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RESEARCH ARTICLE

Achieving Sustainable and Equitable Consumption of Wild Meat

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Wild meat consumption in changing rural landscapes of Indonesian Borneo

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Abstract

1. Wild meat can play a crucial role in the food system of rural communities residing near tropical forests. Yet, socio-ecological changes across tropical landscapes are impacting the patterns and sustainability of meat consumption.

2. To understand the prevalence, frequency and drivers of wild meat, domestic meat and fish consumption in this context, we implemented structured questionnaires across 28 villages in two forested landscapes of Central Kalimantan, a region of Indonesian Borneo characterised by forest-dependent livelihoods.

3. Across the 632 male household heads surveyed, the primary reason for consumption at the species-level was taste, followed by ease of access. Conversely, the main reasons for not consuming wild meat more often were cost and low availability.

4. The frequency of wild meat consumption was relatively low, with most respondents consuming it less than once every 6 months. However, local perceptions of biodiversity change and reported difficulties in accessing wild meat suggest this modest consumption was due to declining availability.

5. Freshwater fish was consumed daily by most respondents, serving as an important animal protein in both landscapes. However, we found a positive association between greater well-being and higher odds of consuming wild meat more frequently. This trend likely reflects disparity in access, with individuals of higher well-being status better positioned to obtain this declining resource.

6. Our findings highlight the multiple environmental and anthropogenic stressors concurrently affecting both terrestrial and aquatic animal populations in Central Kalimantan, with significant implications for the sustainability of wild meat and

wider food security. There were also regional differences in the frequency, diversity and types of domestic and wild species consumed, underscoring the need to consider socio-demographic diversity when developing wildlife conservation and sustainable food initiatives. Finally, we provide recommendations to work towards sustainable wild meat in these changing rural landscapes.

KEYWORDS

animal sourced foods, biodiversity change, bushmeat, food security, Kalimantan, land use change, local perceptions, nutrition

1 | INTRODUCTION

Achieving food security whilst safeguarding biodiversity is a global priority, as highlighted in the 2030 Agenda for Sustainable Development (UN, 2023) and the Post-2020 Global Biodiversity Framework (CBD, 2021). Food systems around the world face a 'triple challenge' of providing nutrition to growing populations, supporting livelihoods and contributing to environmental sustainability (OECD, 2021). This challenge is especially pronounced in tropical regions in the context of wild meat, that is, wild mammals, birds, reptiles and amphibians used for food. Here, indigenous and rural communities have historically relied upon wild meat, but hunting has become unsustainable in some regions (Benitez-Lopez et al., 2019; Ripple et al., 2016). As patterns and drivers of wild meat consumption in rural landscapes evolve with surrounding environmental, socio-economic and livelihood changes (Ingram, 2020), research to understand these processes is needed for sustainable wild meat initiatives that support both local needs and biodiversity conservation (Coad et al., 2019; Ingram et al., 2021).

Consumption of wild meat by communities residing near tropical forests has underpinned their nutritional diversity, medicine, income, social bonds, cultural identity, well-being and livelihoods for millennia (Bizri et al., 2020; Lee et al., 2020; Van Vliet et al., 2022). In these landscapes, wild meat acquisition was historically characterised by subsistence-based communities hunting with traditional weapons in large, relatively undisturbed forests—with little long-term impact on wildlife populations (Dobson et al., 2019; Suarez & Zapata-Ríos, 2019). However, technological advancements in hunting equipment and improved access to markets and once-remote forests have intensified pressures on wildlife (Ingram, 2020; Suarez & Zapata-Ríos, 2019). This coincides with evolving traditional livelihood practices (Setyawan, 2010), food choice behaviours (Cleary et al., 2022; Kenney et al., 2024) and a transition from subsistence to commercial hunting to supply growing demand from both rural and urban markets (Chaves et al., 2021; Pangau-Adam et al., 2012). Pressure on wildlife is compounded by environmental change, including large-scale forest conversion (Romero-Munoz et al., 2020), degradation through extractive industries (e.g. mining; Sonter et al., 2018) and climate change (Struebig et al., 2015). Environmental change is a central issue within food provisioning in many food systems (Ericksen, 2008; Ingram, 2011) and is especially relevant in the

context of wild meat since forest degradation and shifting climatic conditions can diminish habitat suitability and carrying capacity of hunted species, further reducing the number that can be harvested at sustainable levels (Suarez & Zapata-Ríos, 2019).

As a result of these socio-ecological changes, unsustainable consumption of wild meat represents a major conservation and sustainable development challenge (Coad et al., 2019). The depletion of wildlife from tropical forests can have detrimental effects on people, especially rural communities that rely most on wild meat to meet their nutritional and income needs (Golden et al., 2011; Nielsen et al., 2018). In addition to directly affecting food security, forest-dependent livelihoods and the wider food system can be disrupted when over-hunted forests lose key species for ecosystem services such as pollination, nutrient cycling and seed dispersal (Bogoni et al., 2022). As such, there is consensus across multiple fields, including food security, human development and biodiversity conservation, that transitioning towards the sustainable use of wildlife (i.e. at a rate that does not lead to the long-term decline of biological diversity) is imperative for safeguarding both people and wildlife (Coad et al., 2019; Ingram et al., 2021).

Despite the urgency required in finding sustainable solutions to the 'wild meat crisis', characterising wild meat consumption is complex because of the many intertwined intrinsic and external factors that can influence the patterns of its consumption. The Food Systems Framework (GAIN, 2024; Figure 1), adapted from the conceptual framework developed by the High-Level Panel of Experts on Food Security and Nutrition in the Nutrition and Food Systems Report (HLPE, 2017), helps us understand the interplay between factors influencing food security and diets under four headings: Drivers, Food Supply Chains, Food Environment and Individual Factors. Whilst wild meat studies have explored aspects of this framework, they have typically done so without directly embedding the research within a food systems framework. For example, 'Drivers' such as climate change (e.g. flooding in the Amazon; Bodmer et al., 2020), urbanisation (Parry et al., 2014) and sociocultural dynamics including traditional beliefs, taboos and religious practices (Knoop et al., 2020; Nijhawan & Mihu, 2020) have all been identified as drivers of consumption patterns. Similarly, factors including market prices and meat availability within the 'Food Environment' are known to influence consumption (Bauld et al., in review; Chaves et al., 2017), as have 'Individual Factors' such as taste
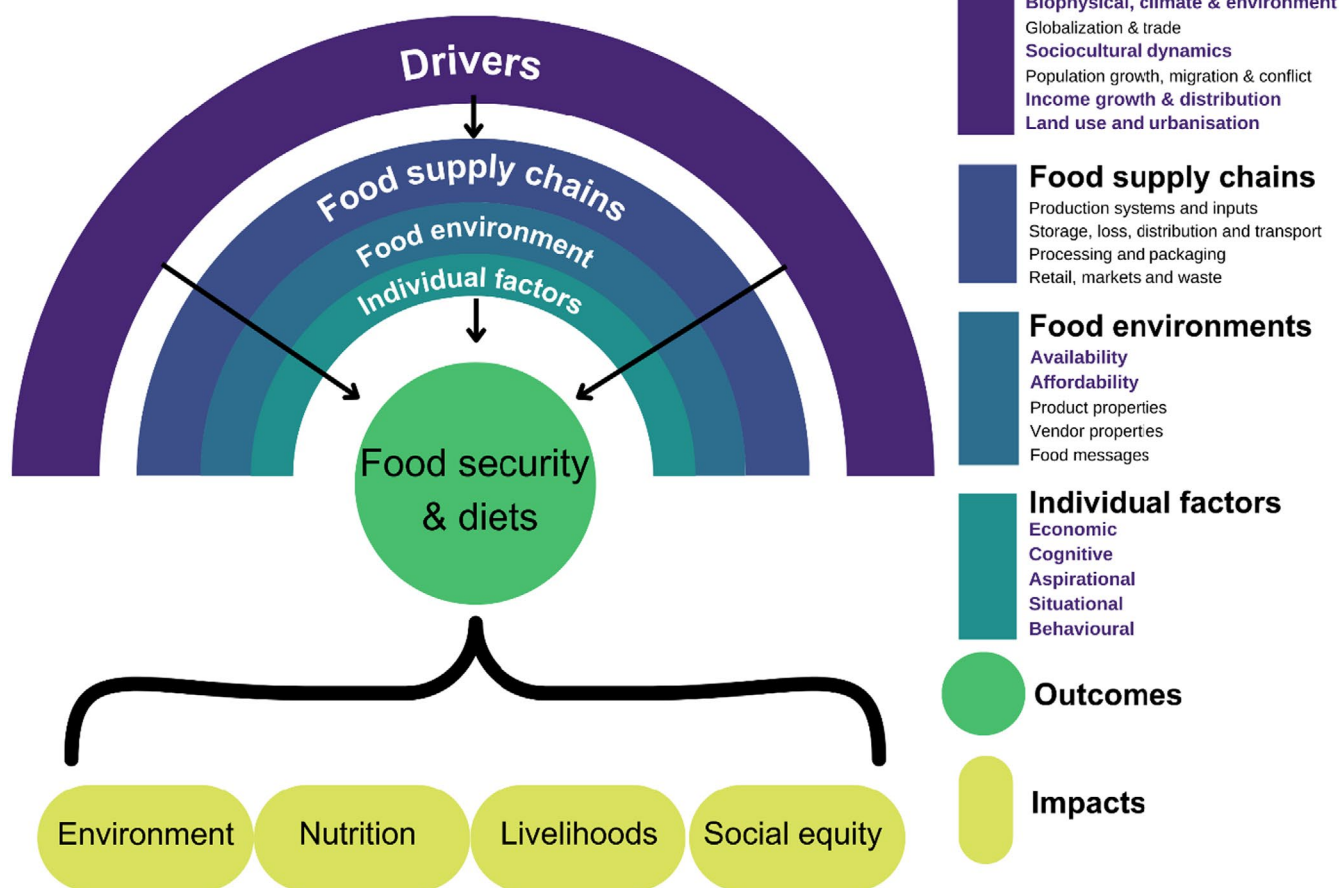
FIGURE 1 The Food System Framework adapted from The Global Alliance for Improved Nutrition (GAIN, 2024). The framework was developed based on the conceptual framework from the High-Level Panel of Experts on Food Security and Nutrition in the Nutrition and Food Systems Report (HLPE, 2017). Drivers, Food Supply Chains, Food Environments and Individual Factors influence food security and diets, which in turn can influence the environment, nutrition, livelihoods and social equity. In this study, we conceptualised the items highlighted in purple text on the right side of the figure as possible predictors of wild meat consumption.

(Brittain, Kamogne Tagne, Roe, et al., 2022), aspiration and economic status (Olmedo et al., 2021). However, the relationship between well-being, poverty and wild meat consumption is highly nuanced, with lower incomes driving wild meat consumption in some regions (e.g. Madagascar; Merson et al., 2019) but preventing it in others (e.g. Gabon; Wilkie et al., 2005). Further research is required to better understand wild meat within different food systems—particularly in understudied regions such as Southeast Asia which are vulnerable to food insecurity, environmental change and overexploitation of wildlife (Harrison et al., 2016; Sundram, 2023; Struebig et al., 2025).

Indonesia exemplifies these challenges as a middle-income country with rapidly transforming food systems (Toiba et al., 2020) and biodiversity that is highly vulnerable to unsustainable hunting (Benitez-Lopez et al., 2019; Struebig et al., 2025) and other co-occurring threats including land-cover change (Jamaludin et al., 2022), fires (Harrison et al., 2024) and infrastructure development (Spencer et al., 2023). This vast archipelago constitutes more than 40% of the Southeast Asian landmass, supporting rich biological (Von Rintelen et al., 2017) and social diversity (BPS, 2024)

across >17,000 islands. In this context, policies and initiatives concerning the sustainability of wild meat are unlikely to be effective if applied uniformly across the nation; instead, they should be designed to be attuned to local contexts and specific needs. To date, wild meat studies in Indonesia have been disproportionately focused within narrow geographic contexts, such as the market-based trade and consumption in North Sulawesi (Bailey et al., 2022; Latinne et al., 2020) or shifts from subsistence to commercial hunting and trade networks in Papua (Pangau-Adam et al., 2012; Pattiselanno et al., 2020). The paucity of information from other Indonesian provinces such as Kalimantan inhibits the development of policies and initiatives to transition towards sustainable wild meat consumption at local and national levels (Struebig et al., 2025).

To address this knowledge gap, we explore wild meat consumption patterns and predictors in two rural landscapes of Central Kalimantan (Indonesian Borneo)—a region that represents rapidly changing livelihoods (Santika et al., 2021; Setyawan, 2010) and landscapes (Meijaard et al., 2013) and biodiversity in need of conservation attention (Spencer et al., 2023). Drawing on The Food System

Framework (GAIN, 2024) and prior knowledge of this region, we examined multiple predictors of wild meat consumption. Working in two contrasting landscapes, we administered a questionnaire containing closed- and open-ended questions to capture measurable factors and subjective perceptions of wildlife abundance and consumption patterns across 28 villages. Overall, we: (1) Characterise the prevalence, frequency and preferences of fish, domestic and wild meat consumption; (2) Identify predictors of more frequent wild meat consumption; (3) Explore local perceptions of biodiversity change and the availability of wild meat; and (4) Provide recommendations for moving towards sustainable consumption in these landscapes.

2 | METHODS

2.1 | Study regions

Our study was focused within Central Kalimantan, Indonesian Borneo, where the livelihoods and basic needs of many rural communities have historically been dependent on forest resources. However, this has been changing over the last two decades alongside a switch to market-driven agriculture and timber plantations (Santika et al., 2021). The region has experienced significant deforestation due to the expansion of these industries, particularly in the lowland peatlands (Jamaludin et al., 2022). As of September 2024, 5.3% of the population in Central Kalimantan were considered to be poor—lower than the 8.6% average across other Indonesian Provinces, which ranged from 3.8% in Bali to 29.7% in Papua Pegunungan (BPS, 2025).

We visited villages across two forested landscapes—Rungan and Sebangau—which lie north and south of the provincial capital, Palangka Raya, respectively (Figure 2). The villages of Rungan surround a ~3100 km² landscape of peat swamp and heath forest, situated between the Rungan and Kahayan rivers. Around 14% of the forest is managed as social forestry (under the village forest scheme, 'Hutan Desa') in which management rights are transferred from the government to local communities. A further 1.6% of the forest is formerly set aside for watershed protection (Hutan Lindung) and the remaining land is allocated for timber production or conversion, primarily for oil palm plantations (MoEF, 2010). Villages of the Sebangau landscape surround ~5700 km² of peat swamp forest between the Katingan and Kahayan rivers, most of which is protected within Sebangau National Park. The national park is surrounded by production and conversion forest, and large-scale oil palm plantations (MoEF, 2010). These two landscapes represent rural communities undergoing environmental and social change, but differ in land-cover composition, land-uses and socio-demographic diversity, and therefore serve as informative case-studies to capture the nuances of consumption patterns.

Both landscapes support a high number of endemic and threatened species (Anirudh et al., 2024; Husson et al., 2018) and have some degree of involvement from local conservation non-governmental organisations. In Indonesia, under the Conservation Act (No. 5) 1990, species are categorised as 'Protected' or 'Unprotected' and are listed under Government Regulation No. 7, 1999 (KSDAE, 2018). Protected species are prohibited from being caught, injured, killed, kept, possessed, cared for, transported or traded, regardless of whether they reside in a protected area. Hunting or collecting of protected or unprotected species is also prohibited within protected areas. However, enforcement of these regulations is hindered by numerous rules for different zones of forests, difficulty in discerning forest boundaries and customary laws for indigenous communities (Setyawan, 2010; Thomas et al., 2023).

2.1.1 | Sampling design

Between October and December 2023, we conducted questionnaires within 28 villages across the Rungan (n=16) and Sebangau (n=12) landscapes. We initially considered 40 villages in Rungan and 19 in Sebangau, selecting the final sample based on spatial distribution, accessibility, population size (fewer than 1500 residents) and recommendations from local collaborators. Approximately 10% of households per village were surveyed (range: 15–47 households), which were identified through systematic sampling wherein every nth household was sampled. Enumerators sought the male household head (aged ≥18 years) for interview, and if he declined or was absent, enumerators continued to the neighbouring house. Whilst we acknowledge that only including men risked losing variation in consumption patterns, our questionnaire was part of a wider study investigating hunting and other forest use activities which are predominantly undertaken by men in these landscapes (Mannion et al., 2025; Meijaard et al., 2013; Wadley & Colfer, 2004; Yi & Mohd-Azlan, 2020). Additionally, it is typical for families in our study landscape to consume meals together, except when men are working in the forest (Namrata Anirudh, pers. comm., June 2023).

Questionnaire data were collected by four teams, each comprising two enumerators local to Central Kalimantan and employed by Yayasan Tambuhak Sinta, an Indonesian social development and research organisation that is independent of any government authorities or wildlife conservation NGOs. Prior to data collection, enumerators underwent a formal training period to familiarise themselves with the aims of the study, practise question delivery and data entry using password-protected KoboToolbox (2018) on smartphones.

2.1.2 | Questionnaire design

Our questionnaire (Appendix S1) contained a mix of closed- and open-end questions enabling us to measure and model potential predictors of wild meat consumption outlined in The Food System Framework (purple text, Figure 1), in addition to capturing personal and contextual nuances regarding wild meat consumption in our study landscapes. To develop questions, we drew on existing literature on wild meat consumption in the tropics and our understanding
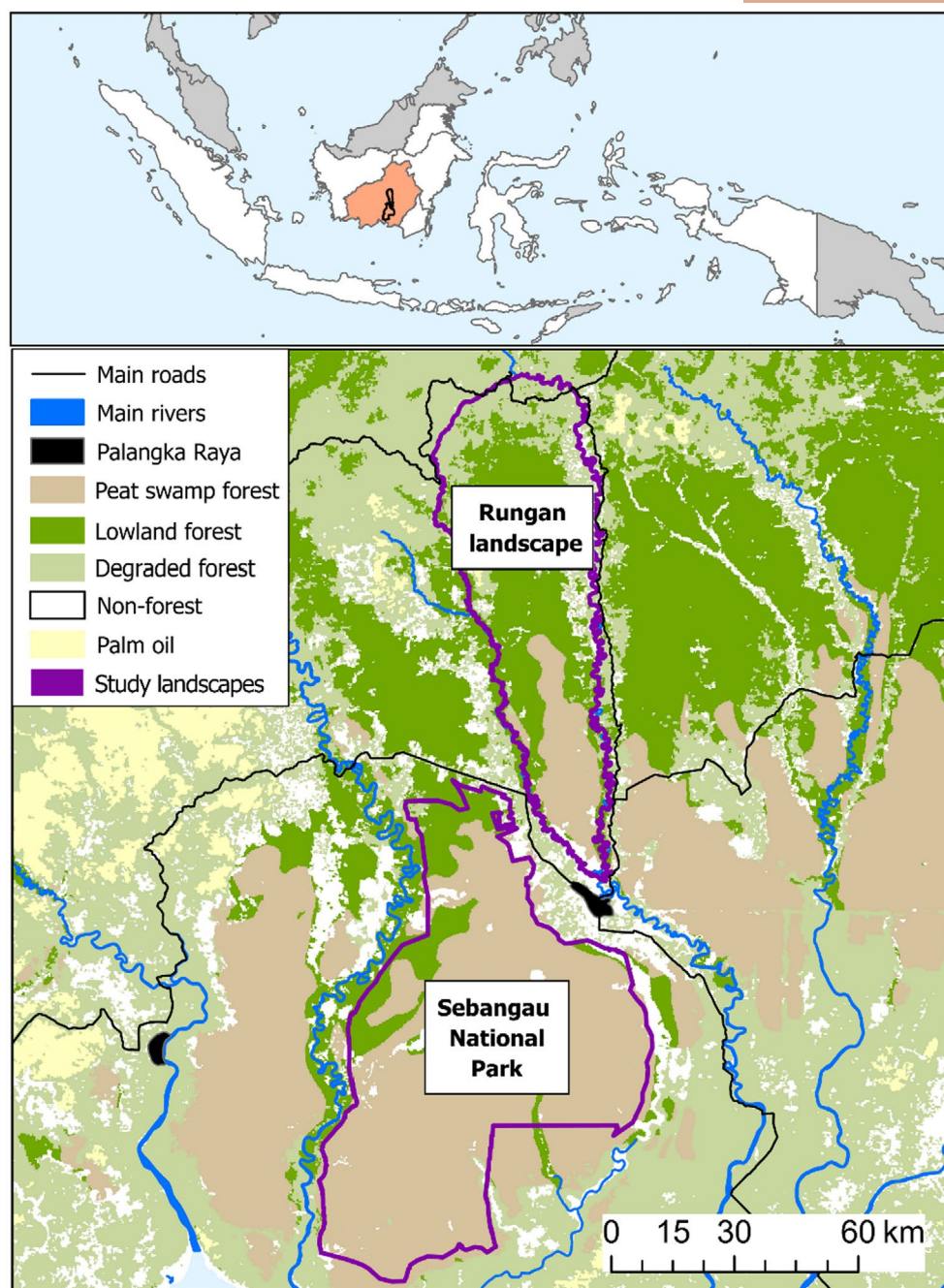
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FIGURE 2 Map of the Rungan and Sebangau landscapes in Central Kalimantan (purple boundaries), including locations of major rivers, major roads, land-cover types and the Provincial capital, Palangka Raya. Exact village locations are not shown to protect anonymity of respondents.

of the food system in these landscapes, with attempts made to standardise protocols from the WILDMEAT Project (https://www.wildmeat.org/). The questionnaire had six subsections: (1) Socio-demographics; (2) Multidimensional well-being; (3) Forest use and accessibility; (4) Wild meat consumption; (5) Hunting; and (6) Local perceptions of biodiversity trends. As the questionnaire was implemented as part of a larger research project, a subsample of questions was utilised for this study.

In section one, respondents were asked socio-demographic questions including age, ethnicity and religion. Recognising the

multiple assets, abilities and attributes that are needed to support and achieve a better life (Alkire, 2015; Sen, 1993), in section two, we measured household-level multidimensional well-being using 10 socio-economic and socio-ecological indicators grouped into five dimensions: education, health, living standards, environment and social cohesion (Table 1). Questions were based on the 'PODES' (*Potensi Desa/Village Potential*) census data collected by Indonesia's Bureau of Statistics to characterise village-level development trajectories. These data have previously been used to examine the well-being implications of oil palm cultivation (Santika et al., 2019), nickel mining (Lo

TABLE 1 Dimensions and indicator questions for our multidimensional well-being index derived from Indonesia's PODES census and adapted from Morgans et al., 2024, Sustainable Development Goals (SDGs) and Indonesia's Village Development Index (Indek Pembangunan Desa, VDI).

Dimensions	Question for indicator	Threshold for household well-being	Supporting reference
Education	What is the highest level/type of education ever achieved or currently being attended by the household head?	None=0; Elementary=1; Senior high school, Islamic senior high, Vocational high, Junior high, Diploma or higher=3	VDIs, SDGs
Health	In the past 12 months, how often have you or your household had to eat a limited variety of foods because of lack of resources?	Never=3; Rarely=2; Sometimes=1; Often=0	VDIs, SDGs
	If someone in your household needed medical treatment, how easy would it be to access?	Very easy or easy=2; Ok=1; Difficult or very difficult=0	VDIs, SDGs
Living standards	What is your main source of drinking water?	Water is primarily obtained via an improved source (e.g. bottled, plumbing, borehole and pump)=1; If an unimproved source (e.g. river, rain)=0	VDIs, SDGs
	What is your main type of toilet facility?	Has access to a private toilet=1; Shared, public or none=0	VDIs, SDGs, Santika et al. (2021)
	What is your main fuel for cooking?	Gas or electricity LPG=1; Kerosine, coal or firewood=0	VDIs, SDGs, Santika et al. (2021)
	What is your main source of light?	PLN=1; Non-PLN=0	VDIs, SDGs
	What is the main material of your house floor?	Any material other than earth=1; Earth=0	VDIs, SDGs
Environment	Has the soil, air or water quality in the village changed in the past 12 months?	Quality has increased=2; Stayed the same=1; Declined=0	SDGs, Santika et al. (2021)
Social cohesion	Have you participated in any of these community activities in the past 2 weeks?	Participated in sports, religious or community service (1 point for each, if none=0)	Santika et al. (2021)

et al., 2024) and protected areas (Morgans et al., 2024) in Indonesia. Here, we adapted indicators for household-level data collection. We also followed '*Has air and water quality in the village changed in the past 3 years?*' with an open-ended question '*Please explain how it has changed*' to provide more context and understanding.

In section three, we asked respondents about trips to the forest and livelihood activities undertaken there. In section four, respondents were asked about fish, domestic and wild meat consumption. Throughout, we use the generic term 'wild meat'; translated to Bahasa Indonesia language as '*daging hewan liar*'. We described wild meat to respondents as all meat from wild animals including birds, mammals, reptiles and amphibians, but excluding fish (Ingram et al., 2021). We asked: '*How often do you typically eat [insert meat]*' and responses were reported on a 7-point scale (*more than once a week, once a week, 2–3 times a month, once a month, less than once a month, less than once every 6 months, never*) and respondents were asked to rank their top three preferred meats. Respondents were also asked why they do not eat wild meat more often. Those that reported eating wild meat were asked to list all of the wild animals they had eaten during the last 12 months and follow-up questions regarding the frequency, reason for consumption and method of acquisition. Picture cards with illustrations of wild animals were available if enumerators or respondents

wished to confirm any species. To understand changing consumption patterns, we also asked '*Are there any wild meats you used to eat but are no longer available around here?*'.

In section five we asked about hunting behaviours including '*Have you caught or hunted any animals in the last 12 months?*'. Finally, in section six, respondents were asked about their perceptions of wildlife population trends in forests surrounding their village. This included a closed-ended question explicitly regarding changes to bearded pig populations: '*In the last two years, do you think the number of bearded pigs around these forests has increased, decreased, or stayed the same?*' as we were interested in the implications of African Swine Fever which was first reported in Kalimantan in 2021 (Daniel et al., 2024). We also asked an open-ended question to understand broader perceptions of biodiversity change and contextualise our quantitative findings: '*Thinking about the last 10 years, are there any animals in the forest you have noticed increasing or decreasing in number?*' with a follow-up question '*Please explain what changes you have noticed and why you think they have occurred?*'.

We asked direct questions regarding wild meat consumption and acknowledge that some respondents might find this a sensitive topic due to legal and/or cultural sensitivities surrounding the behaviour, which could have introduced non-response or social

desirability biases (Nuno & St. John, 2015). However, alternative approaches, including specialised questioning techniques (SQTs) were less appropriate for key reasons. Firstly, our experiences from the landscapes indicated people were generally willing to discuss wild meat consumption and associated law enforcement was limited. Secondly, SQTs have had mixed success in Indonesia, for example, use of the randomised response technique for hunting (St. John et al., 2018). The potentially low sensitivity and prevalence of wild meat consumption, coupled with our aim of gathering information about a wide range of species, make SQTs particularly unsuitable (Ibbett et al., 2022). Instead, we took steps to reduce potential biases, including ensuring interviewee anonymity, asking sensitive questions towards the end of questionnaires (Brace, 2018) and conducting interviews with local enumerators in a conversational manner (Tourangeau & Yan, 2007).

The questionnaire was drafted in English then translated into Bahasa Indonesia by A and N.B.A, before being cross-checked and adapted into a more local conversational manner by the survey team. Following revisions, the final version of the questionnaire was deployed using KoboToolbox (2018) loaded onto smartphones (Xiaomi Redmi 8A). Each question was read aloud to the respondent and answers were recorded by enumerators. On average, the questionnaire took approximately 30 min to complete.

2.2 | Data analysis

Prior to analyses, we prepared the data in the following ways. Ambiguous species (those that were not reliably or consistently identified by respondents) were regrouped to genus or family-level (e.g. mouse-deer [*Tragulus* spp.], porcupine [Hystricidae], muntjac [*Muntiacus* spp], civet [Viverridae], large bats [*Pteropus* spp.]). Therefore, the number of species we report will be a minimum number. For the frequency of wild meat consumption (response variable), we grouped respondents who reported consuming '*once a week*', '*2 to 3 times a month*', '*once a month*' and '*less than once a month*' into one category '*less than once every six months*' due to a low number of respondents who reported consuming meat in each of these categories. This resulted in three consumption categories: '*never*', '*less than once every 6 months*' and '*more than once every six months*'. As the response variable was an ordered categorical variable, we implemented ordinal logistic regression (OLR) analysis using the *clmm* function (cumulative link mixed method) in the *ordinal* package. In all models, villages were included as a random effect to allow for the nesting of households within villages. In ordinal logistic regression, an odds ratio of greater than 1 indicates a higher probability of more frequent wild meat consumption with each unit increase in the explanatory variable, whilst an odds ratio of less than 1 indicates the probability of consumption decreases with the explanatory variable. Only odds ratios with confidence intervals that do not cross one are considered significant.

We explored several explanatory variables that can influence wild meat consumption in rural tropical regions. These included

respondent age, regional differences, town or village size (number of households), distance to nearest urban centre (proxy for market access), whether the respondent had visited the forest or hunted in the last 12 months, multidimensional well-being, food security and living standards. All explanatory variables were derived from the questionnaire apart from travel time to the nearest urban centre, which was estimated from a map of urban centres with 200,000–500,000 people from Nelson et al. (2019) (i.e. the population size for the provincial capital, Palangka Raya). To generate a household-level multidimensional well-being score (hereafter, referred to as '*well-being*'), responses to indicator questions were assigned a score, where higher scores reflect a higher level of well-being (Table 1). Indicator scores were equally weighted and rescaled between 0 and 1 to provide a continuous measure of well-being across each of the five dimensions included in the questionnaire.

All continuous variables were standardised (mean of zero and standard deviation of one) and checked for normality assumptions by inspecting residuals; no overdispersion was detected. We also tested for pairwise multicollinearity between variables and excluded models with collinear variables. Finally, we compared the models based on their Akaike information criterion (AIC) values and selected the top model guided by the lowest AIC which also had >2 AIC units between the next model. All analyses were conducted in R version 4.3.2.

Finally, we also considered answers to open-ended questions to acknowledge the respondents' subjective experiences. Responses were translated into English by fluent and bilingual Indonesian speakers, including the co-authors of this paper. We explored our open-ended question(s) using a qualitative content analysis. All answers were reviewed and coded iteratively to identify recurrent patterns across respondents. This approach enabled a more in-depth understanding of individuals' perceptions of biodiversity and environmental change in relation to their meat consumption that complemented the questionnaire results.

2.2.1 | Ethical considerations

We designed and implemented the study with the ethical considerations of the respondents in mind (Brittain et al., 2020; Ibbett & Brittain, 2020). Enumerators were familiar with the study landscapes, cultural norms and expectations, and were fluent in Bahasa Indonesia and Bahasa Ngaju (local language). Upon arrival in each village, enumerators held a meeting with the village head to explain the research aims and gain permission to work in the community. Before each interview, a participant information sheet was read to the respondent to explain the research aims, proposed use of the data for academic purposes, assure anonymity and clarify that they were free to end the interview at any time and/or refrain from responding to any questions. After explaining this, verbal consent was acquired to continue with the questionnaire. We avoided signing documents as this has proven to be problematic in other Indonesian landscapes (e.g. Ardiantiono et al., 2021).

No personal information that could identify the participant was recorded, including names, addresses or the geographic location of the house. Upon review of all documentation, the study received ethical approval from the University of Kent's Research Ethics Committee (05-PGR-21/22) and Indonesia's National Research and Innovation Agency (023/KE.01/SK/01/2023).

3 | RESULTS

3.1 | Socio-demographics of respondents

In total, 632 men completed our questionnaire across the Rungan ($n=318$) and Sebangau ($n=314$) landscapes. The average age of respondents was 46 (Rungan range: 19–82, Sebangau: 21–79). Most respondents (95% in Rungan, 86% in Sebangau) were of Dayak origin (the collective name for indigenous ethnic groups across Borneo). Christianity was the prominent religion in Rungan (88%), followed by Islam (8%), whereas Islam was practised by most respondents in Sebangau (84%) followed by Christianity (13%). The main occupation in Rungan was mining (39% of respondents, 98% of which was for gold), followed by services (14.8%), rubber (8.8%), fishing (6.2%) and palm oil (4.4%). In Sebangau, the main occupation for respondents was fishing (46.8%), rubber (15.0%) and services (10.8%). The highest level of formal education completed by respondents varied between landscapes; approximately 78% of respondents in Rungan and 54% from Sebangau were educated above elementary level (6 years). A summary of landscape characteristics is outlined in Appendix S2.

3.2 | Household well-being and food security

For those that answered all well-being questions, the average score in Rungan (mean: 0.63, range: 0.28 to 0.90, SD: 0.10) indicated respondents had marginally greater overall well-being than those in Sebangau (mean: 0.57, range: 0.29 to 0.93, SD: 0.18). In a question directly relating to food security, '*In the past 12 months, how often have you or any members of your household had to eat a limited variety of foods because of lack of resources?*' respondents from Rungan and Sebangau had similar responses. Most said 'never' (60.1% and 65.6% respectively), followed by 'rarely' (28.0%, 24.8%), 'sometimes' (6.3%, 7.6%) and 'often' (2.2%, 1.6%).

3.3 | Meat consumption prevalence, frequency and preferences

In Rungan, 99% of respondents ate any type of meat—only three did not, which they attributed to taste ($n=2$) and personal welfare ($n=1$). In Sebangau, 100% of respondents reported eating meat. In Rungan, most people typically consumed freshwater fish (96% of respondents), chicken (95%), wild meat (78.7%) and domestic pig (70%). In Sebangau, most people typically consumed freshwater fish (99%), chicken (97%), cow (40%) and marine fish (18%). Nearly twice as many respondents in Rungan had eaten wild meat in the last 12 months (78.7%), compared to Sebangau (41.4%) (Figure 3a). Frequency of wild meat consumption was relatively low, with typical consumption occurring less than every 6 months in both landscapes (Rungan=49.8%, Sebangau=34.1%). However, a greater number
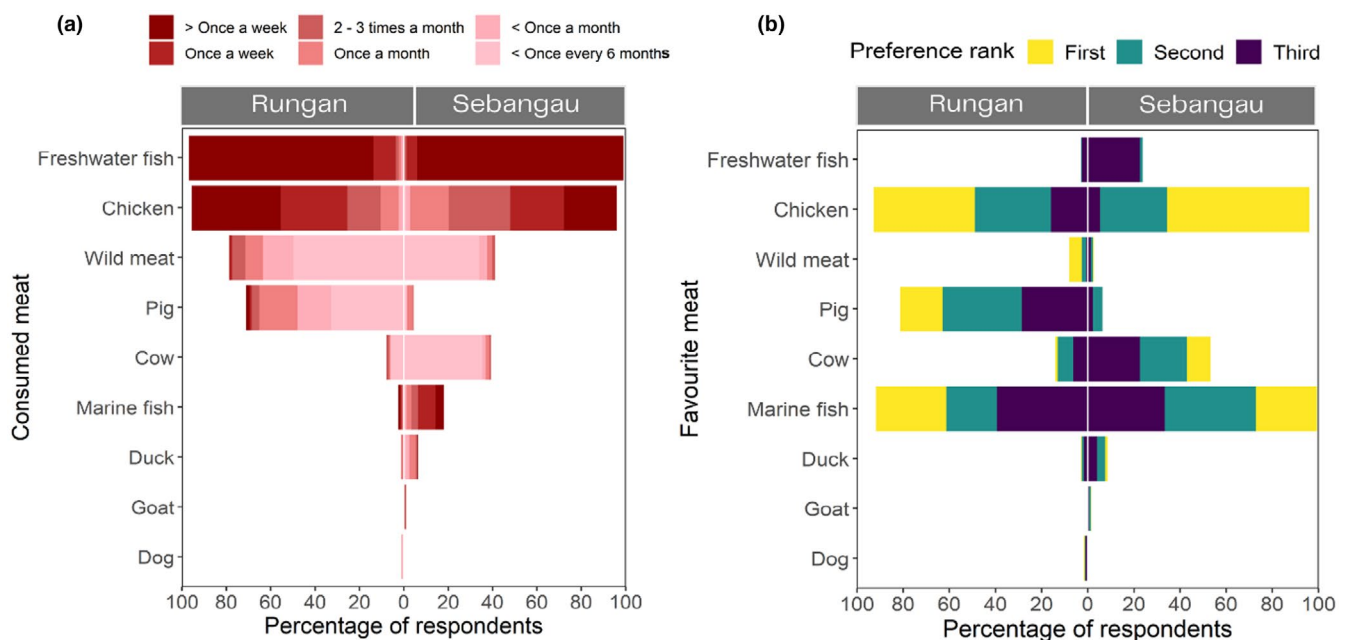

FIGURE 3 Domestic, wild meat and fish consumption patterns across Rungan ($n=315$) and Sebangau ($n=314$); (a) The self-reported frequency and prevalence of each meat typically consumed, with darker colours indicating more frequent consumption, and (b) Preference ranking (top three) of each meat ordered to match panel (a) (most consumed species).

of respondents reported more frequent wild meat consumption in Rungan than in Sebangau. No respondents ate wild meat more than once a week.

In terms of preference, chicken was ranked first by the most respondents in both landscapes (Rungan = 43.9%, Sebangau = 61.8%), followed by marine fish (Rungan = 30.5%, Sebangau = 26.4%), then pig (18.4%) and wild meat (5.4%) in Rungan, but cow (10.2%) and duck (1%) in Sebangau (Figure 3b). Although freshwater fish was the most frequently consumed meat, it was not ranked first by any respondents in either landscape.

3.4 | Species-level wild meat consumption patterns

Overall, at least 24 wild taxa were consumed during the last 12 months across both landscapes (Figure 4). Of these, at least 45.9% were on the Indonesian Protected Species List and vulnerable or higher on the IUCN Red List of Threatened Species (Appendix S3). A minimum of 24 taxa were consumed in Rungan, with a mean of 1.7

per respondent (range: 1–15; SD: 1.4). Bearded pigs were consumed by most people (70.0%), followed by mouse-deer (14.6%), large bats (10.2%), squirrels/tree shrews (7.3%) and unspecified birds (6.3%). In Sebangau, at least 11 taxa were consumed (mean 1.1 per respondent, SD: 0.4, range: 1–4). Muntjac species were the most consumed (15.6%), followed by bearded pig (10.8%), unspecified bird (5.4%), mouse-deer species (4.5%) and squirrel/tree shrews (2.5%). Whilst 13 species were consumed in Rungan that were not reported for Sebangau (Figure 4), no species were only consumed in Sebangau.

Respondents also identified 25 taxa that they used to eat but were no longer available to them (Rungan, n = 24; Sebangau, n = 17) (Figure 4). The three species reported by the most respondents as no longer available were also those eaten by the most respondents during the past 12 months (bearded pig, mouse-deer spp., muntjac spp.), explaining the low frequency of consumption. However, species that had not been consumed in the last 12 months by any respondent, such as pangolin, orangutan, binturong and porcupine, were also reported. In Rungan, the species cited by most respondents were bearded pig (35.6%), muntjac spp. (21.0%), mouse-deer
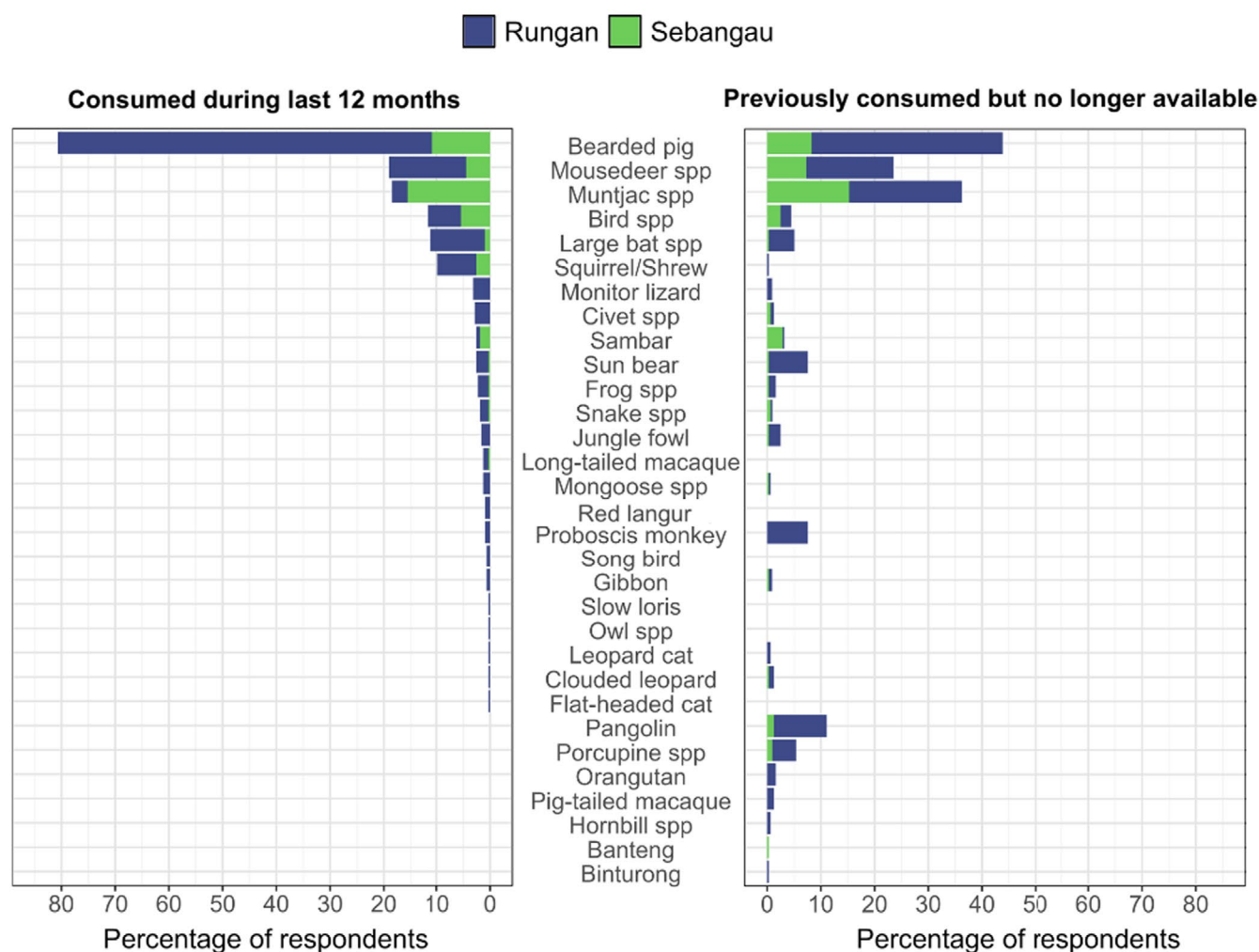

FIGURE 4 Percentage of respondents in each landscape (dark blue = Rungan, green = Sebangau) that reported consuming each wild species in the last 12 months (left panel), and wild species that used to be consumed but were no longer available (right panel).

spp. (16.2%), pangolin (10.0%), proboscis monkey (8.0%) and sun bear (7.3%). In Sebangau, the species cited were muntjac spp. (15.3%), bearded pig (8.3%) and mouse-deer spp. (7.3%).

The frequency of consumption of each wild species was variable, though typically less than once every 6 months, particularly in Sebangau. In both landscapes, birds and squirrels/tree shrews were eaten the most frequently (Figure 5). When asked to list up to three reasons why they had consumed each species, data grouped across all taxa identified taste as the primary motivation (mentioned by 87.7% of wild meat-eating respondents in Rungan and 82.4% in Sebangau). The second most reported reason, albeit to a much lower extent, was that the animal was easily obtained (13.2% Rungan; 21.8% Sebangau). In both regions, species such as sun bear, snake, proboscis monkey, large bats and monitor lizard were eaten for health or medicinal reasons, in addition to their taste. Overall, the primary method of meat acquisition in Rungan was catching the animal from the forest (57.7%). However, some species (e.g. bearded pig) were primarily bought. In Sebangau, respondents typically bought their wild meat from hunters inside the village (40.6%) or a market outside the village (32.3%).

3.5 | Predictors of wild meat consumption frequency

In our top ordinal logistic regression model of wild meat consumption frequency, multidimensional well-being score (estimate 0.52, SE = 0.12, $z = 4.21$, $p < 0.001$), region (estimate −1.72, SE = 0.39, $z = −4.46$, $p < 0.001$) and whether the respondent had hunted in the last 12 months (estimate 2.32, SE = 0.27, $z = 8.74$, $p < 0.001$) all had a significant effect. Additionally, there was a significant interaction effect between a respondent's hunting status and well-being score (estimate = −0.60, SE = 0.28, $z = −2.16$, $p < 0.05$).

For a one-unit increase in well-being score, the odds of consuming wild meat more frequently increased by 67% (OLR: 1.67; 95% CI 1.32–2.12). The odds of consuming wild meat more frequently were 20% greater in Rungan compared to Sebangau (OLR: odds ratio 1.20; 95% CI 1.09–1.47). Finally, for respondents who had hunted in the last 12 months, the odds of consuming wild meat more frequently were 10 times greater than those who had not (OLR: 10.15; 95% CI 6.05–17.12), holding all other variables constant. However, the effect of well-being on wild meat consumption was dependent on whether the respondent had hunted; higher well-being was associated with increased odds of wild meat consumption, but this association was stronger for those who had not hunted. The predicted probabilities of respondents in each region, hunting status and well-being score are shown in Figure 6.

To validate if a higher well-being score was associated with greater capabilities to obtain or purchase alternative meats/proteins, we repeated the model for chicken consumption (the overall favourite meat but not eaten daily by all respondents) and again for freshwater fish (not a favourite meat but eaten daily by most respondents). A higher well-being score was significantly related to higher odds of consuming chicken daily in both landscapes (OLR: 1.47; 95% CI 1.19–1.82), whereas there was no relationship between well-being and freshwater consumption (Appendix S4).

3.6 | Barriers to wild meat consumption

Respondents identified up to three reasons why they had not consumed meat more often (Figure 7). In Rungan, if respondents had eaten wild meat in the last 12 months, the top reported reasons for not eating it more often were the cost (52%), followed by accessibility (35.1%). However, in Sebangau, accessibility was reported most often (68.4%), followed by cost (51.9%). Across both regions, if respondents had not eaten wild meat in the last 12 months, the most reported reason was limited access to wild meat (70.2% Rungan; 53.6% Sebangau), followed by its cost (Rungan = 14.9%; Sebangau = 34.8%).

3.7 | Local perceptions of biodiversity and environmental change

When asked directly, 76% of respondents in Rungan and 50.6% in Sebangau, reported that bearded pig populations had declined during the last 2 years. This was further supported by qualitative findings, particularly in reference to availability of pig meat: 'The wild boar species that hunters obtain or sold in the village are almost gone and mouse-deer is decreasing because habitat or forest has been reduced' (Rungan, Christian Dayak, 56) and 'Yes animals are declining, especially wild boars that are found or sold in villages' (Rungan, Christian Dayak, 39).

Regarding broader changes to all wild animal populations, approximately half had noticed changes (Rungan = 50.3%, Sebangau = 45.9%), a third were not sure (35.2%, 32.2%) and few reported no changes (13.8%, 22.0%). Respondents discussed a wide range of topics in relation to wildlife change. A common theme was the impact of surrounding environmental degradation, including land-use change, deforestation, fires and climate change on wildlife populations and wild meat availability. One respondent reported 'The number of animals that are usually hunted (wild boars, mouse deer) are increasingly rare, since oil palm plantation companies have reduced the animals' habitat' (Rungan, Christian Dayak, 41). Similarly, infrastructure development was also mentioned as a driver of change, with one participant explaining, 'Usually, wild boars often enter the plantations of residents in the village, but after the road was built behind the village and a palm oil company cleared the forest, it caused habitat loss; we cannot see the boar again' (Sebangau, Dayak Muslim, 59). Respondents also connected wildlife declines to past and recent fires 'Before the (2015) fire, the wild animal population had already decreased because in 1997 there was a big fire, so the animal population continued to experience a decline every year' (Sebangau, Muslim Dayak, 52). These sentiments were not exclusive to mammals, 'I used to eat big frog (local name bahuya). Before it
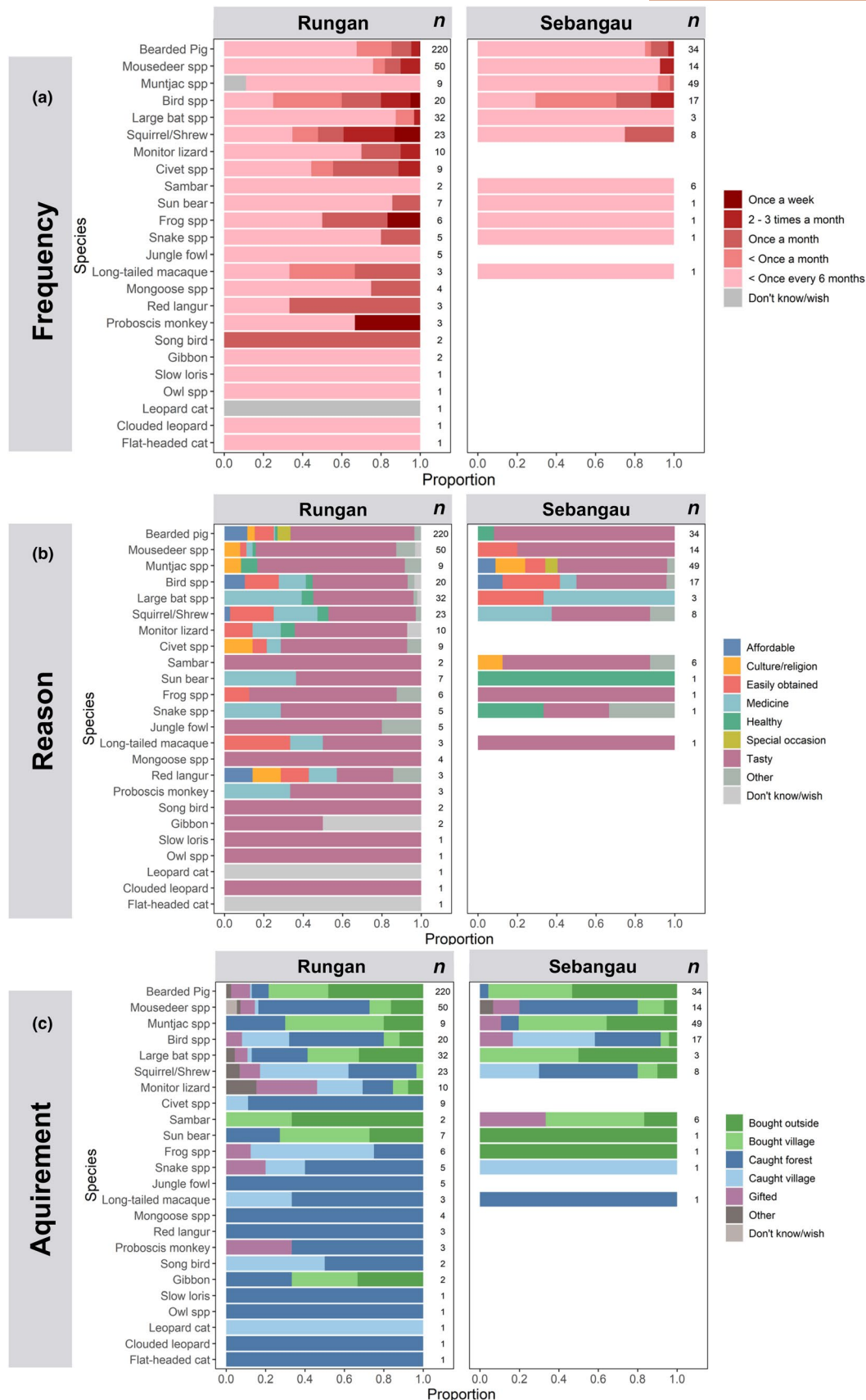
FIGURE 5 Patterns in the frequency, reasons for and acquisition of consuming each wild species within the last 12 months across Rungan and Sebangau; *n* = number of respondents that reported consuming each species.
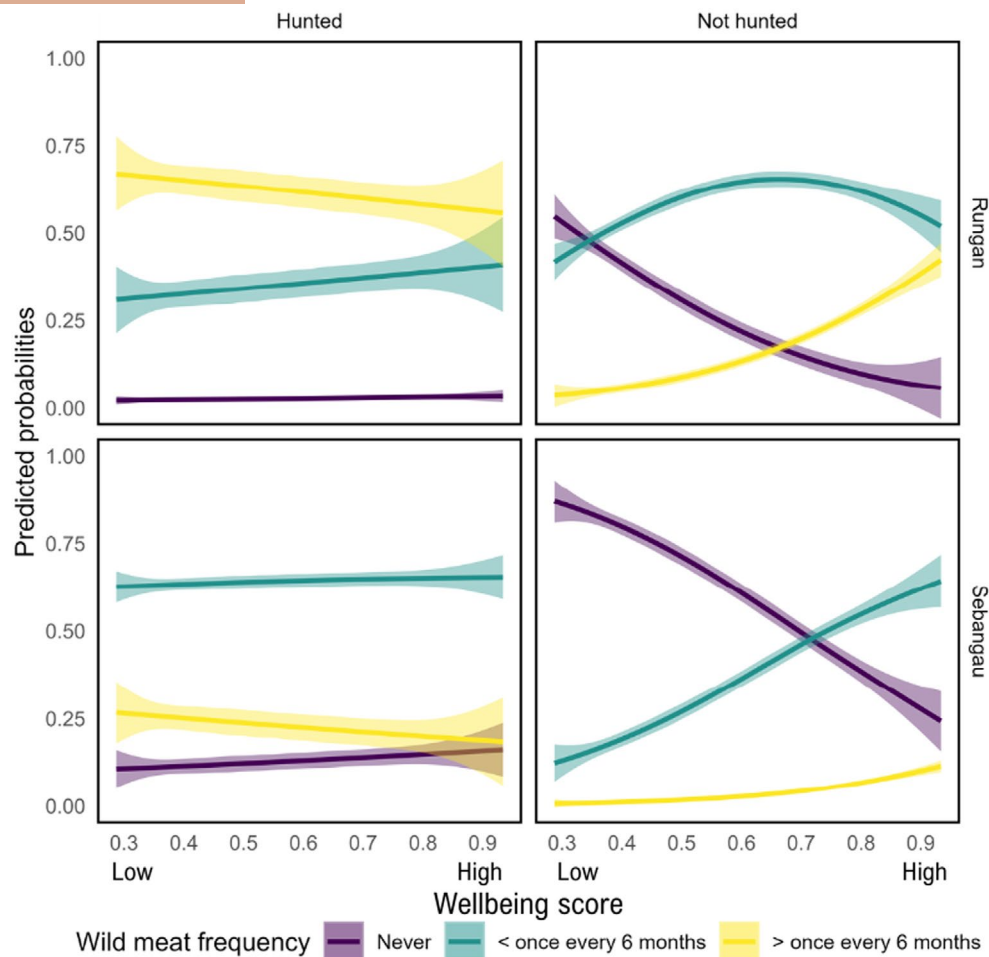
FIGURE 6 Predicted probabilities of respondents for consuming wild meat at different frequencies (never, < once every 6 months and > once every 6 months) based on their hunting status (hunted, not hunted) during the last 12 months, region they reside in (Rungan, Sebangau), and multidimensional well-being score (0 = lowest well-being and 1 = highest well-being).

was easy to find around the Kahayan River but now it's difficult to find. About wildlife... I think that is declining because the habitat is disturbed especially because of fire' (Rungan, Christian Dayak, 62).

Respondents were also concerned over declining fish stocks—climate change, pollution and environmental degradation were all reported as contributing factors. One respondent referenced the droughts experienced in recent years: '[I am] noticing the freshwater fish sector and the drivers of freshwater fish declines because of the dry season' (Rungan, Christian Dayak, 58). When asked if soil, air or water quality had changed recently, one respondent shared, '...Cannot predict for fish catch this year (2023); along with the dry season, it is very difficult to reach fishing spots. Also, pollution from illegal mining and waste make it harder to get fish' (Sebangau, Muslim Dayak, 29). Similarly, another described how polluted water and drought have implicated fishing activities, stating, 'The foggy weather conditions this year were due to fires and long drought, which made fishing activities difficult to carry out, especially as a source of income to meet household needs' (Sebangau, Muslim Dayak, 53).

Responses also suggest that hunting preferences and food choices impacted species level patterns. For example: '[Animals are]

increasingly reduced due to illegal hunting such as snares and weapons' (Sebangau Dayak Christian, 41). Those species not commonly consumed were perceived as increasing due to low hunting pressure, 'Wild animals are decreasing due to hunting, except monkeys are increasing because no one is hunting them and these animals are raiding the community's fruit and crops' (Rungan, Dayak Christian, 69).

4 | DISCUSSION

Wild meat is important for many rural communities residing near tropical forests (Ingram et al., 2021; Nielsen et al., 2018). However, the patterns and drivers of its consumption are evolving due to surrounding environmental and socio-economic change, which has important implications for its sustainability (Coad et al., 2019; Ingram, 2020). We examined these factors alongside local perceptions of wildlife population change across two rural landscapes in Indonesian Borneo. Our findings imply a decline in the availability of wild meat, likely caused by multiple anthropogenic and environmental stressors acting synergistically to negatively impact wildlife populations. Wild meat was typically
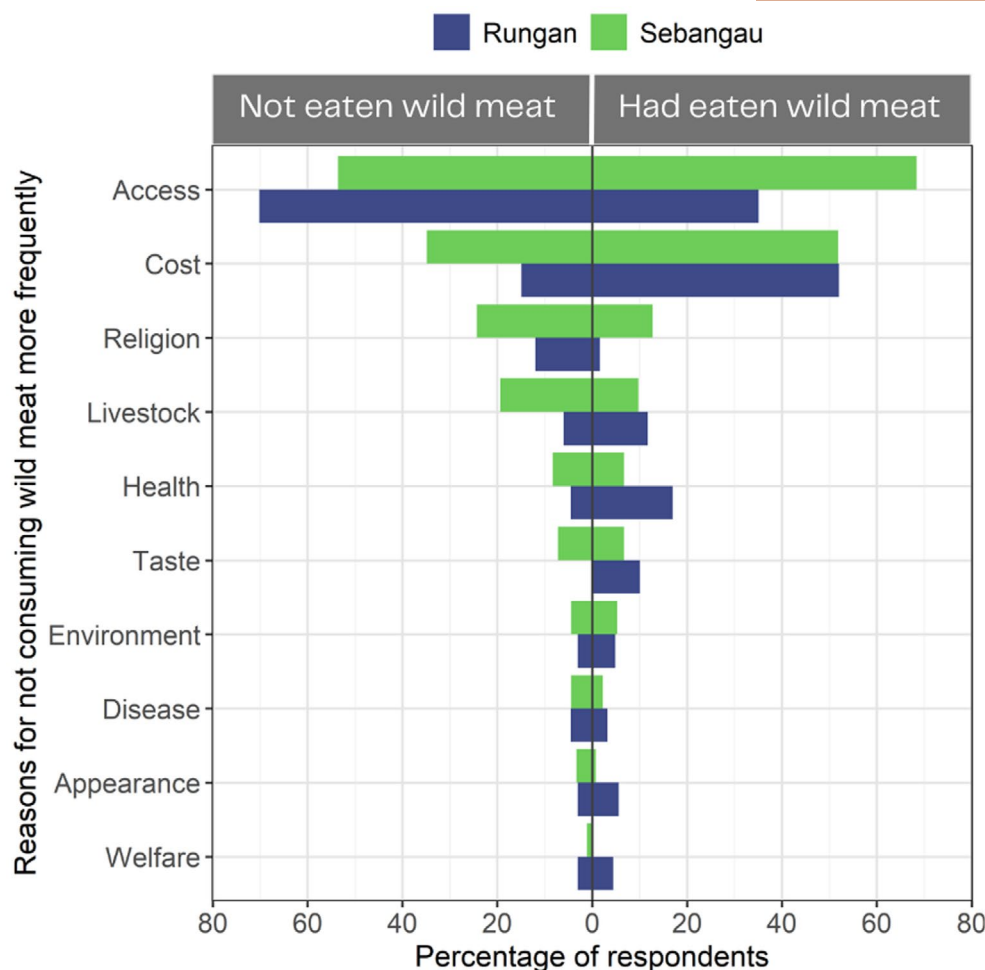
FIGURE 7 Self-reported reasons for not consuming wild meat more frequently in Rungan (dark blue) and Sebangau (green), split by those who had not eaten wild meat in the past 12 months (left panel) and those who had (right panel).

consumed less than once every 6 months, and we found individuals who hunt or have higher well-being have the capabilities to access wild meat more frequently. Moreover, freshwater fish were the primary protein source for most respondents and an important occupation, underscoring the need for protecting the environmental health of watercourses and the long-term viability of fish stocks for livelihoods and food security.

4.1 | Prevalence and frequency of wild meat consumption

Wild meat was consumed by 78.7% and 41.4% of interviewed men in Rungan and Sebangau, respectively (Figure 3a). Across the tropics, wild meat serves as a crucial source of protein for millions of rural people (Nielsen et al., 2018). However, this was not evident in the region we studied in Central Kalimantan, as the frequency of consumption was relatively low, with most respondents consuming wild meat less than once every 6 months (Figure 3a). This was somewhat unexpected given that most respondents were Dayak, with historically strong cultural ties to the forests (Luardini, 2016;

Meijaard et al., 2013), including traditions of hunting and consuming a wide range of wild animals (Puri, 2005; Setyawan, 2010). Whilst comparable studies are lacking for Central Kalimantan, an earlier study within neighbouring Malaysian Borneo found wild meat was typically eaten weekly, though it formed a greater proportion of meals in more remote and rural areas (Bennett et al., 2000). More recently, Kurz et al. (2021) found 72% of respondents in rural villages in Sabah ate bearded pig weekly or more frequently. When we asked respondents why they had not eaten wild meat more often, issues with accessibility and cost were typically cited, echoing trends across the tropics. For example, in a large-scale analysis across the Global South, 76% of communities that considered wild meat to be the most important environmental product for people's livelihoods also perceived it to be declining—predominantly in Indonesia, Bolivia, Brazil, Cambodia, Ghana, Uganda and Mozambique (Nielsen et al., 2018). This has also been reported at local scales; for example, in Bintulu, Sarawak (Malaysian Borneo), 43% of people reported that they could not consume as much wild meat as they had in the past (Thomas et al., 2023), and in North Sulawesi, hunters for wild meat markets reported many species to be insufficiently abundant to be hunted anymore (Latinne et al., 2020).

Similar to other studies across Borneo (Bennett et al., 2000; Cheyne et al., 2016; Mannion et al., 2025; Puri, 2005; Yi & Mohd-Azlan, 2020), the most commonly consumed species included bearded pig, muntjac and mouse-deer (Figure 4). Bearded pigs are the favoured game meat for non-Muslim communities throughout much of Borneo and are strongly tied to food provision, gifting and cultural aspects of celebrations and feasts (Kurz et al., 2021; Puri, 2005). However, 76% of respondents in Rungan and 50.6% in Sebangau believed bearded pig populations had declined during the last 2 years. This could be due to a combination of stressors but is likely attributed to the spread of African Swine Fever, which caused mass pig deaths across Borneo after 2021 (Daniel et al., 2024; Luskin et al., 2023). Additionally, a high number of respondents reported that bearded pig meat was no longer available (Figure 4), and the frequency of consumption was lower than expected (Figure 5) based on reported levels of consumption prior to the outbreak across Borneo (Puri, 2005). A similar finding was also reported from residents in the Temburong district of Brunei Darussalam in 2022, whereby bearded pigs were reported as being unusually scarce (Mannion et al., 2025).

In contrast, despite being rarely or never reported as eaten in the last 12 months, pangolin, proboscis monkey and porcupine were disproportionately reported as previously consumed but no longer available (Figure 4), which echoes patterns of over-hunting and extirpations of populations of these species across their ranges (Atmoko et al., 2024; Gomez, 2021; Nijman, 2023). Interestingly, a study conducted across Kalimantan a decade ago by Cheyne et al. (2016) found that the most hunted species were deer, bearded pigs and pangolins—which were among the top five most reported as no longer available in our study. These findings imply that current consumption patterns reflect what is available to catch, sell or buy as wildlife populations decline—a trend that has been observed elsewhere in Indonesia and across the tropics (Ripple et al., 2016). For example, in North Sulawesi, declining wildlife populations have altered the species assemblages in markets, and hunters reported down-sizing of species available to catch (Bailey et al., 2022; Latinne et al., 2020). This has also been observed in the Amazon (Scabin & Peres, 2021) and Central Africa (Beirne et al., 2019), and we also found smaller species (e.g. squirrels and tree shrews) being consumed more frequently than larger species (Figure 5) with very few respondents citing these as no longer available to eat (Figure 4).

Despite infrequently eating wild meat, respondents rarely reported having a limited variety of foods to eat, which may be attributed to living alongside rivers and accessibility to freshwater fish as a key protein source. Between 96% and 99% of respondents ate freshwater fish regularly—typically daily (Figure 3a). Similarly, in Malaysian Borneo, Kurz et al. (2021) found wild meat to be a favoured delicacy but not an essential food source among people who also had access to wild fish and domestic chicken and pork, whilst Yi and Mohd-Azlan (2020) found communities were dependent on wild meat because alternative meat sources were not available. This highlights the need to consider the wider food environment when designing wild meat initiatives or alternatives. Though freshwater fish has been the traditional source of high-quality animal protein in rural Indonesian communities (Khusun et al., 2022), its role in food security and nutrition strategies at the national level has received limited attention compared to marine sources (McIntyre et al., 2016). Our results provide key evidence that freshwater environments are a crucial part of local food systems and should be recognised as a key contributor to food security and nutrition outcomes (Manohar et al., 2023). Concerningly, some respondents in our study reported declining river health and fish yields in recent years due to environmental degradation caused by mining activities, climate change and deforestation. Therefore, our findings could indicate a potential food and livelihood security issue for villages in these landscapes in the near future, and also raise questions regarding how wild meat consumption could change if alternative sources of protein were removed (Brittain, Kamogne Tagne, Booker, et al., 2022).

4.2 | Predictors of wild meat consumption

There were contrasting patterns of wild meat consumption in the two study landscapes. Respondents in Rungan were 20% more likely to consume wild meat more frequently (Figure 6); they also reported eating a greater diversity of species (Figure 4). This was somewhat expected since the population in Rungan is predominantly Christian, whilst Sebangau is predominantly Muslim. Across Southeast Asia, hunting for wild meat tends to be lower in areas with Muslim communities due to religious dietary restrictions such as prohibiting consumption of pork and 'cold-blooded' animals (Harrison et al., 2016; Mannion et al., 2025).

Greater respondent well-being was also associated with more frequent wild meat consumption, especially among those who had not hunted in the past year (Figure 6). Well-being scores were indicative of a person's capability to access resources, which, in turn, should enable greater choice over their consumption habits. Similar patterns have been observed in urban environments (McNamara et al., 2019; Olmedo et al., 2021; Wilkie et al., 2005), but our research sheds new light on this relationship in rural settings in Southeast Asia. It also challenges the assumption that wild meat consumption is primarily linked to poverty in rural landscapes, as has been found in other tropical forests (e.g. Merson et al., 2019). Our findings could be due to the declining availability and increasing cost of wild meat, whilst also having freshwater fish as an available source. Although we did not directly monitor wild meat prices during this study, prices for certain species have increased, for example, bearded pig meat in Rungan reportedly doubled from IDR 50–60/kilo to IDR 100–120/kilo since 2022 (Namrata Anirudh, Personal Observation, June 2023). This relationship was further supported by our findings of a strong association between higher well-being and more frequent chicken consumption, whilst no association was found for freshwater fish consumption (Appendix S4). This is consistent with studies that demonstrate fish are more common among the diets of lower income rural people in Indonesia, whilst higher income groups consume more chicken and

other animal protein because they have the resources to diversify their diets (Khusun et al., 2022).

Similarly, at the species level, we find taste to be the overall primary driver of wild meat consumption but mediated by what is available (Figure 5). This finding is more typical of urban contexts (Chausson et al., 2019; Olmedo et al., 2021) and disputes the common narrative that rural communities consume wild meat solely to meet nutritional needs (e.g. Merson et al., 2019; Nielsen et al., 2018). However, particular species (e.g. large bats, snake and sun bear) were consumed for purported medicinal properties (Figure 5), demonstrating that additional cultural beliefs and traditions need to be considered when designing wild meat alternative projects (Brittain, Kamogne Tagne, Booker, et al., 2022; Lee et al., 2020; Mannion et al., 2025).

4.3 | Implications for sustainability of wild meat

Food systems around the world are expected to deliver on a 'triple challenge'—ensure food security, provide livelihoods and ensure environmental sustainability (OECD, 2021). The sustainability of consuming wild meat from tropical forests exemplifies this challenge. Despite inherent difficulties in defining and assessing the sustainability of hunting and wild meat consumption (Van Vliet et al., 2015; Weinbaum et al., 2013), we found changing consumption patterns, declining availability of wild meat and local perceptions of biodiversity change indicating many species consumed in Central Kalimantan are less abundant than they were previously. Respondents perceived wildlife declines to be attributed to a combination of factors, particularly in relation to changing weather patterns, the expansion of industrial oil palm plantations, declining river quality, forest fires and over-hunting. Biophysical environmental drivers of food (in)security are a global concern acting at local and global scales (Ingram, 2011), and the interconnectedness of wild meat, fish and the environment were evident in our studied landscapes. Our findings support the growing demand for a more holistic 'food systems approach' within policy, calling for different sectors (e.g. agriculture, fisheries, environment and public health) to work together (OECD, 2021). Therefore, a multifaceted approach that addresses the broader challenges of environmental degradation from extractive industries, increased consumption associated with changing population dynamics, river health and climate change adaptation will be essential for achieving sustainable wild meat and fish consumption in Central Kalimantan.

With declining availability and increasing cost being the main barriers to more frequent wild meat consumption (Figure 7), it is possible that improved affordability or availability could result in an increase in wild meat consumption, potentially presenting a challenge for conservation. Therefore, other measures to decrease the demand of vulnerable species are required. Some fast-reproducing, common species can sometimes be considered tolerant to hunting pressure—such as the bearded pig (Luskin

et al., 2014). However, the rapid spread of African Swine Fever and subsequent crashes of wild pig populations have led to a hunting ban in Sabah (Daniel et al., 2024) and it may be necessary to introduce interventions and quotas in Kalimantan until numbers recover to levels before the disease outbreak. Additionally, hunting of Critically Endangered species, those disproportionately reported to be no longer available for consumption (e.g. pangolin, proboscis monkey) and those on the Indonesian Protected Species List cannot be considered sustainable. Therefore, protected species should be reviewed on a periodic basis and updated to reflect species trends with empirical biodiversity data where possible. The existence of such legislation alone does not guarantee compliance, as evidenced by the consumption of protected species for food and medicine (e.g. sun bear) in our study landscape, and protected species elsewhere in Indonesia (Latinne et al., 2020; Pattiselanno et al., 2020), and therefore should be supported by appropriate law enforcement.

The association between well-being and wild meat consumption demonstrates that consumption is not driven by poverty in these landscapes. As such, providing economic incentives to enable alternative animal proteins will likely have limited impact (Chaves et al., 2018). Importantly, we found clear differences between landscapes in terms of the number, diversity and acquisition of species consumed, despite being geographically close to one another. This further emphasises that in culturally and socio-demographically diverse countries such as Indonesia, the heterogeneous preferences and drivers of wild meat consumption need to be considered along with the surrounding environmental health and alternatives to wild meat in order to develop initiatives, legislation or regulation towards sustainability (Brittain, Kamogne Tagne, Booker, et al., 2022; Brittain, Kamogne Tagne, Roe, et al., 2022).

To further understand wild meat and the wider food system, future research could explore additional drivers (e.g. land-use change), the food supply chain, food environment and more individual factors such as value orientations, which would be useful for designing sustainable wild meat campaigns (Van Vliet et al., 2022). Useful insights might also be gained by extending this work to other landscapes and their cultural and land-use contexts. Additionally, as we only considered responses by men in these landscapes, it would be beneficial to explore women's role in purchasing, preparing and consuming wild meat. Our findings provide new insights into wild meat consumption in an understudied region of Southeast Asia, highlighting the interconnectedness of wild meat within the wider food system and how heterogeneous patterns of consumption can be between neighbouring landscapes. Given the complex interplay between biodiversity conservation, the multiple pressures on the populations of hunted species, and the need for increased food security, there is a clear need to develop effective initiatives for transitioning towards sustainable wild meat. Here, we show the importance of nuanced, localised research efforts to inform the design of such initiatives and the need for a wider research effort into wild meat consumption across the region.

AUTHOR CONTRIBUTIONS

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CONFLICT OF INTEREST STATEMENT

The authors declare there are no competing interests.

DATA AVAILABILITY STATEMENT

Anonymised data will be available on figshare.com after a 12-month embargo https://doi.org/10.6084/m9.figshare.29532962.v1. We also intend to make the full dataset available at https://www.wildmeat.org/.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Appendix S1. Survey form in format for KoboToolbox.

Appendix S2. Summarised characteristics of Rungan and Sebangau landscapes.

Appendix S3. Species reported as consumed during the last 12 months, with their status on the Indonesian Protected Species List and IUCN Red List. Those with NA indicate multiple species grouped into a genus/family and thus excluded from identifying protected/IUCN status.

Appendix S4. Multidimensional well-being and meat consumption.