity of households to rely on wildlife as a safety net. Indeed, previous work has extensively shown that the erosion of knowledge and skills with regards to use of wildlife may constrain the adaptation capacities of rural households (Pearce et al. 2015, Paumgarten et al. 2018). Among the communities studied, 9% of households mentioned enhancing local and traditional knowledge related to hunting and fishing as some of the priorities triggered by the COVID-19 pandemic.

Although access to wildlife offered an immediate solution to food insecurity and lack of income during the first months of the crisis, longer-term strategies mentioned by households included diversifying food sources through domestic meat and crop production. Local chicken came just after fish as the animal-based source of protein whose consumption increased the most during the first months of the crisis as a response to food insecurity. Following Levang et al. (2005), we caution that relying on wildlife as a safety net may constitute a poverty trap in cases where the resource is limited and diversification opportunities beyond

forest-based activities are scarce. This is particularly well exemplified by the community of Sarayaku, which, despite being dominated by forest-dependent households, did not increase wild-meat consumption, mostly as a result of unsuccessful hunts, and therefore felt highly food insecure.

We did not measure the importance of access to land and resources as a determinant of the role that wildlife may play in times of crisis, but this is clearly an area for future research. Previous work has already highlighted access to land as an important factor in dictating how and when forest resources can act as safety nets for the rural poor (McSweeney 2005). According to Walters et al. (2021), access to land and resources played a determinant role in securing food and medicine during the COVID-19 crisis. Policies that promote more secure access to land and wildlife resources will also clearly contribute to improving the food security of millions of people (Booth et al. 2021).

CONCLUSION

In conclusion, our study confirms the hypothesis that wildlife use increased as a short-term response to food insecurity during the pandemic, and that fish played a more significant role than wild meat in that endeavor. Wildlife use did not increase as an alternative means to generate income, because communities were cut off from the market economy for several months. The increase in wild-meat consumption as a response to food insecurity was conditioned by prices and availability (unsuccessful hunts). Also, whereas the reliance on wildlife emerged as an immediate solution during the first months of the crisis, longer-term strategies prioritized at household level involved diversifying food sources through domestic meat and crop production. Of all available animal-based proteins, local chicken came just after fish as the one whose consumption increased the most during the first months of the crisis, as a response to food insecurity.

Responses to this article can be read online at:
https://www.ecologyandsociety.org/issues/responses.php/13570

Author Contributions:

N. V. V. developed the methodology, coordinated data collection, analyzed the data, and wrote the first draft. E. P. coordinated methodology and data analysis from Guyana, and contributed to the writing. A. S. coordinated data collection in Ecuador, cleaned the full data set, and contributed to the writing. E. Y. C. coordinated data collection in Colombia, and contributed to the writing. T. W. coordinated methodology and data analysis from Guyana, and contributed to the writing. S.Q. cleaned data and conducted preliminary statistical analysis.

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Data Availability:

The data that support the findings of this study are available on request from the corresponding author, N. V. V. None of the data are publicly available because of a previous agreement with leaders from local communities. Ethical approval for this research study was granted by CIFOR.

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