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Graduate School of Asia Pacific Studies

Record of Doctoral Dissertation Screening

Name	NGUYEN Minh Hoang
Degree Type	Doctor of Philosophy in Asia Pacific Studies
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Title of Dissertation	Investigating urban residents' involvement in biodiversity conservation in protected areas: Empirical evidence from Vietnam
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Summary of Dissertation Contents	After Chapter 1 (Introduction), there are five chapters in the Literature Review section (Chapters 2-6), each of which focuses on a particular issue. Specifically, Chapter 2 provides the literature review of the benefits of biodiversity to humans, and urban residents in particular, and how humans perceive biodiversity and its related issues. It also helps define the scientific discipline to which the current dissertation belongs. Chapter 3 summarizes the current situations of illegal wildlife trade at the global scale and in Vietnam, identifies the weaknesses of supply-side prevention methods, and suggests how demand-side measures in urban areas can supplement to illegal wildlife trade prevention. Chapter 4 reviews the financing methods of protected areas and the role of tourism as a financing source. At the same time, the chapter also highlights the importance of urban residents in financing protected areas through paying for cultural services (e.g., nature-based tourism), especially in the rapidly developing and urbanizing Asia Pacific region. Chapter 6 marks the end of the first section by establishing a conceptual framework to argue how we can involve urban residents in tackling biodiversity loss in protected areas through reducing their wildlife product consumption demand and improving their willingness to pay when visiting protected areas. The second section consists of three chapters (Chapters 7-9). Chapter 7 explains the Grounded Theory procedure to qualitatively explore urban residents' mental constructs about biodiversity (or perceptions about biodiversity and its connotations). Chapter 8 describes the data collected in a survey collection that was designed based on the first study's findings. Chapter 9 proposes the Bayesian mindsponge framework as a potential analytical approach to study complex and dynamic psychological and behavioral issues. The analysis procedure used to perform the dissertation's second and third studies is also presented in Chapter 9. Three chapters (Chapters 10-12) in the third section present the findings of this dissertation's studies. Chapter 10 shows the coded responses of interviewees about the mental constructs of biodiversity. Chapter 11 presents the variable selection, model construction, and computed results of the second study, which examines the effects of perceived biodiversity loss consequences on the attitude towards illegal wildlife consumption prohibition and bushmeat consumption frequency. Chapter 12 displays the variable selection, model construction, and computed results of the third study. The last section (Chapter 13), summarizes the findings and values of the dataset and 3 studies and discusses how to involve urban humans in biodiversity conservation in protected areas.

Summary of Dissertation Screening Results	This summary includes both a synthesis and brief evaluation of based on the dissertation in question and an oral defense held on 16th January 2023. The unique characteristics of the dissertation derives from its examination of how perceived biodiversity loss consequences affect the endorsement of conservation in protected areas and willingness to pay. It contributes to humanity's intellectual assets by presenting the voices of urban residents in an emerging economy. The result was a unanimous decision from the examiners that this dissertation deserves to be awarded a degree
Summary of Examination Results or confirmation of Academic Skills	The graduating student complied with the Ritsumeikan Asia Pacific University Degree Regulations Article 13 Section 1. 2 and the decision was finalized as "PASS." Some of the findings (Chapter 11) have been peer-reviewed and accepted for publication by Conservation Science and Practice, a journal of the Society for Conservation Biology. The method has also been peer-reviewed and published as a method article in MethodsX (https://www.sciencedirect.com/science/article/pii/S2215016122001881) and as a methodological book (https://sciendo.com/book/9788367405119). The dataset (Chapter 8) is not only valuable for answering questions in the current dissertation but it can also be employed to examine many other interactions between urban humans and biodiversity concepts. The dataset has been peer-reviewed and published by MIT Data Intelligence (https://direct.mit.edu/dint/article/3/4/578/107428/Multifaceted-Interactions-between-Urban-Humans-and).

Investigating urban residents' involvement in biodiversity conservation in protected areas: Empirical evidence from Vietnam

by

NGUYEN Minh Hoang

61119602

September 2022

Doctoral Dissertation Presented to

Ritsumeikan Asia Pacific University

In Partial Fulfillment of the Requirements for the Degree of

Doctor of Philosophy in Asia Pacific Studies

Abstract

Biodiversity provides many benefits to humans in general and urban residents in particular. However, the rising population, income, and wildlife product consumption demands contribute to the deliberately organized illegal wildlife trade expansion. Protected areas are designated mainly for biodiversity conservation but face financial constraints for management activities. The increased illegal wildlife trade and lack of financing in protected areas can negatively affect biodiversity levels. Thus, the current dissertation is dedicated to answering the question: "How can we mitigate biodiversity loss in protected areas by better involving urban residents in biodiversity conservation?"

To answer this question, the dissertation comprises three studies and data collection about the psychology and behaviors related to biodiversity and conservation among urban residents.

As most studies about mental constructs about biodiversity are conducted in developed Western countries and among people living in non-urban areas, little is known about the mental constructs of urban residents in Vietnam – a developing Asian country. Thus, the first study explores urban residents' mental constructs about biodiversity, setting the ground for designing a questionnaire to serve the subsequent two studies. Semi-structured interviews and Grounded Theory were used to acquire and analyze the responses of 38 residents in Ho Chi Minh city and Hanoi capital city, respectively. The results are displayed following these mental constructs: i) biodiversity and biodiversity loss, ii) impacts of biodiversity and biodiversity loss on humans, and iii) human reaction towards biodiversity and biodiversity loss. Besides identifying important conceptual dimensions, The study also found the influence of cultural value, the awareness of multi-stakeholders' participation, and some misunderstandings in the urban residents' perceptions. These findings offer in-depth knowledge of biodiversity mental constructs in an understudied context: urban areas in an Asian developing country. Moreover, they also provide insights to design a data collection that serves future studies about the interactions between urban residents and biodiversity concepts.

Based on the first study, web-based data collection was carried out among urban residents in major cities across Vietnam. The dataset consists of 535 urban residents' responses about their wildlife consumption behaviors, multifaceted perceptions and interactions with biodiversity-related

concepts, and nature-based recreation demand. The data set is constructed with six major categories: 1) wildlife product consumption, 2) general biodiversity perceptions, 3) biodiversity at home and neighborhood, 4) public park visitation and motivations, 5) national park visitation and motivations, and 6) socio-demographic profiles. These resources are expected to support researchers in enriching the literature regarding the role of urban residents in biodiversity conservation and preservation and help policymakers find insights for building up an "eco-surplus culture" among urban residents through effective public communication and policymaking.

The second and third studies performed the Bayesian mindsponge framework (BMF) on the dataset to eventually answer this dissertation's pivotal question. However, BMF is not fully developed, so the dissertation extended the BMF by explaining the advantages of Bayesian inference and the mindsponge mechanism and how they are well-matched in studying psychological and behavioral issues.

The second study applied BMF to 535 urban residents' responses to investigate the associations between biodiversity loss perceptions, the attitude towards the prohibition of illegal wildlife consumption, and bushmeat consumption behaviors. It found that people perceiving environmental degradation, losses of economic growth, nature-based recreation opportunities, health, and knowledge as consequences of biodiversity loss were more likely to support the prohibition of illegal wildlife consumption. Although urban residents tended to consume bushmeat less frequently if they perceived losses of economic growth and knowledge as consequences of biodiversity loss, the perception of environmental degradation had the opposite effect on the behavior. Additionally, people that consume bushmeat frequently and those that support the biodiversity-loss mitigation measures seemed to share similar features: high income and educational levels. These paradoxical results hint at the existence of the cultural additivity phenomenon – the willingness to incorporate into one's mind the new values that might or might not logically contradict their existing core cultural values – on psychology and behavior among Vietnamese urban residents. However, the effects of cultural additivity need further validation in future studies.

The third study applied BMF to 535 urban residents' responses to examine the associations between biodiversity loss perceptions, conservation endorsement attitude, and willingness to pay in protected areas. It was found that perceived environmental degradation, loss of economic growth,

loss of nature-based recreation opportunities, and loss of knowledge as consequences of biodiversity loss indirectly affect paying willingness through the mediation of the attitude towards conservation. Especially the perceived knowledge loss also has a direct positive influence on the willingness to pay for the entrance fee and conservation. In contrast, perceived loss of health is negatively associated with the attitude towards conservation.

Results of the second and third studies indicate that it is possible to involve urban residents in tackling biodiversity loss in protected areas. This can be done by financing social marketing and demarketing programs, public awareness-raising campaigns, educational activities, and pro-environmental entertaining platforms (e.g., commercial games) to make urban residents perceive the tremendous consequences of biodiversity loss among urban residents (including their self-interest). Given the influence of cultural additivity, it is recommended to sometimes put stricter measures (e.g., financial punishment) into perspective so that urban people can recognize the high "cost" of bushmeat consumption and change their attitudes and behaviors accordingly. If these programs, campaigns, and activities are repeated sufficiently, they can help build an eco-surplus culture among urban residents.

Keywords: *biodiversity perception, urban human, wildlife consumption, biodiversity conservation, nature-based tourism, protected areas, conservation social sciences, self-finance, willingness to pay, Bayesian mindsponge framework*

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Declaration

I, Nguyen Minh Hoang (Student ID 61119602), hereby declare that the contents of this Doctoral Dissertation are original and genuine and have not been submitted to any other university or educational institution for the award of a degree or diploma.

All the information derived from other published or unpublished sources has been cited and acknowledged appropriately.

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Abstract

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conservation. Especially the perceived knowledge loss also has a direct positive influence on the willingness to pay for the entrance fee and conservation. In contrast, perceived loss of health is negatively associated with the attitude towards conservation.

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Keywords: *biodiversity perception; urban resident; Bayesian mindsponge framework; mindsponge theory; eco-surplus culture; wildlife consumption; biodiversity conservation; nature-based tourism; protected areas; conservation social sciences; self-finance; willingness to pay*

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Chapter 1:

Introduction

This chapter provides an overview of the topics mainly studied in the dissertation. Moreover, it presents the main questions that drive the current dissertation as well as the research objectives and structure employed to answer those questions. The significance and contributions of the current dissertations in terms of theoretical, practical, and methodological aspects are also mentioned.

1.1. Biodiversity loss

The Earth we live on was formed over 4.5 billion years ago. Through billions of years of development and evolution, Earth has been enriched with the existence of life, making it distinctive from other known planets in the solar system. Approximately 9 million types of species of plants, animals, insects, protists, and fungi are estimated to be existing on our planet, along with more than 7 billion people (Mora, Tittensor, Adl, Simpson, & Worm, 2011). Such diversity of life forms plays indispensable roles in maintaining the ecosystem processes and generating multiple ecosystem services (provisioning, regulating, cultural, and supporting services). In particular, for functioning services, plant diversity increases the resistance to invasion by exotic plants, aboveground carbon sequestration through enhanced biomass production, nutrient mineralization, and soil organic matter. For provisioning services, intraspecific genetic diversity increases the yield of commercial crops; tree species diversity increases wood production in plantations; fish species diversity is associated with the higher stability of fish yield (Cardinale et al., 2012).

However, Kolbert (2014) warns that the sixth mass extinction (a.k.a, the Holocene extinction or Anthropocene extinction) is occurring mainly as a result of activities done by humans or *Homo Sapiens*. In her book, Kolbert indicates that catastrophes, overexploitation, ocean acidification,

global warming (or climate change), invasive species, and habitat fragmentation are the primary causes driving the sixth extinction. The extinctions span various families of plants, animals, fungi, and bacteria. One typical example of extinction in the man-made sixth extinction is the disappearance of the dodo (*Raphus cucullatus*). The endemic flightless bird on the island of Mauritius, located in the East of Madagascar in the Indian Ocean, went extinct during the mid-to-late 17th century due to habitat loss, hunting, and predation by introduced mammals (Hume & Walters, 2012). Over the 1985-2012 period, a significant decline from 28% to 13.8% of coral cover in the Great Barrier Reef, the world's largest coral reef system, was recorded (De'Ath, Fabricius, Sweatman, & Puotinen, 2012). Anthropogenic activities, such as overfishing, terrestrial runoff of sediments and agricultural nutrients, shipping, tourism, etc., in the region are suggested to be significant causes of the coral cover loss (Brodie & Waterhouse, 2012; Hadhazy, 2008).

Given the pressure caused by the exponential growth of human activities, a group of Earth system and environmental scientists, led by Johan Rockström from the Stockholm Resilience Centre and Will Steffen from the Australian National University, have proposed nine planetary boundaries, which help estimate "a safe operating space for humanity with respect to the functioning of the Earth system" (Rockström et al., 2009). Those boundaries are 1) climate change, 2) ocean acidification, 3) stratospheric ozone depletion, 4) atmospheric aerosol loading, 5) biogeochemical flows, 6) global freshwater use, 7) land-system change, 8) rate of biodiversity loss, and 9) chemical pollution. Among nine planetary boundaries, climate change and biosphere integrity (measured by the rate of biodiversity loss) are recognized as two core boundaries based on their fundamental roles in the Earth system (Steffen et al., 2015). Despite the biosphere diversity's importance to the Earth system and pervasive effects on other boundaries, the biodiversity loss rate in the updated status of planetary boundaries has far passed the safe operating and uncertainty zones and been

approaching the tipping point that may possibly trigger irreversible changes to the Earth system (Steffen et al., 2015) (see Figure 1.1).

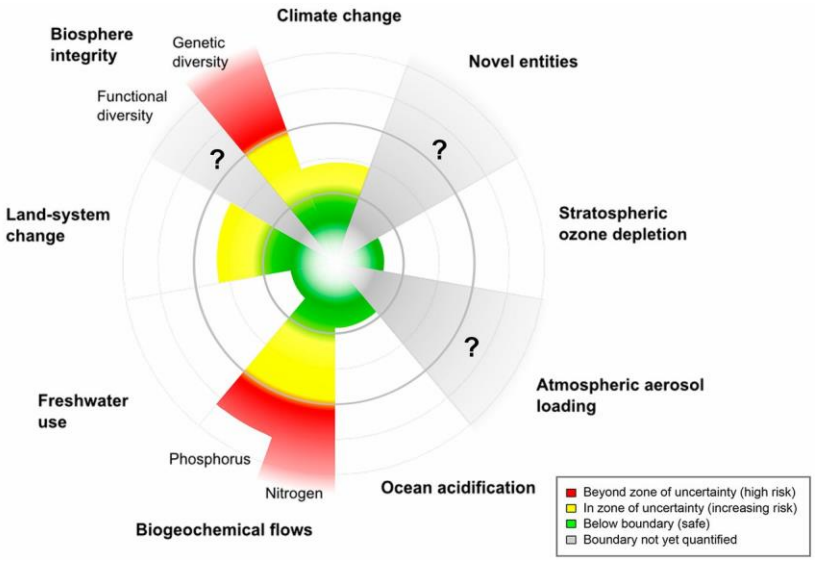

Figure 1.1: The status of the control variables of seven out of nine planetary boundaries. The visualization is retrieved from (Steffen et al., 2015) under the Creative Commons Attribution license (CC-BY).

Economic growth since the 1970s has substantially improved humans' living conditions, health, and knowledge. In the last half-century, the world's human population was doubled, the global economy was increased by fourfold, and global trade was expanded by tenfold. However, these improvements have come with a massive cost to the Earth's ecosystems. The 2020 global Living Planet Index (LPI), which tracked around 21,000 populations of 4,392 species, shows an average 68% decline in the population size of monitored populations from 1970 to 2016 (World Wildlife Fund, 2020). The decline appeared to be most severe in Latin America & the Caribbean, with an average declining rate of 94%. The reduction rate in the Asia Pacific region was also significant, with 45%. According to the Living Planet Report 2020, there are five major causes behind the decrease in animals population sizes around the globe: 1) changes in land and sea use, including habitat loss and degradation, 2) species overexploitation, 3) invasive species and disease, 4)

pollution, and 5) climate change (World Wildlife Fund, 2020). Out of five causes, land and sea use changes are the most influential factor across regions.

Before the Living Planet Report 2020 was published by World Wildlife Fund, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) also published the first Global Assessment Report on Biodiversity and Ecosystem Services in 2019. Based on almost 15,000 references and the expertise of more than 150 scientists in both natural and social sciences, the report indicates that biodiversity loss is happening at an unprecedented rate. Around one million animal and plant species, or approximately 25% of studied species, are threatened with extinction. In particular, analyzing the risk of extinction of plants, Brummitt et al. (2015) find that more than 20% of plant species randomly selected from the Sampled Red List Index for Plants face extinction risk (Brummitt et al., 2015). Most of the threatened plants are in tropical rainforest habitats, where major threats are anthropogenic habitat conversion and harvesting of natural resources.

Southeast Asia is a well-known region worldwide for its rich biodiversity and endemism. Although the area covers at least six of the world's biodiversity hotspots, its level of deforestation is among the highest and most severe in terms of biodiversity loss (Sodhi, Koh, Brook, & Ng, 2004; Sodhi et al., 2010). Vietnam, in which the study sites of this dissertation are located, is a South-East Asian country situated in the Indo-Burma Hotspot region. It has gained early global recognition for various unique and endemic species. In particular, Saola (*Pseudoryx nghetinhensi*) – the first large land vertebrate to be discovered over 50 years before 1992 – was documented in the forests near Vietnam's border with Laos (Van Dung et al., 1993). However, the richness and endemism of species in Vietnam are threatened by many factors, such as habitat fragmentation, deforestation, poaching activities, illegal wildlife trade, etc. In particular, Vietnam Red List in 2007 identified

882 threatened, and endangered species (418 animals and 464 plants), showing an increase of 22.33% (161 species) compared to the first published Vietnam Red List in 1992 (Ministry of Natural Resources and Environment, 2014a). In 2010, the last Javan rhino in Vietnam was found dead with its horn hacked off in Cat Tien national park. Other species, such as bears, pangolins, tigers, etc., are also threatened with extinction (Nuwer, 2018).

Given the severe biodiversity loss conditions due to human activities, expanding our knowledge about interactions between humans and biodiversity loss and conservation is vital. Moreover, the urban population is not the only major consumers of wildlife products (Davis et al., 2019; Davis, Willemsen, Dang, O'Connor, & Glikman, 2020; Lee, Sigouin, Pinedo-Vasquez, & Nasi, 2014; Ministry of Natural Resources and Environment, 2014b; Sexton, Nguyen, & Roberts, 2021) but also a great potential market to finance protected areas and related conservation efforts because they have both the desire and the financial capacity for nature-based tourism (Fredman & Tyrväinen, 2010; Frost, Laing, & Beeton, 2014; Thomas E Jones & Nguyen, 2021; Lundmark & Müller, 2010). Therefore, the current dissertation aims to investigate how the Vietnamese urban residents' perceptions and attitudes about biodiversity may possibly curb biodiversity loss and support biodiversity conservation. The investigation was conducted using both qualitative (e.g., grounded theory, semi-structured interview) and quantitative approaches (e.g., Bayesian Mindsponge Framework, survey).

The following section briefly describes the roles of protected areas in biodiversity conservation. The third section briefly presents barriers that constrain the conservation effectiveness of protected areas. The fourth section indicates the dissertation's main question and how the research questions can be answered. The final section summarizes the significance and contributions of this dissertation in terms of theoretical, practical, and methodological aspects.

1.2. Biodiversity conservation through protected areas

The global biodiversity loss is attributable to various reasons, such as climate change, deforestation, invasive species, land-use intensification, population and economic growth, and wildlife trade (Doherty, Glen, Nimmo, Ritchie, & Dickman, 2016; Giam, 2017; Lambers, 2015; Marques et al., 2019). Urban (2015) predicts that one-sixth of all species will become extinct if the current acceleration of global temperature remains the same. Tropical forests that hold two-thirds of the world's biodiversity are severely disturbed by deforestation and forest alteration caused by human activities. Due to these activities, disturbed areas on the global scale are found to have 41% fewer species than undisturbed ones (Alroy, 2017). The rising international consumption demands lead to increased land use for agriculture and subsequently drive habitat destruction and biodiversity loss in Central and Southern America, Africa, and Asia (Marques et al., 2019).

Many measures have been proposed and implemented for protecting biodiversity and halting biodiversity loss, but modern scientists can deem conservation one of the most typical measures. The International Union for Conservation of Nature (IUCN) defines conservation as "the protection, care, management and maintenance of ecosystems, habitats, wildlife species, and populations, within or outside of their natural environments, in order to safeguard the natural conditions for their long-term permanence" (see *https://www.iucn.org/sites/dev/files/iucn-glossary-of-definitions_en_2021.05.pdf*). Seven targets of 20 targets listed in the Aichi Biodiversity Targets, indicated by the Convention on Biological Diversity (CBD) in the Strategic Plan for Biodiversity 2011-2020, are directly dedicated to achieving conservation objectives.

Protected areas contribute significantly to the conservation of biodiversity worldwide by protecting biodiversity hotspots, preventing anthropogenic threats, and sustaining the local livelihood.

Although several nature reserves had been established locally by rulers and magnates earlier to prevent hunting (e.g., Karpfstock mountain in 1569, the Wood of the Hague in 1576, Walton Park in 1826), the protected area movement only started in North America, Australia, Europe, and South Africa after the first national park was formally established and protected by Environmental Protection Act (Holdgate, 2010). The United States founded the world's first formal protected area – Yosemite Grant – and national park – Yellowstone, in 1872, which had been more than 100 years before the term "biological diversity" was first used. Then, Australia established Royal National Park in 1879; Canada established Banff National Park in 1885; New Zealand established Tongariro National Park in 1894; Sweden established nine national parks in 1909.

One of the primary roles of early protected areas is to protect spectacular fauna, flora, and natural features. Until the middle of the 20th century, the visitor influx into protected areas for recreation demands began to accelerate, generating enormous income from nature-based tourism, especially in developing countries. Nonetheless, soon later, the purposes of protected areas continued to be expanded to include biodiversity conservation (Watson, Dudley, Segan, & Hockings, 2014).

Myers, Mittermeier, Mittermeier, Da Fonseca, and Kent (2000) propose a "silver bullet" strategy identifying biodiversity hotspots for conservation priorities. They argue that the strategy is cost-effective and practical to conserve biodiversity because around 44% of Earth's plant species and 35% of vertebrate species are only contained in 25 hotspots comprising solely 1.4% of the Earth's terrestrial surface. By now, 35 biodiversity hotspots have been identified globally, including the Indo-Burma Hotspot, where the current dissertation's study site is located (Marchese, 2015). Later, Bruner, Gullison, Rice, and Da Fonseca (2001) found the effectiveness of parks in protecting biodiversity by evaluating the anthropogenic threats on 93 protected areas in 22 tropical countries. Given that the efficacy is associated with management activities, like enforcement, boundary

demarcation, and compensation to the locals, conserving biodiversity would greatly benefit from increased funding for protected areas management (Bruner et al., 2001; Myers et al., 2000). Such financing can arrive from various sources, such as government subsidies, international aid, sponsorship, tourism, etc.

More recently, protected areas are expected to meet an increasingly diverse set of environmental, social, and economic objectives, or so-called ecosystem services (Watson et al., 2014). Besides conservation, protected areas are also found to improve local socio-economic development and provide ecosystem services (Bruner et al., 2001; Lubchenco, Palumbi, Gaines, & Andelman, 2003; Postel & Thompson Jr, 2005; Scharlemann et al., 2010; Soares-Filho et al., 2010). One of the most prominent ecosystem services protected areas provide is the enjoyment of nature. Thanks to the service, protected areas are able to attract 8 billion visits per annum for nature-based recreation and tourism, of which 80% are in Europe and North America. It is estimated that around $600 billion per annum of direct in-country expenditure and $250 billion per annum of consumer surplus are generated by these visits (Balmford et al., 2015). Such income from nature-based recreation and tourism can be reinvested into the managerial activities of protected areas, creating a sustainable financial cycle for conservation.

Due to these purposes, effective management and expansion of protected area systems across the globe are set as the main targets in the Aichi Biodiversity Targets. However, management and financing problems still exist, especially in developing countries, hindering conservation effectiveness.

1.3. Constraints in biodiversity conservation

The past several decades have seen the profound development and expansion of protected areas worldwide (Watson et al., 2014). Since the first establishment of the world's first national park –

Yellowstone national park – in 1872, the total area of protected areas and other effective area-based conservation measures (OECMs) have covered at least 16.64% (22.5 million km2) of land and inland water ecosystems, and 7.74% (28.1 million km2) of coastal waters and the ocean (UNEP-WCMC & IUCN, 2021). The areas of particular importance for biodiversity and ecosystem services have been increasingly covered, with 65.5% of Key Biodiversity Areas partially or fully protected (UNEP-WCMC & IUCN, 2021). At the 10th meeting of the Conference of the Parties (COP10), the "Strategic Plan for Biodiversity, 2010-2020" was published with 20 Aichi Biodiversity Targets. Among 20 targets, Target 11 aims to conserve at least 17% of terrestrial and inland water and 10% of coastal and marine areas (areas of particular importance for biodiversity and ecosystem services) through effectively and equitably, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures (see *https://www.cbd.int/sp/targets/*). According to the "Global Diversity Outlook 5" report of the Secretariat of the Convention on Biological Diversity (2020), Target 11 of the global coverage of protected areas has been partially achieved.

Although some progress in the size of protected areas is recorded, there is evidence that the funding support for the operation and management of protected areas is declining (Watson et al., 2014). This trend is even more common in developing countries, leading to ineffective management and conservation as well as the rampant spread of "paper parks" (Bovarnick, Fernandez-Baca, Galindo, & Negret, 2010; Geldmann, Manica, Burgess, Coad, & Balmford, 2019; Watson et al., 2014). "Paper parks" is the concept indicating protected areas that are legally established but create limited or no on-the-ground impacts on biodiversity conservation (Bonham, Sacayon, & Tzi, 2008; Thur, 2010). Ineffective management of protected areas is found to be negatively associated with

a higher deforestation rate (Françoso et al., 2015), lower diversity of tropical bird species (Cazalis et al., 2020), and lower mammal diversity (Oberosler, Tenan, Zipkin, & Rovero, 2020).

A substantial amount of finance is, therefore, needed to maintain the operations of the emerging and expanded protected areas in three aspects: recurrent management costs (e.g., staff salary, training, maintenance, monitoring, and evaluation), systemwide expenses (e.g., national and regional administration, new site selection, securing financial allocation within the political system), and establishment costs (e.g., stakeholder consultations, biological inventories, boundary demarcation, up-front purchase, construction). Over a decade ago, around $1 billion and $1.7 billion per year were lacking to manage all the existing protected areas in developing countries (Bruner, Gullison, & Balmford, 2004). Bruner et al. (2001) and Bruner et al. (2004) suggest rapidly allocating more financial resources to improve the on-the-ground management systems of protected areas in developing countries.

In Vietnam, protected areas receive funding from the province and national government for full operations and maintenance, while the conservation management budget may also come from international donors, such as World Wide Fund for Nature (WWF), Fauna & Flora International (FFI), International Labour Organization (ILO), etc. Nonetheless, there remain many constraints. The domestic government's subsidies are widespread but insufficient and lack priority, whereas international aids are large but can only focus on large, site-specific projects (Bui, Pham, & Jones, 2021). Solely assuring the operation and conservation finance within the park is inadequate for biodiversity conservation, as local people rely on the protected areas' resources for livelihood. As a result, tourism is endorsed by many scientists as a sustainable financing source for biodiversity conservation in protected areas if it is well monitored and managed (Jones, Apollo, & Bui, 2021; Whitelaw, King, & Tolkach, 2014).

The recent escalating illegal wildlife trade also challenges the existing global protected area systems. According to the 2020 World Wildlife Crime Report (United Nations Office on Drugs Crime, 2020), the annual number of seizures increased drastically in the last 20 years, from 3,317 seizures made in 1999 to 20,762 seizures made in 2017. The most frequent types of seizure incidents during 1999-2018 were mammals (23%), reptiles (21.3%), and corals (14.6%). Figure 1.2 shows the confiscated bushmeat at a trader's house in Lam Dong Province.

Figure 1.2. Confiscated bushmeat by Lam Dong Policemen on 29th September 2020 (Vien, 2020)

The rapid expansion of illegal wildlife trade size and network is primarily driven by the increasing demands for traditional medicines and bushmeat in urban areas of emerging countries, such as China and Vietnam (Challender, Harrop, & MacMillan, 2015a). Protected areas can contribute to the prevention of poaching if they are effectively managed and patrolled (Fukushima et al., 2021).

However, illegal wildlife trade networks are getting more complex, deliberately organized, and increasingly involved with corrupted government agencies and law enforcers, creating more barriers to monitoring and law enforcement (United Nations Office on Drugs Crime, 2020; Xu, Cai, & Mackey, 2020).

Given these challenges, additional demand-side measures should be considered and taken to curb poaching and illegal wildlife trading activities (Biggs, Courchamp, Martin, & Possingham, 2013; Challender & MacMillan, 2014; Drury, 2011; Veríssimo, Challender, & Nijman, 2012). In Vietnam, residents of large urban centers like Ho Chi Minh, Hanoi, Hai Phong, and Hue cities, have a high demand for bushmeat consumption due to sociocultural motives (Drury, 2011; Olmedo, Veríssimo, Challender, Dao, & Milner-Gulland, 2021; Shairp, Veríssimo, Fraser, Challender, & MacMillan, 2016). Therefore, social marketing and demarketing campaigns in urban areas are essential to reduce or shift the demand from this commodity to other more sustainable options (Challender & MacMillan, 2014; Veríssimo, Vieira, Monteiro, Hancock, & Nuno, 2020).

1.4. Research questions, objectives, and structure

The current dissertation is dedicated to answering the following **research question (RQs)**:

> **RQ:** How can we curb biodiversity loss in protected areas by involving urban residents in biodiversity conservation?

To answer this question, a conceptual framework was developed in Chapter 6 to argue that the involvement of urban residents in biodiversity conservation is possible to help tackle biodiversity loss and how we can involve them. By answering this question, it is expected to provide additional

insights into how urban residents can help ease the problems in biodiversity conservation (e.g., increased illegal wildlife trade and lack of finance for protected areas).

Based on the framework presented in Chapter 6 and previous literature reviewed in Chapters 2-5, four main **research objectives (RO)** were developed:

RO1: The first research objective was to review the existing literature on prominent associations between urban humans and biodiversity and related issues for developing a conceptual framework. Based on the conceptual framework, five following **sub-questions** need to be answered to provide answers to the **research question** mentioned above:

1) What are the Vietnamese urban residents' perceptions regarding biodiversity and biodiversity loss?
2) How are Vietnamese urban residents' biodiversity perceptions (i.e., perceived consequences of biodiversity loss) associated with the support for the prohibition of illegal wildlife consumption?
3) How are Vietnamese urban residents' biodiversity perceptions associated with the frequency of their bushmeat consumption??
4) How are Vietnamese urban residents' biodiversity perceptions associated with the attitude toward conservation?
5) How are Vietnamese urban residents' biodiversity perceptions associated with the willingness to pay (i.e., for a specific entrance fee or biodiversity conservation) when visiting protected areas?

RO2: The second research objective was to conduct Grounded Theory to answer Question (1). Answering Question (1) would provide an overview of how Vietnamese urban residents

perceive biodiversity and biodiversity loss, paving the ground for answering Questions (2)-(5) through survey design.

RO3: The third research objective was to conduct the Bayesian Mindsponge Framework (BMF) to answer Questions (2) and (3). Answering Questions (2) and (3) would explain how urban residents can help curb biodiversity loss by endorsing illegal wildlife consumption prohibition and reducing bushmeat consumption frequency.

RO4: The fourth research objective was to conduct the Bayesian Mindsponge Framework to answer Questions (4) and (5). Answering Questions (4) and (5) would explain how urban residents can help curb biodiversity loss by endorsing biodiversity conservation in protected areas and improving potential financial sources for protected areas.

To achieve these four main ROs, the following research structure was built (see Figure 1.1). Each research objective is coded using a corresponding color. RO1 corresponds to yellow-coded labels; RO2 corresponds to red-coded labels; RO3 corresponds to cyan-coded labels; RO4 corresponds to green-coded labels.

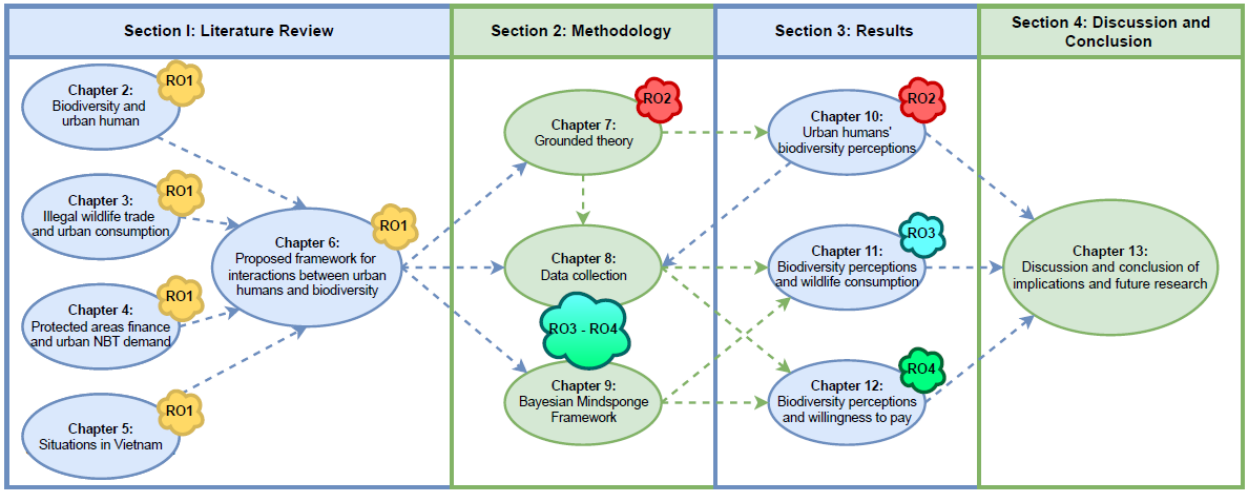

Figure 1.3: Research structure with research objectives

The current dissertation comprises four primary sections:

1) Literature Review
2) Methodology
3) Results
4) Discussion and Conclusion

There are five chapters in the Literature Review section (Chapters 2-6), each focusing on a particular issue. Specifically, Chapter 2 provides a literature review of the benefits of biodiversity to humans, and urban humans in particular, and how humans perceive biodiversity and its related issues. It also helps define the scientific discipline to which the current dissertation belongs. Chapter 3 summarizes the current situation of illegal wildlife trade at the global scale and in Vietnam, identifies the weaknesses of supply-side prevention methods, and suggests how demand-side measures in urban areas can supplement to illegal wildlife trade prevention. Chapter 4 reviews the financing methods of protected areas and the role of tourism as a financing source. At the same time, the chapter also highlights the importance of urban residents in financing protected areas through paying for cultural services (e.g., nature-based tourism), especially in the rapidly developing and urbanizing Asia Pacific region. Chapter 6 marks the end of the first section by establishing a conceptual framework to argue how we can involve urban residents in tackling biodiversity loss in protected areas by reducing their wildlife product consumption demand and improving their willingness to pay when visiting protected areas.

The second section consists of three chapters (Chapters 7-9). Chapter 7 explains the Grounded Theory procedure to qualitatively explore urban residents' mental constructs about biodiversity (or perceptions about biodiversity and its connotations).

Chapter 8 describes the data collected in a survey collection that was designed based on the first study's findings. The dataset is valuable for answering questions in the current dissertation and can also be employed to examine many other interactions between urban humans and biodiversity concepts. The dataset has been peer-reviewed and published by MIT *Data Intelligence* (https://direct.mit.edu/dint/article/3/4/578/107428/Multifaceted-Interactions-between-Urban-Humans-and) (Nguyen, 2021).

Chapter 9 proposes the Bayesian mindsponge framework as a potential analytical approach to studying complex and dynamic psychological and behavioral issues. The analysis procedure used to perform the dissertation's second and third studies is also presented in Chapter 9. The method has been peer-reviewed and published as a method article in *MethodsX* (https://www.sciencedirect.com/science/article/pii/S2215016122001881) (Nguyen, La, Le, & Vuong, 2022b) and a methodological book (https://sciendo.com/book/9788367405119) (Nguyen, La, Le, & Vuong, 2022a).

Three chapters (Chapters 10-12) in the third section present the findings of this dissertation's studies. Chapter 10 shows the coded responses of interviewees about the mental constructs of biodiversity. The findings are under the second round of peer review in *SN Social Sciences*.

Chapter 11 presents the variable selection, model construction, and computed results of the second study, which examines the effects of perceived biodiversity loss consequences on the attitude towards illegal wildlife consumption prohibition and bushmeat consumption frequency. The findings have been peer-reviewed and published by *Conservation Science and Practice* (https://conbio.onlinelibrary.wiley.com/doi/10.1111/csp2.12822), a journal of the Society for Conservation Biology (Nguyen & Jones, 2022).

Chapter 12 displays the variable selection, model construction, and computed results of the third study, which examines how perceived biodiversity loss consequences affect the endorsement of conservation in protected areas and willingness to pay at the protected area (for entrance fees and conservation). The findings have been peer-reviewed and published by *Humanities and Social Sciences Communications* (https://www.nature.com/articles/s41599-022-01441-9), a journal of Nature Portfolio (Nguyen & Jones, 2022).

The last section, also the final chapter (Chapter 13), summarizes the findings and values of the dataset and three studies and discusses how we can involve urban humans in biodiversity conservation in protected areas based on insights generated from the results. This section also provides answers to the **research question** mentioned above.

1.5. Research significance and contributions

The current dissertation has several contributions in terms of theoretical, practical, and methodological aspects. Such contributions are listed as follows:

Theoretical contributions

- Establish the conceptual frameworks to involve urban residents in tackling biodiversity loss through reducing wildlife product consumption demand and increasing the possible finance for protected areas.
- Provide an in-depth understanding of biodiversity mental constructs of urban residents in an Asian developing country.
- Employ the mindsponge mechanism to explain the psychology and behaviors related to biodiversity and conservation of urban Vietnamese people.

Practical contributions

- Provide open resources (e.g., dataset) for further studies to examine the interactions between urban humans and biodiversity concepts.
- Provide insights for enhancing the effectiveness of social marketing and demarketing programs, public awareness-raising campaigns, educational activities, and pro-environmental entertaining platforms (e.g., commercial games), which eventually contribute to biodiversity conservation (e.g., illegal wildlife consumption reduction, increased finance for protected areas).

Methodological contributions

- Extend the BMF by explaining the advantages of Bayesian inference and the mindsponge mechanism and how they are well-matched with each other in studying psychological and behavioral issues.
- Apply BMF to examine the associations between urban people's biodiversity loss perceptions and conservation-related attitudes (e.g., endorsement of illegal wildlife consumption prohibition, endorsement of conservation in protected areas) and behavior (e.g., bushmeat consumption frequency).

Chapter 2:

Biodiversity and urban humans

2.1. Biodiversity and its values to the ecosystem and human

Humans are part of nature, and a healthy ecosystem supports a healthy society. The degree of biodiversity in various aspects influences human well-being, from nutrition to disease prevention (World Health Organization, 2015). In general, biodiversity benefits humanity in several primary ways. Biodiversity helps sustain fertile environments (such as soil) and provides genetic resources for all species we harvest for food. Biodiversity is vital for traditional medicines as well as new biomedical research. Natural biodiversity keeps the balance of the structure and functions of ecosystems, where human activities, whether intentional or accidental, may disrupt this delicate harmony and may lead to the emergence of dangerous pathogens. Biodiversity is also linked to various economic aspects of human society (The World Bank, 2022a). Additionally, there are existence values of many species that we subjectively appreciate (usually species that humans deem to be charismatic or aesthetically pleasing). More benefits of biodiversity toward ecosystems and humans will be presented in more detail below. However, looking at the existing definitions and frameworks of biodiversity is necessary to understand this complex relationship.

The definition of biodiversity is myriad. According to the Stanford Encyclopedia of Philosophy (Faith, 2021), the term "biodiversity," which was heralded by a symposium in 1986 and a follow-up book *Biodiversity* (Ehrenfeld, 1988), is a short form of "biological diversity" or "biotic diversity." Biological diversity is a term appearing early, as in the book *A Different Kind of Country* by Raymond F. Dasmann in 1968 (Dasmann, 1968). Still, the term had not been used commonly in scientific contexts until the 1980s, when Thomas Lovejoy, a biologist in the World Wildlife Fund, presented the term and concept in *Conservation Biology: An Evolutionary-*

Ecological Perspective. Around this time, the matter of biodiversity loss began to receive more attention in the scientific community. Evolutionist Ernst Mayr wrote about the perception of biodiversity in relation to biological science in his book *The growth of biological thought: diversity, evolution, and inheritance* in 1982 that almost all biological processes and phenomena involve diversity (Mayr, 1982). Biologist Edward O. Wilson expressed in 1988 that the diversity of life forms can be seen as the greatest wonder on Earth (Wilson, 1988). The shift of attention to biodiversity conservation and discussions around the concept was driven by changes in the 1930s and 1940s, when Charles Darwin's theory of evolution was confirmed and became widely accepted among biologists, improving understanding and facilitating consensus on the concept of species (Franco, 2013).

The two most inclusive and widely used definitions might be the definitions employed by the Parties to the Convention on Biological Diversity (CBD) and IPBES. Both definitions explicitly emphasize the variability feature of biodiversity. Mace, Norris, and Fitter (2012) recommend using the Convention on Biological Diversity (2006)'s definition due to its common usage, policy status, and inclusiveness: "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems." Not only do the definitions of biodiversity vary across different disciplines, but they also vary quite significantly among high-profile ecologists (Holt, 2006). This is a perception problem. In other words, people put different values on the concept of "biodiversity" in their own minds. Thus, it is essential to note that while the majority may share the same values of biodiversity based on quantifiable parameters, what it really means to each person is determined by one's own subjective perception.

Therefore, people with different backgrounds may have different mental constructs about biodiversity, or perceptions of biodiversity and its connotations.

Research on biodiversity and ecosystem functioning began around the 1990s, and the related research agenda on biodiversity and ecosystem services was later formed to study how ecosystems benefit humanity (Perrings, Folke, & Mäler, 1992). A review by Cardinale et al. (2012) of studies on how biodiversity affects humanity summarizes several major points in the research landscape. According to their review, there are six consensus points on biodiversity and ecosystem functions:

1. Biodiversity loss reduces the efficiency of capturing biologically essential resources, biomass production, decomposition, and recycling of biologically important nutrients within the ecosystem.
2. Biodiversity improves the long-term stability of ecological functions.
3. The effect of biodiversity on any single ecosystem function is nonlinear and saturating, so changes in the ecosystem accelerate as biodiversity loss increases.
4. Ecosystems with greater diversity are more productive since they contain more important species that improve the ecosystem's productivity.
5. Biodiversity loss across tropic levels is more likely to affect ecosystem functions than biodiversity loss within trophic levels.
6. Extinction can result in a wide range of impacts on ecosystem functions because the scale of those functions is greatly influenced by the functional features of species.

Biodiversity's definition is multiplex, especially when putting it in an ecological system. Confusion about terminology and concepts while assessing how biodiversity and ecosystems affect humans can be an obstacle to policymaking. Thus, it is helpful to present clear concepts of the terms. There are two main approaches to the relationship between biodiversity and ecosystem

services: one is to treat biodiversity and ecosystem services synonymously, implying that enhancing either will benefit both (The Economics of Ecosystems and Biodiversity, 2010). One is to treat biodiversity as an ecosystem service, emphasizing the intrinsic value of biodiversity. The former view tends to only focus on the ecological functional roles of biodiversity, whereas the latter tends to only focus on certain species. Considering the complex interactions within ecological processes underlying the observable ecosystem services (Carpenter et al., 2009), a multilayered relationship model proposed by Mace et al. (2012) can help reduce confusion by categorizing biodiversity's different roles: i) as a regulator of ecosystem processes, ii) as a final ecosystem service, and iii) as a good. The classification has later become foundational categorization for studying and interpreting biodiversity and ecological system issues.

Following this multilayered relationship model, regarding the first role (biodiversity as a regulator of ecosystem processes), an analysis of 446 measures of biodiversity on 50 years of experimental work confirmed that biodiversity is positively associated with improved ecosystem functions (Balvanera et al., 2006). A review of scientific literature also shows consensus on this association, with clear concerns about the impacts of species loss and disturbance due to human activities on the ecosystem processes (Hooper et al., 2005). For example, the biodiversity in soils was identified as a critical driver for soil-related ecosystem services in many aspects, such as microbial communities' organic matter processing and soil biota's involvement in biochemical cycles (Smith et al., 2015).

Regarding the second role (biodiversity as a final ecosystem service), genetic diversity benefits medicinal research and improvement for crops and livestock. For example, traditional medicine practices heavily rely on the abundance of wild species, and modern medicines also require bioresources such as bioactive compounds extracted from non-human organisms (Alves & Rosa,

2007). In particular, considering the negative impacts of climate change on agriculture, diversification of crop and livestock varieties can increase their tolerance against climatic stresses as well as their ability to fight against pests and diseases outbreaks due to climate change (Rojas-Downing, Nejadhashemi, Harrigan, & Woznicki, 2017).

Regarding the third role (biodiversity as a good), the diversity of organisms is value being directly appreciated by humans, including aesthetic, recreational, cultural, or spiritual values. For example, biodiversity is linked to the perceived beauty of nature (Kiester, 1996) and local bio-cultural heritage (Rotherham, 2015).

Regarding studies on the relationship between human health and biodiversity, disciplines approach the issue differently. While many studies generally show positive associations, there are those that state the opposite. Overall, the evidence so far has been inconclusive in identifying the exact beneficial role of biodiversity toward human health (Lovell, Wheeler, Higgins, Irvine, & Depledge, 2014).

Exposure to nature is generally found to be beneficial for humans' mental health (Bratman, Hamilton, & Daily, 2012), while environmental degradation has the opposite effect (Speldewinde, Cook, Davies, & Weinstein, 2009). Most research on this topic did not deeply examine the variation in environmental characteristics, so the connection to biodiversity is still unclear. Based on this limitation, Clark et al. (2014) propose that the effects of biodiversity on human health can be either direct or through more complex cultural pathways, including three steps of cultural goods, cultural values, and human well-being, respectively. Clark et al. present four corresponding stages along the cultural pathway to emphasize why biodiversity conservation is necessary: i) biodiversity loss will reduce the availability of cultural goods, ii) fewer cultural goods provide less opportunity to realize and place cultural values, iii) having fewer opportunities to realize and place cultural

values can negatively affect human well-being, and iv) reduced well-being can be detrimental to human health.

2.2. Biodiversity and urban humans

Urbanization is an undeniable tendency of modern human society. While there have been great efforts to make urban environments more ecologically sustainable, it is still a long way to achieve that goal. A city not only consists of artificial elements, but countless other organisms also live in urban environments besides humans. And although the ecological characteristics of urban environments are different to various degrees compared to natural environments, the interactions among species, including humans, are still complex. As biodiversity affects humans' well-being and living activities in general contexts, urban biodiversity is also an important factor for urban people's livelihood. This includes aspects such as urban green space and nature-based entertainment. Additionally, not only the local urban biodiversity affects urban people, but the biodiversity of other regions also affects local people's lives, considering today's national and global transportation and intercommunication capacity. This includes aspects such as trading and consumption of nature-based goods, green tourism, environmental education, etc.

The benefit of urban green spaces to humans is a widely studied subject with reasonable evidence of their positive roles on urban ecosystems, human physical and psychological well-being, and economic aspects within cities (Farinha-Marques, Lameiras, Fernandes, Silva, & Guilherme, 2011). Ecosystem services in urban areas are not only beneficial ecologically and socially, as commonly known, but they can also provide monetary benefits through various pathways such as material processes or improving welfare (Elmqvist et al., 2015). A study on park users finds that biodiversity is the major predictor of urban green space's psychological restorative effects (Wood et al., 2018). As other examples of urban biodiversity's role in public health, Walters (2004) finds

that the decline of species diversity can increase disease carriers such as mice and chipmunks. Mills et al. (2019) propose that the diversity of urban microbiota is positively associated with urban humans health. The biodiversity benefits can come from green spaces, including private gardens, especially with a "wildlife-friendly" management approach (Goddard, Dougill, & Benton, 2010). On the importance of urban biodiversity, Dearborn and Kark (2010) present seven motivations for corresponding conservation efforts: "preserving local biodiversity, creating stepping stones to non-urban habitat, understanding and facilitating responses to environmental change, conducting environmental education, providing ecosystem services, fulfilling ethical responsibilities, and improving human well-being."

Regarding research on the relationship between biodiversity and ecosystem services in urban areas, Ziter (2015) conducts a review of studies indexed in the Web of Science database and finds some remarkable issues: the majority of studies "were conducted in western, developed countries, and typically assessed a single service in a single city – largely ignoring ecosystem services' synergies and tradeoffs, and cross-city comparisons." Research also mainly focused on weather and climate-related regulating services, while attention to cultural services was insufficient. It is also worth noting that in urban biodiversity conservation research, while it is true that ecosystems of artificial landscapes are different from natural or semi-natural remnants, we still should not only focus on relict habitats and native species but rather consider the whole urban setting, including distinct urban ecosystems with nonnative species (Kowarik, 2011).

In addition to the benefits that urban biodiversity provides, urban people also benefit from the biodiversity of areas beyond their cities, as presented in the above section about biodiversity's benefits to humanity in general. Given the benefits that urban people receive from the biodiversity within and beyond urban areas, it is necessary to involve urban humans in biodiversity

conservation endeavors to avoid the tragedy of the commons. Moreover, urban areas are the hotspots in terms of both human population and activities, with a high concentration of capital as well as consumption demands. Thus, if the psychology and behaviors of urban residents towards biodiversity can be well understood, it will help generate insights for reducing consumption demands leading to biodiversity loss and increasing financial resources for conservation efforts (e.g., in protected areas and public parks).

2.3. Conservation social sciences

The consensus on biodiversity conservation is clear from the rich literature on the relationship between biodiversity and humanity. Researchers have been trying to tackle biodiversity loss from various disciplines. Conservation science incorporates conservation biology (a concept often associated with biologist Michael Soulé) into many human dimensions, forming an interdisciplinary field aiming at studying environmental conservation and management (Kareiva & Marvier, 2012). Given the impacts of socioeconomic and cultural factors on conservation practices, conservation science employs a broad range of theories and approaches to different social aspects such as economics, governance, culture, and individual psychology. Studies using a social science approach for improving conservation efforts are later grouped under the recently emerging field: conservation social sciences.

According to Bennett, Roth, Klain, Chan, Christie, et al. (2017), conservation social science focuses on human dimensions of conservation, and the concept is closely related to or overlaps with other existing terms, such as environmental social science, human dimensions of natural resource management, social-ecological systems, and environmental humanities. Bennett, Roth, Klain, Chan, Christie, et al. (2017) also categorized conservation social science into three main groups: classic fields (e.g., environmental anthropology, environmental psychology,

environmental economics, etc.), applied fields (e.g., conservation education, conservation law, etc.), and interdisciplinary fields (e.g., political ecology, human ecology, etc.).

Social conservation science is highly interdisciplinary. Therefore, insights from social science research can be incorporated into all conservation planning and implementation stages. Information exchange and collaboration between social and natural scientists are also very important (Bennett, Roth, Klain, Chan, Clark, et al., 2017). Regarding the current landscape of conservation science, there is a concern that incorporating social sciences is viewed only as a means for justifying and promoting status quo conservation practices (Bennett & Roth, 2019). To avoid treating social conservation science at its superficial level, Chua et al. (2020) suggest the following ways to improve the relationship between conservation and social science: "[…] through careful use of proxies as bridging devices, through the creation of new, shared spaces, and through a willingness to destabilize and overhaul status quos. This demands an open-ended, unavoidably political commitment to critical reflexivity and self-transformation on the part of both conservationists and social scientists."

Bennett, Roth, Klain, Chan, Christie, et al. (2017) classify conservation social sciences into 18 categories, although many might overlap. Among these categories, environmental and conservation psychology focuses on humans' thoughts and behaviors regarding natural and conservation-related topics. Having insights into the individuals' thoughts and behaviors towards a particular conservation initiative, management action, and consumer behavior can help enhance the effectiveness of marketing campaigns, management strategies, and policymaking (Bennett, Roth, Klain, Chan, Clark, et al., 2017).

Considering the characteristics of conservation social sciences, studying the psychology and behaviors of urban people towards biodiversity can be deemed to belong to the field. Moreover,

studying how to involve urban residents in biodiversity conservation in protected areas can be considered a bridge for "mutual transformation" or "transformative dialogue" between social sciences and conservation sciences (Chua et al., 2020).

2.4. Humans' perceptions of biodiversity

Conservation effectiveness can be improved by understanding residents' perceptions, attitudes, and behaviors, so it is essential to understand the public's perceptions related to biodiversity and conservation. As for urban residents, there are two main reasons why knowing their mental constructs about biodiversity is beneficial. By saying "mental constructs," it is to indicate people's own perceptions about biodiversity and their connotations relating to other concepts (e.g., conservation). Such indication is adopted from the study of Fischer and Young (2007).

Reasons for the existence of the illegal wildlife trade, one of the world's largest illegitimate businesses, are myriad (Wyler & Sheikh, 2013). Wildlife is primarily traded for medicines, luxury goods, cultural purposes, and petting (Scheffers, Oliveira, Lamb, & Edwards, 2019). Despite multiple policies and regulations implemented, wildlife trading intensity for these products is still rising. Illegal trading's continuous expansion is largely attributable to the growing price and demand for wildlife products and utilities in urban markets (Challender, Harrop, & MacMillan, 2015b; Zhang & Yin, 2014). Thus, understanding the mental constructs of urban residents about biodiversity (loss) might ease the policymaking and prevention programs that cut down wildlife consumption demand in urban areas.

Exploring urban residents' mental constructs also provides valuable information for policymaking and management in another aspect of biodiversity conservation: nature-based tourism. Among the benefits of biodiversity, improving human health and well-being through cultural pathways is one of the most valuable merits (Clark et al., 2014). By interacting with nature or immersing in a natural

environment, humans might have lower risks of mental illness and increased happiness. Such merits of biodiversity might lead to the increasing demand for nature-based tourism in protected areas globally, which might, in turn, generate sustainable finance for biodiversity conservation (Balmford et al., 2009; Chung, Dietz, & Liu, 2018; Tapper, 2006). Specifically, Khai and Yabe (2014) find that urban residents in the Mekong Delta (Vietnam) are willing to pay approximately $11 million per year for biodiversity conservation. However, the ideal interaction between tourism and biodiversity conservation can only be obtained with appropriate management and regulation strategies (Chung et al., 2018). Given that a great part of nature-based tourism's demand derives from urban areas (Fredman & Tyrväinen, 2010; Karanth & DeFries, 2011; Lundmark & Müller, 2010), it is reasonable to examine the future visitors' perceptions towards biodiversity (loss) for better monitoring, management, and regulation in protected areas.

Previous studies have examined the public views and knowledge regarding biodiversity and biodiversity-related issues. Those studies can be classified into two types. The first type attempts to quantify individuals' knowledge and perceptions through established scales (Hunter & Brehm, 2003; Kaltenborn, Gundersen, Stange, Hagen, & Skogen, 2016), whereas the second type aims to explore individuals' perceptions through conceptual constructs (or mental constructs) (Bakhtiari, Jacobsen, Strange, & Helles, 2014; Fischer & Young, 2007). The second type (exploring perceptions through conceptual constructs) is more appropriate to the current dissertation since it can provide a deep understanding of how Vietnamese urban people perceive biodiversity and its related connotations.

Various other studies advocate that lay persons can acquire rich and deep perceptions of biodiversity in spite of their limited scientific knowledge about the terms (Buijs, Fischer, Rink, & Young, 2008; Nisiforou & Charalambides, 2012; Şekercioğlu, 2012; Tonin & Lucaroni, 2017).

Scientists find that heterogeneity, naturalness, peacefulness, richness, and wilderness are primary attributes that are usually attached to the biodiversity concept (Bakhtiari et al., 2014; Dandy et al., 2012; Fischer & Young, 2007). Muratet, Pellegrini, Dufour, Arrif, and Chiron (2015) reveal that "plant species richness is mainly appreciated for the beauty and sense of well-being it provides," while a study on farmers' perceptions towards biodiversity find that spirituality and emotions are also linked to biodiversity (Kelemen et al., 2013). Besides these notions, the general public associates biodiversity with the natural balance, food chains, and the interactions between humans and nature (Fischer & Young, 2007).

Not only do scientists attempt to explore the normative attributes of biodiversity in lay persons' perceptions, but they also utilize scientific definition's classification to categorize the mental constructs. For example, the biodiversity classification proposed by Mace et al. (2012) is also employed in interpreting the mental constructs of the public about biodiversity by Bakhtiari et al. (2014). Particularly, using the qualitative data acquired from interviews and focus group discussions with local laypeople, they categorize individuals' perceptions about forest biodiversity as i) a good in itself and ii) a regulator of the ecosystem.

Several studies have been conducted to explore the mental constructs of the general public regarding biodiversity. However, those studies are mainly about the residents living near a forest or protected area. Even though Muratet et al. (2015)'s investigation was conducted among urban park users, its scope is not particularly about biodiversity, but plant species richness. Additionally, most of the studies were in developed Western countries, so little is known about the public's perceptions of other countries, especially those with different cultural values (Vuong & Napier, 2015) and economic conditions (Christie, Fazey, Cooper, Hyde, & Kenter, 2012; Nguyen, Le, et

al., 2021). For these reasons, the first study in this dissertation aims to examine the perceptions towards biodiversity and biodiversity loss of Vietnamese urban residents.

2.5. Chapter Summary

This chapter reviews major definitions and frameworks of biodiversity. Biodiversity has indispensable roles in the functions of ecosystems, so it greatly affects humans in general and urban humans in particular. Besides, the chapter also implies the scientific discipline to which the dissertation belongs: conservation social sciences. This discipline focuses on studying the human-related aspects in conservation. To improve conservation effectiveness, understanding the perception of humans is necessary. However, little has been known about the urban residents' perceptions of biodiversity and its connotations, especially those from developing countries like Vietnam. As a result, the research objective of the first study in this dissertation is proposed.

Chapter 3:

Urban demand-induced illegal wildlife trade

3.1. Illegal wildlife trade

Humans have been harvesting wild plants and catching wild animals throughout our history. While the word "wildlife" often refers to animals (especially mammals), in this context (or dissertation), it should include all fauna, flora, as well as others (e.g., fungi). We use wildlife products such as food (e.g., cereal, vegetables), transportation (e.g., horses, camels), ornaments (e.g., orchids, seashells), pets (e.g., dogs, cats), and many other purposes. The consumption and trading of wildlife products are a natural part of the interactions between other species and humans. However, humans' wildlife use can also be unsustainable, with early examples including large-scale wildlife product consumption during the Roman Empire (Hughes, 2003). Harmful exploitation of wildlife is a significant threat to biodiversity and is thus deemed illegal in many law systems to conserve such valuable resources. Besides various other negative impacts of biodiversity loss, uncontrolled wildlife trade can also bring serious health risks such as zoonotic diseases. The devastating COVID-19 pandemic is a dreadful reminder for humanity (Borzée et al., 2020).

The wildlife trade is worth billions of dollars annually, but in places where trade occurs, species abundance can decline by more than 60%, indicating a dangerous risk of extinction (Morton, Scheffers, Haugaasen, & Edwards, 2021). 't Sas-Rolfes, Challender, Hinsley, Veríssimo, and Milner-Gulland (2019) summarize several other vital points on illegal wildlife trade:

1) it is associated with biodiversity loss and other social problems;

2) unsustainable exploitation is especially concerning for rare or charismatic species;

3) illegal trade that is deemed socially legitimate by involving actors is a huge challenge for policymakers;

4) the illegal wildlife trade systems are complex, accurate information is difficult to collect, and quantification is challenging.

Additionally, ‘t Sas-Rolfes et al. (2019) also point out that illegal wildlife trade on the national scale (such as bushmeat) often involves few actors and is context-based. Meanwhile, the trade chains from supply to consumption on the international scale involve many intermediate actors. Unsustainable wildlife trade is a major problem for conservation in Asia, with major exporters being Malaysia, Vietnam, Indonesia, and China, and their major importers are the European Union and Japan (Nijman, 2010).

Early wildlife trade research approaches focused on economic aspects, influenced by theories such as Garret Hardin’s “Tragedy of the Commons” (Hardin, 1968). From the last decades of the 20th century, research on the matter became more interdisciplinary, including the extension and incorporation of many other fields such as criminology, anthropology, and psychology. Several examples of such diverse approaches are briefly presented as follows.

Baker et al. (2013) address the issue of animal welfare and ethics in wildlife trade – a topic still not well studied. Humans’ treatment of wildlife is also examined through the moral concept of compassion (Wallach, Bekoff, Batavia, Nelson, & Ramp, 2018). Regarding the aspect of subjective perception, Courchamp et al. (2006) argue that the way humans place exaggerated value on rarity further increases the exploitation of rare species, creating reinforcing loops that push those species toward extinction. This phenomenon is defined as the anthropogenic Allee effect. In the modern world, wildlife trafficking crime can be conducted over the Internet, requiring

corresponding new research directions to properly investigate emerging illegal activities that capitalize on digital advancement (Lavorgna, 2014).

In the 2020 report of the United Nations Office on Drugs Crime (2020), the share of all seizure incidents from 1999 to 2018 by main taxonomic groups from high to low is as follows: mammals (23%), reptiles (21.3%), coral (14.6%), plants (14.3%), etc. Regarding the share of type of wildlife among total seizures, rosewood and elephants are the two most dominant categories. According to the report, organized crime uses strategies such as exploiting weak legislation in certain countries, shifting to alternative species with similar values, utilizing online platforms like social media, and captive breeding. Illegal trading is also facilitated by bribery that capitalizes on corruption by government officials, the military, and the police.

While there is no exact universal definition for wildlife crime due to differences among national laws about the matter, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) offers a framework to protect wildlife through international cooperation to monitor and manage wildlife trading activities. CITES holds a crucial role in wildlife trade global governance, aiming to ensure that trading activities of wild organisms' specimens do not negatively affect species' survival. As of February 2022, CITES had 184 Parties (member states or regional economic integration organizations). However, the effectiveness and legitimacy of CITES are open questions (Hutton & Dickson, 2000). An analysis from the CITES database reveals that from 1975 to 2014, the total yearly trading (legal and illegal) of whole-organism equivalents increased from 25 million to 100 million. Still, data from CITES has the problem of inconsistency due to differences in measurement and legality, as well as misreporting and nonreporting (Harfoot et al., 2018).

Mitigation measures can be categorized into three categories corresponding to three groups of actors: supply-side, transactional, and demand-side (‘t Sas-Rolfes et al., 2019). Respectively, each type of countermeasure aims to reduce illegal activities involving harvesters (e.g., poachers), trade enablers (e.g., smugglers), and consumers. Supply-side and transactional countermeasures are often done through top-down regulation, while perception change is the main factor in demand-side countermeasures. From 2010 to 2016, the World Bank estimates that the total funding for combating illegal wildlife trade in Africa and Asia was USD 1.3 billion (World Bank Group, 2016). Trade activities of wildlife products, just like with many other products, are driven by people’s demands. For example, the bushmeat trade is found to be fueled by the increasing consumption demand of urban people that is growing in terms of population and wealth (East, Kümpel, Milner-Gulland, & Rowcliffe, 2005). In the case of Vietnam presented below, the target of the investigation is within-nation consumption of wildlife products where the supply chain has few middle actors. Thus, the focus is mostly on supply-side and demand-side countermeasures.

Illegal and excessive exploitation of biological resources is one of the leading causes that directly drive the severe biodiversity degradation in Vietnam. Approximately 3,000 tons of wildlife and wildlife products are transferred in and out of Vietnam annually, with only a minimal proportion (3%) intercepted (Dang & Dang, 20210; Ngoc & Wyatt, 2013). In 2010, the government confiscated over 34 tons of 13,000 wild animals from illegal traders (Ministry of Natural Resources and Environment, 2014b). Nguyen estimates that the total revenue from illegal wildlife trade in 2000 was $67 million, 12 times higher than the total amount of legal wildlife trade ($5.5 million) (Van Song, 2008). It is also calculated that half of the transaction is for domestic consumption, mostly in urban areas (Ngoc & Wyatt, 2013). Vietnam’s persistent and even expanding illegal wildlife trading network derives mainly from the human-centered mindset towards the diverse

ecosystem, historical consumption of wildlife, and inadequate environmental legislation system (Ngoc & Wyatt, 2013).

3.2. Supply-side countermeasures

3.2.1. General situation

Supply-side countermeasures can restrict harvesting activities or provide incentives for not harvesting. The measures can target specific areas or specific species that need protection. Protected area is a common concept in environmental conservation that helps safeguard biodiversity against unsustainable wildlife exploitation. As of February 2022, according to the World Database on Protected Areas, the total number of protected areas is nearly 270000 in over 245 countries and territories (UNEP-WCMC, 2022a). However, support for protected areas is declining, and there are low political commitments to maintain and improve protection effectiveness, as only about 20-50% of protected areas are effectively managed (Watson et al., 2014). An analysis of over 8000 assessments of protected area management pointed out that 40% showed major deficiencies, with the weakest aspects being community benefit programs, resourcing, and management evaluation (Leverington, Costa, Pavese, Lisle, & Hockings, 2010). A recent study examining management reports from over 2000 protected areas showed that less than a quarter of them had adequate staffing and budget (Coad et al., 2019).

Providing community-based incentives is one of the approaches for controlling activities related to the supply of wildlife trade. For example, a study in Namibia found that trophy hunting and tourism generate revenues for local communities and private operators, increasing the value of wildlife as a land-use option and thus supporting conservation (Naidoo et al., 2016). Policies allowing controlled trophy hunting can provide economic incentives for protecting wild animals and their habitats. Additionally, international hunters prefer areas with abundant non-target

wildlife and hunting programs benefiting local people, and they are willing to pay more if the revenues come to local communities rather than governmental bodies (Fischer, Tibebe Weldesemaet, Czajkowski, Tadie, & Hanley, 2015).

Supply-side restrictions can support biodiversity conservation efforts and benefit local people, but good governance is crucial for such projects to be effective (Roe et al., 2015). Alternative supply-side measures include conducting sustainable artificial cultivation like ranching, farming, and captive breeding to create cheaper substitutes for illegal wildlife products, thus aiming to decrease unsustainable harvesting (Bulte & Damania, 2005). However, such measures must be carefully researched and employed since they can negatively affect local wild species' populations (Williams, Jones, Annewandter, & Gibbons, 2014).

Supply-side measurements alone may be ineffective due to how demand drives the trading process. The socioeconomic factors of residents also determine their behaviors toward wild resources. For example, the effects of anti-poaching policies that restrict supply can be weakened because the value perception of rarity makes people become willing to pay an even higher price for wildlife goods (Chen, 2016). Demands from foreign markets, internal corruption, and poverty contribute to the degree of poaching activities (Nuwer, 2018; United Nations Office on Drugs Crime, 2020).

3.2.2. Vietnam's situation

The Vietnamese government has demonstrated a great commitment to biodiversity protection and conservation by implementing national strategic plans, programs, and initiatives (Ministry of Natural Resources and Environment, 2014b). Since participating in the Convention on Biological Diversity in 1994, Vietnam has undertaken actions to conserve biodiversity by implementing National Biodiversity Action Plans (NBAP). The latest NBAP, with strategic plans for 2020 and a vision for 2030, was approved by the Prime Minister in 2014. Effective conservation of wildlife

and endangered, rare, and precious species is considered one of five key targets of the plan (Ministry of Natural Resources and Environment, 2014b). The government also released *Decree 32/2006/ND-CP* and *Decree 82/2006/ND-CP* to prohibit the harvest, trade, use, and consumption of all protected species (Shairp et al., 2016).

However, efforts controlling the supply side in the wildlife trade network (e.g., enforcement and farmed wildmeat) seem to be ineffective due to several reasons:

1) the wildlife protection policies are slowly and inadequately implemented and enforced;
2) resources for monitoring and law enforcement (e.g., manpower, finance, equipment) are insufficient;
3) the deficiency in the governmental system (e.g., corruption, bureaucracy) hinders protection efforts (Van Song, 2008);
4) the cooperation among agencies, organizations, and countries is lax (Challender & MacMillan, 2014);
5) the socio-economic problem (e.g., crippling poverty) in source areas is still not resolved;
6) the illegal wildlife trading network has been more deliberately organized using social media to avoid enforcers' monitoring and inspection (Ngoc, 2020);
7) poached wildmeat's low cost and sociocultural values make it preferable to farmed substitutes (Brooks, Roberton, & Bell, 2010; Drury, 2009);
8) wildlife farming depends on wild populations for restocking, resulting in the laundering of illegal wildlife products (Tensen, 2016).

3.3. Demand-side countermeasures

3.3.1. General situation

The attention to demand-side countermeasures for unsustainable wildlife trade started early in the 1970s (Arthur & Wilson, 1979). Demand-side measures can be legal restrictions (e.g., purchase or consumption bans) or influences on behavior change (e.g., through education and public communication). The legal restriction approach shares similarities with common supply-side measures. However, demand-side measures often focus on the approach of voluntary behavior change through campaigns to raise public awareness on the negative impacts of wildlife consumption. This type of approach aims to shift people's perceptions of wildlife products, as well as provide information about alternative products that are more ecologically friendly.

Veríssimo and Wan (2018) resent the main issues regarding demand-reduction campaigns. There are taxonomic biases in demand-reduction campaigns, as the species involved are usually mammals (e.g., rhino horn, elephant ivory, tiger bone, pangolin scales), with the addition of sharks (e.g., shark fin consumption). Nonetheless, while plant trade is a major concern, according to CITES, plants are largely ignored in these campaigns compared to charismatic and familiar animals. Campaigns' content mainly focuses on strategies and outputs, with little attention to outcomes and impacts. Veríssimo and Wan (2018) refer to outputs as information on the implementation and use of previously described strategies, whereas evidence of specific changes in the target audience is considered outcomes. The provided information is heavily anecdotal, holding a high risk of bias. Due to the complexity of the addressed issues as well as barriers to accurate impact assessment, the effectiveness of such demand-reduction campaigns is unclear. There are also shortfalls regarding appropriate application of behavioral theories.

Collecting data on demand for illegal products is also a problem. Consumption of wildlife products, especially those involving illegal trade, is a socially sensitive topic, requiring conservation scientists to have proper strategies and techniques to avoid biased responses (Ibbett, Jones, & St John, 2021). This aspect is even more critical considering the "face-saving" cultural tendency in many Asian societies. Overall, interventions involving behavior change can influence pro-environmental decisions, but still, this is a complex matter (Byerly et al., 2018). People's consumption behaviors are based on reasoning using three main components of attitude, subjective norms, and perceived behavioral control that results in the corresponding behavioral intentions, as suggested by the Theory of Planned Behavior (Ajzen, 1991). Decision-making regarding wildlife product consumption is a multiplex process; thus, its underlying psychological mechanisms should be examined deeper with the information processing approach (Lindsay & Norman, 1972; M.-H. Nguyen, La, et al., 2022b).

3.3.2. Vietnam's situation

Given the aforementioned difficulties with supply-side measures in Vietnam, many scientists have suggested paying more attention to tackling the wildlife consumption demand, particularly among the middle class in urban areas. The consumption of wildlife products in Vietnamese urban areas is prevalent with multiple purposes, such as traditional medicines (e.g., tiger bones, bear bile, etc.) (Davis et al., 2019; Davis et al., 2020), wildmeat (Olmedo et al., 2021; Sandalj, Treydte, & Ziegler, 2016), and petting (Nguyen, 2021), but legal mechanisms are still missing. Social marketing campaigns have also been suggested as a potential method to reduce the consumption demand of wildlife products or redirect it to herbal substitutes (Greenfield & Veríssimo, 2019; Moorhouse, Coals, D'Cruze, & Macdonald, 2020; Shairp et al., 2016). Understanding how biodiversity

perceptions influence wildlife product consumption behaviors can help improve the effectiveness of public communication and law implementation in urban areas.

In Vietnam, residents of large urban centers like Ho Chi Minh, Hanoi, Hai Phong, and Hue cities, have a high demand for bushmeat consumption due to sociocultural motives (Drury, 2011; Olmedo et al., 2021; Shairp et al., 2016). Therefore, social marketing and demarketing campaigns in urban areas are essential to reduce or shift the demand from this commodity to other more sustainable options (Challender & MacMillan, 2014; Veríssimo et al., 2020). During the COVID-19 pandemic, the government has implemented Directive No. 29/CT-TTg to consolidate law enforcement of illegal wildlife trade for the sake of public health (Nguyen, 2020). Besides strengthening supply-side measures, the Directive also prohibits illegal wildlife consumption among all citizens, especially government officers and their relatives.

Several studies have been conducted to explore the behaviors of wildmeat consumption and their underlying motives among Vietnamese urban residents. More specifically, a majority of reported wildmeat consumption cases take place in restaurant settings (Drury, 2011; Sandalj et al., 2016; Shairp et al., 2016). The profiles of bushmeat consumers are heterogeneous. Drury (2011) suggests that successful, high-income, high-status male residents are more likely to eat bushmeat to convey wealth and social status. In contrast, Olmedo et al. (2021) indicate that there are three major groups of bushmeat consumers: 1) classic consumers (older, less educated), 2) up-and-coming professionals (younger, wealthier, more educated), 3) and students. Among these groups, students have limited influence on food choice in certain social contexts and are less likely to consume wildmeat than classic consumers and up-and-coming professionals.

Even though the most frequently consumed wildmeat is wild pigs (*Sus Scrofa* – least concerned species in the IUCN red list), many species listed as ‘endangered’ and ‘critically endangered’ in

the red list are also eaten, such as pangolins (Manis spp.), Vietnamese box turtles (*Cuora galbinifrons*), civets (*Viverra zibetha* or *Viverricula indica*) (Drury, 2011; Sandalj et al., 2016; Shairp et al., 2016).

In Vietnam, serving others with rare wildmeats will help display social status and prestige. Specifically, one of the noteworthy sociopsychological aspects in Vietnamese culture is face-saving – which can be considered as both an individual and collective possession and a subjective value based on social evaluation (Nhung, 2014). The widespread conceptualization and practices of saving one's face (preserving one's reputation, credibility, or dignity) are heavily influenced by Chinese Confucianist values (Hwang & Han, 2010). Face-saving and group orientation characteristics in East Asian culture, including Vietnam, affect perceptions of luxury goods consumption (Le Monkhouse, Barnes, & Stephan, 2012). It can be explained that serving others with rare bushmeat will help the person gain others' attention/admiration ("make face") or cover up weaknesses by using all forms of impression management passively ("keep face"), and in turn, display social status and prestige (Hwang & Han, 2010).

Apart from being a medium to communicate prestige and social leverage, associating bushmeat with quality, nutritional value, health benefits, and taste is also a significant motive that influences bushmeat consumption (Sandalj et al., 2016). The Vietnamese cultural values might shape such perceptions through generations (e.g., traditional medicinal philosophy) (Shairp et al., 2016; Wright, Nancarrow, & Kwok, 2001).

Understanding the predictors of urban residents' wildlife consumption behaviors and support for wildlife consumption prohibition might help improve the effectiveness of social marketing, demarketing, and law enforcement endeavors. It has been found that increased environmental knowledge can positively affect environmental attitudes, pro-environmental behavioral intentions

and behaviors (Amoah & Addoah, 2021; Bradley, Waliczek, & Zajicek, 1999; Faize & Akhtar, 2020; Liu, Teng, & Han, 2020; Polonsky, Vocino, Grau, Garma, & Ferdous, 2012). However, little is known about the associations between urban people's perceptions of biodiversity loss, attitudes towards preventive measures, and bushmeat consumption behavior among urban residents.

3.4. Chapter Summary

Chapter 3 discusses the situations of illegal wildlife trades on a global scale and in Vietnam. Two major types of illegal wildlife trade countermeasures are identified and reviewed: supply-side and demand-side measures. Based on the existing literature, supply-side measures in Vietnam (e.g., top-down enforcement and farmed wildmeat) are ineffective and insufficient for preventing illegal wildlife trade in Vietnam. Scholars suggest complementing supply-side measures with demand-side measures (e.g., behavior change interventions) in illegal wildlife trade prevention. Finally, the chapter clarifies the significance of the dissertation's second study. To elaborate, it explains the importance of studying associations between urban people's perceptions of biodiversity loss, attitude towards preventive measures, and bushmeat consumption behavior.

Chapter 4:

Financing protected areas: the roles of urban people

4.1. Protected areas

The International Union for Conservation of Nature (IUCN) defines a protected area as "a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values" (see *https://www.iucn.org/theme/protected-areas/about*). Protected areas have many forms, such as national parks, wilderness areas, community conserved areas, nature reserves, etc. They can be considered prominent methods for biodiversity conservation. On the main objective of the Global Protected Areas Programme, IUCN states that "Protected Area systems are both ENDS (protected areas directly conserve genetic resources, species, ecosystems and ecosystem processes) and MEANS (to enable many other thematic conservation objectives through *in situ* implementation, governance and equitable sharing)" (see *https://www.iucn.org/theme/protected-areas/about/iucn-global-protected-areas-programme*)

Besides protected areas, there are also other effective area-based conservation measures (OECMs), defined by the Convention on Biological Diversity as "A geographically defined area other than a Protected Area, which is governed and managed in ways that achieve positive and sustained long-term outcomes for the *in situ* conservation of biodiversity with associated ecosystem functions and services and where applicable, cultural, spiritual, socio–economic, and other locally relevant values" (see *https://www.cbd.int/doc/decisions/cop-14/cop-14-dec-08-en.pdf*).

The past several decades have seen the profound development and expansion of protected areas worldwide in geography and function (Watson et al., 2014). Since the first establishment of the world's first national park – Yellowstone national park – in 1872, the total area of protected areas

and OECMs have covered at least 16.64% (22.5 million km2) of land and inland water ecosystems, and 7.74% (28.1 million km2) of coastal waters and the ocean (UNEP-WCMC & IUCN, 2021). The areas of particular importance for biodiversity and ecosystem services have been increasingly covered, with 65.5% of Key Biodiversity Areas partially or fully protected (UNEP-WCMC & IUCN, 2021). Along with the geographical expansion, protected areas' functions have also been diversified to achieve various conservation, social and economic targets (Watson et al., 2014). Due to protected areas' vital roles, effective management and expansion of protected areas over terrestrial and marine areas are set as Target 11 of the Aichi Biodiversity Targets as well as Goals 14 and 15 of the United Nations' Sustainable Development Goals.

As of February 2022, the World Database on Protected Areas recorded 269,643 protected areas covering 245 countries and territories. Additionally, 671 OECMs cover nine countries and territories (UNEP-WCMC, 2022a). The UN Environment Programme World Conservation Monitoring Centre's 2020 report summarizes some important points including:

1) since 2010, 21 million km^2 of protected areas have been added to the global network;
2) OECMs were officially recognized, and they have shown significant expansion;
3) the most remarkable growth in protected areas and OECMs has been in marine and coastal areas;
4) about 34% of Key Biodiversity Areas (sites contributing significantly to global biodiversity) still lacked coverage by protected areas or OECMs;
5) the data on governance and management effectiveness of protected areas is poor, as effectiveness assessments have only been conducted in about 18% of the total area;
6) there should be better recognize and support for indigenous peoples, local communities, and private actors (UNEP-WCMC & IUCN, 2021).

As mentioned in the previous section, there are still major problems with the governance effectiveness of a considerable proportion of protected areas, especially in resourcing and evaluation.

In Vietnam, as of February 2022, according to UNEP-WCMC, in total, there are 209 protected areas (of which 48 have management effectiveness evaluations) and no OECM. This total number consists of 190 national designations (with 32 national parks) and 19 international designations. Terrestrial coverage is 7.58% (24,994 km^2), and Marine and coastal coverage is 0.56% (3,630 km^2) (UNEP-WCMC, 2022b). As of 2018, Vietnam's Ministry of Natural Resources and Environment recorded 172 protected areas (24,938 km^2) in total with 33 national parks; terrestrial coverage is 6.8% (22,694 km^2) (Ministry of Natural Resources and Environment, 2019). In this 2019 national report, community-based conservation management approaches and ecological tourism models for protected areas are also emphasized. Among protected areas in Vietnam, famous national parks include Cúc Phương (22,000 hectares, established in 1982), Yok Đôn (115,000 hectares, established in 1988), Cát Tiên (72,000 hectares, established in 1998), Phong Nha-Kẻ Bàng (858 hectares, established in 2001), Ba Vì (12,000 hectares, established in 1991), Côn Đảo (20,000 hectares, established in 1993).

Specifically, in developing a management system for the nation's protected areas, the Vietnamese government stated six main objectives (Ministry of Natural Resources and Environment, 2019). These objectives are described in Appendix 1.

4.2. Protected areas financing

To curb the substantial degradation of biological diversity, keeping and expanding protected areas are suggested as major solutions. Nevertheless, a substantial amount of finance is needed to maintain the effective operations of such protected areas; otherwise, the "paper park" problem will

be rampant (Dharmaratne, Sang, & Walling, 2000; Emerton, Bishop, & Thomas, 2006; Thur, 2010). Therefore, the current study aims to investigate how biodiversity loss perceptions among urban residents can potentially contribute to conservation initiatives and the finance of protected areas, and in turn, suggest implications for policymakers and protected managers to improve conservation effectiveness.

The IUCN identifies 11 financing mechanisms for protected areas: "government allocations; taxes, levies, surcharges and subsidies; user fees; cause-related marketing; debt-for-nature swaps; joint implementation projects and carbon offsets; grants from multilateral/bilateral sources and foundations; loans from the private and public sectors; and public and private donations" as well as seven steps to develop a financing plan (Athanas et al., 2001):

1) define protected area goals and objectives;
2) identify the existing customer base;
3) list financial resources and demands on these resources;
4) identify new customers and relative levels of use versus contribution;
5) identify mechanisms to capture income from customers;
6) evaluate the feasibility of the proposed mechanisms;
7) clearly state the financial plan.

On the issue of financing protected areas, Bonham et al. (2014) present several important points. To fund conservation projects such as protected areas in the long term, Conservation Trust Funds (CTFs) were established and have been growing since the 1990s. However, donors and governments are skeptical about the effectiveness of CTFs, especially their tangible impacts on biodiversity. The Global Conservation Fund (GCF) was established in 2001 for sustainable

financing of protected areas and conserving natural assets. Regular, sustained investment in protected area management resulted in a significant decline in deforestation rates. The GCF so far has established a total endowment of $230 million, which helps create or expand 135 protected areas (81 million hectares in 26 countries), contributing to the conservation of more than 500 globally threatened species (see *https://www.conservation.org/about/global-conservation-fund*). The Global Environment Facility (GEF) was established in 1991, with the GEF Trust Fund from 40 donor countries administered by the World Bank; GEF funds are available to developing countries and transition economies; the fund replenishment cycle is every four years, and the 2018-2022 fund is about 4 billion USD (see *https://www.thegef.org/who-we-are/funding*).

In the business approach of financing protected areas, customers of the services provided by protected areas are beneficiaries such as local residents, researchers, trophy hunters, domestic or international tourists, and tourism agencies. Developing a customer base for protected areas can provide sustainable income flows that support long-term conservation efforts; the IUCN (2000) states three key points on ensuring an appropriate customer base: "(1) compatible with the objectives of the protected area; (2) compatible with other users of the protected area; and (3) compatible with the social, cultural, legal, institutional and geographic context of the protected area". Benefits provided for the customers can be categorized into four groups: public goods (e.g., scenery, carbon dioxide capturing), private goods (e.g., animal products from trophy hunting activities), toll goods (e.g., entry fees), and common pool goods (e.g., plants or mushrooms available in the area that can be harvested by anyone). Thus, management should not only focus on the aspect of public goods, which mainly requires public funding and philanthropic grants, but should also expand the customer base and pay more attention to other sources of income (IUCN, 2000).

Either effective management or expansion of protected areas requires a substantial, sustainable amount of finance. Even though the coverage of protected areas is increasing, financial support for protected areas is falling behind, leading to poor management, especially in developing countries (Bovarnick et al., 2010). In Vietnam, national parks receive funding from the province and national government for operations and maintenance, while the conservation management budget may also come from international donors, such as World Wide Fund for Nature (WWF), Fauna & Flora International (FFI), International Labour Organization (ILO), etc. Nonetheless, there remain many constraints. The domestic government's subsidies are widespread but insufficient and lack priority, whereas international aids are large but can only focus on large, site-specific projects (Bui et al., 2021).

Solely assuring the operation and conservation finance within the park is inadequate for biodiversity conservation, as local people rely on the protected areas' resources for livelihood. A review of 65 scientific publications from various disciplines on conflicts related to protected areas found that in developing countries, conflicts were mainly driven by impacts on people's livelihoods (Soliku & Schraml, 2018). As a result, tourism is endorsed by many scientists as a sustainable financing source for biodiversity conservation in protected areas (Jones et al., 2021; Whitelaw et al., 2014).

4.3. Tourism as a financing method

The demand for nature-based tourism is one of the fundamental reasons driving people to visit protected areas. The revenue generated from the influx of visitors to protected areas is massive. On a global scale, Balmford et al. (2015) estimate that around 8 billion visits are made per year to the world's terrestrial protected areas. These visits generate roughly $600 billion per year in direct in-country expenditure $250 billion per year in consumer surplus. Thanks to the income generated

by tourism expenditure, some national parks can pay more than 50% of their expenditure for park operation and the conservation of some endangered species (Buckley, 2012). For example, more than 80% finance of Hustai National Park – one of 99 protected areas in Mongolia and a UNESCO Biosphere Reserve – is from tourism (e.g., entrance and lodging fees, horse riding, and souvenirs). The remaining park finance is from research activities, donations, and soft loan interest. Moreover, most of the revenue sources for South African National Parks in 2016 came from tourism, retail, concession and other (51.6%), while only 43.6% of the revenues derived from government grants and other funding.

Moreover, if the benefits of tourism are allocated in fair and equitable ways, tourism development also helps sustain the local livelihood, which reduces the pressure on conservation efforts (Naughton-Treves, Holland, & Brandon, 2005; Walpole & Goodwin, 2001; World Bank, 2021).

Nature-based tourism is a focus of Vietnam's national efforts to create a sustainable source of financial support for biodiversity conservation. However, so far, tourism's contribution to conservation purposes is still lacking. There are also major concerns about the uncontrolled development of tourism that pollutes local natural environments (Ministry of Natural Resources and Environment, 2019). While tourism can benefit conservation as well as local people in many ways, shortcomings in governance such as bureaucratic burden, lack of institutional capacities, top-down processes, and little benefit-sharing can hinder conservation efforts, as shown in the case of the Phong Nha-Ke Bang National Park (containing the world's most extensive cave system) in central Vietnam (Phong, 2014).

In Vietnam, decentralization efforts have been made to empower local communities to participate in national parks' tourism activities (Bui et al., 2021). Three forms of nature-based tourism businesses are outlined in Decision 104/2007 QD-BNN dated 27/12/2007 of the Ministry of

Agriculture and Rural Development: 1) businesses organized by the management board of the parks, 2) private sector investment in the parks, and 3) public-private partnerships. National parks with adequate infrastructure and proximity to tourist hubs often gain economic benefits from entrance fees. According to the Division of Nature Conservation, tourism generated around six billion VNĐ (3.43%) of revenue in national parks, of which 28% was from the entrance fee. In Cuc Phuong and Ba Vi national parks, most visitors to Vietnam's protected areas are domestic tourists (Ly & Nguyen, 2017; Pham, 2016). Although policies supporting decentralization and delegation of additional powers to provincial and municipal authorities have been benefiting biodiversity conservation in protected areas, there is evidence that the recentralization of resource management happened in recent mega tourism projects (Bui et al., 2021). A study in the Nha Trang Bay area reveals that tourism has not benefited local people economically as much as expected. One of the reasons preventing the locals from participating in the tourism industry is low education levels (Pham-Do & Pham, 2020). Tourism can provide financial power for both conservation programs and local communities, but it is clear that it is not a straightforward solution but rather one that requires complex governance as well as further interdisciplinary research.

There is a conservation approach suggesting that providing direct payments for individuals or communities to compromise and avoid ecologically destructive behaviors is more effective than complex development interventions (Ferraro, 2001). While this study does not examine this particular approach, the reality remains that it is challenging to induce desirable behavior change compared to reaching compromises through economic incentives. There is a big mindset gap between being paid to behave pro-ecologically and being willing to pay for conservation programs. However, financing protected areas with donations from visitors or the general public is not a fantasy but a very practical approach that has been existing for a long time.

One of the most widely used methods to generate revenue from visitors within the protected area is levying the fee. Such fees can appear in various forms, like fees within a tour, entrance fees, conservation fees, user fees, etc. (Thur, 2010; Whitelaw et al., 2014). Visitors' willingness to pay for the fee is distinct depending on the protected areas' features and the visitors' characteristics (Baral & Dhungana, 2014; Bhandari & Heshmati, 2010; Estifanos, Polyakov, Pandit, Hailu, & Burton, 2021; Gelcich et al., 2013; Wang & Jia, 2012). Specifically, income level, educational attainment, and institutional trust are strong predictors of an increasing willingness to pay the entrance fee in the Dalai Lake protected area (Wang & Jia, 2012). Visitors are more willing to pay more for the protection of Ethiopian wolves if the wolf population increases (Estifanos et al., 2021).

However, studies also show that a certain number of visitors are unwilling to pay because they attribute biodiversity conservation to the government's responsibility (Bhandari & Heshmati, 2010; Wang & Jia, 2012). A study in South Carolina found that while visitors with high levels of adventure-seeking tend to seek stimulating services, the relationship with willingness to pay extra is not significant (Weaver, 2012). Most of the studies regarding willingness to pay are conducted on-site with visitors visiting the protected areas.

Urban residents can have a high demand for nature-based tourism, but the urban living environments often lack such desirable natural assets (Hall & Boyd, 2005). However, it cannot be denied that the urban population is a great potential market to finance protected areas and related conservation efforts because urban people have both the desire and the financial capacity for ecotourism (Fredman & Tyrväinen, 2010; Frost et al., 2014; Jones & Nguyen, 2021; Lundmark & Müller, 2010). Thus, a promising financial source for protected areas may come from places far

away from them: cities. To this end, knowing the factors that influence subjective perceptions and personal decision-making among urban residents is essential.

4.4. Chapter summary

Chapter 4 provides an overview of protected areas and their financing methods. Furthermore, it explains how tourism can be deemed a sustainable financial source for protected areas with effective and sufficient management. Nature-based tourism brings finance from cities to protected areas through the market-based mechanism, highlighting channels through which urban residents can contribute to biodiversity conservation in protected areas. Eventually, the need to understand factors influencing urban residents' willingness to pay is described to improve protected areas' finance.

Chapter 5:

A brief overview of Vietnam

5.1. Overview: geography, population, economic development

Vietnam is a Southeast Asian country on the east side of the Indochinese peninsula, with an area of approximately 331,000 km^2 and a coastline of 3260 km. Spanning over 15° of latitude, Vietnam has a monsoonal tropical climate where the north has four distinct seasons (Spring, Summer, Autumn, and Winter) and the south has two (dry and rainy) as well as the temperate climate in mountainous areas. The mean temperature of the country is 24-25 °C. There are two main deltas: the Hong River Delta in the north and the Mekong Delta in the south. The mountainous areas in Vietnam are along the Annamite Range (*Dãy Trường Sơn*), with the highest peak being 3147 m in height (the Fansipan mountain), and a large plateau of more than 50,000 km^2 – the Central Highlands (*Tây Nguyên*) having the distinct rich basalt soil. The rainfall in most areas is 1,400-2,400 mm per year, with 90% of rain coming during monsoons from May to October.

According to the Vietnamese General Statistics Office, the population of Vietnam in 2021 was 98.51 million people, of which 37.1% are in urban regions (General Statistics Office, 2022). Vietnam's annual population growth rate has declined from 3% in 1961 to 0.9% in 2020 (The world Bank, 2022e), and the birth rate has been mostly unchanged since 2001 (The world Bank, 2022b). The majority of people live in the Hong River Delta and the Mekong Delta areas, as well as along the coastline. The Vietnamese government recognizes 54 ethnic groups within the country, of which the *Kinh* ethnic group accounts for more than 85% of the total population. Ethnic minorities primarily live in mountainous and rural regions. Still, they also live in urban areas with Kinh people – particularly, the *Hoa* people (of Chinese origin) are closely connected to Vietnamese culture. Ethnic minorities can have an essential role in environmental conservation, but their

participation faces obstacles such as low subsidies and distrust (Sang, 2021). Additionally, it is crucial to provide ethnic minorities in mountainous and rural regions with sufficient knowledge and management skills to prevent environmentally destructive behaviors such as deliberate forest burning or excessive hunting.

The total GDP of Vietnam had increased from 6 billion USD in 1990 to 271 billion USD in 2020 (The World Bank, 2022c), with an annual growth rate of almost always over 5% for the last 30 years until 2020, when the COVID-19 pandemic began (The World Bank, 2022d). Vietnam's economy has seen significant positive changes in the last several decades, starting from the milestone of the *Đổi Mới* economic reform in 1986 and continuing to innovate and adapt to international markets (Chính & Hoàng, 2009). While having achieved better economic capacity as a transitional and middle-income economy, Vietnam still requires international financial support for big environmental conservation projects. Vietnam is among the recipient countries in the Global Environment Facility (GEF), with the total funding received from the GEF Trust Fund of $186,314,268 for national projects and $853,707,652 for regional or global projects (see https://www.thegef.org/projects-operations/country-profiles/viet-nam).

The Viet Nam Biodiversity Expenditure Review (BER) in 2018 (Tran, 2018), part of the Global Biodiversity Finance Initiative (BIOFIN) project managed by the UNDP, estimated that from 2011 to 2015, Vietnam's spending for biodiversity-related activities was approximately 1 billion USD, of which 76.7% was for the public sector, 19.1% for the social sector, and 4.2% for the private sector. The majority of expenditure in this period was for sustainable use, benefit sharing, and conservation of natural ecosystems. The annual spending on biodiversity projects was considered to be associated with Vietnam's economic growth, as regression analysis from the BER showed that the percentage increase in GDP corresponds to a 1.32% increase in total annual biodiversity

expenditure. Thus, it is estimated that annual biodiversity expenditure in the year 2030 would probably be over 600 million USD. Based on the BER, the main recommendations for the Vietnamese government and other related actors in managing biodiversity expenditure besides data recording issues are as follows:

- The government needs to develop a Biodiversity Finance Plan to maintain and strengthen government budget finance (through government-regulated instruments) and improve finance mobilization from social and private sector sources (e.g., education and awareness-raising campaigns).
- Actors financing biodiversity conservation in Vietnam need to improve the effectiveness and efficiency of the financial flows to meet the national biodiversity conservation targets.

5.2. Biodiversity in Vietnam

Vietnam is located in the Indo-Burma region – one of the most biologically important and threatened hotspots worldwide. It has gained early global recognition for various unique and endemic species. In particular, Saola (*Pseudoryx nghetinhensi*) – the first large land vertebrate to be discovered over 50 years before 1992 – was documented in the forests near Vietnam's border with Laos (Van Dung et al., 1993). With the land area stretching over 1,650 km vertically, including different biomes of mountains, tropical forests, wetlands, and many others, the terrestrial ecosystems in Vietnam contain a great diversity of species that include more than 13,200 floral species and around 10,000 faunal species (Fauna & Flora International, 2021). Vietnam has about 300 species of mammals and 900 species of birds. Regarding marine species, with a sea area of about 1 million km^2, a coastline of 3,260 km, 3,000 large and small islands, and two archipelagos, there are about 11,000 marine species in Vietnam, including more than 2000 species of fish, 15 species of sea reptiles, 12 species of aquatic mammals, five species of sea turtles, and more than

400 species of coral, together with many other categories (Mai, 2021). Vietnam is ranked 16th among the countries with the highest biodiversity levels in the world, according to BIOFIN (see https://www.biofin.org/viet-nam).

However, biodiversity loss is happening at a critical rate. In particular, Vietnam Red List in 2007 identified 882 threatened, and endangered species (418 animals and 464 plants), showing an increase of 22.33% (161 species) compared to the first published Vietnam Red List in 1992 (Ministry of Natural Resources and Environment, 2014a). Several species have gone extinct, like the flagship Javan rhinoceros (*Rhinoceros sondaicus*). The Javan rhino in Vietnam was declared to be locally extinct after the last one of its kind was found dead with its horn hacked off in Cat Tien National Park in 2010 (Brook et al., 2014). Other species, like bears, pangolins, tigers, etc., also face the risk of extinction. While Vietnam's forest cover is 47%, only 1.8% of this (5700 km^2) is primary forest (Fauna & Flora International, 2021). Vietnam is considered to have the "empty forest syndrome" – despite the forest cover rate, the wildlife within is declining; additionally, it is estimated that 99% of Vietnam's natural wetlands have been lost (USAID, 2019).

Figure 5.1. Distribution of 30 designated national parks in Vietnam by 2012. The visualization is retrieved from Le, Markowski, and Bartos (2018) under the Creative Commons Attribution license (CC-BY).

The richness and endemism of species in Vietnam are under threat by many factors. Besides land conversion for agricultural use, infrastructure development, urbanization, invasive species, pollution, and climate change, the rising demand for wildlife products due to consumption in urban areas is also the leading cause of biodiversity loss in Vietnam (Lee et al., 2014; Ministry of Natural Resources and Environment, 2014b). To reduce the biodiversity loss rate, the Vietnamese government has demonstrated commitment to biodiversity protection and conservation by implementing national strategic plans, programs, and initiatives (Ministry of Natural Resources and Environment, 2014b). Conservation of ecosystems, endangered, rare, and precious species, and genetics is one of the government's main objectives.

As keeping and expanding protected areas are deemed fundamental solutions for conservation, the Vietnamese government established a national park system to protect nature, including rare species, forest ecosystems, and genetic resources. From 2002 to 2012, the number of national parks expanded from 16 (476,621 ha) to 30 (1,077,236 ha) national parks (see Figure 5.1). By 2018, that number had increased to 33 (Bui et al., 2021), with the new establishment of Du Gia national park in 2015, Phia Oac-Phia Den national park, and Ta Dung national park in 2018.

Despite the expansion of the protected areas network, efforts controlling the supply side in the wildlife trade network seem to be ineffective due to 1) slow and inadequate law enforcement and policy implementation, 2) lacking resources for monitoring and management, such as human resources, funding, and equipment, 3) corruption among influential people, 4) conflicts of conservation initiatives and programs with local livelihoods, and 5) the increasingly organized and expanded criminal networks. Moreover, expanding and effectively managing protected areas require substantial, sustainable finance; otherwise, it will lead to poor management and rampant "paper park" situations. In Vietnam, national parks primarily receive funding from the state for

operations and maintenance, but the subsidies are insufficient and lack priority. According to the Division of Nature Conservation, state funding (channeled through central and local levels of government) contributed up to 78.07% of revenue for national parks in 2015, approximately $8 million (around 175 billion VND) (Pham & Bui, 2020). Revenue from nature-based tourism is, therefore, a potential sustainable source of finance for conservation if appropriately managed (Jones et al., 2021; Whitelaw et al., 2014).

Given these difficulties, understanding urban residents' consumption of wildlife products and attitude towards preventive measures of biodiversity loss is necessary for preventing wildlife trafficking on the demand side as well as improving public financial support for conservation efforts. More details supporting this argument are presented in Chapter 6.

5.3. Vietnamese culture

The Vietnamese culture is complex and has a long history. Besides its original values, the culture of Vietnam has been influenced by many other cultures throughout history, mainly from China, the Champa and Khmer in earlier periods, and Western culture more recently. The interactions of cultural values from different origins can be observed through many social aspects, such as the Indochine architecture and the decoration patterns in many old Vietnamese buildings (Vuong et al., 2019).

Notably, the Three Teachings (*Tam Giáo* in Vietnamese, 三教 in Chinese), which consists of Confucianism, Buddhism, and Taoism, had their values influence each other and over time became new Vietnamese cultural values through the phenomenon of cultural additivity (Vuong et al., 2018). Under Chinese domination from 111 B.C. to A.D. 939, Chinese cultural forms and practices were assimilated into Vietnamese society. The Three Teachings were considered to be from the

same root as the Chinese concept of 三教 (Sān jiào), implying the co-existence and convergence of these three religions in Vietnam (Lan, 2016). The effects of the Three Teachings on Vietnamese culture and people's attitudes toward "good" or "bad" behaviors are very complex and may even appear counter-intuitive at first glance (Vuong, Ho, et al., 2020).

Buddhism appeared early in Vietnam, with the first Buddhist temples being built in the third century, likely from Indian influence (Taylor, 2018). Buddhism is now widespread across Vietnam, with teachings and practices focusing on the core concepts of the Four Noble Truths, the Eightfold Path, *karma*, and reincarnations. In particular, the concept of *karma* (*nghiệp*) is quite deeply integrated into Vietnamese culture, commonly referred to as the natural principle of cause and effect. This factor can be crucial when considering Vietnamese people's perceptions of good and bad behaviors in relation to their speculations about their own future and even the afterlife or next lives.

Confucianism was introduced into Vietnam during the Chinese domination period and is often considered a way of life rather than a religion. According to Nguyen (2015), during the 2000 years of development, Confucianism in Vietnam became "Vietnamized," which is different from Chinese Confucianism and has the following main characteristics:

1. Foreign cultural values can be integrated and developed if used to solve existing problems in Vietnamese contexts.
2. Foreign cultural values can exist along with indigenous cultural values.
3. The concept of "Vietnamization" was founded on the confirmation of humanism.
4. The Vietnamization process was practical, and every cultural value tended to have a close connection with reality.

5. “Vietnamization” was founded on an open-minded, multiculturalist spirit that sought to prevent thinking monopolies.
6. Vietnamese are not fanatic as they exhibit critical attitudes while learning foreign cultural values.

While Confucianism is often associated with governance, it also helped establish many deep moral concepts in Vietnamese society, such as “righteousness” (*nghĩa* in Vietnamese, 義 in Chinese).

Taoism appeared early in Vietnam, around the second century. Compared to Chinese Taoism, Vietnamese Taoism does not have Taoist schools. Vietnamese Taoist masters are shaman-like specialists who practice healing and other spiritual rituals that do not link to temples (Tran, 2017). Taoist temples in Vietnam do not train priests but serve as a place to worship famous deities in Vietnamese culture, such as the Jade Emperor (*Ngọc Hoàng*). Taoism in Vietnam is shamanistic and ritualistic, and the practices are sometimes even considered superstitious. Overall, Taoism promotes a greater connection between humans and the natural world, influencing how Vietnamese people perceive the nature-human relationship (Vuong et al., 2018).

In general, Vietnamese people tend to emphasize family and group benefits more than the relatively more individualistic tendency in Western cultures. With traditional values focusing on upholding moral standards and rather collectivistic mindsets, Vietnamese people may pay more attention to social responsibility and reputation, which can influence their decision-making, particularly when considering collective values such as environmental conservation and social legitimacy-related behaviors. One of the noteworthy sociopsychological aspects in Vietnamese culture is face-saving – which can be regarded as both an individual and collective possession and a subjective value based on social evaluation (Nhung, 2014). The widespread conceptualization

and practices of saving one's face (preserving one's reputation, credibility, or dignity) are heavily influenced by Chinese Confucianist values (Hwang & Han, 2010). Face-saving and group orientation characteristics in East Asian culture, including Vietnam, affect perceptions of luxury goods consumption (Le Monkhouse et al., 2012). This is an important point when examining Vietnamese people's attitude toward luxury wildlife goods such as bushmeat, which is often considered a high-class delicacy. To elaborate, rare species that are more endangered and receive greater protection have higher prices in the market. Being able to pay for high-priced products can show an individual's prestige to others and help them gain more social status, which can be beneficial in building a social network (Drury, 2011; Shairp et al., 2016). As a result, the rarer a species is, the higher demand it has in the market, which motivates illegal wildlife trade and threatens the species' extinction.

5.4. Urbanization in Vietnam

In 1986, the urban population of Vietnam was fewer than 13 million – 20% of Vietnam's population (The World Bank, 2020). As of 2020, the urban population in Vietnam is about 36 million people (The World Bank, 2022f) – about 37% of the country's total population. The number of urban residents has been continuously growing since 1960, and the urban population growth rate has been faster after *Đổi Mới* (economic reforms in 1986). The two largest cities in Vietnam are Ho Chi Minh city, with about 9 million people, and Hanoi capital city, with about 8 million people. The third-largest city is Haiphong, with about 2 million people, followed by Can Tho, Da Nang, Bien Hoa, and Thu Duc, with about 1 million people each. Hanoi, Ho Chi Minh City, Hai Phong, Da Nang, and Can Tho are the only five municipalities that are given provincial status (municipalities under the central government) and consist of multiple districts. There are 68 provincial cities in the other 58 provinces.

There are more than 800 urban administrative units of different designated classes across Vietnam. Because the central government bases budget allocations on the urban classification system (five normal and one special class), local towns and cities have strong incentives to move up the class ladder. Due to the classification system putting a disproportional focus on infrastructure, local towns and cities tend to invest excessively and inefficiently in infrastructure for rapid urbanization (Coulthart, Quang, & Sharpe, 2006). Economic incentives for urban livelihood also drive internal migration. An analysis of interprovincial migration in Vietnam from 1989 to 2009 found that provinces with high income per capita and urbanization are more likely to have higher in-migration rates (Kim Anh, Hoang Vu, Bonfoh, & Schelling, 2012). Urban areas contribute more than 50% of Vietnam's total GDP, but the welfare cost of air pollution from urbanization is also considerable, as it amounted to 5.2% of the national GDP in 2013 (The World Bank, 2020).

While urbanization in Vietnam helps improve many socioeconomic conditions, it also has negative environmental impacts (Fan et al., 2019; Petrişor et al., 2020). The Vietnamese government is paying more sustainable urban development more attention. Many programs have been approved by the Prime Minister and are currently being implemented, such as the Plan for Sustainable Smart City Development and the Project on Developing Vietnam's Cities to Respond to Climate Change, National Urban Upgrading Plan (Tran, 2021). While the Socio-Economic Development Plan 2016-2020 of Vietnam aimed to increase the urbanization rate further, it also encouraged modernizing urban infrastructure and driving urban planning toward sustainable development. Strategic tasks oriented to 2030 from the National Green Growth Strategy for sustainable urbanization include reducing GHG emissions, promoting renewable energy use, and promoting green lifestyle and consumption (OECD, 2018). Urban green growth has been incorporated into Vietnam's Law on Urban Planning, and guidance has been provided to policymakers.

Globally, urbanization has put tremendous pressure on biodiversity and ecosystem services (Elmqvist et al., 2013). Urbanization is considered one of Southeast Asia's main challenges in conserving biodiversity. Still, efforts to improve the ecosystems within cities face various obstacles in data, policy, monitoring, and implementation (Hughes, 2017). However, considering the high financial capacity of the urban population, protected areas elsewhere may greatly benefit from these potential sources of sustainable finance coming from big cities, which is also the main focus of this study.

5.5. Chapter summary

This chapter provides an overview of Vietnam's economic, environmental and sociocultural situations and characteristics in Vietnam. Vietnam is a Southeast Asian country located in the Indo-Burma region – one of the most biologically important and threatened hotspots worldwide, so it contains a great diversity of species that include more than 13,200 floral species and around 10,000 faunal species. However, due to rapid population growth, urbanization, and economic development, demand for wildlife products in urban areas is also rising, causing biodiversity loss in Vietnam. However, a majority of finance in Vietnam is held by the urban population, making cities potential sources of sustainable finance (through nature-based tourism) for conservation. Based on these situations and characteristics, Vietnam's urban areas suit the current dissertation's aims.

Chapter 6:

Proposed research framework and design

6.1. Proposed research framework

The framework is shown in Figure 6.1. As can be seen that biodiversity is the supplier of many ecosystem services that are beneficial for urban residents directly and indirectly, namely: provisioning, regulating, supporting, and cultural services (Morton & Hill, 2014). Urban residents are major consumers of those services. Because the study is designed as a social study, so only biodiversity-supplying services that urban residents can easily perceive are included in the framework. Therefore, in this study, biodiversity's two prominent direct services are wildlife products (as provisioning services) and nature-based tourism (as cultural services) (Clark et al., 2014; Mace et al., 2012).

The framework was designed explicitly for the biodiversity bounded by protected areas, but not urban biodiversity, because of the prominent roles of protected areas in conservation, especially in the biodiversity hotspots (Myers et al., 2000; Watson et al., 2014), as well as the lack of knowledge about the relationship between urban residents and biodiversity protected areas in previous literature (see Chapters 2-4).

There are three main reasons that the urban residents are the primary focus of this framework. First, the urbanization and income of people in developing countries, specifically Vietnam, are rising swiftly. Second, high and upper-middle-income people living in cities are a major group of wildlife product consumers (e.g., bushmeat, bear bile, tiger bones). Third, urban people can provide a tremendous amount of finance for conservation in protected areas through recreational activities.

In the proposed framework, protected areas are deemed sites that manage, monitor, and inspect the value exchanges between urban people and biodiversity conditions. The framework classifies the value exchange into two types: on-site and off-site exchange. The on-site exchange refers to all the value exchange pathways of protected areas' resources that occur between urban people and biodiversity in the protected areas (e.g., nature-based tourism, wildlife tourism), while off-site exchange refers to all the value exchanges of protected areas' resources that happen in other areas that could not be managed, monitored, and inspected by protected area agencies (e.g., illegal wildlife trade). It should be noted that any products or services that are delivered from protected areas to urban areas through intermediates are still considered on-site transactions as the intermediates have to receive the products and services at the protected areas (e.g., wildlife tours, documentary movies, souvenirs made from resources within the protected areas). Moreover, any products or services made in other places and transferred to protected areas for selling are not considered in this framework because they are not related to the resources in the protected areas.

Protected areas have some fundamental functions, including conserving biological diversity and allocating biodiversity resources for sustainable use. Thus, biodiversity is covered by a green dash-line boundary representing protected areas in the framework. Due to the basic functions of protected areas, its boundary helps distinguish the urban residents' transactions for biodiversity-supplying services (here are wildlife products and nature-based tourism) in two types: on-site and off-site transactions.

Poaching activities are prohibited in most protected areas, so poaching activities happen in areas with no or lack of monitoring by protected areas agencies. The wildlife products from these activities are later transferred to urban areas in exchange for money. Thus, transactions are deemed to be made off-site. In contrast, nature-based tourism is the on-site activity that requires urban

residents to be within the protected areas. Usually, such activities are under the management and monitoring of protected area agencies, so transactions are deemed to be made on-site.

In other words, biodiversity bounded by protected areas supplies two types of products and services that are traded off-site and on-site, respectively. S1 represents the biodiversity-supplying services and products traded within the protected areas (green line), while S2 represents those traded outside the protected areas (yellow line). When urban residents receive the services, the transactions are made, and urban residents will provide financial resources through payments in exchange for the services. As the transactions for nature-based tourism are made on-site, the financial resources can go directly to the budget of protected areas agencies and become finance for subsequent restoration and conservation activities. The flow of these financial resources is indicated by the P1 pathway (blue line) in the framework. However, the urban residents' payments for wildlife products exploited by poachers cannot generate financial resources for protected areas' restoration and conservation activities because they flow to the illegal wildlife trade networks and result in the expansion and sustain of these illegal activities. The flow is indicated by the P2 pathway (yellow line). Therefore, to capitalize on the financial resources derived from urban areas and reduce the overexploitation of biodiversity induced by poaching activities, we need to mitigate the number of transactions made off-site (or illegally traded) and increase the transactions being made on-site in exchange for biodiversity-supplying services.

Earlier efforts (including research) mainly focus on preventing S2 and promoting S1 to persuade visitors to pay more money for entrance fees or conservation programs.

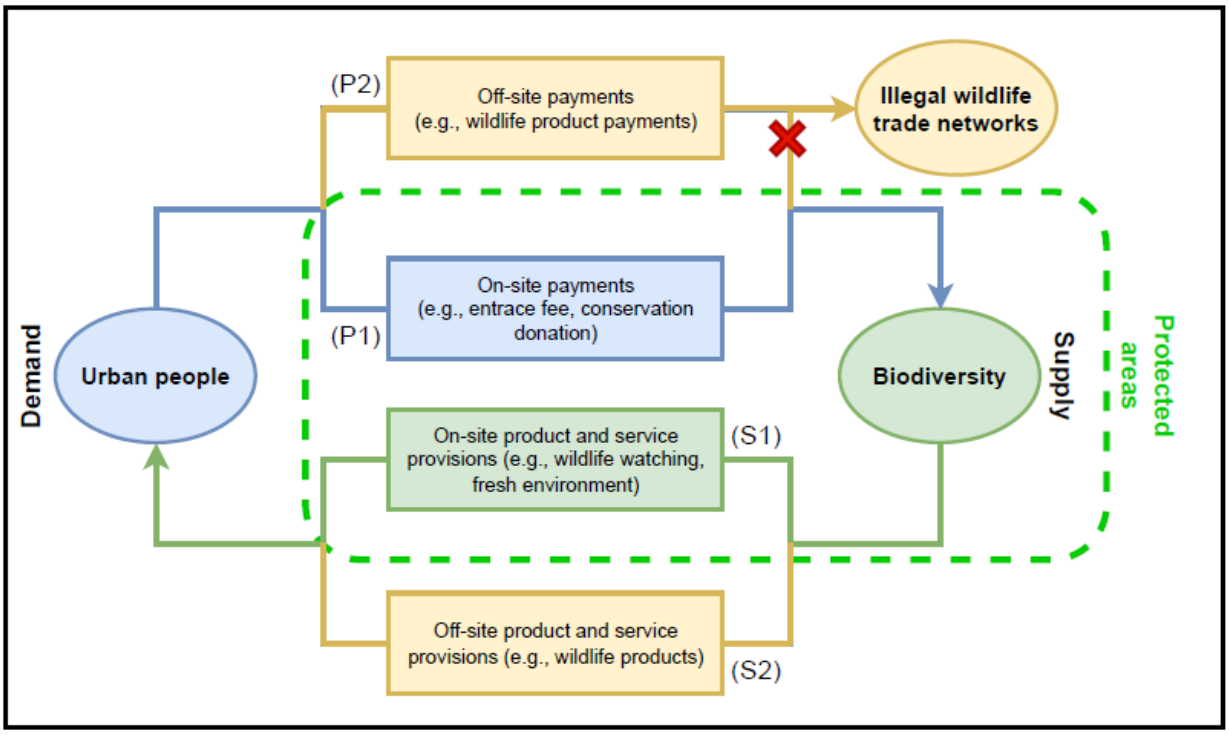

Figure 6.1: Proposed framework to involve urban residents in biodiversity conservation in protected areas

6.2. Chapter summary

To sum up, a research framework on the relationship between urban residents and biodiversity bounded by protected areas was proposed in this chapter based on the literature reviewed in previous chapters. According to the framework, biodiversity bounded by protected areas supplies two types of products and services that are traded off-site and on-site, respectively. If those products and services are traded on site (e.g., through tourism mechanism), urban residents' payments for those products and services can aid biodiversity conservation. However, if they are traded off-site (e.g., through illegal wildlife trade networks), urban residents' payments for them will flow to the illegal trade network, sustaining illegal activities and threatening protected species' extinctions. Therefore, the demand-side measures for biodiversity loss prevention are 1) reducing

the consumption demands for wildlife products in the cities and 2) enhancing urban residents' willingness to pay for services in protected areas. These points helped generate the research questions presented in Chapter 1.

Chapter 7:

Grounded theory

This chapter presents an overview of Grounded Theory and how to conduct it. In addition, It also explains the interview and coding procedures used to generate results about urban residents' mental constructs about biodiversity.

7.1. An overview

The Grounded Theory methodology was employed in the first study to explore Vietnamese mental constructs about biodiversity and biodiversity loss. Grounded Theory is a well-known methodology in many psychological and social sciences (Chun Tie, Birks, & Francis, 2019). The methodology was initially employed in *Awareness of Dying* by Glaser and Strauss (1965), the founders of Grounded Theory (Glaser & Strauss, 1967). Grounded Theory is usually used to study phenomena with little prior knowledge or information (Allen & Davey, 2018; Hardy, 2005). This is also the main reason I employed the Grounded Theory in this study.

Even though several studies have been done to explore the mental constructs of lay residents in Western countries (Bakhtiari et al., 2014; Fischer & Young, 2007), little is known about those of urban residents in emerging South-East Asian countries with rich biological resources, like Vietnam. As the mindset and perceptions of an individual are constructed and continuously reinforced by the surrounding environment (e.g., economic, socio-cultural, and environmental values) (Nguyen, La, et al., 2022b; Vuong & Napier, 2015; Vuong, Nguyen, & La, 2022a), there are three reasons that make using Grounded Theory plausible in the current study:

1) the current study's site is in a developing country, whereas the former studies' sites are in developed countries;

2) the current study's samples obtain different cultures from the former studies' (East Asian culture versus Western culture);

3) the current study's samples live in the urban environment, whereas the former studies' samples are tourists or living near a natural environment.

Since the separation of Glaser and Strauss due to divergent viewpoints, there have many variations of how to use Grounded Theory (Ralph, Birks, & Chapman, 2015), namely: the post-positivism approach of Glaser and Strauss, symbolic interactionism and pragmatism approach of Strauss and Corbin, constructivism approach of Charmaz, etc. In brief, Grounded Theory is "a dynamic methodology in that it is characterized by the contemporaneously interpreted philosophical perspectives of the researcher in response to their interaction with wider social forces" (Ralph et al., 2015). Despite the methodological dynamism of Grounded Theory, Chun Tie et al. (2019) suggest a general research design framework with six primary steps: 1) purposive sampling, 2) data collection, 3) initial coding, 4) intermediate coding, 5) advanced coding, and 6) grounded theory. In follow, I will present how the current study was conducted according to these steps.

7.2. Data sampling and collection

The current study purposively collected data from the two largest cities in Vietnam to explore the mental constructs of Vietnamese urban residents towards biodiversity and biodiversity loss: Ho Chi Minh city and Hanoi capital city, respectively. Ho Chi Minh is located in the South of Vietnam, with approximately 9 million residents, while Hanoi capital city is located in the North of Vietnam, with more than 8 million residents (General Statistics Office, 2020). While the former is considered the largest financial center, the latter is deemed Vietnam's cultural and political center. Collecting data from these two regions was expected to mitigate the economic, social, and cultural biases due to geographical distinction.

For collecting the data, face-to-face semi-structured interviews were conducted. Because biodiversity is a multiplex and quite an abstract issue, it is a huge barrier to getting relevant answers from lay residents. It is even more challenging when the interviewees are urban residents who often have little experience with natural environments during their lifetime. Thus, a structured interview could not provide enough flexibility to achieve satisfactory answers. On the contrary, the unstructured interview is relatively varying and incomparable among cases, so it is not a suitable method to examine the mental constructs of biodiversity, requiring a systematic evaluation and comparison between individuals. As a result, the semi-structured interview was selected because it shares the advantages of both structured and unstructured interviews: organized, systematic, and highly flexible (Horton, Macve, & Struyven, 2004; Whiting, 2008).

	I. Biodiversity
1	Have you ever come across the term ‘‘biodiversity’’, or biological diversity? *If not, provide information: ‘‘Biodiversity means the variety of life. Biodiversity includes all living things and the environment of which they are part.”*
2	What does ‘biological diversity’ mean to you? What first comes to your mind? *Anything else?*
3	How important is biological diversity to human beings? And why? How important is biological diversity to your everyday life? And why?
4	In your opinion, in what way biological diversity could best be managed and maintained?
	II. Biodiversity loss
1	Have you ever come across the term ‘‘biodiversity loss’’? *If not, provide information: ‘‘Biodiversity loss is a decrease in biodiversity within a species, an ecosystem, a given geographic area, or Earth as a whole.”*
2	What does ‘biodiversity loss’ mean to you? What first comes to your mind?
3	How does biodiversity loss affect human beings? How does biodiversity loss affect your everyday life?
4	How do you think biodiversity loss could best be halted?
5	Do you think the people around you and yourself can contribute to the management and conservation of biodiversity or stopping biodiversity loss?

Figure 7.1: The interview guideline, which is implemented accordingly

The interview guideline is implemented accordingly.

The interview questions were designed by referring to previous studies (Bakhtiari et al., 2014; Fischer & Young, 2007). Nevertheless, they were modified to fit the current study's research questions. Two pilot interviews were also conducted before finalizing the final version of the interview guideline. The interview guideline with two major sections is presented in Figure 7.1. The first section explores the interviewee's mental constructs about biodiversity, whereas the latter explores the biodiversity loss aspect.

All the semi-structured interviews were conducted from 15th November 2020 to 26th December 2020 in both Ho Chi Minh and Hanoi cities. Interviewees were chosen through my social network. When the requested residents agreed to participate in the interview, the interview time and location were determined for the convenience of the interviewees. Before any interview, permission to record the interview was asked. Then, the content and purpose of the interview were thoroughly explained, along with the guarantee of the participants' confidentiality. The interview only started when the interviewee verbally consented to participate in the interview, which was recorded. There was no required number of participants, but I applied the 'theoretical saturation' principle to decide when to stop the interview process (Creswell & Poth, 2018). Theoretical saturation is when gathering extra data on a theoretical construct reveals no new properties or creates any incremental theoretical insights about the grounded theory (Bernard, 2017). The principle has also been employed in other qualitative studies (Bakhtiari et al., 2014; Chakraborty, Avtar, Raj, & Thu Minh, 2019). Eventually, 38 recorded responses were acquired, of which 22 were in Ho Chi Minh (57.90%), and the remaining 16 were in Hanoi (42.10%). The average length of an interview was about 30 minutes.

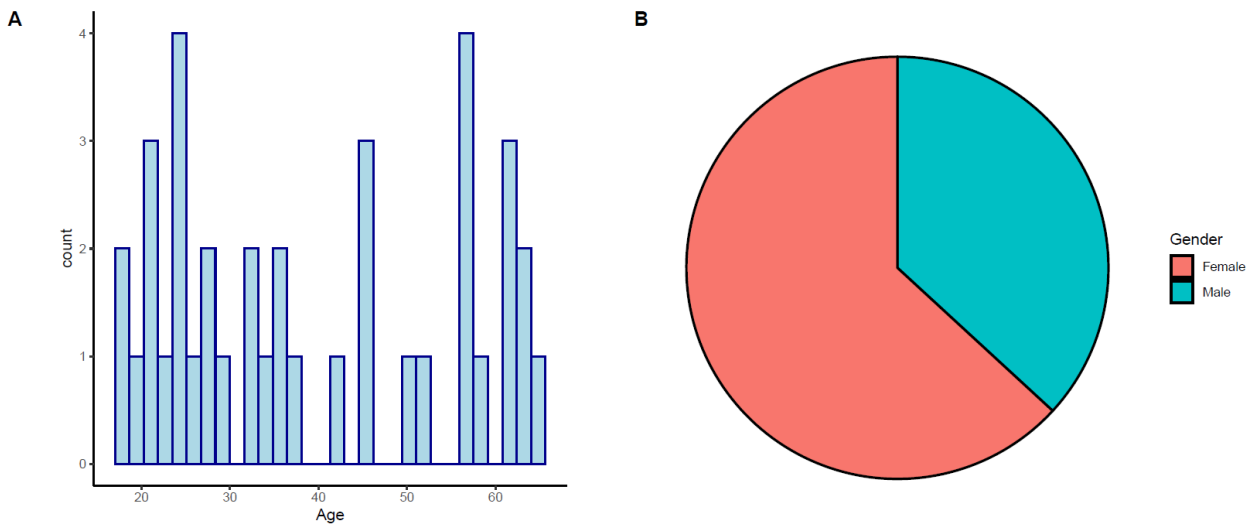

Figure 7.2: The distribution of interviewed samples by: **A** – age, and **B** – gender

The sample was purposively selected to reflect a range of residents from different age cohorts, genders, occupations, and prior experiences that might have dissimilar mental constructs. Therefore, the attributes of the interviewee were diversified as much as possible. Eventually, 38 interviewed residents were distributed across all age cohorts: 39.47% from 18-30, 31.58% from 31-55, and 28.95% from above 55 (see Figure 7.2-A). For gender, 63.16% of the samples are female, and the remaining 36.84% are male (see Figure 7.2-B). Participants included residents from a wide range of occupations, such as banker, engineer, entrepreneur, freelancer, government officer, housewife, manager, media producer, teacher, etc. Twenty-four interviewed residents (63.16%) reported that they have ever lived near a jungle or a coastline.

7.3. Data coding

Like other studies employing Grounded Theory, a three-step coding after the data collection process was performed: initial, intermediate, and advanced coding (see Table 7.1 for several examples). As all the interviews were conducted in Vietnamese, the transcribed texts from the recordings were later translated into English. Whenever the translation is not accurate, back-and-

forth translations were performed multiple times until the "correct" interpretation of the interviewees' viewpoint was obtained (Abfalter, Mueller-Seeger, & Raich, 2020). It took over two weeks to complete the transcription and translation (between 8th January and 25th January 2021). The procedure of conducting Grounded Theory, from the interview to the coding phases, is illustrated in the flowchart in Figure 7.3.

Figure 7.3. The procedure of conducting Grounded Theory

Table 7.1: Examples of three-step coding

Type of percepion	Original text	Initial coding	Intermediate coding	Advanced coding
Perceptions about biodiversity	Biodiversity is like a diversity of species, such as plants and animals, in an ecosystem	Biodiversity is species in an ecosystem	Species in an ecosystem	Goods in an ecosystem

Perceived impacts of biodiversity	When thinking about the impact of biodiversity on human, the first thing appears in my mind is that everything in nature has its balance. This species is the natural enemy or beneficial for another species. When there is diversity, there is balance. That balance makes human's life better.	Biodiversity is a state of balance in nature, which helps improve human life	Biodiversity is a natural balance	Equilibrium
Perceived humans' reactions to conserve biodiversity	I know some friends doing conservation at a small scale, but I don't know how the conservation is done at national or international scale. Their societies establish seed banks for conserving plant species	Societies establish seed banks for conserving plant species	Humans establish seed banks	Protection/Conservation

In the initial coding step, I inductively create as many meaningful codes as possible by reading the transcribed texts line-by-line. In other Grounded Theory studies, coding usually has only three types of code – *action*, *interaction,* and *process*, which are eventually combined to generate a complete diagram or hypotheses (Creswell & Poth, 2018). For example, the *actions* can be as follows: 'the air is clean,' 'the forest is green,' 'the animal becomes extinct'; the *interactions* can

be as follows: ‘biodiversity helps balance the ecosystem,’ ‘biodiversity loss breaks the biological life cycle.’ The *process* was defined as a complicated set of actions and interactions that was hard to be separated. The *process* can be as follows: ‘biodiversity and biodiversity loss affect the variety of agricultural products I consume daily.’

The next step is called intermediate coding. By continuously comparing the *action*, *interaction*, and *process* codes, I tried to find the general categories for codes that have similar characteristics or patterns. The comparison process was repeated multiple times until the categories were deemed as most coherent, comprehensive, and fit with the codes. This was also the process when I decided whether the data were theoretically saturated or not. Specifically, suppose no new category emerges from the last four interviewees’ responses (two in Hanoi city and two in Ho Chi Minh city). In that case, the theoretical saturation can be deemed to be reached. In fact, the theoretical saturation was reached after the first group of interviewees (38 residents), so no more interviews were carried out.

The last step is advanced coding. Birks and Mills (2015) defined advanced coding as “techniques used to facilitate the integration of the final grounded theory.” In other words, advanced coding is employed to generate the final theory or most integrated category. This theory might be abstract and represent many issues (Chun Tie et al., 2019).

Chapter 10 presents the most integrated categories (or grounded theories) within the mental constructs of biodiversity and biodiversity loss, along with their statistics and typical responses of interviewees.

Chapter 8:

Data collection

This chapter is dedicated to describing the dataset that was used in the second and third studies of the current dissertation. A detailed description of the survey design and validation, data sample, and response coding of the dataset is provided.

8.1. Overview

The interactions between urban ecosystems and biodiversity concepts are multiplex, and so do the relationship between urban humans and biodiversity concepts. While urban residents' demand for wildlife products is one of the major causes of biodiversity loss, the associations between biodiversity concepts and the human urban ecosystem need further research to improve urban people's quality of life and education and facilitate biodiversity preservation and conservation. The current data descriptor, thus, presents a dataset of multifaceted interactions between urban residents and biodiversity concepts in Vietnam – a highly urbanized country with a rich biodiversity level. Specifically, the dataset is valuable for studying urban people's wildlife product consumption behaviors, perceptions, and interactions with biodiversity across different levels (individual, home, neighborhood, and public parks) and nature-based recreation demand.

The questionnaire was designed based on three sources of materials:

1) findings of Vietnamese urban residents' mental constructs about biodiversity (see Chapter 10);
2) other studies in the literature (see Chapters 2-4);
3) self-formulation based on the mindsponge and ecomindsponge theories (Vuong, 2023; Nguyen, Le, & Vuong, 2023).

This chapter presents a dataset of 535 urban residents' wildlife consumption behaviors, multifaceted perceptions and interactions with biodiversity concepts, and nature-based recreation demand. These resources are expected to support researchers in enriching the lax literature regarding the role of urban residents in biodiversity conservation preservation and facilitate policymakers to find insights for building up an "eco-surplus culture" among urban residents through effective public communication and policymaking (Vuong, 2021).

8.2. Methodology

8.2.1. Survey design and validation

The survey was systematically designed with five major steps: (i) questionnaire design, (ii) survey collection, (iii) data check and validation, (iv) dataset generation, and (v) data analysis.

First, as the biodiversity perceptions among Vietnamese urban people lack qualitative research, an in-depth semi-structured interview was conducted to set the stage for questionnaire design. Specifically, 38 urban residents in the two largest cities (Ho Chi

Minh City and Hanoi Capital City) in Vietnam were interviewed from 15th November to 26th December 2020. The interviewees were purposively chosen to diversify opinions according to their gender, age, occupations, and prior experiences with nature. The interview was stopped when the 'theoretical saturation' point was met (Creswell & Poth, 2018). Based on the interviewed results, the questionnaire was constructed with six major categories (see Appendix 2 for the questionnaire).

1. Wildlife product consumption
2. General biodiversity perceptions
3. Biodiversity at home and in the neighborhood
4. Public park visitation and motivations
5. National park visitation and motivations
6. Socio-demographic profiles

The data were collected through a web-based survey via Google Forms. Google Forms was employed due to its user-friendly interfaces, confidentiality, and easy distribution (Nguyen, Ho, Nguyen, & Vuong, 2019). The sampling strategy used was exponential non-discriminative snowball sampling (Lai et al., 2020; Norbu & Dendup, 2021; Rahman & Shorkar, 2021). Specifically, I recruited the first batch of participants from my personal network; then I asked them to distribute the online questionnaire to their friends or relatives. New referrals were again encouraged to pass the questionnaire to

their friends or relatives that resided in urban areas. The sampling was stopped when there were no new referrals.

Data collection was carried out in approximately two months, from 18th June to 8th August 2021. Even though the distribution was targeted at people living in Ho Chi Minh City and Hanoi Capital City, several respondents from other provinces and cities also participated in the survey. At the beginning of the questionnaire, respondents were required to read and agree with the consent form, which stipulates the research purposes, questionnaire contents, and confidentiality of participants. Two hundred random participants who completed the questionnaire were given a gift card with a value ranging from $1 to $10 through their email addresses. Eventually, 581 people got involved in the data collection.

Next, a four-step quality check was performed to ensure the dataset quality. First, a certain number of questionnaire respondents were from other provinces that were not urban, so their responses were excluded from the dataset using the residency they reported. Secondly, children under 18 years old were also excluded from the dataset as their agreement to the consent form was not legitimate without guardians' acceptance. Thirdly, based on the reported email addresses, duplicate responses were detected and removed afterward.

Finally, 'straightlining' and 'select-all' behavior can distort the analysis results (Kim, Dykema, Stevenson, Black, & Moberg, 2019), so any respondents giving identical answers to a set of questions using the same response scale and selecting all answers

of checkbox questions simultaneously were excluded. Although responses with solely 'straightline' answers were not excluded, they were marked 'warning' in the *Quality Assessment* column at the end of the dataset. In detail, 27 responses were removed due to inappropriate residency; 13 were removed due to insufficient age; three were removed due to repeated reporting; three were removed due to their simultaneous 'straightlining' and 'select-all' behaviors. Eventually, 535 responses were included in the cleaned dataset.

All four steps of the quality check were completed in the Microsoft Excel spreadsheet (xls.) file downloaded from Google Forms. After cleaning the data, all the responses were encoded and saved under comma-separated value format for easing later uses. During this step, any missing data were coded as 'NA' (a.k.a 'Not Applicable'). The dataset will be validated using Bayesian analysis in the later section.

8.2.2. Data sample

Most respondents were from the two largest cities in Vietnam: 347 people from Ho Chi Minh City (accounting for 64.86%) and 107 people from Hanoi Capital City (accounting for 20%). The remaining respondents (15.14%) came from other urban areas, like Hue city, Vung Tau city, Thanh Hoa city, etc. Among 535 responses, female participants constituted a greater proportion than male participants (58.31% of females versus 41.12% of males). The average mean age of all participants was around 33.80 (see Figure 8.1). The educational level of participants was relatively high, as 85.05% of them acquired an undergraduate (63.18%) or post-graduate levels (21.87%).

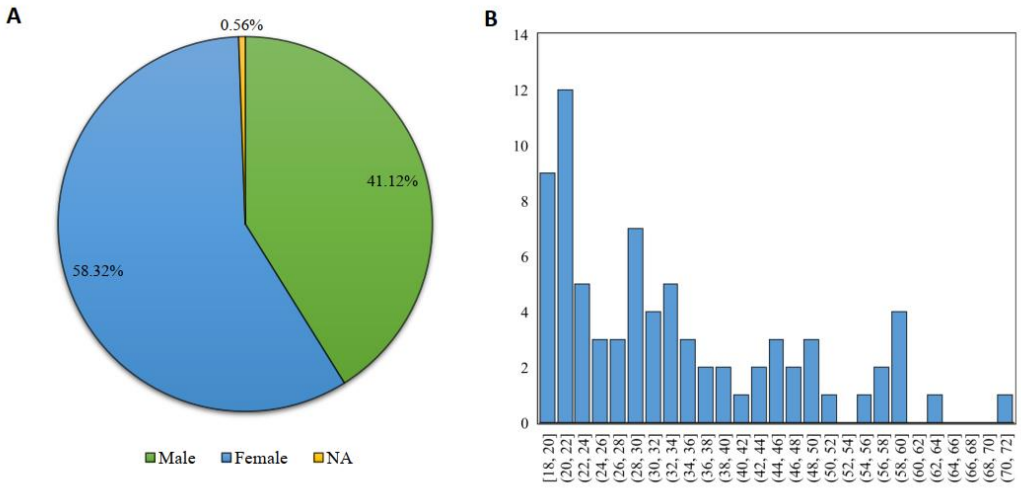

Figure 8.1: The distribution of surveyed samples by: **A** – age, and **B** – gender

The occupational backgrounds of participants were highly diverse, ranging from accountant, activist, and actor to retiree and unemployment. The income of most participants (39.24%) fell into the range of 5 million to 15 million VNĐ monthly. No-income participants consisted of 4.11% of the total number, whereas the percentage of participants acquiring more than 30 million VNĐ monthly was 7.48%. Most participants reported spending most of their lifetime living in urban areas (84.86%). Only 54 and 26 participants spent most of their lifetime in sub-urban (10.09%) and rural areas (4.86%), respectively.

8.2.3. Response coding

The current section presents how the responses of six major categories (see Sub-section 8.2.1). Two main types of responses are categorical (including binary variables) and

numerical variables. In the next sub-sections, categorical variables are described using seven kinds of information corresponding with six columns: ‘Variable,’ ‘Name,’ ‘Explanation,’ ‘Level,’ ‘Code,’ ‘Frequency,’ and ‘Proportion.’ Meanwhile, the last four columns are replaced with ‘Range’, ‘Mean’, and ‘Standard deviation’ for the description of numerical variables.

A. Wildlife product consumption

The first sub-section of the dataset comprises 12 categorical variables that demonstrate the wildlife product consumption behaviors among urban residents. The variables were generated by questions about four ways of consuming wildlife products: bushmeat, traditional medicine, products made from animal skin/fur/leather, and uncommon pet. Variables *A1* and *A2* are used to present whether the respondent has ever consumed bushmeat and their consumption frequency (see Table 8.1).

The behaviors of consuming traditional medicines made from wildlife are indicated by variables *A3_1* to *A5*. While variables *A3_1* to *A3_3* are whether the respondent has ever consumed animal bones, bile bear, and pangolin scale for medical treatment, the other two variables (*A4* and *A5*) are the respondent’s information sources of traditional medicine and perception of effective medicine. Animal bones, bile bear, and pangolin scale are three frequently consumed materials for traditional medicines in Vietnam (Davis et al., 2019; Davis et al., 2020; Sexton et al., 2021).

The consumption behaviors of products made from animal skin/fur/leather are indicated by variables *A6* to *A8*. The remaining two variables are to demonstrate the

uncommon pet adoption behaviors of the respondent. Uncommon pets are animals that are not dogs or cats.

Table 8.1: Description of variables related to wildlife product consumption

Categorical variables						
Variable	**Name**	**Explanation**	**Level**	**Code**	**Frequency**	**Proportion**
A1	Bushmeat consumption	Whether the respondent has ever consumed bushmeat	Yes	1	202	37.76%
			No	0	333	62.24%
A2	Bushmeat consumption frequency	Bushmeat consumption frequency	Never	1	345	64.49%
			Sometimes	2	188	35.14%
			Often	3	1	0.19%
			Very often	4	1	0.19%
A3_1	Animal bone consumption	Whether the respondent has ever consumed animal bone (monkey, tiger, horse, etc.) for traditional medicine	Yes	1	77	14.39%
			No	0	458	85.61%
A3_2	Bile bear consumption	Whether the respondent has ever consumed bile bear for traditional medicine	Yes	1	116	21.68%
			No	0	419	78.32%
A3_3	Pangolin scale consumption	Whether the respondent has ever consumed pangolin scale for traditional medicine	Yes	1	11	2.06%
			No	0	524	97.94%

A4	Information source of traditional medicine	Information source of traditional medicine	Family and Friends	a	321	60.00%
			Newspaper	b	270	50.47%
			Social Media	c	359	67.10%
			Book	d	112	20.93%
			Doctor	e	31	5.79%
			Other	f	7	1.31%
A5	Perceived effective medicine	Perceived effective type of medicine	Eastern medicine	1	64	11.96%
			Same	2	219	40.93%
			Western medicine	3	252	47.10%
A6	Skin/fur/leather product consumption	Whether the respondent likes consuming animal skin/fur/leather	No, I don't	1	449	83.93%
			Yes, a little	2	76	14.21%
			Yes, a lot	3	10	1.87%
A7	Number of skin/fur/leather product	The number of products made from animal skin/fur/leather that the respondent owns	Nothing	1	429	80.19%
			1-3 products	2	95	17.76%
			3-5 products	3	4	0.75%
			More than 5 products	4	7	1.31%
A8	Skin/fur/leather product consumption	Whether the respondent owns any products made	Yes	1	106	19.81%
			No	0	429	80.19%

		from animal skin/fur/leather				
A9	Interest in uncommon pet	Whether the respondent likes owning uncommon pet	No, I don't	1	363	67.85%
			Yes, a little	2	142	26.54%
			Yes, a lot	3	30	5.61%
A10	Uncommon pet adoption	Whether the respondent has ever adopted any uncommon pet	No, never	1	401	74.95%
			Yes, in the past	2	116	21.68%
			Yes, I'm adopting now	3	18	3.36%

B. General biodiversity perceptions

The second sub-section focuses on the urban residents' general perceptions towards biodiversity, like the self-assessment knowledge (variable *B1*), perceived importance of biodiversity loss (Variable *B2*), perceived consequences of biodiversity loss (variables *B3_1* to *B3_13*), perceived preventive measures of biodiversity loss (variables *B4_1* to *B4_9*), perceived biodiversity-affected objects (variables *B5_1* to *B5_4*), and perceived contributors to biodiversity loss prevention (variables *B6_1* to *B6_5*). In total, 33 variables belong to this group (see Table 8.2).

Table 8.2: Description of variables related to general biodiversity perceptions

Categorical variables						
Variable	**Name**	**Explanation**	**Level**	**Code**	**Frequency**	**Proportion**
B1	Biodiversity knowledge	Self-assessment knowledge about biodiversity	Never heard about	1	64	11.96%
			Poor	2	189	35.33%
			Adequate	3	243	45.42%
			Good	4	39	7.29%
B2	Biodiversity perception	Perception about the importance of biodiversity loss	Biodiversity loss is not real	1	17	3.18%
			Biodiversity loss is real but only a small problem	2	30	5.61%
			Biodiversity loss is real and a major environmental problem	3	488	91.21%

Numerical variables					
Variable	**Name**	**Explanation**	**Range**	**Mean**	**SD**
B3_1	Perceived impact [pollution]	Agreement with the following consequences of biodiversity loss [Environmental pollution (air pollution, water pollution, etc.)]	1. Strongly disagree 2. Disagree 3. Agree	3.34	0.74
B3_2	Perceived impact [climate change]	Agreement with the following consequences of biodiversity loss [Climate change]		3.33	0.72
B3_3	Perceived impact	Agreement with the following consequences of		3.17	0.76

	[Life imbalance]	biodiversity loss [Loss of life balance]	4. Strongly agree		
B3_4	Perceived impact [good's diversity loss]	Agreement with the following consequences of biodiversity loss [Loss of daily product variety (food, medicine, etc.)]		2.95	0.84
B3_5	Perceived impact [Economic growth]	Agreement with the following consequences of biodiversity loss [Negative impacts on economic growth]		2.85	0.83
B3_6	Perceived impact [green space]	Agreement with the following consequences of biodiversity loss [Loss of green space]		3.34	0.72
B3_7	Perceived impact [natural scenery]	Agreement with the following consequences of biodiversity loss [Loss of natural aesthetics]		3.35	0.72
B3_8	Perceived impact [nature-based recreation]	Agreement with the following consequences of biodiversity loss [Loss of opportunities for nature-based recreation]		3.02	0.80
B3_9	Perceived impact [knowledge loss]	Agreement with the following consequences of biodiversity loss [Loss of knowledge about nature]		3.15	0.81
B3_10	Perceived impact [life quality loss]	Agreement with the following consequences of biodiversity loss [Reduction of quality of life]		3.14	0.76
B3_11	Perceived impact [physical health loss]	Agreement with the following consequences of biodiversity loss [Reduction of physical health]		3.00	0.81
B3_12	Perceived impact	Agreement with the following consequences of		3.04	0.78

	[mental health loss]	biodiversity loss [Reduction of mental health]			
B3_13	Perceived impact [life expectancy loss]	Agreement with the following consequences of biodiversity loss [Reduction of life expectancy]		2.95	0.82
B4_1	Perceived prevention method [conservation]	Agreement with the following preventive measure of biodiversity loss [Species conservation in protected areas]		3.36	0.72
B4_2	Perceived prevention method [reduction of deforestation and exploitation]	Agreement with the following preventive measure of biodiversity loss [Reduction of deforestation and exploitation]	1. Strongly disagree	3.60	0.67
B4_3	Perceived prevention method [environmental law]	Agreement with the following preventive measure of biodiversity loss [Environmental law enactment]	2. Disagree	3.54	0.65
B4_4	Perceived prevention method [research]	Agreement with the following preventive measure of biodiversity loss [Scientific research]	3. Agree	3.30	0.68
B4_5	Perceived prevention method [public communication]	Agreement with the following preventive measure of biodiversity loss [Public communication about biodiversity (loss)]	4. Strongly agree	3.48	0.67
B4_6	Perceived prevention method [education]	Agreement with the following preventive measure of biodiversity loss [Education about biodiversity (loss)]		3.48	0.67

B4_7	Perceived prevention method [wildlife consumption prohibition]	Agreement with the following preventive measure of biodiversity loss [Prohibition of illegal wildlife consumption]		3.60	0.67
B4_8	Perceived prevention method [environmental tax]	Agreement with the following preventive measure of biodiversity loss [Environmental tax]		3.24	0.77
B4_9	Perceived prevention method [donation]	Agreement with the following preventive measure of biodiversity loss [Donation for biodiversity conservation]		3.25	0.73
B5_1	Affected object [my life]	Agreement with the following biodiversity loss affected object [My life]	1. Strongly disagree	3.06	0.69
B5_2	Affected object [my family]	Agreement with the following biodiversity loss affected object [My family]	2. Disagree	3.03	0.70
B5_3	Affected object [my neighborhood]	Agreement with the following biodiversity loss affected object [My neighborhood]	3. Agree	3.14	0.67
B5_4	Affected object [my city]	Agreement with the following biodiversity loss affected object [My city]	4. Strongly agree	3.23	0.67
B6_1	Contributor [myself]	Agreement with the following contributor to biodiversity loss prevention [Myself]	1. Strongly disagree	3.30	0.62
B6_2	Contributor [my family]	Agreement with the following contributor to biodiversity loss prevention [My family]	2. Disagree	3.27	0.62

B6_3	Contributor [my neighbors]	Agreement with the following contributor to biodiversity loss prevention [People in my neighborhood]	3. Agree	3.29	0.62
B6_4	Contributor [government]	Agreement with the following contributor to biodiversity loss prevention [Government]	4. Strongly agree	3.53	0.65
B6_5	Contributor [international organization]	Agreement with the following contributor to biodiversity loss prevention [International organization]		3.55	0.64

C. <u>Biodiversity at home and neighborhood</u>

The third sub-section focuses on the interactions between humans and biodiversity at the respondent's home and neighborhood (see Table 8.3). The first four variables (from *C1_1* to *C1_4*) show the respondent's behaviors and willingness to plant varied types of plants in their houses, while the next four variables (from *C2_1* to *C2_4*) present the respondent's behaviors and willingness of adopting varied types of pet in their houses. The respondent's feelings (e.g. comfortability and aesthetics) when being in the house are indicated by variables *C3_1* to *C3_4*. The last three variables (*C4_1*, *C4_2*, and *C4_3*) are used to present the perceived availability of plants in the respondent's neighborhood, their willingness to donate to a planting project, and considered important aspects of the project, respectively.

Table 8.3: Description of variables related to biodiversity at home and neighborhood

Categorical variables						
Variable	**Name**	**Explanation**	**Level**	**Code**	**Frequency**	**Proportion**
C1_1	In-house planting (scale)	Whether the respondent plants plant in their house	Not at all	1	31	5.79%
			Yes, but only a few	2	292	54.58%
			Yes, I plant many	3	212	39.63%
C1_2	In-house planting (binary)	Whether the respondent plants plant in their house	Yes	1	504	94.21%
			No	0	31	5.79%
C1_3	Number of types of plants planted	The number of types of plants planted in the house	0	0	30	5.61%
			1	1	17	3.18%
			2	2	48	8.97%
			3	3	66	12.34%
			4	4	32	5.98%
			5	5	50	9.35%
			More than 5	6	292	54.58%
C1_4	Willingness to plant more plants	Whether the respondent is willing to plant more plants	No, I wouldn't	1	38	7.10%
			Yes, I would plant more plants from the same type	2	49	9.16%
			Yes, I would plant more plants from various types	3	448	83.74%
C2_1	Petting	Whether the respondent owns any pet	Yes	1	254	47.48%
			No	0	281	52.52%
C2_2			Cat	a	142	26.54%

	Type of pet	Type of pet that the respondent owns	Dog	b	225	42.06%
			Fish	c	174	32.52%
			Other	d	23	4.30%
			No pet	e	154	28.79%
C2_3	Number of pets	Number of pet types that the respondent owns	0	0	200	37.38%
			1	1	183	34.21%
			2	2	70	13.08%
			More than 2	3	62	11.59%
C2_4	Willingness to adopt more pet	Whether the respondent is willing to adopt more pet	No, I wouldn't	1	347	64.86%
			Yes, I would adopt more pets from the same type	2	78	14.58%
			Yes, I would adopt more pets from various types	3	110	20.56%
C3_1	Feeling comfortable at home (scale)	How much comfortable the respondent feels in the house	Very Uncomfortable	1	25	4.67%
			Uncomfortable	2	33	6.17%
			Comfortable	3	258	48.22%
			Very comfortable	4	219	40.93%
C3_2	Feeling comfortable at home (binary)	Whether the respondent feels comfortable in the house	Comfortable	1	477	89.16%
			Uncomfortable	0	58	10.84%

C3_3	Feeling aesthetic at home due to plant/animal (scale)	How much comfortable the respondent feels the house is	Very negative effect	1	12	2.24%
			Negative effect	2	12	2.24%
			Positive effect	3	316	59.07%
			Very positive effect	4	195	36.45%
C3_4	Feeling aesthetic at home due to plant/animal (binary)	Whether the respondent feels the house aesthetic due to plant/animal	Positive effect	1	511	95.51%
			Negative effect	0	24	4.49%
C4_1	Plants in the neighborhood	Whether there are any plants in the neighborhood	Not at all	1	26	4.86%
			A few	2	232	43.36%
			Many	3	188	35.14%
			Abundant	4	89	16.64%
C4_2	Donation to planting project in the neighborhood	Whether the respondent is willing to financially contribute to the planting project in the neighborhood	Not at all	1	5	0.93%
			Not really	2	60	11.21%
			Willing	3	284	53.08%
			Very willing	4	186	34.77%
C4_3	Favorable planting characteristics in the neighborhood	Important aspects that should be considered in the planting project	Amount	a	248	46.36%
			Variety	b	267	49.91%
			Aesthetics	c	388	72.52%
			Location	d	323	60.37%
			Utilities (shades, etc.)	e	365	68.22%
			Other	f	5	0.93%

D. Public park visitation and motivations

Respondent's public park visitation and involvement in planting projects can be explored using the variables in the fourth sub-section (see Table 8.4). At the beginning of the sub-section, the question, "is there any public park near your house?" was asked. If the respondent answered 'yes', other questions about their visitation to the public park and planting-project contribution willingness would be given. Otherwise, these questions would be skipped. In this sub-section, specific questions about the public park's biodiversity characteristics were not included to avoid respondent's recall bias, which downgrades the answers' reliability.

Table 8.4: Description of variables related to public park visitation and motivations

Categorical variables						
Variable	**Name**	**Explanation**	**Level**	**Code**	**Frequency**	**Proportion**
D1	Availability of a nearby public park	Whether there is a public park near where the respondent lives	Yes	1	415	77.57%
			No	0	120	22.43%
D2	Public park visitation frequency	Frequency of going to the nearby public park	Never	1	21	3.93%
			Almost never	2	38	7.10%
			Sometimes	3	281	52.52%
			Almost everyday	4	55	10.28%
			Everyday	5	20	3.74%

D3	Public park visitation reasons	The respondent's reasons to visit the nearby public park	Relaxation	a	260	48.60%
			Physical activities	b	238	44.49%
			Meeting with friends	c	96	17.94%
			Spending time with family	d	107	20.00%
			Educational activities for children	e	101	18.88%
			Enjoying nature	f	220	41.12%
			Community events	g	70	13.08%
			Other	h	2	0.37%
D4	Donation to planting project in the public park	Whether the respondent is willing to contribute financially to the planting project in the nearby public park	Not at all	1	8	1.50%
			Not really	2	58	10.84%
			Willing	3	244	45.61%
			Very willing	4	105	19.63%
D5	Favorable planting characteristics in the public park	Important aspects that should be considered in the planting project	Amount	a	220	41.12%
			Variety	b	281	52.52%
			Aesthetics	c	326	60.93%
			Location	d	228	42.62%
			Utilities (shades, etc.)	e	284	53.08%
			Other	f	7	1.31%

E. National park visitation and motivations

The fifth sub-section is about the respondent's national park visitation (see Table 8.5). Besides the visitation behaviors (variable *E1*) and motivations (variables *E2* to *E4*), the respondent's willingness that might contribute to conservation finance in national parks was also measured by variable *E5* (entrance fee payment willingness) and *E6* (donation willingness). The questions in this sub-section were kept as general (or not context-based) as possible because urban residents in different cities had distinct impression with particular national parks, so their perceptions about national parks might be different accordingly. Moreover, recall bias also alleviates the reliability of responses to specific (or context-based) questions.

Table 8.5: Description of variables related to national park visitation and motivations

Categorical variables						
Variable	**Name**	**Explanation**	**Level**	**Code**	**Frequency**	**Proportion**
E1	National Park visitation frequency	Frequency of going to the national park	Never	1	114	21.31%
			Less than once a year	2	259	48.41%
			Once a year	3	111	20.75%
			Twice a year	4	27	5.05%
			More than twice a year	5	24	4.49%
E2	National park visitation reasons	The respondent's reasons to	Escape and Relaxation	a	300	56.07%
			Enjoying nature	b	342	63.93%

		visit the national park	Watching wild animals	c	290	54.21%
			Meeting with friends	d	107	20.00%
			Spending time with family	e	223	41.68%
			Educational activities for children	f	182	34.02%
			Seeking new knowledge (animals, plants, etc.)	g	244	45.61%
			Outdoor activities (hiking, trekking, etc.)	h	233	43.55%
			Other	i	7	1.31%
E3	Willingness to visit a national park (scale)	Whether the respondent is willing to visit a national park in the next 12 months	No, I don't even think about it	1	30	5.61%
			No, but maybe later	2	36	6.73%
			Yes, but I'm still not sure	3	232	43.36%
			Yes, certainly	4	237	44.30%
E4	Willingness to visit a national park (binary)	Whether the respondent is willing to visit a national park in the next 12 months	Yes	1	469	87.66%
			No	0	66	12.34%
E5			Yes	1	522	97.57%

	Entrance fee payment willingness	Whether the respondent is willing to pay for the national park's entrance fee	No	0	13	2.43%
E6	Conservation project donation willingness	Whether the respondent is willing to donate to the national park's conservation activities	Yes	1	508	94.95%
			No	0	27	5.05%

F. Socio-demographic profile

The last sub-section consists of variables about the socio-demographic characteristics of the respondent, such as gender (variable *F1*), age (variable *F2* and *F3*), occupation (variable *F4*), educational level (variable *F5*), and income (variables *F6* and *F7*). Apart from basic information, the nearby landscape (variable *F8*), environmental information source (variable *F9*), most frequently lived area (variable *F10*), and current residency (variable *F11*) are also included in the sub-section (see Table 8.6).

Table 8.6: Description of variables related to respondents' socio-demographic profiles

Categorical variables						
Variable	**Name**	**Explanation**	**Level**	**Code**	**Frequency**	**Proportion**
F1	Gender	Gender	Female	0	312	57.08%

			Male	1	220	42.92%
F3	Age group	The age group in which the respondent belongs to	18-22	1	120	13.95%
			23-30	2	132	21.36%
			31-40	3	140	25.75%
			41-50	4	87	17.37%
			51-60	5	36	7.58%
			More than 60	6	20	3.99%
F4	Occupation	The current occupation of the respondent	NA	NA	NA	NA
F5	Education	The highest educational level of the respondent	Primary school	1	1	0.2%
			Secondary school	2	9	1.8%
			High school	3	70	13.77%
			Undergraduate	4	338	61.68%
			Post-graduate	5	117	22.55%
F7	Income group	The income group in which the respondent belongs to	No income	1	22	4.39%
			Less than 5 million VNĐ	2	53	10.58%
			5 - 10 million VNĐ	3	99	15.37%
			10 - 15 million VNĐ	4	107	20.16%
			15 - 20 VNĐ	5	40	7.78%
			20 - 30 million VNĐ	6	44	9.38%
			More than 30 million VNĐ	7	40	7.78%
F8	Nearby landscape	The landscapes that the	Forest	a	121	23.15%
			Ocean	b	133	24.35%

		respondent has ever lived nearby	River	c	201	36.73%
			Cropland	d	205	37.72%
			Pond	e	203	37.92%
			Other	f	143	28.54%
			Not at all	g	6	0%
F9	Environmental Information source	The sources from which the respondent receives environment-related information	Newspaper	a	382	71.86%
			Online newspaper	b	380	71.46%
			Social Media	c	464	87.03%
			Lecture	d	228	43.91%
			Word of mouth	e	278	52.50%
			Books	f	253	47.90%
			Textbooks	g	228	43.51%
			Documentary movies	h	339	64.27%
			Observations	i	292	56.09%
			Local government	j	99	19.56%
			Others	k	3	0.6%
F10	Area with most living time	The area in which the respondent has spent a majority of their lifetime	Urban	a	454	85.63%
			Sub-urban	b	54	10.38%
			Rural	c	26	3.79%
F11	Current residency	The current city in which the respondent is living	NA	NA	NA	NA
Numerical variable						

Variable	Name	Explanation	Range	Mean	SD
F2	Age	The reported age of the respondent	18-71	33.80	12.18
F5	Income	The reported income of the respondent	0-100,000,000	13,708,971	16,646,862

Chapter 9:

Bayesian Mindsponge Framework

This dissertation's second and third studies employed the Bayesian Mindsponge Framework (BMF) to analyze 535 eligible responses from people living in major Vietnamese cities. In this chapter, I present what the mindsponge mechanism and Bayesianism are, how they are advantageous, and how they greatly fit each other and form an analytical approach: BMF.

9.1. Mindsponge mechanism

9.1.1. Brief history and applications

The term mindsponge refers to the metaphor that the mind is analogized to a sponge that absorbs new compatible values and squeezes out incompatible values with its core values. It was first coined by Vuong et al. (2014, p. 8) as a measurement for the "ability to absorb and integrate new cultural values into corporate mindset toward innovative change and creative performance" in the Inclusive Innovation Metrics (or i2Metrix), which helps estimate the corporate innovation capacity. Incorporating the existing prominent literature about acculturation and global mindset at the current time, Vuong and Napier (2015) and Vuong (2016) continued to develop the concept of "mindsponge" into the mindsponge mechanism. The concept has been expanded into mindsponge theory, of which its functions are supported by evidence from natural evidence, in a recent book (Vuong, 2023).

The mindsponge mechanism is a framework that describes how and why an individual learns new cultural values through education and work in "foreign settings" and unlearns cultural values that are no longer appropriate. The "foreign settings" refer to any contexts that the individual was unfamiliar with in the past. For example, when a person works or studies in a foreign country as an expatriate or international student; when a person works and studies with foreign friends in their home country; when a person stays in the home country but surfs the Internet to see information related to foreign countries (e.g., an American Vietnamese person anime that originated in Japan, was drawn in Korea and translated in the Philippines).

The mechanism was first proposed by Vuong and Napier (2015, p. 355) to explain "why and how professionals and managers could replace the cultural values they have grown up with by those they have absorbed following education and work in "foreign" settings." Later, Nguyen et al. (2021) suggested that the mindsponge mechanism can be employed to explain and construct theoretical models for complex psychological and behavioral issues. Specifically, they use the mindsponge mechanism to explain suicidal ideation through a sense of connectedness and help-seeking behaviors. This study also marks the first time the Bayesian Mindsponge Framework was employed. Since then, the mindsponge mechanism has been used to demonstrate the absorption and rejection process of not only cultural values but also information and ideations.

The applications of the mindsponge mechanism are various. It has been employed to study and explain many issues in multiple disciplines, such as business and

management sciences (Bărbulescu, Tecău, Munteanu, & Constantin, 2021; Kim, Lee, & Lee, 2021; Nguyen et al., 2022; Vuong, 2016), creativity and innovation sciences (Nguyen, 2022; Stoermer, Lauring, & Selmer, 2020; Vuong, 2022), psychology and behavioral sciences (Ärleskog, Vackerberg, & Andersson, 2021; Basinska & Rozkwitalska, 2020; El Fakahany, 2021; Liu, Wan, & Fan, 2021), socio-cultural sciences (Ho et al., 2022; Mantello, Ho, Nguyen, & Vuong, 2021; Ruining & Xiao, 2022; Ruining et al, 2023; Shen, Li, & Zhang, 2021; Vuong et al., 2018), education sciences (Lasekan & Alarcón, 2021; Tran et al., 2020), scientific publishing (Nguyen & Vuong, 2021; Vuong, Nguyen, Pham, Ho, & Nguyen, 2021), and environmental sciences (Khuc et al., 2020).

Particularly, Vuong (2016) finds that mindsponge, measuring the readiness to adjust to emerging sociocultural values, is a significant predictor of entrepreneurs' decisions to start a business. Due to this feature of mindsponge, developing a mindsponge-like culture is promoted as a way to obtain a sustainable business that is open to innovation and adapts to environmental changes (Bărbulescu et al., 2021; Wurster, 2021). In a recently proposed organizational theory of resilience (Kantabutra & Ketprapakorn, 2021), the mindsponge mechanism is referred to as a foundational framework along with the General System Theory by Von Bertalanffy (1973) and the theory-building approach by Dubin (1976). Regarding psychology and behavioral sciences, Stoermer et al. (2020) suggest that the mindsponge concept can be a promising tool to examine "how the experience of cultural differences in conjunction with expatriate personality

affects the internalization of new values and information and how this eventually influences expatriates' creativity." In addition, mental health issues can also be explained using the mechanism, such as the associations between acculturative stress, social connectedness, and depression (Nguyen, Le, & Meirmanov, 2019; Ranizal, Zabidi, Shariff, Stanis, & Amir, 2019). Especially, the mechanism plays a foundational role in discovering cultural additivity phenomena in Vietnamese culture (Vuong et al., 2019; Vuong et al., 2018; Vuong et al., 2020).

9.1.2. Fundamental components

The mindsponge mechanism is dynamic and multiplex, it is often displayed through a conceptual diagram with a pie shape representing a mind and the surrounding environment (see Figure 9.1). The diagram consists of five main components: 1) mindset, 2) comfort zone, 3) multi-filtering system, 4) cultural and ideological setting (or environment), and 5) cultural values (or information) (Vuong et al., 2022a).

The outermost part of the pie – the yellow-colored part – demonstrates the cultural and ideological settings (or environment, in general), where the individual is within. The innermost part of the pie – the red-colored nucleus – represents the mindset or a set of core values. Given that culture can be defined as "the set of attitudes, values, beliefs, and behaviors shared by a group of people, but different for each individual, communicated from one generation to the next" (Matsumoto & Juang, 2016), the mindset includes but is not limited to cultural values. Sometimes, highly trusted values or information are also deemed as core values. Such core values are used as

benchmarks explicitly or implicitly for judging the appropriateness of newly absorbed values (or information) and making decisions or responses. In other words, the mindset greatly influences an individual's perceptions, attitudes, and behaviors. Due to this function of the mindset, it creates a self-protection mechanism for the individual's "self," which is analogous to the assertion of the self-affirmation theory that "the overall goal of the self-system is to protect an image of its self-integrity, of its moral and adaptive adequacy. When this image of self-integrity is threatened, people respond in such a way as to restore self-worth" (Sherman & Cohen, 2006).

The blue part in the middle of the outermost part and the nucleus is the comfort zone, also called the buffer zone. This zone is constituted by values in the mind that are not core values. It has two fundamental functions. First, any values that want to enter the mindset have to pass through the comfort zone, so the comfort zone helps protect the mindset from external shocks when the environment changes swiftly (e.g., cultural shocks). Second, the comfort zone is the place where the multi-filtering system kicks in to evaluate the appropriateness and usefulness of the newly entering values. Although the filtering process can happen anywhere within the mind, no matter how close it is to the mindset, the white membranes between the yellow/blue and blue/red parts represent the point of evaluation or filtering (for a more straightforward interpretation). The closer the values are to the mindset, the stricter the evaluation or filtering will be.

The multi-filtering system has two essential functions: integration and differentiation of information (Levy, Beechler, Taylor, & Boyacigiller, 2007). When the information from the environment enters the mind, it is treated in two ways. If the information is compatible with the core values (or mindset), it will be synthesized and incorporated through integration. Suppose the emerging information is different from the existing information (or values). In that case, the difference will be measured through differentiation to assess the cost and benefit of accepting or rejecting the emerging values (or replacing existing ones with new ones).

The multi-filtering system is driven by the 3D (three dimensional) filter (Vuong & Napier, 2014), the notion of inductive attitude (Pólya, 1954), and trust evaluators (Paliszkiewicz, 2011; Schoorman, Mayer, & Davis, 2007). The 3D filter refers to disciplined processes that evaluate, connect, compare, and imagine emerging and existing values to create useful and ready-to-use insights. The emerging values are information absorbed from the environment (or out-of-discipline information), while the existing values are information existing within the mind (or within-discipline information). In other words, the 3D filter is a "proactive disciplined process of mindsponge filtering begins by comparing foreign information and values to benchmarks (the existing core values), accepting or rejecting the new values to integrate into the comfort zone" (Vuong & Napier, 2015). This filter is operated under an assumption that the individual is aware of his/her desire(s) or has clear priorities.

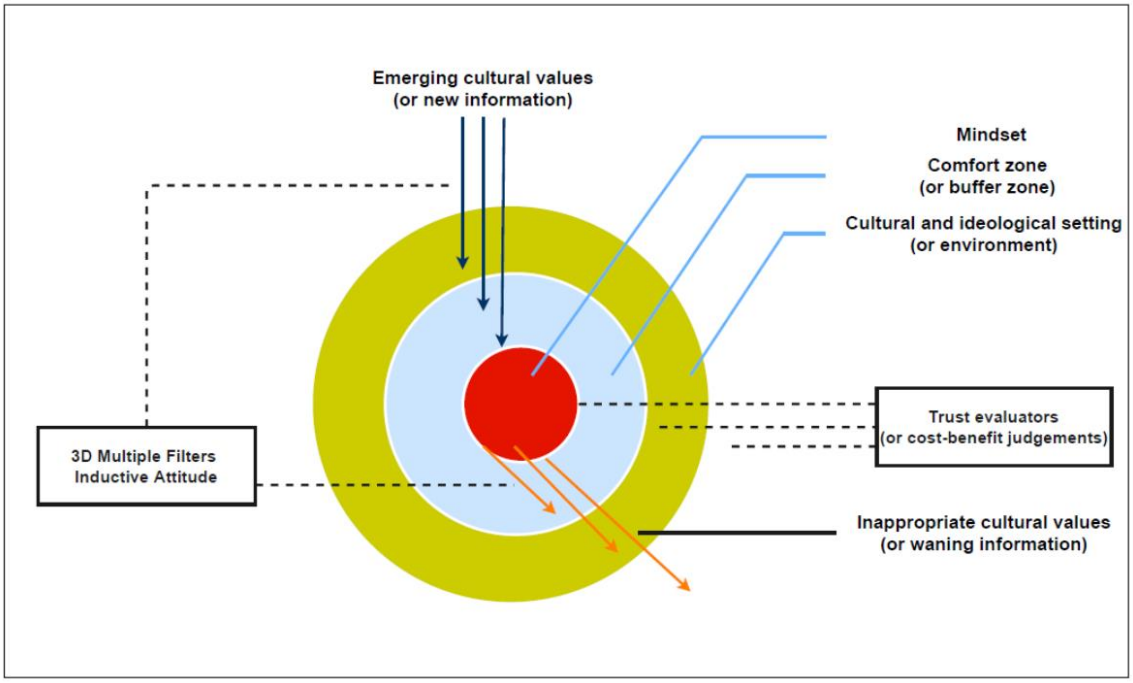

Figure 9.1: Mindsponge mechanism. The visualization is retrieved from M.-H. Nguyen, Vuong, Ho, and Le (2021) under the Creative Commons Attribution licence (CC-BY).

Pólya (1954)'s inductive procedure offers a three-step mechanism to filter information that starts with noticing similarities (or analogies) between new and existing values. Then, such analogies are generalized into conjectures, and the conjectures are eventually tested in a specific context. The inductive attitude is thinking that dares to test and retest certain existing beliefs without fear of being easily contradicted by experience. The testing results are stored in mind and form the "guard of trust" (or trust evaluators). Vuong and Napier (2015) suggest that there are at least four levels of trust evaluation:

1) personal qualities and properties;
2) expectation of future costs and benefits in both the short and long term;
3) ability to verify a value's adaptability to the existing mindset;
4) suitability of generalized values at the philosophical level.

The absorption and ejection of information and values are represented by the arrows moving in and out directions, respectively. The arrows heading to the nucleus demonstrate the emerging information and values, while the arrows heading out demonstrate the wanning values and information no longer compatible with the core values. The in- and out-flows are non-stop, continual processes, which creates the updating feature of the mindsponge mechanism. This updating feature helps clarify the distinction between the 3D filter and trust evaluator, which are analogous at first glance, because both are related to cost-benefit judgement. To elaborate, the cost-benefit judgement of new values engaging trust evaluators employs the analogous existing values that were formerly absorbed, evaluated, and validated through the inductive procedure. For this reason, the new values might be given a "priority pass" that requires less timely and rigorous evaluation to be absorbed into the mindset. In contrast, if no existing formerly evaluated and validated values are analogous to the emerging values and information, the emerging values and information have to be evaluated carefully, as usual, by a 3D filter to be absorbed into the mindset. In some cases, when the information is perceived as totally untrustworthy, it might be ejected from the mind immediately by the trust evaluator.

9.1.3. Advantages of studying psychology and behavior

Due to the features described above, the mindsponge mechanism has several advantages in studying and analyzing psychological and behavioral issues. First of all, the mindsponge mechanism shows a non-stop, continual absorption and ejection processes of information, which are driven by the multi-filtering system, so it can help explain the multiplex and dynamic of humans psychology and behaviors. Moreover, as the mindsponge mechanism uses information and values as basic components, its applicable scope is broad and not limited by specific disciplinary boundaries. Therefore, it helps study highly interdisciplinary topics, such as conservation social sciences, environmental psychology, human behavioral ecology, etc. (Khuc et al., 2023a; Khuc et al., 2023b; Khuc et al., 2022; Nguyen & Jones, 2022; Nguyen & Jones, 2022; Vuong, Le, Khuc, Nguyen, & Nguyen, 2022)

Second, due to the non-stop continual information processing process, the mindsponge mechanism can reflect the human mind's updating (or changing) characteristics. The argument is built upon the discovery that the brain can change its structure and function through thinking processes and behaviors, and this change is affected by various things, such as love, sex, grief, relationships, learning, addictions, culture, technology, economic status, etc. (Davidson & McEwen, 2012; Doidge, 2007). This changing brain phenomenon is referred as neuroplasticity or brain plasticity – "the ability of the nervous system to change its activity in response to intrinsic or extrinsic stimuli by reorganizing its structure, functions, or connections" (Mateos-Aparicio & Rodríguez-

Moreno, 2019). A framework with the updating feature (or considering the time dimension), like the mindsponge mechanism, can be a better tool for studying human psychology and behaviors than other static frameworks.

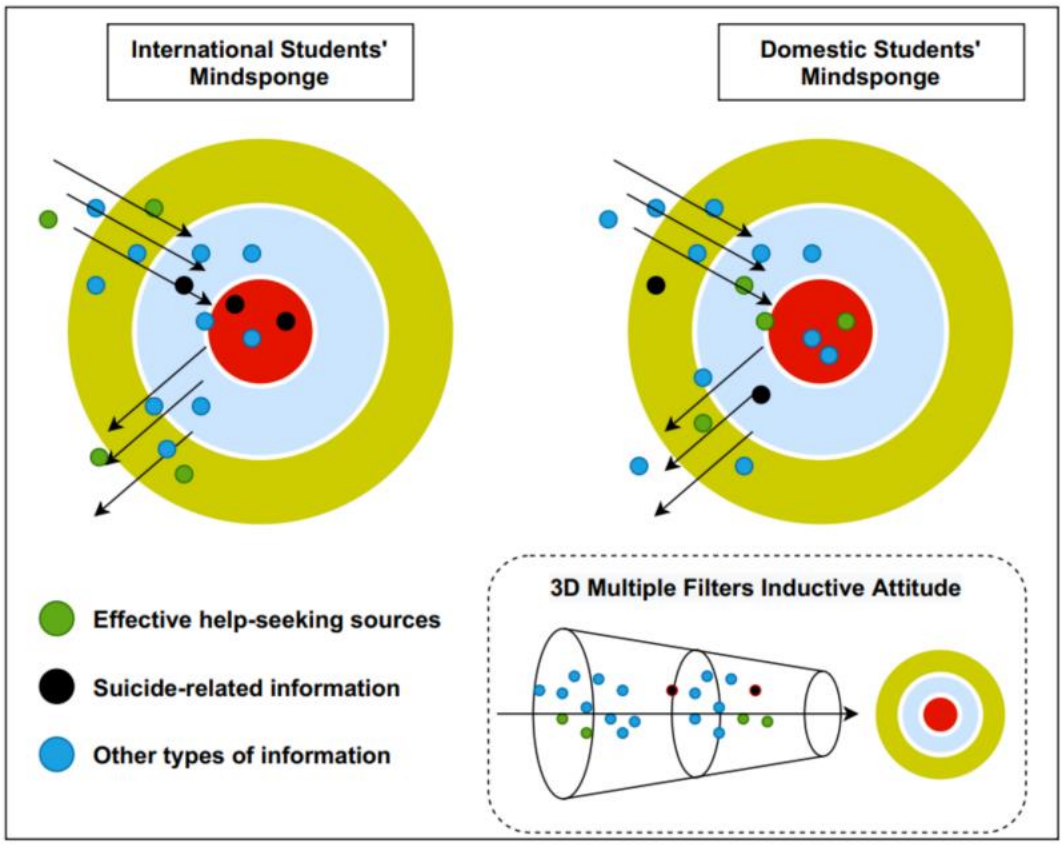

Figure 9.2: Example of demonstrating the mindsponge process using the Euler diagram. The visualization is retrieved from Nguyen, Le, et al. (2021) under the Creative Commons Attribution license (CC-BY).

Third, the mindsponge mechanism can be interpreted and visualized using the set theory – a branch of mathematical logic that studies the collection of things or objects.

Two typical demonstrations of set theory are the Euler and Venn diagrams. The conceptual diagram of the mindsponge mechanism is constructed using the Euler diagram, which provides the capacity to explain complex hierarchies and overlapping properties. Visualizations of mindsponge in the study of Nguyen, Le, et al. (2021) is a typical example (see Figure 9.2). Although the mind-brain mechanism (or the connections between mind and brain) remain debatable, it is not hard to recognize the complexity and multiscale of the mind given the complex temporally and spatially multiscale structure of the brain (Bassett & Gazzaniga, 2011). Thus, a framework that provides the ability to visualize hierarchies and overlapping properties would help substantially explain and study humans' psychology and behaviors.

Fourth, human thought or behavior is a result of multiple interconnected factors that already influenced (e.g., experience), are influencing (e.g., current biological and emotional conditions), and are expected to influence the human in the short or long term (e.g., expectations about an outcome in the future). Given this multiplexity, it is sometimes out of researchers' capacity to examine all the components involved in the psychological process of thinking or behavior at a time. In order to study psychological and behavioral issues effectively, the principle of parsimony is favored to construct scientific models because it facilitates the discovery of laws (or patterns of data) and generates a more precise and integrated conclusion (Bentler & Mooijaart, 1989; Cougle, 2012; Simon, 2001). However, constructing parsimonious models require researchers to understand when the inclusion of parameters is sufficient (Bentler &

Mooijaart, 1989), and when it is too simple, that can lead to the impoverishment of our interpretation of the studied phenomenon (Simon, 2001). Mindsponge mechanism aided by the set theory can help us determine the boundary in which the psychological might happen or which components have a high probability to be involved, which subsequently facilitates the construction of parsimonious models.

Last but not least, the interactions between the mind and the environment can be highlighted through the flows of information absorbed and ejected. Such flows of information are driven by the multi-filtering system that involve subjective cost-benefit judgements and trust evaluation. For that reason, it is possible to explain a particular psychological process, decision, or behavior based on both the information existing in mind (mostly the core values) and the emerging information from the external environment. In other words, the mindsponge mechanism is not a closed system, but it is open to integrating other theories and frameworks that are context-based into the framework.

9.2. Bayesian inference

9.2.1. Bayes' Law and fundamental components

Bayesian inference is a statistical inference method that employs Bayes' Law (a.k.a. the Bayes' Theorem). The Theorem was written by Thomas Bayes – an English statistician, philosopher, and Presbyterian minister – in the "Essay towards solving a problem in the doctrine of chances." However, the essay was only found and published by his friend, Richard Price, in 1763, two years after the Bayes' death. Although the

Theorem bears Bayes' name because he first wrote it, Pierre-Simon Laplace – a French scholar and polymath – was the one who independently provided a more detailed analysis that is more relevant to the practice of contemporary Bayesian statistics (Laplace, 1774, 1781). Bayesian thinking has been widely applied to answer questions in multiple disciplines: astrophysics, weather forecasting, biology, and social and psychological sciences (Cowles, 2013). Besides science, it is even used to guide learning and decision-making in business and industry. For example, Google's driverless robotic car is guided by Bayesian inference software (McGrayne, 2011). Mars Rovers – motor vehicles designed to travel on the surface of Mars – are also programmed to think Bayesianly.

Both Bayes and Laplace assumed a uniform distribution (a flat distribution that assigns an equal probability for every possible outcome) for the unknown parameter. In a probability context, Bayes' Theorem can be presented as follows (Gill, 2014).

Suppose we have two events *A* and *B*, which are not independent. Based on the basic axioms of probability, we have the conditional probability of *A* given *B* occurrence:

$$\rho(A|B) = \frac{\rho(A,B)}{p(B)} \quad \textbf{(9.1)}$$

where $\rho(A|B)$ is the probability of A given that B has occurred, $\rho(A,B)$ is the probability that both A and B occur, and $p(B)$ is the unconditional probability that B occurs. $\rho(A,B)$ can also be known as the joint probability between A and B, denoted by $\rho(A \cap B)$.

Similarly, the conditional probability of B given A occurrence is shown as:

$$\rho(B|A) = \frac{\rho(B,A)}{p(A)} \quad \textbf{(9.2)}$$

Because the probability that A and B occur is equal to the probability that B and A occur, we can combine Equation (1) and (2) as follows:

$$\rho(A|B)p(B) = \rho(B|A)p(A)$$

$$\rho(A|B) = \frac{\rho(B|A)p(A)}{p(B)} \quad \textbf{(9.3)}$$

This equation is the famous Bayes' Theorem or Bayes' Law.

The Bayes' Law can also be applied to multiple events, but not only two. Suppose we are interested in the probabilities of three events *A*, *B*, and *C*, which are conditional on the data **D** that we observe. Applying the Bayes' Law for event A (any of the three events can be selected), we have:

$$\rho(A|\mathbf{D}) = \frac{\rho(\mathbf{D}|A)\rho(A)}{\rho(\mathbf{D})} \quad \textbf{(9.4)}$$

Given the Total Probability Law and the definition of conditional probability, we have:

$$p(\mathbf{D}) = p(A \cap \mathbf{D}) + p(B \cap \mathbf{D}) + p(C \cap \mathbf{D})$$

$$= \rho(\mathbf{D} \mid A)p(A) + p(\mathbf{D} \mid B)p(B) + p(\mathbf{D} \mid C)p(C) \quad \textbf{(9.5)}$$

Then, if we substitute the denominator of Equation (4) by Equation (5), we will get:

$$\rho(A|\mathbf{D}) = \frac{\rho(\mathbf{D}|A)\rho(A)}{\rho(\mathbf{D} \mid A)p(A)+p(\mathbf{D} \mid B)p(B)+p(\mathbf{D} \mid C)p(C)} \quad \textbf{(9.6)}$$

Equation (9.6) demonstrates the conditional probability for any of the hypotheses that can be produced when there exist unconditional distributions for three rival hypotheses, $p(A)$, $p(B)$, and $p(C)$, and three statements about the probability of the data given these hypotheses, $\rho(\mathbf{D}|A)$, $\rho(\mathbf{D}|B)$, and $\rho(\mathbf{D}|C)$.

In realistic statistical models, what we have to do is to estimate the distribution of the unknown k-dimensional $\boldsymbol{\theta}$ coefficient vector (or parameter), given the rectangular $n \times k$ matrix of data, $\mathbf{X}$. $\mathbf{X}$ is for replacing $\mathbf{D}$ in equation (6). The distribution of $\boldsymbol{\theta}$ coefficient vector given $\mathbf{X}$ is called posterior distribution and denoted as $\rho(\boldsymbol{\theta}|\mathbf{X})$. Applying Bayes' Law, the posterior distribution will be calculated as follows:

$$\rho(\boldsymbol{\theta}|\mathbf{X}) = \frac{\rho(\mathbf{X}|\boldsymbol{\theta})p(\boldsymbol{\theta})}{p(\mathbf{X})} \quad \textbf{(9.7)}$$

where $\rho(\mathbf{X}|\boldsymbol{\theta})$ is the probability of the sample for the fixed $\boldsymbol{\theta}$ under the assumption that the data are independent and identically distributed according to $\rho(X_i|\boldsymbol{\theta})\ \forall\ i = 1, \ldots, n$, and $p(\boldsymbol{\theta})$, $p(\mathbf{X})$ are the corresponding unconditional probabilities. $\rho(\mathbf{X}|\boldsymbol{\theta})$ can be treated as a likelihood function that assigns a probabilistic prediction to the observed data $\mathbf{X}$. Because the implication of $\rho(\mathbf{X}|\boldsymbol{\theta})$ that known quantity is conditional on the unknown quantity, so the $\rho(\mathbf{X}|\boldsymbol{\theta})$ quantity is usually written as $L(\mathbf{X}|\boldsymbol{\theta})$ to represent the likelihood function. $p(\boldsymbol{\theta})$ is a distributional statement about the unknown parameter vector $\boldsymbol{\theta}$ before observing the data (a.k.a. the prior distribution). $p(\mathbf{X})$ is called by many names, such as the normalizing constant, the normalizing factor, the marginal likelihood, and the prior predictive distribution. Nonetheless, since it is not conditional

on $\boldsymbol{\theta}$, in turn, gives no inferential information about the value of parameter $\boldsymbol{\theta}$, Equation (9.7) can be formulated more compactly and succinctly by removing $p(\mathbf{X})$ from the denominator and replacing the equal notation ("=") with the proportional notation ("$\propto$"):

$$\rho(\boldsymbol{\theta}|\mathbf{X}) \propto L(\mathbf{X}|\boldsymbol{\theta})p(\boldsymbol{\theta}) \quad \textbf{(9.8)}$$

This Equation can be translated into the simplest rule of Bayesian inference:

Posterior Probability $\propto$ Prior Probability $\times$ Likelihood Function

Based on this rule, it can be said that, in all Bayesian models, the posterior probability distribution is always proportional to the prior probability distribution and the likelihood function. Visually, the posterior distribution, prior distribution, and likelihood can be presented in Figure 9.3. As can be seen, the prior distribution represents subjective expectation towards the probability distribution of the parameters in the model, while the likelihood represents the evidence derived from the data at hand. The longer the intervals of prior distribution are, the more uncertain the expectation is. The wider the likelihood intervals are, the higher the noise of the data is. After the estimation, the posterior distribution is pulled towards the prior distribution, which is called "shrinkage." Speaking differently, the posterior mean shrinks towards the prior mean (Gill, 2014).

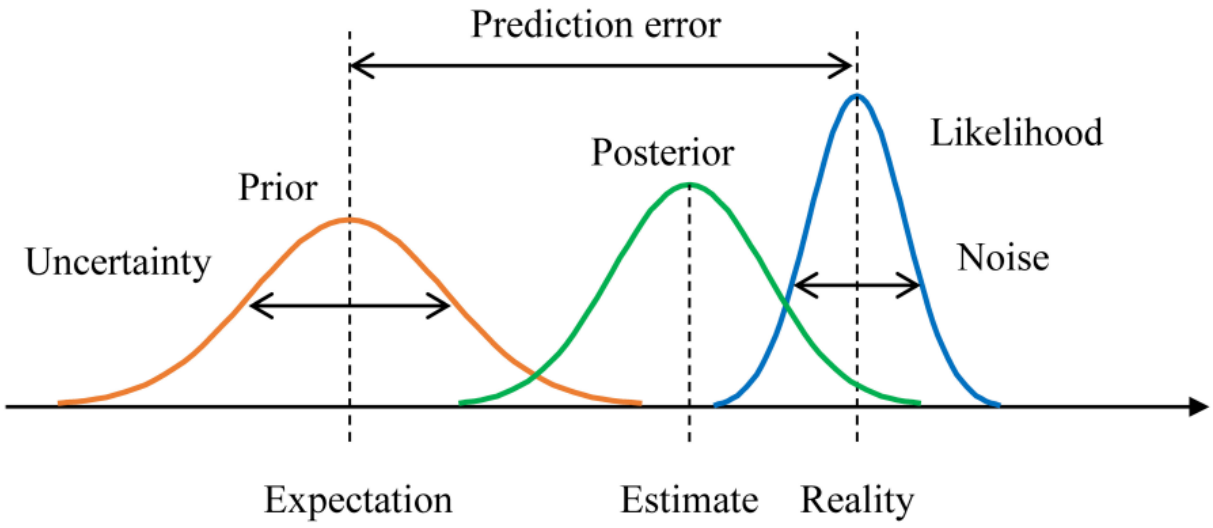

Figure 9.3: Example of Bayesian inference with a posterior distribution, prior distribution, and likelihood function. The visualization is retrieved from Yanagisawa, Kawamata, and Ueda (2019) under the Creative Commons Attribution license (CC-BY).

In Bayesian inference, the interval of the posterior distribution is not called a confidence interval like in the frequentist approach, but it is called a credible interval. The intervals of a parameter's posterior distribution are two parameter values that "contain between them a specified amount of posterior probability, a probability mass" (McElreath, 2018). When interpreting the Bayesian analyses' results, the Highest Posterior Density Intervals (HPDIs) are very important to determine whether the fixed $\boldsymbol{\theta}$ is significantly different from 0. The HPDIs help define the Highest Posterior Density region, which has a higher posterior density than any region outside the region.

9.2.2. Advantages of Bayesian inference

To understand the advantages of Bayesian inference, I will first go through the current reproducibility crisis in the social and psychological sciences, which encourages more scientists to adopt Bayesian inference instead of the frequentist approach for their statistical analyses. In 2015, a large-scale audit was carried out by a team of 270 researchers led by Brian Nosek – executive director of the Center for Open Science – for replicating 100 experimental and correlational studies published in three psychology journals. The audit suggests that only 36% of the studies could be confirmed, and 47% could if using another statistical method (Open Science Collaboration, 2015). Another inspecting study published in *Nature Human Behaviour* also reports a low reproduction rate when replicating 21 systematically selected experimental studies in social sciences published in two of the most prestigious journals (*Nature* and *Science*) between 2010 and 2015. Specifically, only 62% of the replicated studies show a significant effect in the same direction as the original studies (Camerer et al., 2018). In response to these worrisome results, *Nature* conducted a survey of 1,576 researchers in multiple disciplines to shed more light on the crisis. As a result, more than half of the respondents agree that there is a significant reproducibility crisis (Baker, 2016).

Many reasons have led to the reproducibility crisis. One of the major causes behind the crisis is the wide sample-to-sample variability in the *p*-value. The *p*-value was developed by Ronald Fisher to aid judgement whether we should doubt the null

hypotheses. However, the *p*-value in modern science is being treated as a dichotomous value (usually taking 0.05 as a threshold) or "an absolute index of the truth" that scientists employ to reject the null hypothesis. However, *p*-value = 0.04 should be considered to have a similar effect as *p*-value = 0.06. A small sample drawn from a population can hardly represent the features of the given population, so increasing the sample size will enhance the representation of the population and, thus, the reliability of the *p*-value. Nevertheless, even if the statistical power is increased up to 80% – the often suggested level, the *p*-value still remains highly variable. Only when the statistical power is increased up to at least 90%, the *p*-value would become invariable (Halsey, Curran-Everett, Vowler, & Drummond, 2015). The statistical power is relatively low in psychological studies, with approximately 50% (Maxwell, 2004).

Given the flawed *p*-value, Halsey et al. (2015) suggest scientists should not give binary judgements based on the *p*-value but rely on more mature alternatives to grade the evidence. Many scientists assert that the estimation of the 95% confidence intervals and visual presentation of the data can support the evaluation of the evidence because they provide more information and are more intuitive than the *p*-value (Krzywinski & Altman, 2013; Lavine, 2014; Masson & Loftus, 2003). In particular, Masson and Loftus (2003) recommend employing visualization of the data's means and corresponding confidence intervals as an alternative to standard null hypothesis testing.

Bayesian inference can be a good alternative for the *p*-value approach employed in frequentist inference as estimation and visualization of the confidence intervals are

basic features of Bayesian analysis. However, Bayesian inference employs credible intervals but not confidence intervals for interpretation. Bayesian credible intervals treat the estimated parameter as a random variable and their bound as fixed, so the intervals demonstrate the probability that the unobserved parameter value falls in. In contrast, frequentist confidence intervals treat the estimated parameter as fixed (true parameter value) and their bounds as random variables, so confidence intervals can only indicate the interval that we believe (or be confident) it contains the true parameter value of the unknown population parameter. For example, a 95% confidence interval indicates 95% of the confidence intervals calculated at the 95% confidence level contain the true parameter value, whereas 95% credible intervals help define the credible region that the true parameter value has a 95% probability of being in. This distinction makes the Bayesian inference more theoretically advantageous than the frequentist approach (Wagenmakers et al., 2018).

There are only two fundamental types of quantities in the Bayesian inference approach: known and unknown quantities. All of them are treated probabilistically. For a clear description, we can refer to the statements of Gill (2014):

> "From the Bayesian perspective, there are only two fundamental types of quantities: known and unknown. The definition of such unknown quantities is very general; they can be any missing data or unknown parameters. When quantities are observed, they are considered fixed and conditioned upon. […] Bayesians make no fundamental distinction between unobserved data and

> unknown parameters, the world is divided into: immediately available quantities, and those that need to be described probabilistically."

Due to this feature, the estimated results using Bayesian inference are conditional on the data at hand but not the asymptotic theory (or large sample theory), which assumes that the sample size may grow indefinitely, and the properties of estimators and tests are then gauged under the limit of $n \to \infty$. Pragmatically, a large finite sample size can be considered approximately valid for the assumption. However, this distinction helps Bayesian inference provide more precise estimation over small sample sizes than frequentist approaches.

Other advantages of Bayesian inference are derived from how it looks at probability. The frequentist approach views probability as objective, which follows the definition of Laplace (1814) that probability is the number of successful events out of trials observed. In contrast to the frequentism view on probability, Bayesianism adopts the subjective probability view, which associates probability with the "degree of belief." Subjective probability is defined as "a qualitative estimate of the possibility of the event given […] by the individual experience of the investigator" (Savchuk & Tsokos, 2011). Keynes (1921) and Jeffreys (1961) were early proponents of the view. They observed that different people in the same situation would have distinct probability assignments about future occurrences.

Following the view of subjective probability, Bayesian inference is conditional on prior knowledge (e.g., experience, intuition, former empirical evidence, theoretical ideas).

In other words, the incorporation of prior knowledge into the statistical framework allows researchers to include reliable information in addition to empirical data. Incorporating prior information also helps solve the multicollinearity problem in statistical analysis. Multicollinearity is when independent variables are correlated, causing less reliable statistical inference. Dealing with multicollinearity is tricky; even Blanchard (1987) famously quoted: "Multicollinearity is God's will, not a problem with OLS or statistical techniques in general." However, according to Leamer (1973), the multicollinearity problem is "the weak data problem associated with large standard errors of estimated coefficients and, in a Bayesian analysis, the coincidence of prior and posterior distributions on certain subspaces." Therefore, multicollinearity can be solved effectively if the prior information is informative. Particularly, it is found that the Bayesian approach with informative priors outperforms the Ridge regression approach to solve the multicollinearity problem (Adepoju & Ojo, 2018; Jaya, Tantular, & Andriyana, 2019).

Despite the benefits of including prior knowledge in model estimation, it is heavily criticized due to subjectivity. Some researchers worry that the involvement of subjectivity will enable the analysts to manipulate the probability estimations to acquire desired results. Other researchers believe science should be kept as objective as possible, which is aligned with the objective view of probability. Nonetheless, uninformative priors can still be used by specifying a flat prior distribution to provide the least amount of prior information possible to the model estimation. Although the

prior information still exists, it is so small that it can be negligible (Diaconis & Ylvisaker, 1985). In this case, the posterior distribution is mostly calculated based on the likelihood function. When the sample size is large, informative prior can only generate a very small effect on the posterior estimation (Gill, 2014). Additionally, the prior-tweaking technique can be performed to test the robustness of the posterior results or test the results' sensitivity when the priors are adjusted. If the posterior results of the model specifying informative and uninformative priors are not much different, the estimated model can be deemed robust (Vuong, Ho, et al., 2021).

The principles of Bayesian inference are applicable for both simple and complex models because Bayesian inference only features one estimator: the posterior distribution. However, computing the posterior distributions of complex models requires high-dimension integral calculations that cannot be solved analytically. Thanks to the development of computational power, researchers are nowadays able to employ Markov Chain Monte Carlo (MCMC) algorithm to compute the characteristics of posterior distributions. Specifically, the MCMC techniques iteratively generate samples of the serially correlated parameters drawn from the joint posterior distribution of the model's parameters. After iteratively generating a large sample, we can obtain the convergence of Markov chains that reflects the posterior distribution of any parameters in the model (Dunson, 2001). Due to this feature, Bayesian inference aided by MCMC techniques provides great flexibility in model fitting (Lunn, Jackson, Best,

Thomas, & Spiegelhalter, 2012). For instance, it supports fitting complex hierarchical models that contain nonlinearities (Wagenmakers et al., 2018).

9.3. Bayesian Mindsponge analytical approach

9.3.1. An overview

Bayesian Mindsponge Framework (BMF) is an analytical framework that combines the strengths of the mindsponge mechanism and Bayesian inference to facilitate investigation into psychological and behavioral issues. In the framework, the mindsponge mechanism, with its ability to reflect the complexity and dynamics of a human mind, is used to construct theoretical models. At the same time, the Bayesian inference, with its great flexibility, allows researchers to fit those models. The strength of this method lies in the theoretical value. Although the method only uses the regular statistical procedure of Bayesian analysis, it enables us to answer complex and dynamic questions through logical justifications of set theory and Bayes' Theorem.

BMF is relatively "young." It was first used to study the suicidal ideation mechanism among university students from multiple backgrounds in Japan. Based on the mindsponge mechanism, Nguyen, Le, et al. (2021) assume that the emergence of suicidal ideation in a student's mind is influenced by her/his subjective cost-benefit judgements. In other words, a student is assumed to consider suicide an option when dealing with particular circumstances (e.g., depression, anxiety, loneliness, perceived burdensomeness), besides seeking help, solving the problem, doing more meaningful activities. Suicide appears to be an option after two conditions are met. First, suicide-

related information exists within the environment surrounding the individual. Second, the suicide-related information is allowed to get closer or even enter the mindset and eventually influence the thinking process and behaviors of the individual. To prevent the emergence of suicidal ideation, an individual needs to absorb help-related information to negate the influence of suicide-related information or even eject them out of mind. Therefore, increasing the accessibility to help-related information, increasing the individual's belongingness (to reduce restriction to help-related information), and building an environment with "healthy" responses to mental health (to increase the availability of help-related information) are suggested to be systematically coordinated and implemented for suicide prevention among students.

The proposed suicidal ideation mechanism is also employed to study the psycho-religious mechanism behind suicide attacks in the book: "Mindsponge-Based Investigation into the Psycho-Religious Mechanism Behind Suicide Attacks." The book employed BMF as the analytical approach. Besides suicidal ideation, BMF has also been used to study various psychological and behavioral issues in multiple disciplines, such as education, environmental psychology, public health, scientific publishing, etc. Particularly, Nguyen, Nguyen, Ho, Le, and Vuong (2022) employed BMF to study the roles of female involvement and risk aversion in Open Access publishing patterns in Vietnamese Social Sciences and Humanities. Using the BMF on 4966 Vietnamese secondary students, Vuong, Nguyen, and Le (2021a) show how home

scholarly culture and book selection reason can influence the book reading interest among students with different academic performances.

9.3.2. Bayesian inference and mindsponge mechanism: "a couple"

The wide applicability of BMF is attributable to its strength: the good match between the mindsponge mechanism and Bayesian inference. This sub-section presents six major points to explain why the mindsponge mechanism and Bayesian inference are a good match for each other.

First, both mindsponge and Bayesian inference are built on subjectivity at philosophical and theoretical levels. Specifically, in the mindsponge mechanism, the mindset (or a set of core values) influences not only the information multi-filtering system but also the thinking process, perceptions, attitudes, and behaviors of the individual. Different individuals have dissimilar sets of core values, so their psychology and behaviors will be more or less different accordingly. This characteristic of the mindsponge mechanism reflects a greatly subjective worldview. As for Bayesian inference, subjectivity is also clearly exhibited in Bayes' theorem, which is built upon subjective probability. This type of probability makes statistical analyses more human-like by allowing researchers to incorporate their intuition, prior knowledge, experiences, wisdom, etc. It cannot be denied that removing subjectivity from psychological research is almost impossible, so a scientific approach that can make subjectivity accountable is demanded (Gough & Madill, 2012). The high subjectivity and logic dependence of the mindsponge mechanism and Bayesian inference offer

researchers an intuitive tool that can account for subjectivity but does not tradeoff the scientific rigor, from the conceptualizing to operational steps.

Second, the mindsponge mechanism and Bayesian inference all give researchers great flexibility in model selection. Human psychology and behaviors are multiplex, so complex models are required to study them. While the mindsponge mechanism can help researchers reason the complexity and dynamics of the human mind and reflect them onto models (e.g., non-linear relationships), Bayesian inference aided by MCMC algorithms allows researchers to fit high-dimensional and highly complex models. However, sometimes parsimonious models are preferable because of their great explanatory predictive power. Using the logic of the set theory, the mindsponge mechanism provides a framework to define the boundary of studied subjects, which helps achieve parsimony in model construction. The framework's effectiveness has been validated by a number of empirical studies (Nguyen, Nguyen, et al., 2022; Vuong, Nguyen, & Le, 2021a; Vuong, Nguyen, & Le, 2021b). Meanwhile, Bayesian inference, which treats all properties (including unknown parameters and uncertainties) probabilistically, allows researchers to focus solely on estimating models containing the issues of interest.

Third, both the mindsponge mechanism and Bayesian inference can deal with hierarchical problems. With its features (e.g., the logic of set theory), the mindsponge mechanism can help construct models with parameters that vary at different levels. Reviewing the conceptual diagram of the mindsponge mechanism in Figure 9.1 might

help understand this point better. Because the mindsponge process is influenced by both external information and internal preferences (or the mindset's cost-benefit judgment), the difference in parameters can be reflected at the environment or individual level. For example, at the individual level, pro-environmental marketing campaigns influence the pro-environmental behaviors of urban residents, but the effect size is different between groups of residents with distinct mindsets. Similarly, at the environment level, the effects of such campaigns on urban residents' behaviors vary depending on the greenness (or density of trees) in their neighborhood.

Multilevel modelling is a great method that enables estimating variation across individuals or groups of individuals explicitly while avoiding averaging and retaining uncertainties. It also helps improve the estimation precision when unbalanced sampling is present. These benefits come with a price. We need to identify distributions from which the characteristics of the group arise. Moreover, multilevel modelling is so complex that it can hardly be solved analytically. Fortunately, all forms of multilevel models are Bayesian (in the sense of assigning probability distributions to the varying regression parameters) (Gelman & Hill, 2006), and MCMC techniques help overcome the complexity of multilevel modelling and compute posterior distributions (Cowles, 2013). As a result, Bayesian inference aided by MCMC algorithms is a good match with the mindsponge mechanism in formulating and analyzing hierarchical models.

Fourth, the strength of Bayesian inference is the ability to incorporate prior knowledge into the statistical inference process. However, this feature of Bayesian inference also

receives many critiques because consideration of subjectivity is often deemed unscientific. Prior selection is, thus, one of the most debatable steps in Bayesian analysis if the priors cannot be appropriately justified. Employing the mindsponge mechanism to construct models and justify prior distributions of parameters in the model will help justify and increase the precision of prior choices through the logic of the set theory. In addition, given that Bayesian inference provides more accurate inference for small sample datasets than the conventional method if the prior is adequately specified (Uusitalo, 2007), the supplement of the mindsponge mechanism to the prior selection process can help enhance effectiveness and cut the cost of scientific activities. This benefit is even more crucial in developing countries where researchers lack the resources to collect and generate large datasets.

Fifth, both the mindsponge mechanism and Bayesian inference obtain the updating feature. The updating feature has several advantages. It enables researchers to design and conduct studies that explore the changes in psychology and behaviors on the temporal dimension. Moreover, as humans live in a world in which massive amounts of information are generated every day and become accessible through the Internet and digital devices, the psychology and behaviors of humans are more likely to be affected, or even change contingent on the information absorbed. A methodological approach with the updating feature will ease the explanation and investigation of dynamic changes in human psychology and behaviors. The reproducibility crisis in psychological research is partly attributable to contextual factors (e.g., time, place,

culture) (Van Bavel, Mende-Siedlecki, Brady, & Reinero, 2016). The updating feature helps take the varying contexts into consideration when examining a particular research question. Specifically, instead of giving a general inference result and assuming they are similar in all contexts, the methodological approach with updating feature generates unified inference results based on both the information at hand (or data that are contextually dependent) and former knowledge (or empirical results generated in other contexts). Differentiating the currently unified and former results also provides insights into the effects of contextual factors on the psychological process, eventually alleviating the reproducibility crisis.

Despite the aforementioned benefits of BMF, one question remains. Given that survey data are one of the most common data types in psychological and behavioral studies, especially in developing countries where advanced technologies are lacking, is BMF applicable to survey data?

The answer is yes. To answer the questionnaire, survey respondents have to employ the information that are existing in their minds and is perceived from the external environment. Thus, the survey responses can be considered outcomes generated by respondents' psychological and behavioral processes until the survey collection. The mindsponge mechanism can explain the psychological and behavioral processes that led to the thoughts and behaviors the respondents answered. In other words, the mindsponge mechanism is a framework that helps establish and imagine a psychological process retrospectively using the data at hand; the studies of Nguyen,

Le, et al. (2021) and Vuong, Nguyen, and Le (2021a) are typical examples of this retrospective explanation.

The establishment and imagination of the psychological process are not boundless but follow the logic of set theory and the updating feature of the mind, which is assumed based on neuroplasticity. For example, if a person has never seen or heard of a dog, the information about the dog does not exist in his/her mind and cannot affect the psychological processes leading to his/her thought or behavior. When a person perceives the existence of a computer, the information will go into his/her mind and have it updated, subsequently affecting the decision for entertainment. In other words, a person's decision for entertainment is likely to change after he/her knows about the existence of a computer. Although BMF is applicable to survey data, it cannot help researchers eliminate the natural limitation of survey data: the recall bias.

9.3.3. Procedure of BMF

There are five steps to conducting the BMF: 1) identifying a research problem, 2) identifying research factors and their proxies, 3) constructing a logical framework, 4) constructing and fitting a model, and 5) interpreting and evaluating results. Before these steps, understanding the mindsponge mechanism's components and how it works is necessary. The subject or the problem of interest has to be determined in the first step.

After determining the research problems, factors related to the problems and their proxies need to be defined. Particularly, based on the interview's results, perceived

consequences of biodiversity loss can be considered as biodiversity perceptions, and they are proxied by the respondents' agreement levels of whether the given results (e.g., air pollution, climate change, loss of life balance) are caused by biodiversity loss. Further information regarding the studied factors and how they are proxied is described in later chapters (see Chapters 11 and 12).

In the third step, the mindsponge mechanism is used as a framework to rationalize how the associations between biodiversity perceptions and conservation-related attitudes and behaviors can occur. Directions of the associations are also predicted during this process to generate prior distributions in the next step. All the rationalizations are also shown in later chapters for clarity (see Chapters 11 and 12).

When the rationalization is completed, the models for computation will be constructed and fitted using Bayesian analysis software. All the analyses in this dissertation were conducted using the bayesvl R package due to its user-friendly operation method, capacity to visualize eye-catching graphics, and cost-effectiveness (La & Vuong, 2019; Vuong, La, Nguyen, Ho, Ho, et al., 2020; Vuong, La, Nguyen, Ho, Tran, et al., 2020; Vuong, Nguyen, & La, 2022b). Besides these benefits, the package also offers the Hamiltonian Monte Carlo algorithm – one of the most prominent MCMC methods – for computation and supports constructing a logical network before model fitting. All the models were fitted with four Markov chains. Each chain includes 5,000 iterations, of which the first 2,000 were set as warmup iterations.

Finally, the computed results are evaluated and interpreted. In order to validate my models' robustness, a three-step validation strategy was adopted.

First, Pareto smoothed importance-sampling leave-one-out cross-validation (PSIS-LOO) was employed to check the model's goodness-of-fit (Vehtari & Gabry, 2019; Vehtari, Gelman, & Gabry, 2017). The model's goodness-of-fit can be classified into four levels: 1) 'good' if its k-values are all below 0.5, 2) 'OK' if its k-values are more than 0.5 and below 0.7, 3) 'bad' if its k-values are more than 0.7 and below 1, and 4) 'very bad' if its k-values are more than 1.

Next, I checked the Markov chain central limit theorem using two diagnostic statistics: effective sample size (n_eff) and Gelman shrink value (Rhat). If the n_eff values are larger than 1,000 and the Rhat values equal 1, they will imply the good convergence of parameters' Markov chains. The Markov chains' convergence was also validated visually using trace plots, Gelman plots, and autocorrelation plots.

The "prior-tweaking technique" was the third validation step to check the results' sensitivity if the prior distributions were adjusted. In detail, we reran the model estimations using prior distributions that represent our disbelief in the existence of the associations in the models. The prior distribution of disbelief was set as a normal distribution, with 0 as the mean and 0.5 as the standard deviation. If the new posterior results are not sensitive to adjusted prior belief, they can be deemed robust and not subjectively biased.

Chapter 10:

Urban residents' perceptions of biodiversity and biodiversity loss

This chapter presents the findings of the first study, which attempts to explore three biodiversity mental constructs of urban residents in two of Vietnam's largest cities. The study employed the Grounded Theory and semi-structured interviews with 38 urban residents in Ho Chi Minh city and Hanoi capital city. The mental constructs of urban residents are displayed following these mental constructs: i) biodiversity and biodiversity loss, ii) impacts of biodiversity and biodiversity loss on humans, and iii) human reaction towards biodiversity and biodiversity loss. Besides identifying important conceptual dimensions, I also found the influence of cultural value, the awareness of multistakeholders' participation, and some misunderstandings in the urban residents' perceptions.

10.1. Perceptions about biodiversity (loss)

Out of 38 respondents, 36.84% reported that they have never heard of biodiversity, and that percentage for biodiversity loss is 52.63%. We categorized their perceptions into three perceptions and five features based on their responses. The perception is the respondents' impression about the term 'biodiversity' and 'biodiversity loss', whereas the feature is the characteristics that they relate to 'biodiversity' and 'biodiversity loss'.

Overall, three Vietnamese urban residents' perceptions of biodiversity were found: 1) *goods in an ecosystem*, 2) *an ecosystem itself*, and 3) *a stage of equilibrium*. In contrast, biodiversity loss perceptions were also categorized as 1) *the loss of goods in an*

ecosystem, 2) *the loss of an ecosystem itself*, and 3) *the loss of the stage of equilibrium*, respectively. The first two perceptions were referred to the definitions proposed by Bakhtiari et al. (2014) and Mace et al. (2012). However, there was a certain difference. While the respondents in our study perceive biodiversity as an ecosystem, respondents in Bakhtiari et al. (2014)'s study think biodiversity is a regulator of the ecosystem.

One example of how an interviewee perceived biodiversity as *goods in an ecosystem* is presented as follows:

> "*Basically, I think biodiversity is something that is closely connected to nature. There are trees, and the environment is clean. Humans, plants, and other animals live peacefully together*."
>
> Interviewee 36 (65 years old, male, retiree, Ho Chi Minh)

On the contrary, biodiversity loss is perceived as *the loss of goods in an ecosystem*:

> "*To what I know, biodiversity loss is the extinction of some species because humans destroy the natural environment of those species. The population of plants and animals also decline, accordingly*."
>
> Interviewee 28 (35 years old, female, banker, Ho Chi Minh)

Below responses belong to the interviewees who thought biodiversity is *an ecosystem itself,*

> "*To what I understand, biodiversity is a natural ecosystem that encompasses many things, such as forest, trees, flowers, water, wild animals, etc. There are also rare soil or stones in the ecosystem.*"
>
> Interviewee 9 (24 years old, female, officer, Hanoi)

and biodiversity loss is the *loss of an ecosystem itself*:

> "*Biodiversity is associated with the living environment, so when the diversity is lost, the environment will be gradually modified, deteriorated, and become disappear.*"
>
> Interviewee 14 (22 years old, female, student, Hanoi)

For a few numbers of Vietnamese urban residents, biodiversity is neither what the scientists define nor their counterparts in the southern region of Scania perceive. They think biodiversity represents *a stage of equilibrium*. That stage of equilibrium is expressed through the harmony and balance in their imagination of biodiversity.

> "*I think biodiversity has several matters. First, forest, mountain, nature, plants, sceneries, living environment have to be harmonious with the human's life […]*"

Interviewee 24 (62 years old, male, officer, Ho Chi Minh)

"*Biodiversity is a balance between species, in which species mutually negates each other. If the number of one species in the environment declines, the natural balance will be lost, so we must keep all animals and plants at a balance stage. Such balance will create harmony.*"

Interviewee 30 (38 years old, female, teacher, Ho Chi Minh)

While only a few respondents perceived biodiversity as *a stage of equilibrium*, most of them (34.21%) viewed biodiversity loss as *the loss of the stage of equilibrium*.

"*I've heard about biodiversity. For example, the human focuses on planting or nurturing certain species, so they exterminate other species, creating a natural imbalance.*"

Interviewee 30 (38 years old, female, teacher, Ho Chi Minh)

"*Biodiversity loss is the unbalance number of species in the nature and number of individuals in a population, causing the environmental disorder.*"

Interviewee 2 (21 years old, female, student, Hanoi)

When talking about biodiversity, the respondents connected their perceptions of biodiversity with five primary features: 1) *high diversity*, 2) *plentifulness*, 3) *cleanliness and refreshment*, 4) *naturalness*, and 5) *existence of unique objects/species*. The most usually mentioned feature (44.74%) is the genuine meaning of the term 'biodiversity': *high diversity*. Mace (2007) also found this dimension in their study about the biodiversity mental construct of individuals in a national park. A student in Hanoi related biodiversity with *high diversity* and *plentifulness* as follows:

> "*In my opinion, the term 'biodiversity' indicates the diversity, uniqueness, and plentifulness of plants and animals in the environment.*"
>
> Interviewee 10 (21 years old, female, student, Hanoi)

Interestingly, the respondents could report the features of biodiversity loss more frequently than biodiversity (see the percentage in Table 10.1). The five primary features attached to biodiversity loss were: 1) *extinction*, 2) *decline in number*, 3) *lack of diversity*, 4) *imbalance*, and 5) *adverse consequences*. The most common feature was not *lack of diversity* but *extinction* and *decline in number*.

> "*To what I knew, biodiversity loss is the extinction of some species due to the destruction that the human does to the natural environment. The*

destruction also results in the decline of species number. Currently, some species extinct, and some will be soon."

Interviewee 28 (34 years old, female, banker, Ho Chi Minh)

Table 10.1: Perceptions of urban residents on biodiversity and biodiversity loss concepts

	Biodiversity			**Biodiversity loss**		
	Category	**#**	**%**	**Category**	**#**	**%**
Perceptions	Goods in an ecosystem	13	34.21%	Loss of point of equilibrium	13	34.21%
	An ecosystem itself	12	31.58%	Loss of goods in an ecosystem	11	28.95%
	Stage of equilibrium	4	10.53%	Loss of stage of ecosystem	10	26.32%
Features	High diversity	17	44.74%	Extinction	16	42.11%
	Plentifulness	5	13.16%	Decline in number	11	28.95%
	Clean and refreshing context	3	7.89%	Lack of diversity	6	15.79%
	Naturalness	2	5.26%	Imbalance	6	15.79%
	Existence of unique objects/species	2	5.26%	Adverse consequences	5	13.16%

10.2. Biodiversity (loss) impacts

Table 10.2: Urban residents' perceived impacts of biodiversity and biodiversity loss on human

	Impacts on the human			Impacts on the self		
	Category	**#**	**%**	**Category**	**#**	**%**
Benefits	General impacts	29	76.32%	Resources	12	31.58%
	Resources	21	55.26%	General impacts	8	21.05%
	Health	14	36.84%	Health	7	18.42%
	Equilibrium	12	31.58%	Recreation	5	13.16%
	Recreation	9	23.68%	Equilibrium	1	2.63%

By asking the interviewees in two ways, we separated the perceived effect of biodiversity and biodiversity loss into two types: impact on humans in general and impact on the individual's self (see Table 10.2). In either type, the perceived effects could be classified into five categories: 1) *general impacts*, 2) *resources* (impacts associated with resource provision, such as food, medicines, products, etc.), 3) *health* (impact associated with human health, such as mental illness, well-being, animal attack, etc.), 4) *equilibrium* (impacts associated with perceived balance and harmony among human, other species, and the environment), and 5) *recreation* (impacts associated with recreational factors, such as nature-based tourism, natural scenery, etc.). The *general impacts* category refers to fresh air, natural disaster, biological life cycle, climate change, air pollution, water pollution, etc. Because these factors were hard to be differentiated and sometimes not scientifically inappropriate (e.g. natural disaster, pollutions, climate change), so we grouped them into one category and called them *general impacts*. Effects in this category were most frequently mentioned by the respondents (76.32%). The second most commonly perceived effect category was *resources*, encompassing food, medicine, agricultural products, etc.

"*I think biodiversity is very important. If we do not conserve animals and plants well, our next generation will not be able to know extinct species. […] Biodiversity loss has great impacts on the human's food and shelter due to floods, saltwater intrusion, and erosion. It also leads to air pollution, making residents less healthy.*"

Interviewee 24 (62 years old, male, officer, Ho Chi Minh)

"*Trees provide humans with oxygen; animals provide humans with food. They help humans develop. However, we, humans, are exploiting nature too much. […] For example, the extinction of species will make us lose the opportunity to watch their beauties, or we cannot eat extinct animals anymore.*"

Interviewee 19 (35 years old, female, seller, Ho Chi Minh)

Some residents knew that biodiversity and biodiversity loss had impacts on humans but could not describe what they were.

"*Biodiversity is very important because an environment with high biological diversity is better than an environment without biological diversity. […] If there is no biodiversity, the human's life will be affected, human development will not be natural.*"

Interviewee 20 (62 years old, male, officer, Ho Chi Minh)

We found that most respondents could report how biodiversity (loss) affects humanity (86.84%). In contrast, 36.84% of respondents said that they did not know or there was no impact on themselves at all. Some even said that they did not care about the impact of biodiversity or biodiversity loss on their daily life.

> "*I think biodiversity does not affect me. Because even animal or plant species are exterminated or destroyed, it will not directly affect my living place and my life, so I don't really care. […] Some effects might happen in the future, but there is nothing to worry now.*"
>
> Interviewee 2 (21 years old, female, student, Hanoi)

10.3. Human's reaction towards biodiversity (loss)

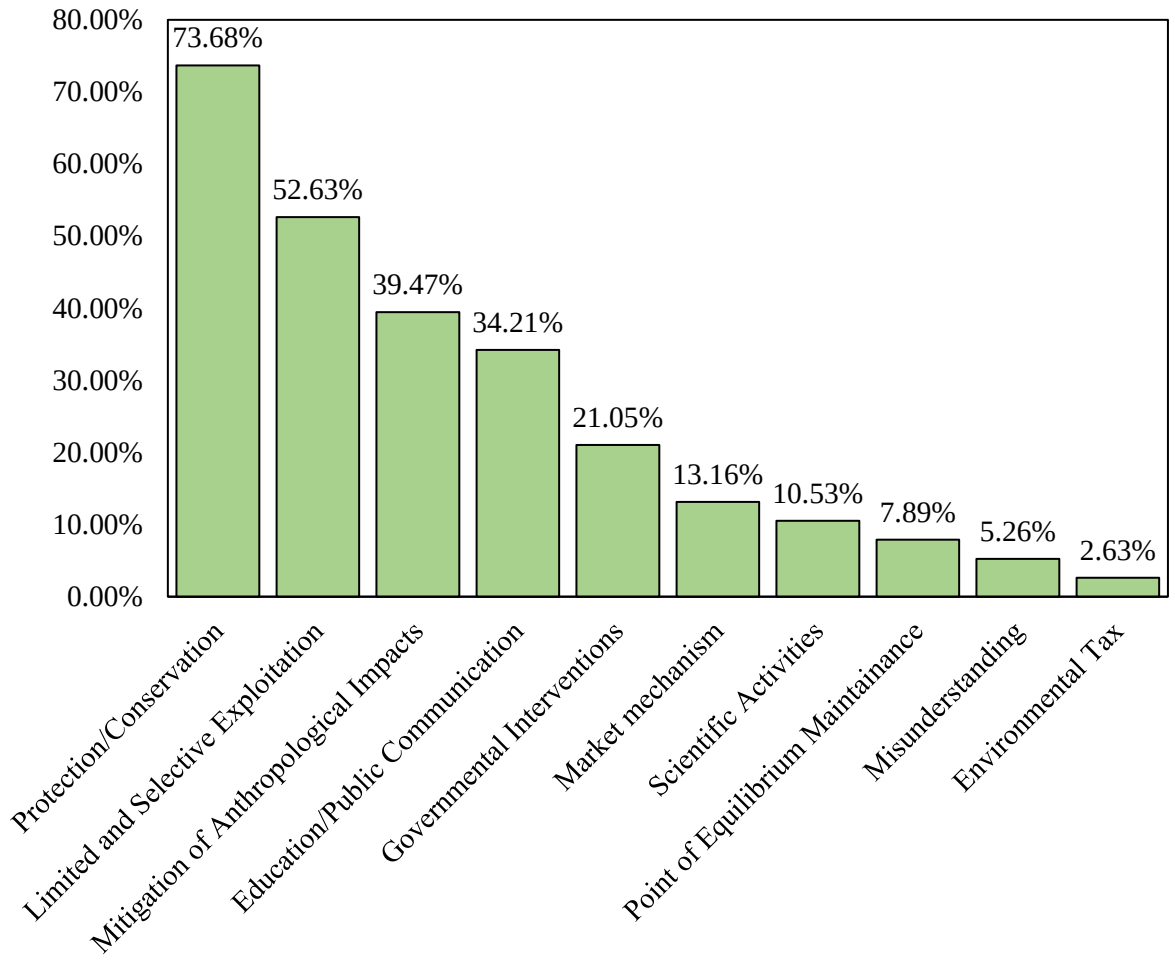

Figure 10.1: Urban residents' perceived measures of human to conserve biodiversity

This section reveals major categories of Vietnamese urban residents' perceived reaction to conserve biodiversity or halt biodiversity loss. We determined to combine both answers because the answers of how the interviewees and the human in general react were relatively mixed. Nine respondents (23.68%) reported that they did not know whether residents around them and they could contribute to the conservation of

biodiversity or prevention of biodiversity loss. Based on the analysis of the remaining responses, we categorized the reactions into ten different types following the descending order: 1) *protection/conservation*, 2) *limited and selective exploitation*, 3) *mitigation of anthropological impacts*, 4) *education/public communication*, 5) *governmental interventions*, 6) *market mechanism*, 7) *scientific activities*, 8) *point of equilibrium maintenance*, 9) *misunderstanding*, and 10) *environmental tax* (see Figure 10.1). Some example responses are displayed below:

> "*Protect the environment; stop illegal deforestation, stop wildlife trading, stop littering plastic bottle or objects that are made from incombustible materials.*"
>
> Interviewee 17 (18 years old, female, student, Ho Chi Minh)
>
> "*We need to have a plan if we want to change something related to nature. The Vietnamese government has to implement more stringent regulations. For example, some mandatory environment-related criteria have to be met before constructing a building. Most of the land fund is currently used for construction without green space. Ocean and forest are being overexploited, and there is no natural conservation […]. Everyone and I have to avoid using plastic products. […] Endangered species have to be protected and conserved. There is a lot of marketing about the benefit and uniqueness of rhino*

> *horn, but I think that we cannot die without using the rhino horn, deer antler, or bear gall. They cannot help me live longer either.*"
>
> Interviewee 13 (46 years old, female, businesswoman, Hanoi)

From the ten categories above, one significant finding emerges. The respondents were aware that biodiversity conservation and biodiversity loss prevention requires multi-stakeholders' participation: the public, the private sector, the academia, and the government. *Environmental tax* was also mentioned as a potential solution when the interviewee talked about policies and private sectors.

> "*First of all, the effort has to start from the residents's awareness, which can be changed quickly. If residents are getting more aware of protecting the forest, the environment, or even the surrounding living environment, they will be aware of protecting biodiversity. Besides residents's awareness, the government has to implement stricter policies and regulations. The scientists need to measure and evaluate the current situation of the environment for more appropriate exploitation, construction, and establishment of the special economic zone. Moreover, there needs to be a policy that requires residents to*

pay a certain amount of money for biodiversity conservation and improvement."

Interviewee 9 (24 years old, female, officer, Hanoi)

Sometimes, the respondents were over-optimistic about the role of genetic engineering in increasing biological diversity.

"*On the one hand, the human needs to limit the exploitation. On the other hand, the human needs to create more animal and plant species with a mutated gene for increasing the biological diversity.*"

Interviewee 26 (20 years old, male, student, Ho Chi Minh)

Chapter 11:

Associations between biodiversity loss perceptions and attitude towards illegal wildlife consumption prohibition and bushmeat consumption frequency

Chapter 11 examines the associations between biodiversity loss perceptions, attitude towards the prohibition of illegal wildlife consumption, and bushmeat consumption behaviors among urban residents in Vietnam. The investigation employed the Bayesian Mindsponge Framework (BMF) on 535 respondents from multiple urban areas across Vietnam. I found that people perceiving environmental degradation, losses of economic growth, nature-based recreation opportunities, health, and knowledge as consequences of biodiversity loss were more likely to support the prohibition of illegal wildlife consumption. Although urban residents tended to consume bushmeat less frequently if they perceived losses of economic growth and knowledge as consequences of biodiversity loss, the perception of environmental degradation had an opposite effect on the behavior. Additionally, people consuming bushmeat frequently and supporting the biodiversity loss preventive measure seemed to share similar features: high income and educational levels. These paradoxical results hint at the existence of cultural additivity effects on psychology and behavior among Vietnamese urban residents.

11.1. Variable description

In order to examine the associations between urban residents' perceptions about biodiversity loss, bushmeat consumption behaviors, and attitude towards the

prohibition of illegal wildlife consumption, we employed 11 variables in the Bayesian analysis (two outcome variables and nine predictor variables). *WildConsProhibi* is the outcome variable demonstrating the attitude towards the prohibition of illegal wildlife consumption, while *Bushmeat* is the outcome variable representing the bushmeat consumption frequency.

Nine predictor variables could be classified into two types: 1) demographic features and 2) perceptions about biodiversity loss's impacts (see Table 11.1). Variables of demographic features included *Sex, Education*, and *Income*. Initially, there were ten variables regarding the perceptions about biodiversity loss, but some of them were relatively similar, so we grouped them into five variables based on their characteristics to avoid multicollinearity and model redundancy. Specifically, perceived pollution and climate change as consequences of biodiversity loss were grouped into *EnvironmentalDegradation*, with 0.88 of Cronbach alpha; perceived loss of green space, natural aesthetics, and nature-based recreation were grouped into *NatureRecreationLoss*, with 0.85 of Cronbach alpha; perceived reduction of physical health, mental health, and life expectancy were grouped into *HealthLoss*, with 0.92 of Cronbach alpha. All the Cronbach alphas were higher than 0.8 and 0.9, suggesting that these groups had good and excellent internal reliabilities (Jones & Nguyen, 2021; Taber, 2018).

Table 11.1: Description of variables

Variable	Meaning	Type of variable	Value
WildConsProhibi	Whether the respondent supports the prohibition of illegal wildlife consumption is a preventive measure of biodiversity loss	Binary	Agree = 1 Disagree = 0
Bushmeat	Frequency of consuming bushmeat	Numerical	Never = 1 Sometimes = 2 Often = 3 Very often = 4
Sex	Biological sex	Binary	Male = 1 Female = 0
Education	Highest educational level	Numerical	Primary school = 1 Secondary school = 2 High school = 3 Undergraduate = 4 Post-graduate = 5
Income	Income level	Numerical	No income = 1 Less than 5 million VND = 2 5 – 10 million VND = 3 10 – 15 million VND = 4 15 – 20 million VND = 5 20 – 30 million VND = 6 More than 30 million VND = 7
EnvironmentalDegradation	Whether the respondent perceives environmental degradation (pollution and climate change) as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)
EconomicGrowthLoss	Whether the respondent perceives the loss of economic growth as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)
NatureRecreationLoss	Whether the respondent perceives the loss of nature-based recreation (loss of green space, natural aesthetics,	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)

	nature-based recreation) as a consequence of biodiversity loss		
HealthLoss	Whether the respondent perceives the loss of health (reduction of physical health, mental health, and life expectancy) as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)
KnowledgeLoss	Whether the respondent perceives the loss of knowledge as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)

11.2. Model construction based on BMF

To construct the models for statistical analyses, we employed the mindsponge mechanism to illustrate the information processing process related to biodiversity loss perceptions, attitude towards illegal wildlife consumption prohibition, and bushmeat consumption frequency. I started with the assumption that each individual has a mindset (or a set of core values) that influences the perceptions, attitudes, and behaviors through affecting the multi-filtering system of the mind. The multi-filtering system helps incorporate information that is compatible with the mindset and differentiate information that is distinct from the mindset for cost-benefit evaluation. The goal of the multi-filtering system is to maximize the perceived benefits and minimize the perceived cost of the individual. If the emerging information is deemed subjectively appropriate or beneficial, it will be allowed to approach or even enter the mindset. In contrast, the information will be ejected to minimize perceived cost if it contradicts the

mindset. However, the mindset can still be updated when the contradiction happens if the individual has an inductive attitude, but that attitude is not elaborated further due to irrelevance. When the information enters the mindset, it will influence the subsequent multi-filtering system, and thus the individual's perceptions, attitudes, and behaviors.

Based on the mindsponge's subjective cost-benefit judgement process of an individual, I postulated that individuals perceiving more negative impacts inflicted by biodiversity loss are more likely to accept the ideation of prohibiting illegal wildlife consumption and consume bushmeat less frequently. To clarify this postulation, I conceptualize the individual's judgement process in Figure 11.1. In Figure 11.1, the red nucleus represents the mindset, the blue pie in the middle represents the buffer zone (where the multi-filtering system kicks in to evaluate newly absorbed information from the environment), and the yellow pie represents the environment. In this study, I consider three main types of information: 1) information related to bushmeat consumption benefits (yellow particles), 2) information related to cost of biodiversity loss (blue particles), and 3) information endorsing prohibition of illegal wildlife consumption (green particles). Other types of information are illustrated as black particles.

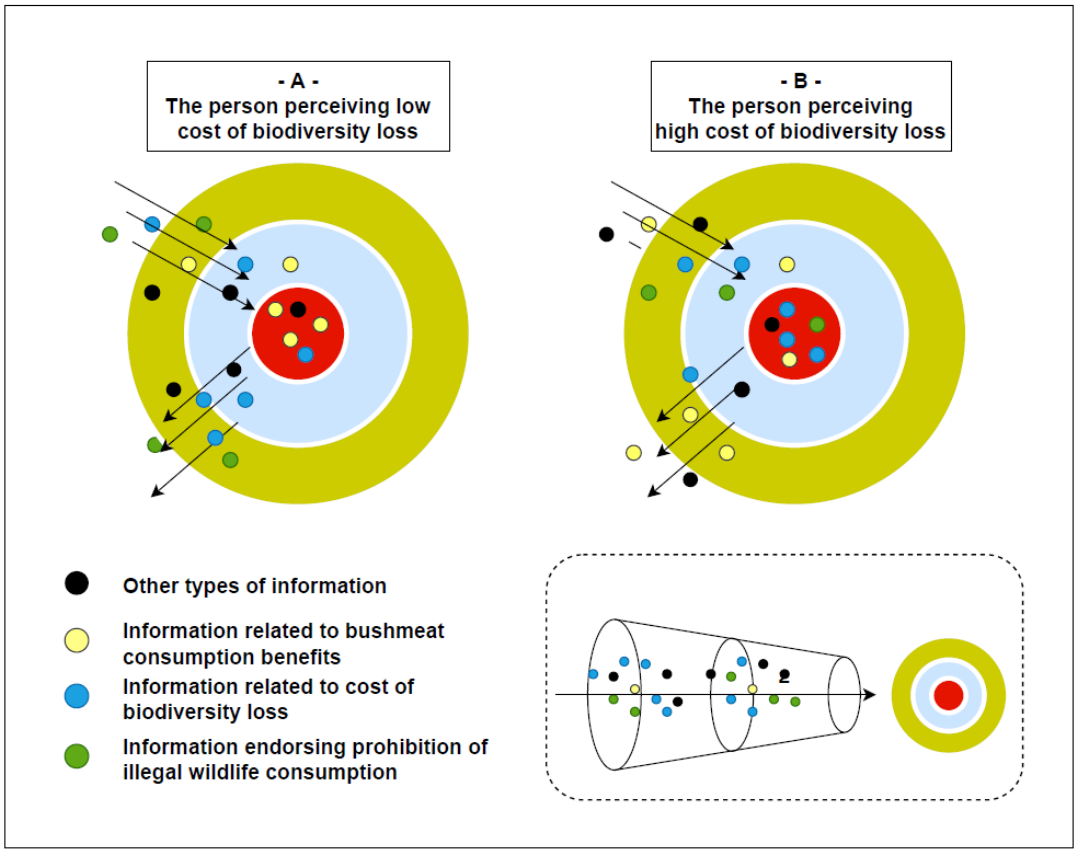

Figure 11.1: The information-based psychological process leading to the endorsement of illegal wildlife consumption prohibition and reduced bushmeat consumption frequency

In the conceptual diagram, I illustrate two primary scenarios.

- In scenario A, the person perceives the low cost of biodiversity loss. This perception is illustrated by the small number of blue particles (information related to the cost of biodiversity loss) located within the mindset. To elaborate, a person perceives the low cost of biodiversity loss when no or limited

information about the cost of biodiversity loss exists in his/her mindset. Even if the information exists in mind (within the buffer zone), it is deemed insignificant enough to influence the person's perception. Moreover, as little information related to the cost of biodiversity loss exists in the mindset, the person will be more likely to absorb information related to bushmeat consumption benefits (yellow particles) as he/she sees no or little cost of doing so. Although the information related to bushmeat consumption benefits and information related to the cost of biodiversity loss negate each other due to their conflicting nature, they can still coexist when the person finds both of them valuable. This situation can be explained by the cultural additivity concept.

- In scenario B, the person perceives the high cost of biodiversity loss. This perception is illustrated by the high number of blue particles (information related to the cost of biodiversity loss) located within the mindset. When this type of information is dominant in the mindset, it will greatly influence the subsequent multi-filtering system to negate information related to behaviors that can make the biodiversity loss worse (e.g., information related to bushmeat consumption benefits). When the number of information related to bushmeat consumption benefits decreases, it will subsequently mitigate the bushmeat consumption frequency. Moreover, when knowing that biodiversity loss is costly, the person will be more likely to absorb information that can help curb biodiversity loss. Such information includes the information endorsing the prohibition of illegal wildlife consumption. As a result, the green particle can

be seen in the mindset of the person perceiving the high cost of biodiversity loss. Similar to scenario A, the information related to bushmeat consumption benefits and information related to the cost of biodiversity loss can coexist in the mindset.

To sum up, the bushmeat consumption frequency and the endorsement of illegal wildlife consumption prohibition are conditional on the existence of information related to the cost of biodiversity loss in the mindset. The perceived costs of biodiversity loss among urban residents can be proxied by *EnvironmentalDegradation*, *EconomicGrowthLoss*, *NatureRecreationLoss*, *HealthLoss*, and *KnowledgeLoss* variables. Suppose a respondent has stronger agreement toward a given consequences of biodiversity loss. In that case, it can be deemed that there is more information related to the cost of biodiversity loss located in the mindset. As a result, the following models are constructed:

$$WildConsProhibi \sim Sex + Education + Income + EnvironmentalDegration + EconomicGrowthLoss + NatureRecreationLoss + HealthLoss + KnowledgeLoss \quad \textbf{(11.1)}$$

$$Bushmeat \sim Sex + Education + Income + EnvironmentalDegration$$

$$+EconomicGrowthLoss + NatureRecreationLoss$$

$$+HealthLoss + KnowledgeLoss \quad \textbf{(11.2)}$$

Besides the perceptions of biodiversity loss's impacts, demographic factors were also added to the two models for identifying urban people groups that are more likely to support the prohibition of illegal wildlife consumption and consume bushmeat more frequently. Moreover, adding demographic factors into the models also help validate the current study's results with formerly published studies' results (Drury, 2009, 2011). These insights would be valuable for policymaking recommendations. As a result, Models 1 and 2 are presented as follows:

11.3. Bayesian analysis results

Overall, female respondents constituted more than half of the samples (57.08%). The mean age reported was around 33-year-old, and their average income was approximately 13,700,000 VND per month. 95.51% of the respondents agreed with the prohibition of illegal wildlife consumption. Regarding bushmeat consumption frequency, most urban residents reported having never consumed bushmeat (64.49%), while only 0.37% consumed bushmeat often and very often.

11.3.1. Model 1: Effects of biodiversity loss perceptions on the attitude towards prohibition of illegal wildlife consumption

In this subsection, we present the simulated results of Model 1, which was constructed to explore how urban residents' perceptions about biodiversity loss and demographic features predict their attitude towards the prohibition of illegal wildlife consumption. Model 1's logical network is shown in Figure 11.2.

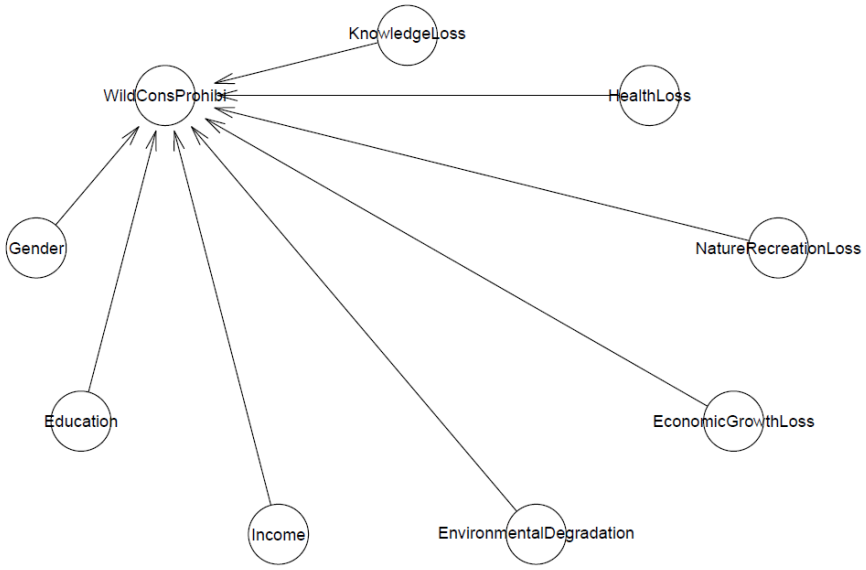

Figure 11.2: Model 1's logical network

According to the PSIS-LOO test, Model 1's goodness-of-fit can be considered 'good' as all its *k*-values are located below the threshold of 0.5 (see Figure 11.3).

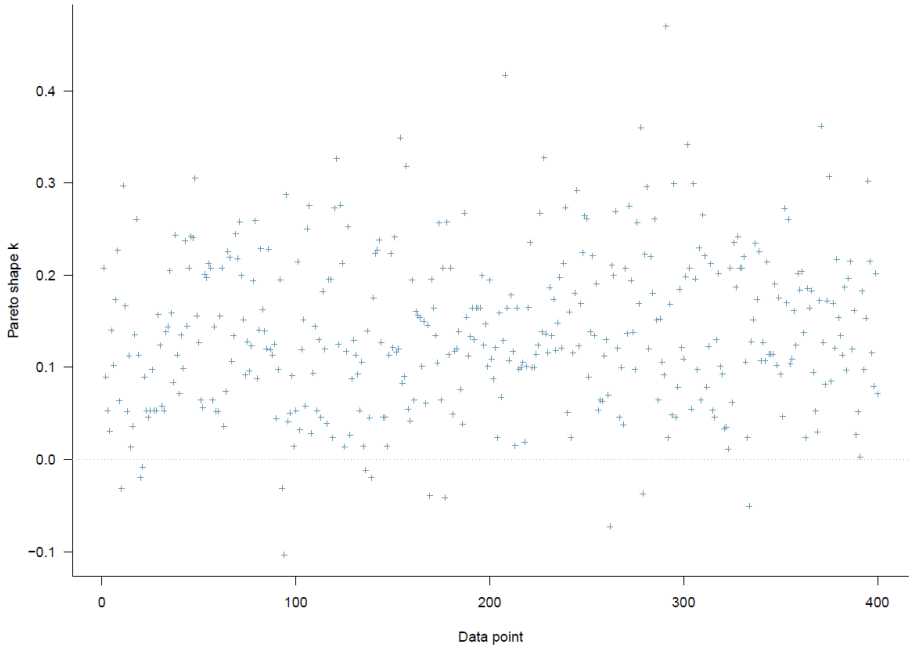

Figure 11.3: PSIS diagnostic plot of Model 1 with informative prior being normal distribution (1, 0.5)

Then, we checked whether the Markov chain central limit theorem is held after fitting Model 1. The n_eff and Rhat statistics of Model 1 indicate good signals of convergence, regardless of informative priors. In particular, all n_eff statistics are larger than 1,000, and all Rhat statistics are equal to 1 (see Table 11.2). Visually, the trace plots shown in Figure 11.4 demonstrate good convergence of Markov chains, or "healthy" stochastic simulation processes, which are stationary and centralized. In the Gelman plots in Figure S1, the shrink factors drop rapidly to 1 before the warmup period ends (before the 2,000th iteration). At the same time, the parameters' autocorrelation levels in Figure S2 decline swiftly to 0 after a certain number of lags (well below 5). These signals are

also firm evidence that the Markov chain central limit theorem is held when fitting Model 1.

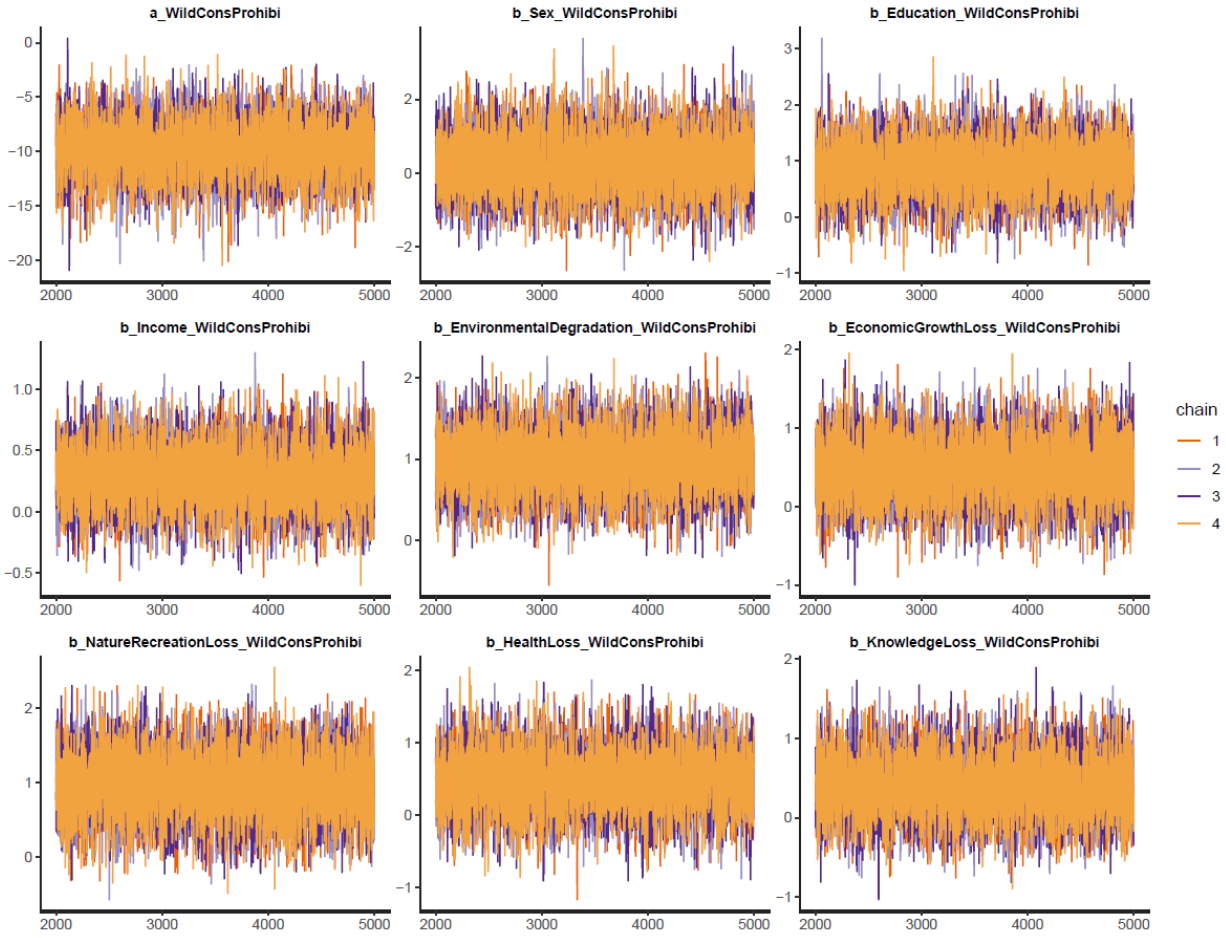

Figure 11.4: Model 1's trace plots with informative prior being normal distribution (1, 0.5)

When fitting Model 1 using informative priors implying our belief on the effects of biodiversity loss perceptions on the attitude towards the prohibition of illegal wildlife consumption, we find that all five perceptions are positively associated with the

attitude. In other words, urban residents who think that biodiversity loss causes environmental degradation, loss of economic growth, loss of nature-based recreation opportunities, loss of health, and loss of knowledge are more likely to agree with the measure prohibiting illegal wildlife consumption (see Table 11.2). Among five perceived adverse impacts, *EnvironmentalDegradation* ($\mu_{EnvironmentalDegradation}$ = 0.96 and $\sigma_{EnvironmentalDegradation}$ = 0.36) and *NatureRecreationLoss* ($\mu_{NatureRecreationLoss}$ = 0.96 and $\sigma_{NatureRecreationLoss}$ = 0.42) are two perceptions that have the greatest effect on the urban residents' attitude.

The simulated results using informative priors implying our disbelief, all five biodiversity loss perceptions still exhibit positive impacts on the biodiversity prevention attitude, so Model 1's results can be deemed robust. However, some effects are less reliable. Specifically, most of the probability distributions of parameters about biodiversity loss perceptions in Figure 11.5-A are located mostly on the right side of the red vertical line (at 0), indicating reliable positive effects. However, although most of the probability distributions of *EconomicGrowth* and *HealthLoss* lie on the right, they still have some probabilities of negatively affecting the biodiversity prevention attitude (see Figure 11.5-B).

Regarding the demographic factors, it is found that the highest level of education ($\mu_{Education}$ = 0.88 and $\sigma_{Education}$ = 0.47) and level of income ($\mu_{Education}$ = 0.28 and $\sigma_{Education}$ = 0.24) are both positively associated with the prevention attitude, but there is no clear impact of respondent's sex on the attitude (μ_{Sex} = 0.26 and σ_{Sex} = 0.77).

The effect of *Income* is relatively reliable as a certain part of its probability distribution is still located on the negative side in Figure 11.5-B (left side of the red vertical line). In contrast, most of *Education*'s probability lies on the positive side, regardless of informative priors, suggesting the high reliability of the association.

Table 11.2: Model 1's simulated posterior results

Parameters	**Informative priors (belief on effect)**				**Informative priors (disbelief on effect)**			
	Mean	**SD**	**n_eff**	**Rhat**	**Mean**	**SD**	**n_eff**	**Rhat**
Constant	-9.77	2.48	7461	1	-6.92	2.14	7465	1
EnvironmentalDegradation	0.96	0.36	10152	1	0.79	0.34	10021	1
EconomicGrowthLoss	0.48	0.38	10264	1	0.25	0.36	10612	1
NatureRecreationLoss	0.96	0.42	10132	1	0.79	0.41	10622	1
HealthLoss	0.47	0.40	10842	1	0.26	0.39	11785	1
KnowledgeLoss	0.40	0.37	10963	1	0.33	0.35	10732	1
Gender	0.26	0.77	10457	1	0.29	0.68	12622	1
Education	0.88	0.47	8978	1	0.72	0.42	8112	1
Income	0.28	0.24	9987	1	0.19	0.22	10531	1

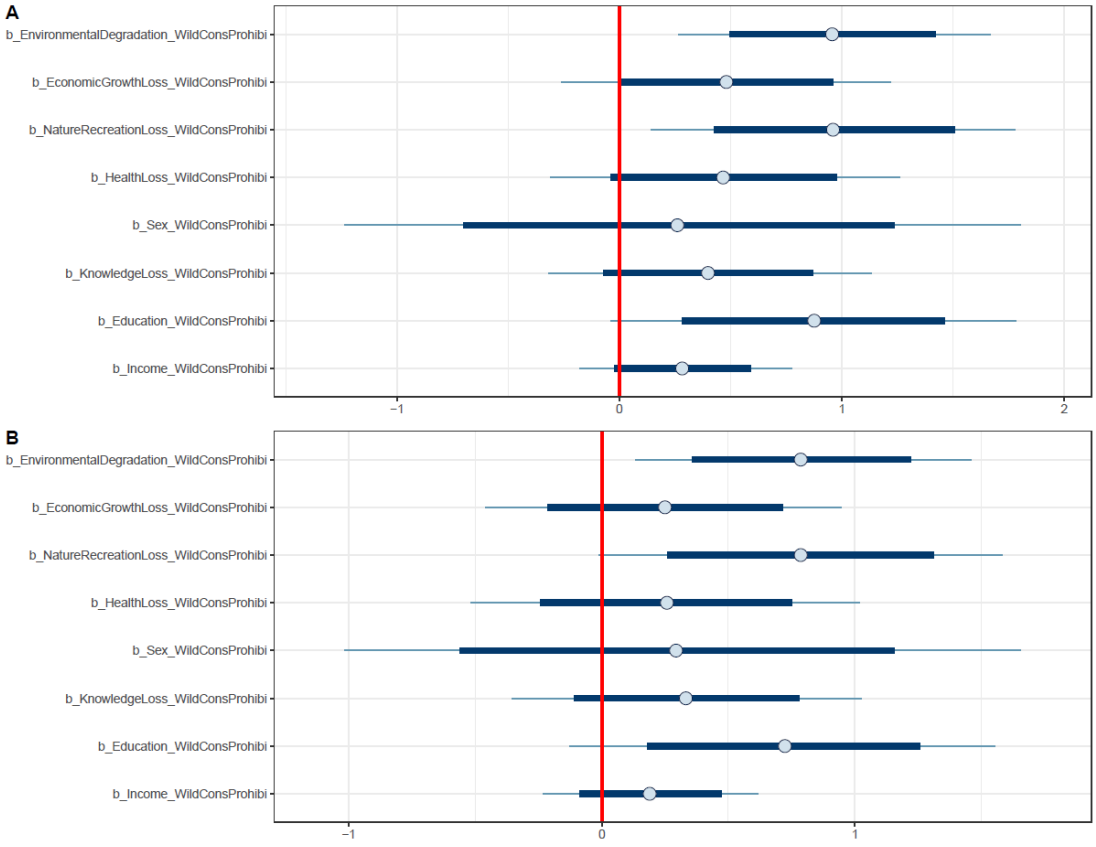

Figure 11.5: Model 1's interval plots of parameters' probability distributions. **A** – with informative prior being normal distribution (1, 0.5), **B** – with informative prior being normal distribution (0, 0.5)

11.3.2. Model 2: Effects of biodiversity loss perceptions on bushmeat consumption frequency

In the second model, we aim to investigate how urban residents' perceptions about biodiversity loss impacts and demographic features predict their bushmeat consumption behaviors. The logical network of Model 2 is illustrated in Figure 11.6.

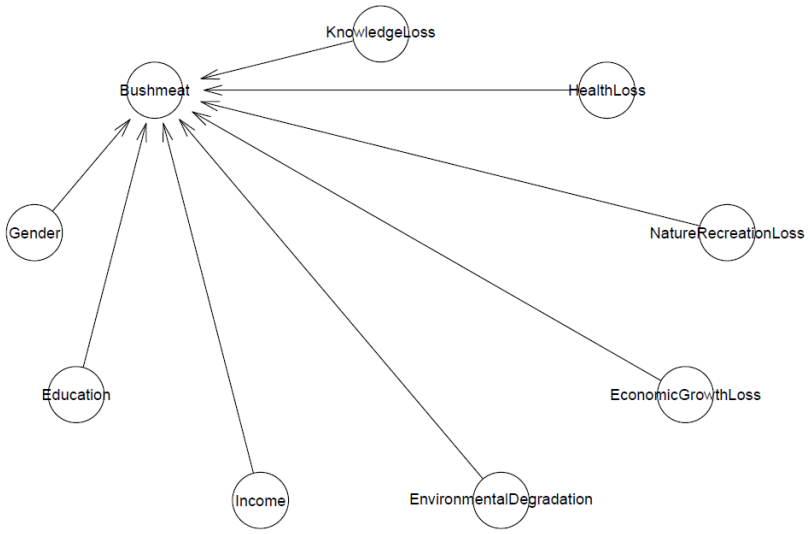

Figure 11.6: Model 2's logical network

Model 2's goodness-of-fit with the data is generally good because *k*-values are well below the 0.5 threshold (see Figure 11.7).

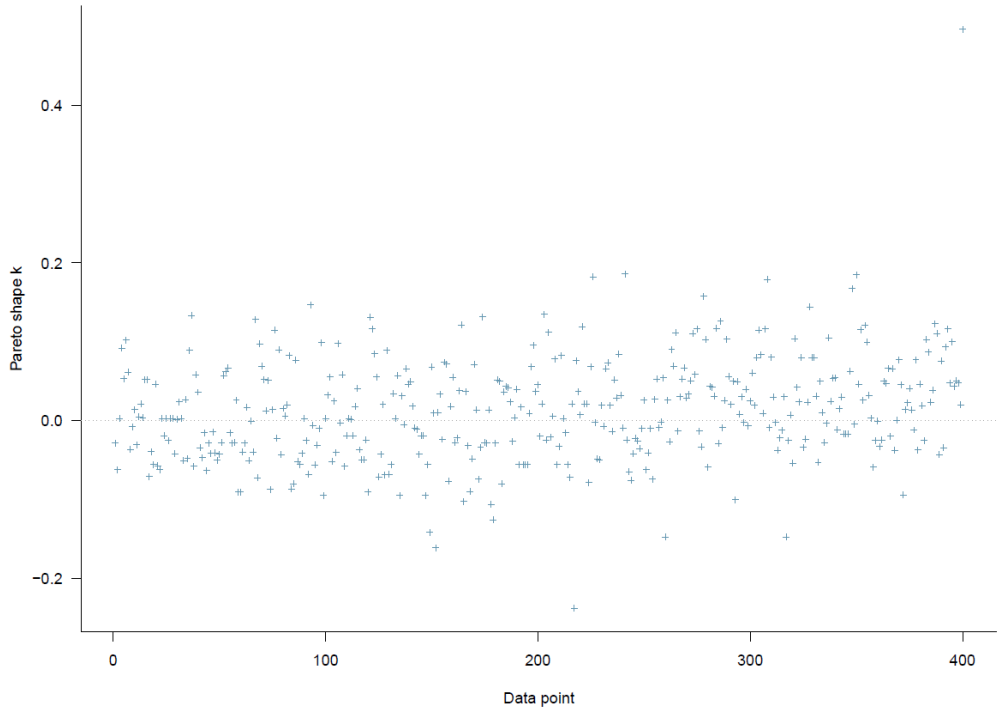

Figure 11.7: PSIS diagnostic plot of Model 2 with informative prior being normal distribution (-1, 0.5)

The Markov chain convergence in Model 2 can be examined using the effective sample size and Gelman factor displayed in Table 11.3. As can be observed that in both simulations using informative priors implying belief or disbelief in the effect, all the n_eff statistics are beyond 1,000, while all Rhat statistics are equal to 1. These statistics hint at the good convergence of Markov chains during the stochastic simulation process. The healthy convergence of Markov chains is clearly visualized using trace plots in Figure 11.8. The rapid decline of shrink factors and autocorrelation levels in Figure S3 and S4, respectively, also validate that the Markov central limit theorem is held in Model 2.

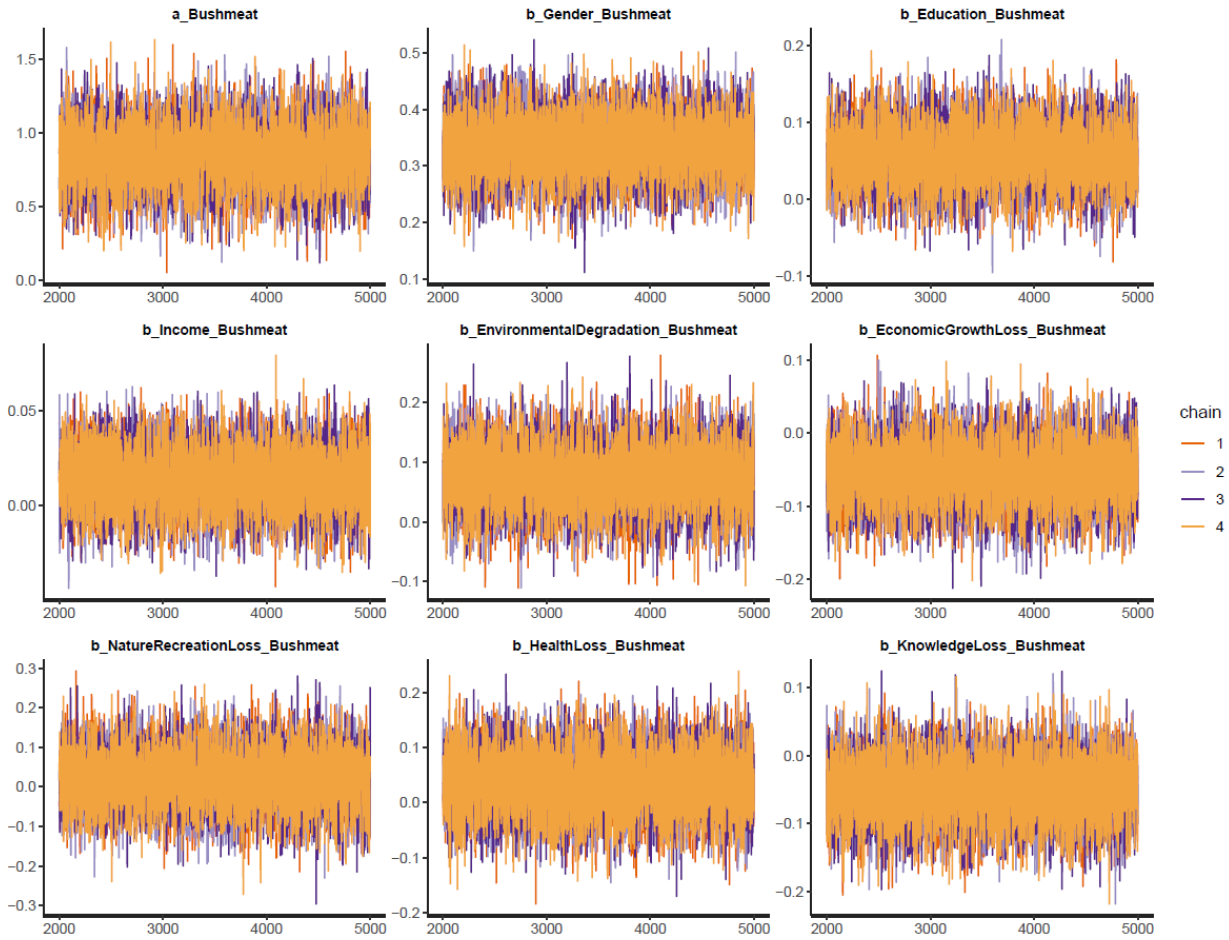

Figure 11.8: Model 2's trace plots with informative prior being normal distribution (-1, 0.5)

The simulated results using informative priors being normal distribution (-1, 0.5) show that among five biodiversity loss perceptions, two perceptions ($\mu_{EconomicGrowth}$ = -0.06 and $\sigma_{EconomicGrowth}$ = 0.04; $\mu_{KnowledgeLoss}$ = -0.05 and $\sigma_{KnowledgeLoss}$ = 0.04) exhibit negative associations with the bushmeat consumption frequency as we postulated, whereas one perception ($\mu_{EnvironmentalDegradation}$ = 0.07 and

$\sigma_{EnvironmentalDegradation}$ = 0.05) exhibits a positive association, and the remaining two have ambiguous tendencies ($\mu_{HealthLoss}$ = 0.03 and $\sigma_{HealthLoss}$ = 0.05; $\mu_{NatureRecreationLoss}$ = 0.02 and $\sigma_{NatureRecreationLoss}$ = 0.07) (see Table 11.3). The negative effects of *EconomicGrowthLoss* and *KnowledgeLoss* as well as the positive effect of *EnvironmentalDegradation* on urban residents' bushmeat consumption frequency are highly reliable since most of their probability distributions are located on one side of the x-axis: left side for *EconomicGrowthLoss* and *KnowledgeLoss* and right side for *EnvironmentalDegradation* (see Figure 11.9-A).

Table 11.3: Model 2's simulated posterior results

Parameters	Informative priors (belief on effect)				Informative priors (disbelief on effect)			
	Mean	**SD**	**n_eff**	**Rhat**	**Mean**	**SD**	**n_eff**	**Rhat**
Constant	0.87	0.21	7956	1	0.84	0.21	7121	1
EnvironmentalDegradation	0.07	0.05	10956	1	0.07	0.05	9221	1
EconomicGrowthLoss	-0.06	0.04	10633	1	-0.05	0.04	10612	1
NatureRecreationLoss	0.02	0.07	8421	1	0.02	0.07	8132	1
HealthLoss	0.03	0.05	10653	1	0.03	0.05	9785	1
KnowledgeLoss	-0.05	0.04	11511	1	-0.05	0.04	9732	1
Sex	0.33	0.05	12062	1	0.33	0.05	10622	1
Education	0.06	0.04	7541	1	0.06	0.04	7112	1
Income	0.01	0.02	10362	1	0.01	0.02	9531	1

Probability distributions *Sex* and *Education* demonstrate reliable positive association with the consumption behavior (μ_{Sex} = 0.33 and σ_{Sex} = 0.05; $\mu_{Education}$ = 0.06 and $\sigma_{Education}$ = 0.04). Specifically, male urban residents consume bushmeat more frequently than female ones; urban residents' educational level also predicts their more frequent consumption of bushmeat. People with high income are also found to consume

bushmeat more frequently, but the prediction only has weak reliability because of its high standard deviation (μ_{Sex} = 0.01 and σ_{Sex} = 0.02).

These results remain almost similar when fitting Model 2 using informative priors being normal distribution (0, 0.5) (see Figures 11.9-A and 11.9-B), so Model 2's findings can be deemed robust.

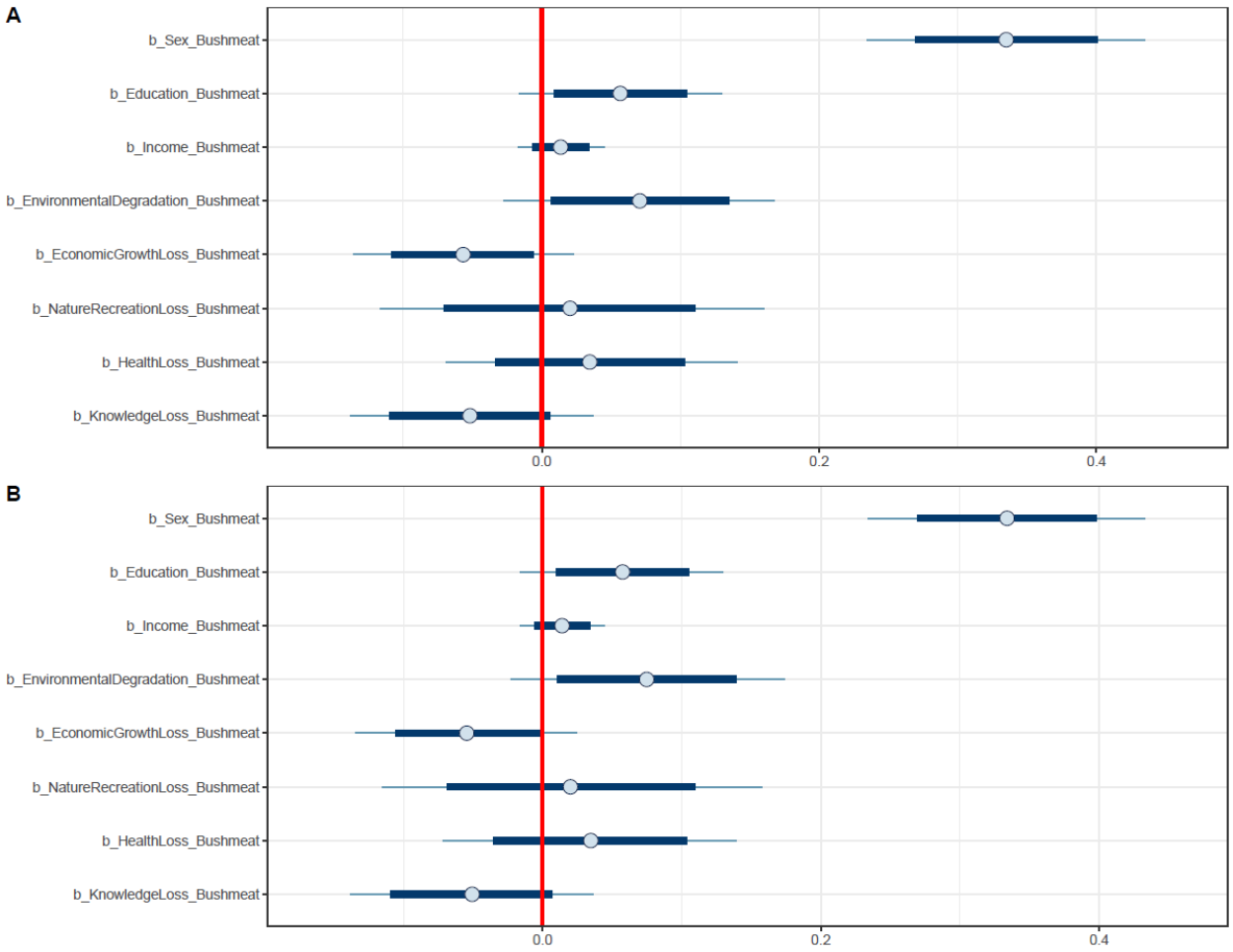

Figure 11.9: Model 2's interval plots of parameters' probability distributions. **A** – with informative prior being norm (-1, 0.5), **B** – with informative prior being normal distribution (0, 0.5)

Chapter 12:

Associations between biodiversity loss perceptions and attitude towards conservation in protected areas and willingness to pay

This chapter presents analyzed results regarding the associations between biodiversity loss perceptions, conservation endorsement attitude, and willingness to pay using the Bayesian Mindsponge Framework (BMF). I found that perceived environmental degradation, loss of economic growth, loss of nature-based recreation opportunity, and loss of knowledge as consequences of biodiversity loss has indirect effects on paying willingness through the mediation of the attitude towards conservation. Especially, the perceived knowledge loss also has a direct positive influence on the willingness to pay for the entrance fee and conservation. In contrast, perceived loss of health is negatively associated with the attitude towards conservation.

12.1. Variable description

In this study, we employed eight variables that can be categorized into three main groups. The first group includes five variables demonstrating how urban people perceive the consequences of biodiversity loss in five aspects: 1) environmental degradation, 2) loss of economic growth, 3) loss of nature-based recreation opportunities, 4) loss of health, and 5) loss of knowledge. These five variables were generated from ten variables in the dataset. Some variables are relatively similar, so we grouped them into one variable and took the average value. Specifically, perceived pollution and climate change as consequences of biodiversity loss were grouped into

EnvironmentalDegradation, with 0.88 of Cronbach alpha; perceived loss of green space, natural aesthetics, and nature-based recreation were grouped into *NatureRecreationLoss*, with 0.85 of Cronbach alpha; perceived reduction of physical health, mental health, and life expectancy were grouped into *HealthLoss*, with 0.92 of Cronbach alpha; *EconomicGrowthLoss* and *KnowledgeLoss* remained the same (see Table 12.1).

Table 12.1: Variable description

Variable	Meaning	Type of variable	Value
EnvironmentalDegradation	Whether the respondent perceives environmental degradation (pollution and climate change) as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)
EconomicGrowthLoss	Whether the respondent perceives the loss of economic growth as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)
NatureRecreationLoss	Whether the respondent perceives the loss of naturebased recreation (loss of green space, natural aesthetics, naturebased recreation) as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)
HealthLoss	Whether the respondent perceives the loss of health (reduction of physical health, mental health, and life expectancy) as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)
KnowledgeLoss	Whether the respondent perceives the loss of knowledge as a consequence of biodiversity loss	Numerical	Ranging from 1 (strongly disagree) to 4 (strongly agree)

Conservation	Whether the respondent supports conservation as a preventive measure of biodiversity loss	Binary	Agree = 1 Disagree = 0
WillingEntranceFee	Whether the respondent is willing to pay for the entrance fee when visiting protected areas	Binary	Agree = 1 Disagree = 0
WillingDonation	Whether the respondent is willing to pay for the entrance fee when visiting protected areas	Binary	Agree = 1 Disagree = 0

The second group only has one variable that indicates the respondents' attitude towards conservation as a preventive measure of biodiversity loss. The last group consists of two variables implying the willingness to pay for entrance fee and willingness to donate for conservation if the respondents have a chance to visit protected areas.

In this study, models were initially constructed based on the Mindsponge information processing mechanism to examine how perceptions towards biodiversity loss may affect the willingness to pay for the entrance fee and conservation through the support of conservation as a preventive measure (Vuong, Nguyen, et al., 2022a).

According to the Mindsponge mechanism, an individual has a mindset, or a set of core values, that influences thinking, attitudes, and behaviors. For information to enter the mindset, it has to pass through the multi-filtering system. The filtering system consists of two major components: 1) cost-benefit judgements and 2) trust evaluation. These two components determine whether to accept, reject, or keep the information in the buffer zone for later use or assessment. Both the cost-benefit judgements and trust evaluation are operated based on the preferences of the mindset and perceived information from the environment (Nguyen, La, et al., 2022a). In this study, we only

consider how information in the mindset affects the information process and assume that the ultimate goal of the person's psychological process is to maximize their perceived benefits and minimize perceived cost.

12.2. Model construction based on BMF

It is assumed that a person is willing to pay for entrance fee and donation when the information willing to pay for such purposes could enter their mindset to influence the respondent's answer. Grounded on the cost-benefit judgements of the mechanism, there has to be a condition for the information appearing in the mindset: paying for entrance fee and donation is subjectively perceived as beneficial by the person. Entrance fee and donation payments are usually associated with conservation efforts, so it is expected that the existence of information endorsing conservation in the mindset will attach more beneficial values to the act of paying for entrance fee and donation, which subsequently leads to a higher probability of being willing to pay.

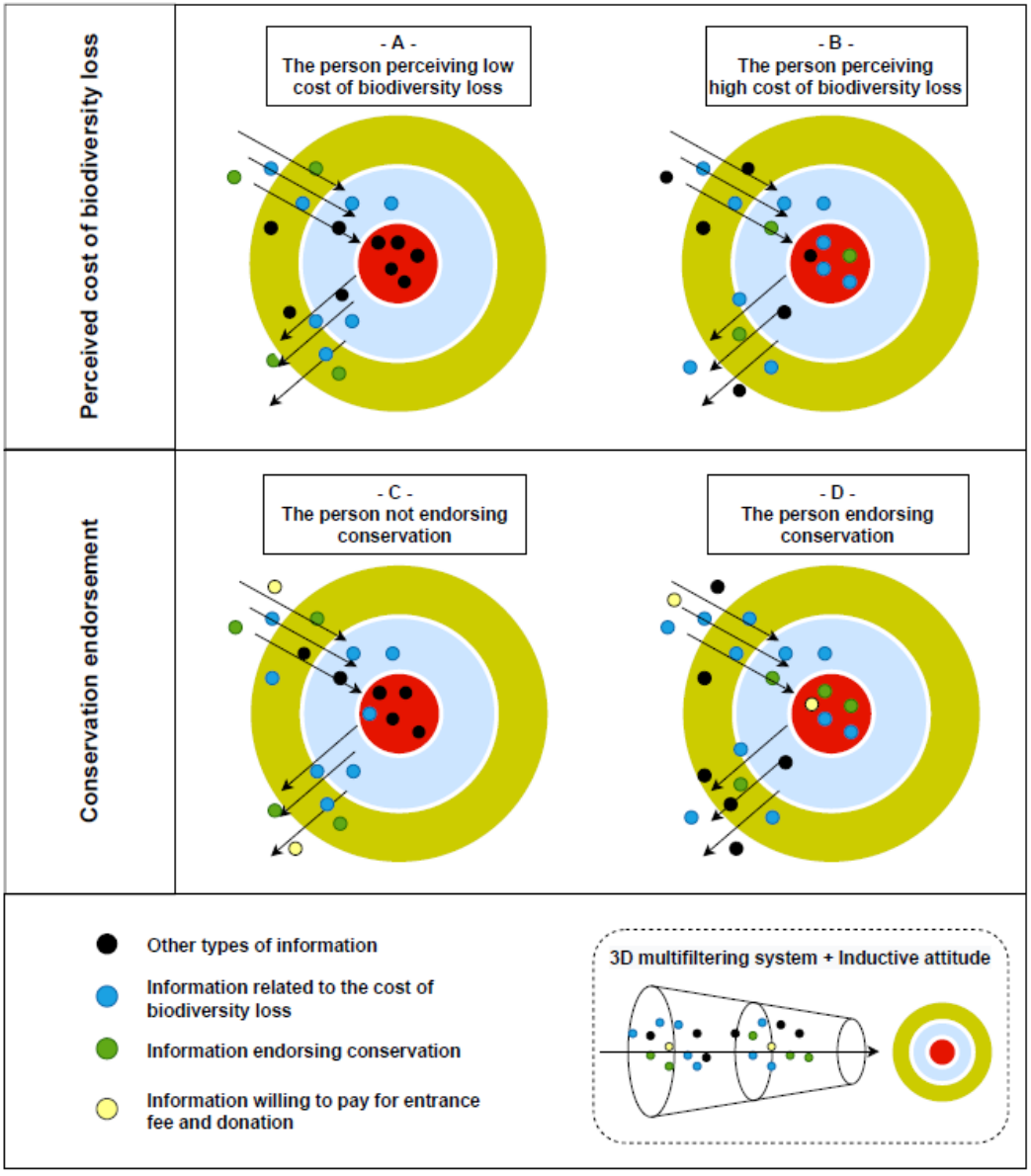

Figure 12.1: The information-based psychological process leading to conservation endorsement and willingness to pay

Applying the same reasoning approach can also explain how the conservation endorsement ideation emerges in the mindset. Objectively, biodiversity loss can result

in multiple negative consequences, such as environmental problems, economic growth loss, health loss, loss of nature-based creation opportunity, loss of knowledge, etc. However, a person will be not likely to obtain the ideation endorsing conservation if their mind is not aware of biodiversity loss's adverse consequences. In other words, a person needs to subjectively perceive the adverse effects of biodiversity loss to accept information associated with preventive measures (here is conservation) to enter their mindset. Visual elaborations of the information processes are shown in Figure 12.1. There are four scenarios:

- In scenario A, there is a low amount of information related to the cost of biodiversity loss in the mindset, so the perceived cost of biodiversity loss is insignificant, making the person more likely to eject information related to biodiversity loss preventive measures.
- In scenario B, there is a high amount of information related to the cost of biodiversity loss in the mindset, so the perceived cost of biodiversity loss is significant, making the person more likely to consciously or subconsciously seek and accept information related to biodiversity loss preventive measure to enter the mindset. As conservation is a typical preventive measure and often suggested as an important preventive measure, the information endorsing conservation is more likely to be accepted to enter the mindset.
- In scenario C, although the person, to some degree, perceives the cost of biodiversity loss, the amount of information related to the cost of biodiversity

loss in the mindset is insufficient to influence the information-seeking behaviors or the filtering process to allow conservation endorsement information to enter the mindset. Another reason is that such a person is not accessible to information indicating the value of conservation towards biodiversity loss. Without the information endorsing conservation in the mindset, the ideation of paying for entrance fees and donation is less likely to emerge in the mindset and lead to the willingness to pay.

- In scenario D, when ideation of support for conservation emerges in the mindset, it would subsequently affect the filtering system and accept information involved with conservation to enter mindset. Among conservation-related methods, paying for the entrance fee and donating for biodiversity conservation in protected areas might be perceived as two common ways to support conservation. Thus, the information of paying for entrance fees and donation is more likely to be absorbed into the mindset.

From these scenarios, the associations between biodiversity loss perceptions and support for conservation are expected to be positive, and urban residents' awareness of biodiversity loss's adverse impacts might positively affect their willingness to pay for entrance fee and conservation through improving support for conservation measures.

To check our assumptions, we construct the following models. Model 1 examines the associations between perceived consequences of biodiversity loss and support for conservation as a preventive measure among urban residents. Models 2a and 2b

estimate influences of the participants' support for conservation on their willingness to pay for the entrance fee and conservation, respectively. Finally, Model 3a and 3b are constructed to check whether the relationships between biodiversity loss perceptions and willingness to pay are also direct associations or only indirect through the pathway of support for conservation. If the direct associations are not confirmed, our assumptions using an information processing mechanism to explain the phenomena can be deemed trustworthy.

$$Conservation \sim EnvironmentalDegradation + EconomicGrowthLoss + NatureRecreationLoss + HealthLoss + KnowledgeLoss \quad \textbf{(12.1)}$$

$$WillingEntranceFee \sim Conservation \quad \textbf{(12.2a)}$$

$$WillingDonation \sim Conservation \quad \textbf{(12.2b)}$$

$$WillingEntranceFee \sim Conservation + EnvironmentalDegradation + EconomicGrowthLoss + NatureRecreationLoss + HealthLoss + KnowledgeLoss \quad \textbf{(12.3a)}$$

$$WillingDonation \sim Conservation + EnvironmentalDegradation$$

$$+ EconomicGrowthLoss + NatureRecreationLoss$$

$$+ HealthLoss + KnowledgeLoss \quad \textbf{(12.3b)}$$

12.2. Bayesian analysis results

12.2.1. Model 1: Effects of biodiversity loss perceptions on conservation-related attitude

Model 1 was estimated to examine the associations between biodiversity loss perceptions and conservation-related attitude among urban residents. Five predictor variables used in the model correspond with five different perceptions on the consequences of biodiversity loss: environmental degradation, loss of economic growth, loss of nature-based recreation opportunity, loss of health, and loss of knowledge. PSIS-LOO test was initially performed to check whether Model 1 had a good fit with the collected data. All the *k*-values in Figure 12.2 are below the 0.5 thresholds, so the model can be considered fit with the data.

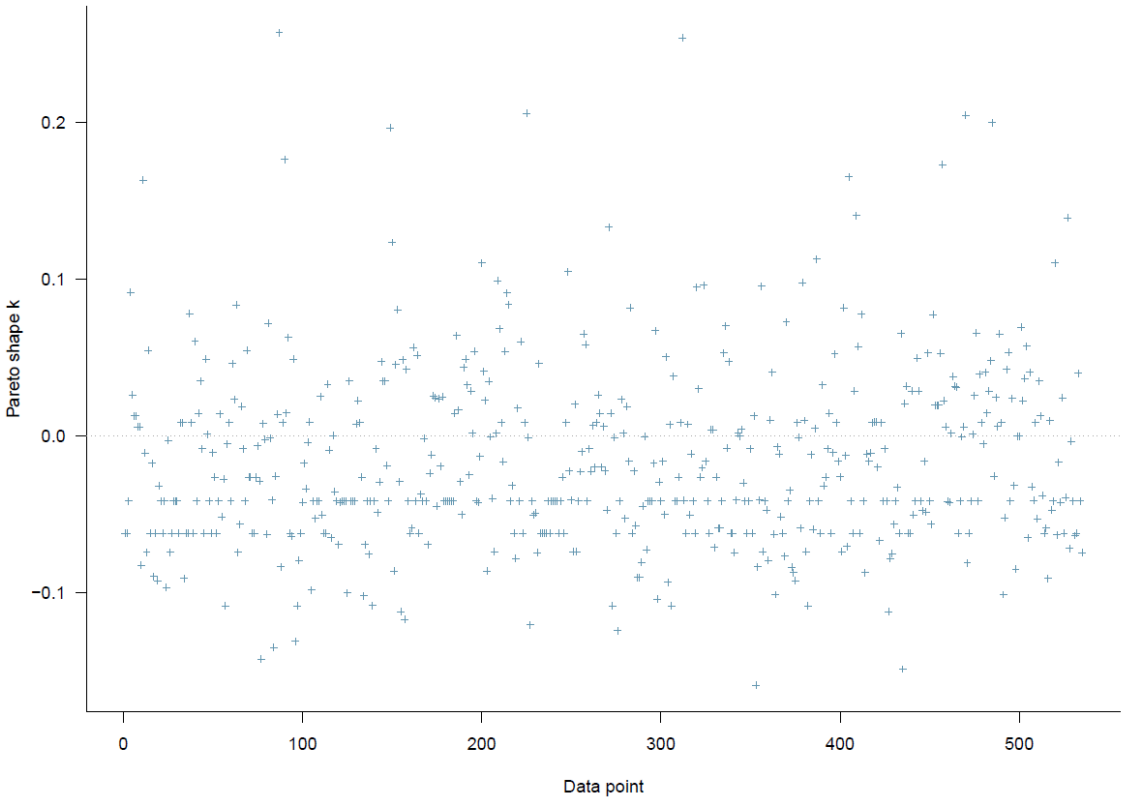

Figure 12.2: Model 1's PSIS-LOO diagnosis with priors as norm (1,0.5)

Next, it is necessary to verify the convergence of the model using two diagnostic values: effective sample size (n_eff) and Gelman shrink factor (Rhat). The n_eff value indicates the number of iterative samples that are not autocorrelated during the stochastic simulation process. Generally, it is accepted that if the n_eff value is greater than 1000, the Markov chains are convergent, and the effective samples are enough for accurate inference. In terms of the Rhat value, if the value is above 1, it implies that the chains have not converged, so inference should not be made with the current iterative samples. On the contrary, if the value is equal to 1, it is a good convergence

signal. As the parameters' n_eff values are all larger than 9000 and Rhat values are equal to 1, Model 1 seems to have good convergence, even when priors used are different (Table 2).

Table 12.2: Model 1's simulated posterior results

Parameters	Informative priors (belief on effect)				Informative priors (disbelief on effect)			
	Mean	**SD**	**n_eff**	**Rhat**	**Mean**	**SD**	**n_eff**	**Rhat**
Constant	1.20	0.14	12522	1	1.22	0.14	12512	1
EnvironmentalDegradation	0.35	0.05	10215	1	0.35	0.05	12151	1
EconomicGrowthLoss	0.05	0.04	11215	1	0.05	0.04	11512	1
NatureRecreationLoss	0.18	0.07	9212	1	0.18	0.07	10215	1
HealthLoss	-0.05	0.05	11215	1	-0.05	0.05	12562	1
KnowledgeLoss	0.13	0.04	12841	1	0.13	0.04	12354	1

The convergence is validated again using the trace, Gelman, and autocorrelation plots. Figure 12.3 demonstrates the trace plots of Model 1, which indicate that the Markov chains are all convergent. Two signals can be used to diagnose convergence. First, the Markov chains are good mixing, illustrated by the rapid zig-zag motion of each line. Second, the Markov chains are stationary, or the chains only stay within the posterior distribution. In Figure 12.3, all iterations before the 2000^{th} order are removed since warmup iterations are not used for inference.

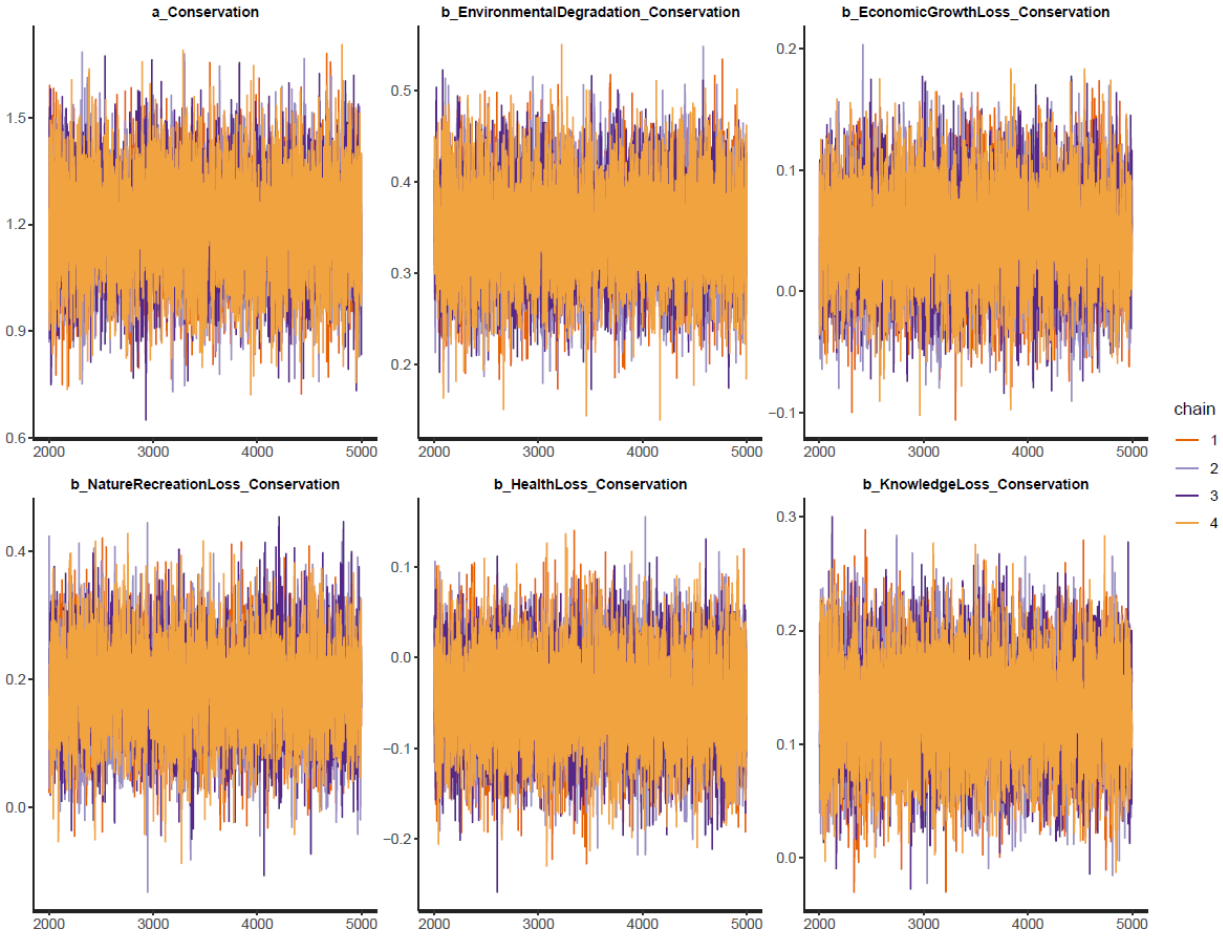

Figure 12.3: Model 1's trace plots with priors as norm (1,0.5)

A Gelman plot is the visualization of the Gelman shrink factor (y-axis) corresponding to the sequential order of iterations (x-axis). As shown in Figure 12.4, the Gelman shrink factor values drop rapidly to 1 before the warmup period ends (before the 2000th iteration). This signals a good convergence of Model 1.

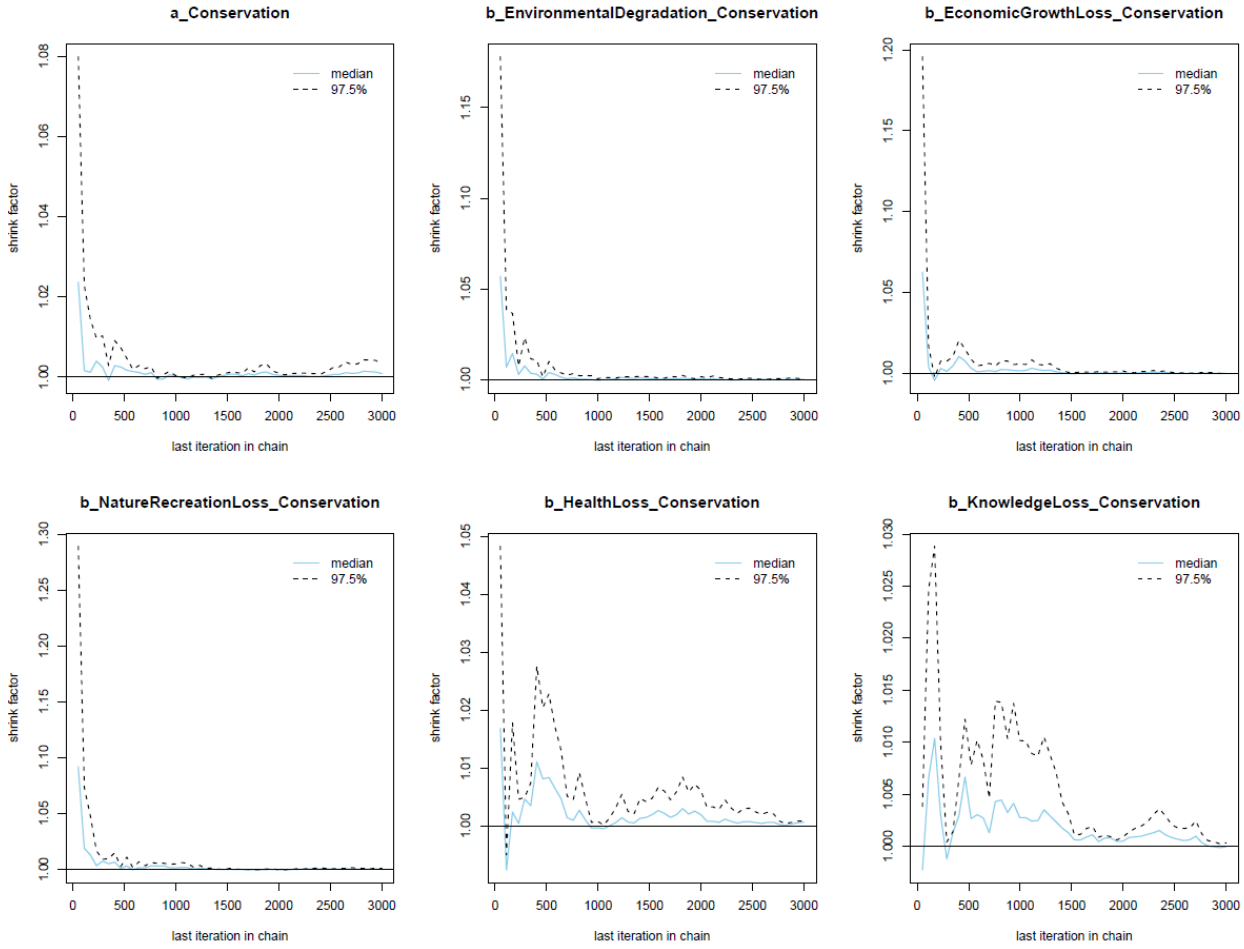

Figure 12.4: Model 1's Gelman plots with priors as norm (1,0.5)

The last diagnostic plot of model convergence is the autocorrelation plot. For a model's Markov chains to converge, the stochastic process has to present the memoryless property. In other words, the simulated samples are independent of previously simulated samples. The autocorrelation plots display a rapid decline of autocorrelation level to 0 after a finite lag, validating that the model's Markov chains are convergent (see Figure 12.5).

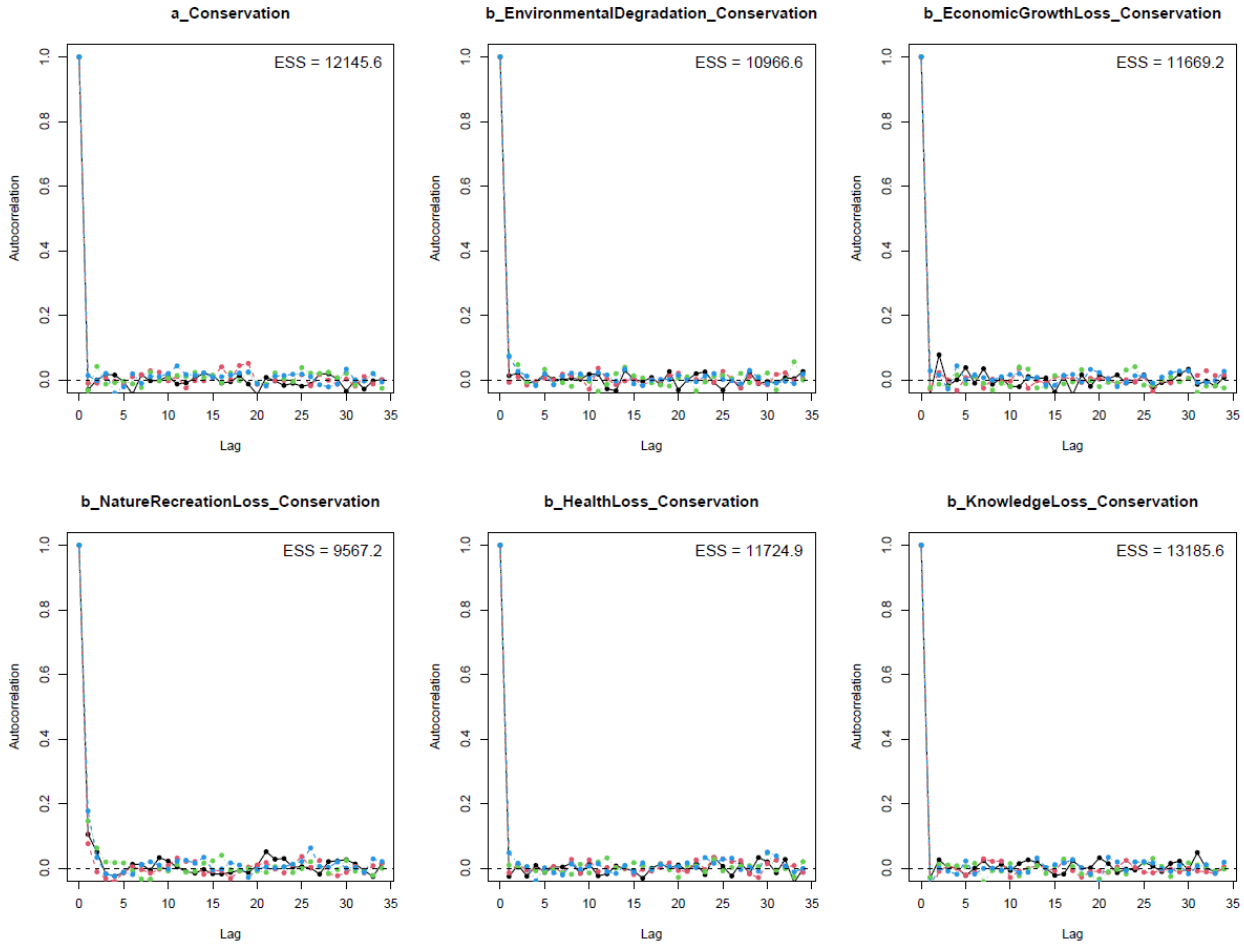

Figure 12.5: Model 1's autocorrelation plots with priors as norm (1,0.5)

The simulated posteriors employing priors as norm (1,0.5) show that four out of five biodiversity loss perceptions are positively associated with the conservation-related attitude, namely: environmental degradation ($\mu_{EnvironmentalDegradation}$ = 0.35, $\sigma_{EnvironmentalDegradation}$ = 0.05), loss of economic growth ($\mu_{EconomicGrowthLoss}$ = 0.05, $\sigma_{EconomicGrowthLoss}$ = 0.04), loss of nature-based recreation opportunity ($\mu_{NatureRecreationLoss}$ = 0.18, $\sigma_{NatureRecreationLoss}$ = 0.07), and loss of knowledge

($\mu_{KnowledgeLoss}$ = 0.13, $\sigma_{KnowledgeLoss}$ = 0.04). Interestingly, perceiving loss of health as a consequence of biodiversity loss has an opposite effect on conservation-related attitude ($\mu_{HealthLoss}$ = -0.05, $\sigma_{HealthLoss}$ = 0.05).

The parameters' posterior distributions are shown in Figure 12.6, along with their Highest Posterior Distribution Interval (HPDI) at 90%. Apparently, all the credible intervals of *EnvironmentalDegradation*, *EconomicGrowthLoss*, *NatureRecreationLoss*, and *KnowledgeLoss* fall entirely on the positive side of the x-axis, suggesting that the positive associations between these variables and outcome variable (*Conservation*) are highly reliable. Regarding *HealthLoss*'s posterior distribution, the majority of its HPDI is located on the negative side but not entirely, and its standard deviation (SD) is equal to the absolute value of the mean, so *HealthLoss*'s negative effect on conservation-related attitude can be deemed moderately reliable. Even "prior-tweaking" is performed using the priors representing our disbelief on the associations between biodiversity loss perceptions and conservation-related attitude, the change is negligible, which indicates the model's robustness (see Table 12.2).

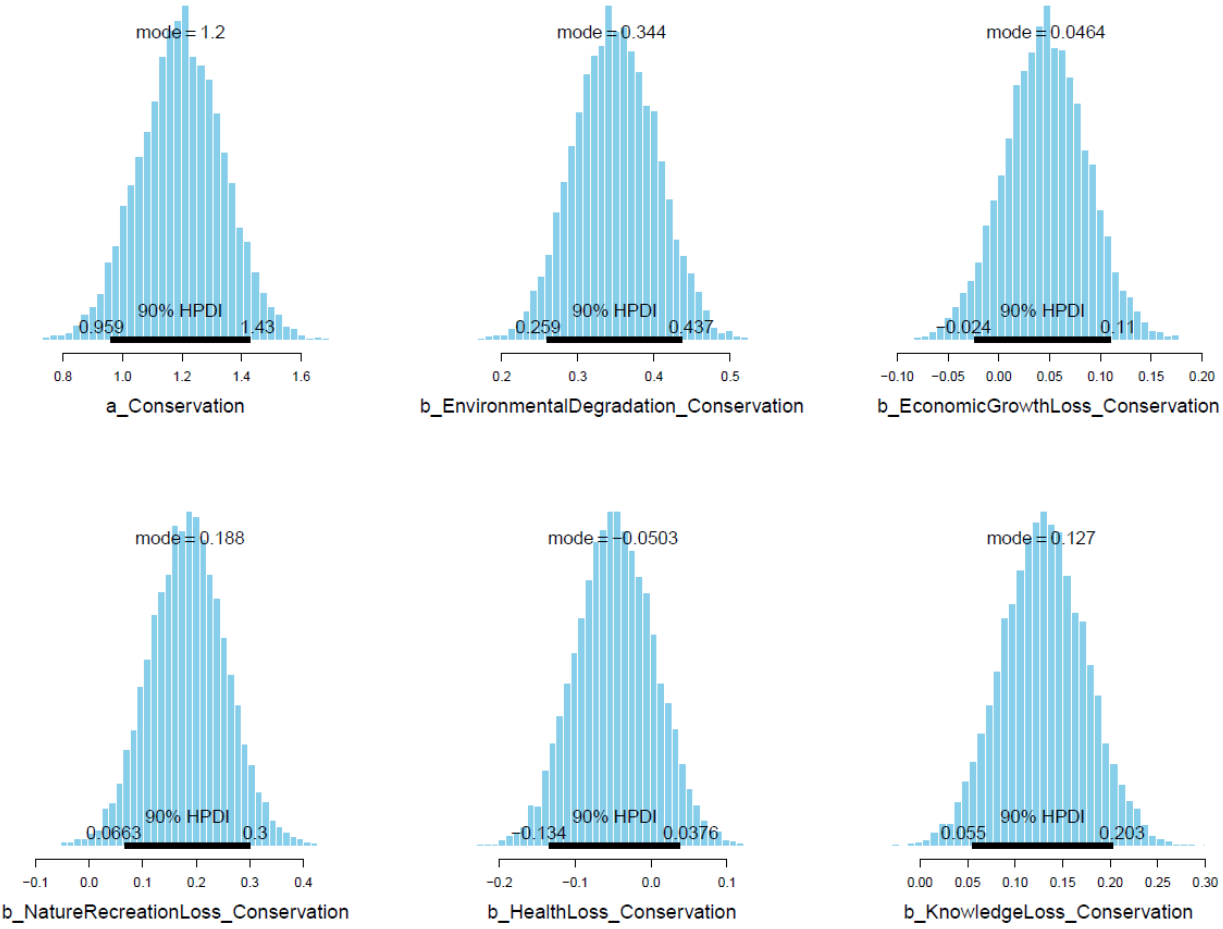

Figure 12.6: Model 1's posterior distributions with priors as norm (1,0.5)

12.2.2. Models 2a and 2b: Effects of conservation-related attitude on willingness to pay

Models 2a and 2b were examined to check whether urban residents' conservation-related attitude has positive impacts on their willingness to pay for the entrance fee and conservation when visiting protected areas in the future. We applied the same fitting and validating procedures of Models 2a and 2b with Model 1. The visual PSIS-LOO

diagnoses of Models 2a and 2b are displayed in Figures 12.7-A and 12.7-B, respectively. *k*-values in both Figures are below the 0.5 thresholds, so Models 2a and 2b have a good fit with the data.

Convergence diagnostic values (n_eff and Rhat) of both models indicate that the models' Markov chains are convergent. The trace, Gelman, and autocorrelation plots also confirm the model convergence. Figures S5, S6, and S7 are the trace, Gelman, and autocorrelation plots of Model 2a, respectively, while those of Model 2b are presented in Figures S8, S9, and S10.

Table 12.3: Model 2's simulated posterior results

Model 2a: *WillingEntraceFee ~ Conservation*								
Parameters	**Informative priors (belief on effect)**				**Informative priors (disbelief on effect)**			
	Mean	**SD**	**n_eff**	**Rhat**	**Mean**	**SD**	**n_eff**	**Rhat**
Constant	1.23	0.80	2648	1	2.04	0.89	2542	1
Conservation	0.81	0.26	2643	1	0.53	0.28	2342	1
Model 2b: *WillingDonation ~ Conservation*								
Constant	0.28	0.63	2698	1	0.76	0.66	2324	1
Conservation	0.86	0.21	2517	1	0.70	0.21	2321	1

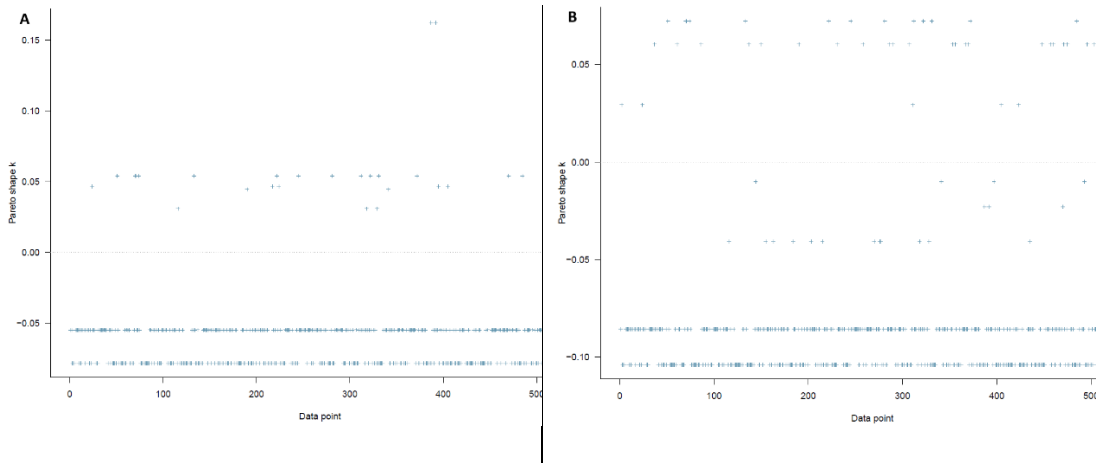

Figure 12.7: PSIS-LOO diagnosis for **A –** Model 2a and **B –** Model 2b with priors as norm (1,0.5)

As can be seen from Table 12.3, people with a higher agreement level with conservation as a preventive measure of biodiversity loss are more willing to pay for entrance fee ($\mu_{Conservation\_WillingEntranceFee}$ = 0.81, $\sigma_{Conservation\_WillingEntranceFee}$ = 0.26) and conservation ($\mu_{Conservation\_WillingDonation}$ = 0.86, $\sigma_{Conservation\_WillingDonation}$ = 0.21). The posterior distributions of the parameters representing the association between conservation-related attitude and willingness to pay for entrance fee and conservation are displayed in Figures 12.8-A and 12.8-B, respectively. The distributions clearly lie on the positive side of the x-axis (separated by the red vertical line), stipulating highly reliable positive associations. When estimating Models 2a and 2b employing priors as norm (0,0.5), the magnitude of the posterior distribution declines, its reliability is still high. Evidently, their mean values are much greater than the standard deviation values.

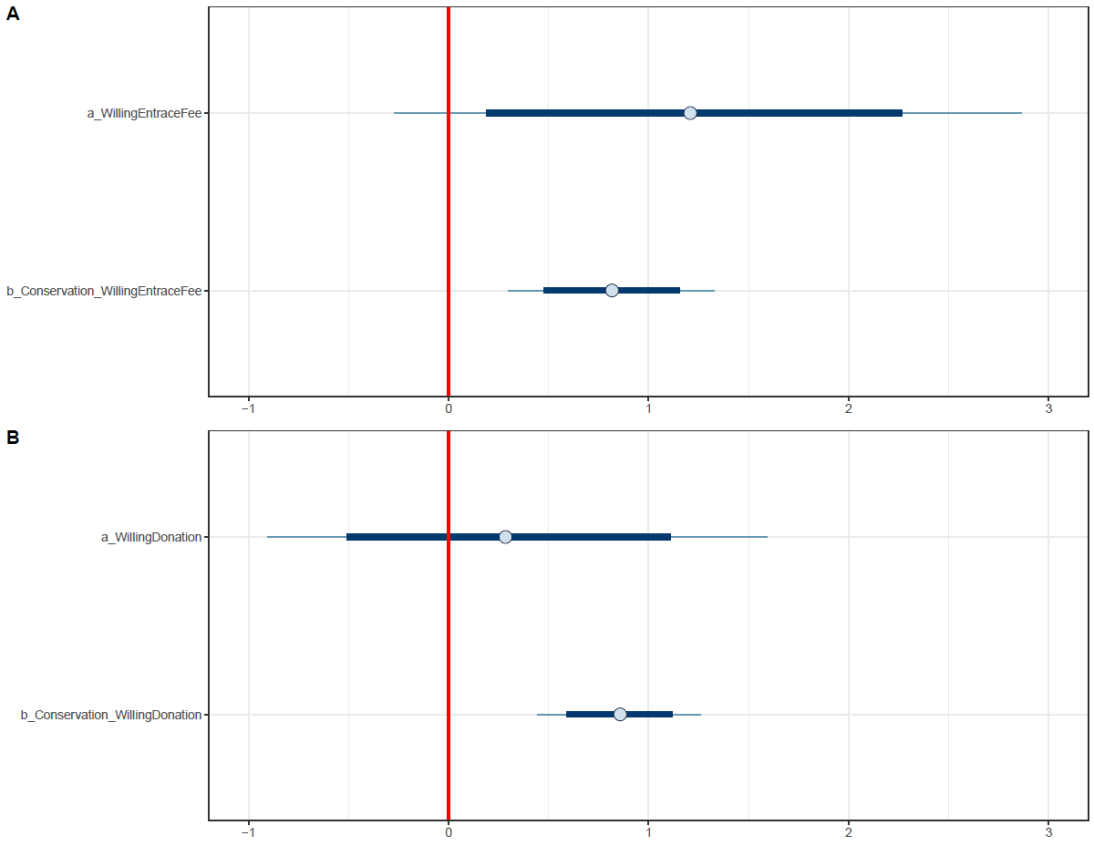

Figure 12.8: Interval plots of posterior distributions for **A –** Model 2a and **B –** Model 2b

12.3.3. Model 3: Effects of biodiversity loss perceptions and conservation-related attitude on willingness to pay

Fitting Models 3a and 3b, we aimed to examine the predictions of conservation-related attitude and biodiversity perceptions against the willingness to pay for the entrance fee and conservation in protected areas. The fitting and validating procedures are also similar to those employed with Model 1. First of all, PSIS-LOO diagnosis was conducted with both models. The visualizations of *k*-values (all *k*-values are lower than

0.5) in Figures 12.9-A and 12.9-B show that Models 3a and 3b are neither underfit nor overfit with the data.

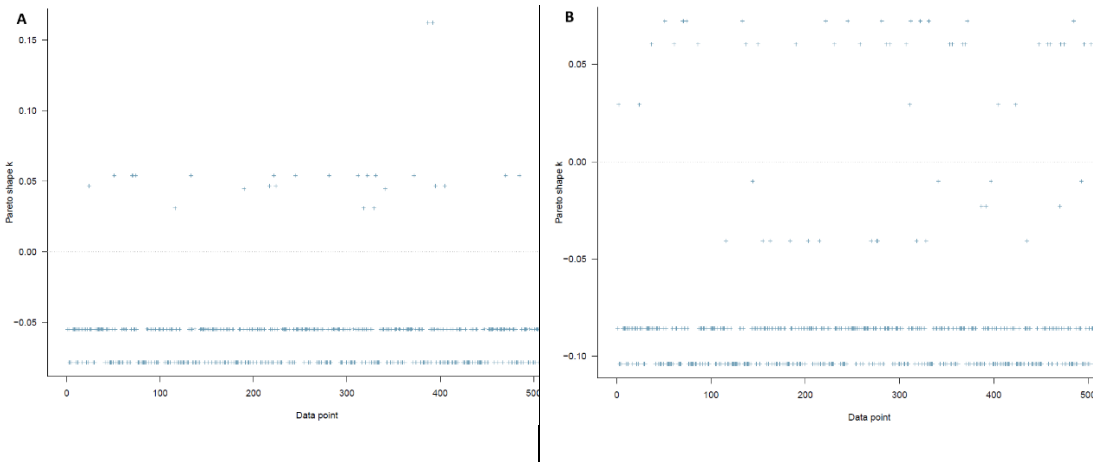

Figure 12.9: PSIS-LOO diagnosis for **A –** Model 3a and **B –** Model 3b with priors as norm (1,0.5)

The n_eff and Rhat values presented in Table 12.4 confirm the convergence of Models 3a and 3b (n_eff > 8000 and Rhat = 1). The visual diagnoses by trace, Gelman, and autocorrelation plots also verify the convergence. Figures S11, S12, and S13 demonstrate Model 3a's trace, Gelman, and autocorrelation plots, while Figures S14, S15, and S16 are Model 3b's trace, Gelman, and autocorrelation plots, respectively. Interpretation of the plots can be viewed in sub-section 3.1.

Table 12.4: Model 3's simulated posterior results

Model 3a: ***WillingEntraceFee ~ Conservation + EnvironmentalDegradation+ EconomicGrowthLoss+ NatureRecreationLoss+ HealthLoss+ KnowledgeLoss***		
Parameters	**Informative priors**	**Informative priors**

	(belief on effect)				(disbelief on effect)			
	Mean	**SD**	**n_eff**	**Rhat**	**Mean**	**SD**	**n_eff**	**Rhat**
Constant	0.06	0.96	9412	1	1.49	1.14	8421	1
Conservation	0.51	0.31	9778	1	0.39	0.31	10332	1
EnvironmentalDegradation	-0.09	0.35	9321	1	-0.15	0.35	9221	1
EconomicGrowthLoss	0.15	0.33	10654	1	0.03	0.33	10963	1
NatureRecreationLoss	0.22	0.40	10596	1	0.13	0.39	9654	1
HealthLoss	-0.09	0.37	9632	1	-0.18	0.37	9231	1
KnowledgeLoss	0.61	0.32	10212	1	0.55	0.31	10321	1
Model 3b: *WillingDonation ~ Conservation + EnvironmentalDegradation+ EconomicGrowthLoss+ NatureRecreationLoss+ HealthLoss+ KnowledgeLoss*								
Constant	-0.47	0.63	10512	1	0.37	0.84	10393	1
Conservation	0.64	0.21	10517	1	0.57	0.25	10417	1
EnvironmentalDegradation	0.18	0.30	9232	1	0.14	0.30	10963	1
EconomicGrowthLoss	-0.02	0.27	10351	1	-0.09	0.26	11736	1
NatureRecreationLoss	-0.09	0.35	11542	1	-0.13	0.35	9551	1
HealthLoss	0.07	0.31	8021	1	0.02	0.31	10789	1
KnowledgeLoss	0.35	0.27	10123	1	0.32	0.27	10545	1

The simulated posterior results of Models 3a and 3b show that the positive associations between conservation-related attitude and willingness to pay for entrance fee and conservation remain robust with Models 2a's and 2b's results. Most of the biodiversity loss perceptions' effects on both willingness to pay for the entrance fee and conservation are negligible and unreliable. In particular, their standard deviation values are much higher than the means' absolute values. Only *KnowledgeLoss* has positive effects on the willingness to pay for the entrance fee ($\mu_{KnowledgeLoss\_WillingEntranceFee}$ = 0.61, $\sigma_{KnowledgeLoss\_WillingEntranceFee}$ = 0.32) and conservation ($\mu_{KnowledgeLoss\_WillingDonation}$ = 0.35, $\sigma_{KnowledgeLoss\_WillingDonation}$ = 0.27).

The interval plots of Models 3a's and 3b's posterior distributions manifest that *Conservation*'s and *KnowledgeLoss*'s HPDIs at 90% are entirely located on the positive side, highlighting the high reliability of their effects on willingness to pay (see

Figures 12.10-A and 12.10-B, respectively). The HPDI at 90% is illustrated by the thick part in the middle of an interval. After conducting the "prior-tweaking" technique, the parameters' magnitudes slightly change, but their tendencies are not. Hence, the simulated results are robust.

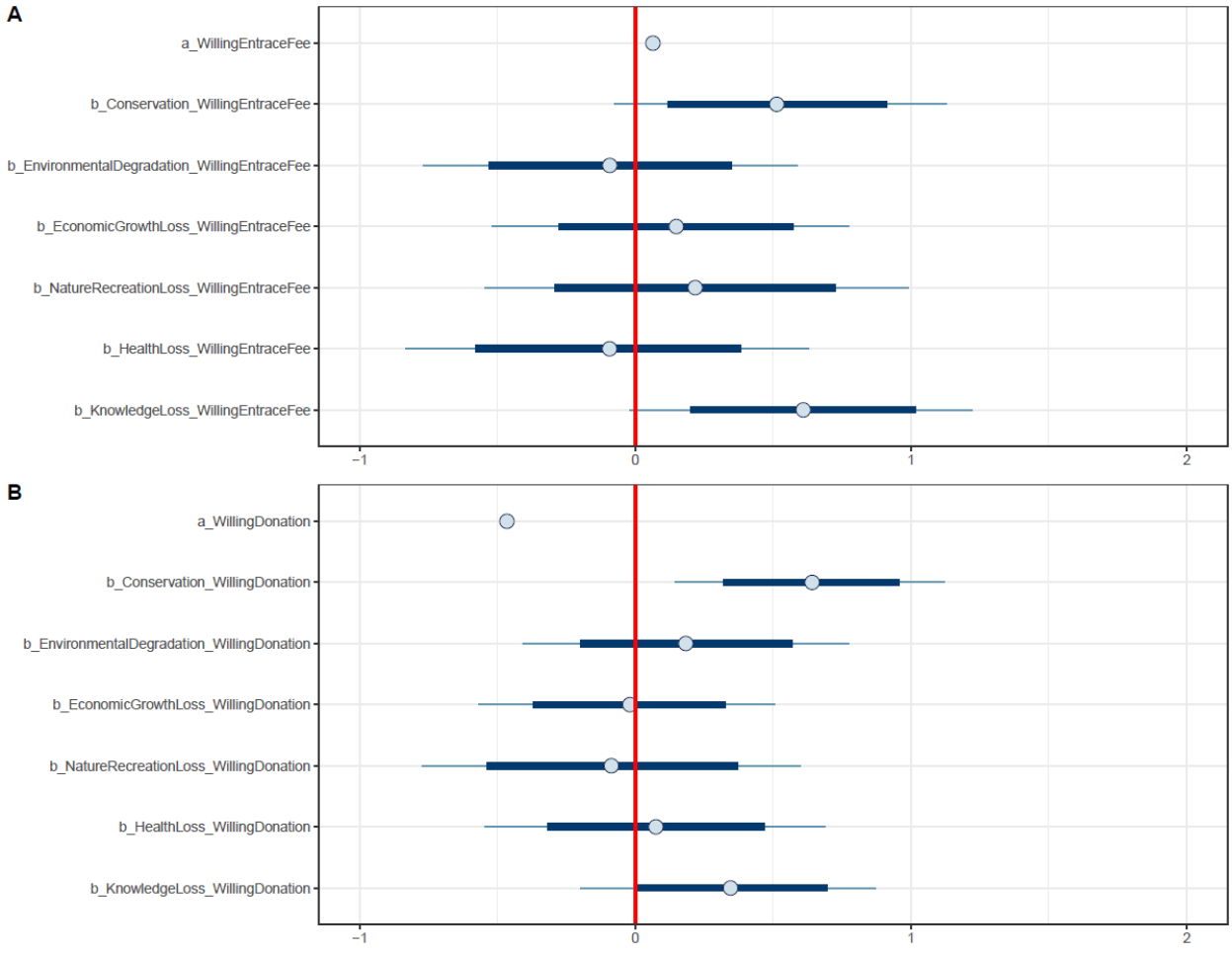

Figure 12.10: Interval plots of posterior distributions for **A –** Model 3a and **B –** Model 3b

Based on the results reported above, it is conclusive that biodiversity loss perceptions (*EnvironmentalDegradation*, *EconomicGrowthLoss*, *NatureRecreationLoss*, and *KnowledgeLoss*) have direct positive impacts on the conservation-related attitude and indirect positive impacts on willingness to pay for entrance fee and conservation through affecting the conservation-related attitude. Perceiving the loss of knowledge as a consequence of biodiversity loss directly positively influences the conservation-related attitude and willingness to pay.

Chapter 13:

Discussion and Conclusion

The Discussion will be classified into four sub-sections to discuss the value of the generated dataset and the results of the three studies conducted above separately. However, the Conclusion will incorporate all the main findings of three studies to conclude this dissertation's theoretical, practical, and methodological contributions.

13.1. Discussion

13.1.1. Dataset

The current dataset provides resources for studying important aspects of the interactions between urban residents and biodiversity concepts.

First of all, mitigating the demand for the wildlife product among urban residents is crucial for biodiversity loss reduction. Raising urban residents' awareness through social marketing campaigns is a potential measure to achieve such a target (Challender & MacMillan, 2014; Shairp et al., 2016). Using the current dataset to explore how biodiversity perceptions influence wildlife product consumption behaviors might help improve the effectiveness and efficiency of public communication campaigns and programs. Besides, insights generated from this dataset (e.g., the associations between biodiversity loss perception and bushmeat consumption behavior) might also contribute to the biodiversity conservation-related legislation and law enforcement in urban areas (Sandalj et al., 2016).

Secondly, based on the current dataset, researchers can also investigate the interactions of urban residents with biodiversity concepts in multiple locations, like home, neighborhood, urban public park, and national park. This might enrich the literature in both sustainable urban development and biodiversity conservation. For example, planting and petting behaviors can be hypothetically associated with the willingness to support planting projects in the neighborhood and public parks. Moreover, the frequency of visiting national parks might be predicted by the biodiversity perceptions of urban residents, which provides more insights for social marketing campaigns to attract more visitors. The increasing influx of visitors might help generate sustainable finance for biodiversity conservation in national parks and preservation in urban public parks (Chung et al., 2018; Tapper, 2006).

Thirdly, making the current dataset open helps reduce the cost of doing science for researchers in developing countries with similar characteristics to Vietnam (Vuong, 2018): high urbanization rate and high level of biodiversity (e.g. being located in a biodiversity hotspot). Making the dataset open also enhances transparency and facilitates open review and dialogue among researchers (Vuong, 2020).

In summary, the dataset was systematically designed, collected, and validated to explore the interactions between urban residents and biodiversity concepts. Thus, researchers can make use of the dataset to enrich the lax literature regarding the role of urban residents in biodiversity conservation preservation; policymakers can find

insights for building up an "eco-surplus culture" (Vuong, 2021) among urban residents through effective public communication and policymaking.

13.1.2. Study 1

The first study in this dissertation is one of the first studies about the mental constructs of biodiversity and biodiversity loss among urban residents in southeast Asia. Previous studies were mainly conducted in developed Western countries, while this study was done in a developing Asian country – Vietnam. Grounded Theory and semi-structured interviews were performed on 38 residents in the two largest cities in Vietnam. After coding and analyzing the data, three main perceptions of the term 'biodiversity' and 'biodiversity loss' were found, along with their perceived features (see subsection 10.1). Moreover, the analysis also identified five categories of perceived impacts of biodiversity (loss) on human (see subsection 10.2), and ten categories of perceived human's reaction that contributes to biodiversity conservation and biodiversity loss prevention (see subsection 10.3). Such findings were later used for questionnaire design (Nguyen, 2021).

In either the perceptions of biodiversity or biodiversity loss, the equilibrium factor always appeared as a major category through typical expressions: 'balance', 'imbalance', 'harmony', 'peaceful', etc. It is clear that the notion of balance is frequently associated with biodiversity, even in the context of Western countries (Bakhtiari et al., 2014; Buijs et al., 2008; Dandy et al., 2012; Fischer & Young, 2007). However, besides the knowledge and information that the interviewees knew about

biodiversity (loss), it is suspected that Vietnamese culture also had a certain influence on residents' perceptions. The cultural value was manifested through the expression of 'harmony' as a final goal of biodiversity (see subsection 10.1), which was not reported in former studies. Vietnamese residents are considerably affected by Confucianism, which has been embedded in their culture for many centuries (Vuong et al., 2018; Vuong, Ho, et al., 2020). Since the Confucian ideology emphasizes achieving harmony in society, it is plausible that the Vietnamese often associate good things, such as biodiversity, with harmony.

Comparably, findings from this study had both similarities and differences with prior research. Our results offered some consistent perceived features of biodiversity with the study of Fischer and Young (2007), like *naturalness, plentifulness,* and *high diversity*. . Still, two new biodiversity features perceived by urban residents could be identified: *clean and refreshing context* and *existence of unique objects/species*. Bakhtiari et al. (2014) suggested two types of forest biodiversity definitions: *biodiversity as a good in itself* and *biodiversity as a regulator of the ecosystem*. Only one of the three interviewees' perceptions (*goods in an ecosystem*) in our study was consistent with Bakhtiari et al. (2014)'s suggestion. Instead of considering biodiversity a regulator in an ecosystem, Vietnamese urban residents genuinely perceived biodiversity as *an ecosystem itself* or *a stage of equilibrium*.

Apparently,urban residents' perceptions about biodiversity and biodiversity loss are not very much aligned with scientific definitions of the two conepts. Still, they are

plausible results because of five reasons: 1) a significant number of respondents have never heard of the term ‘biodiversity’ (36.84%) or ‘biodiversity loss’ (52.63%); 2) a majority of urban residents have limited experience with the natural environment; 3) environmental education is not focal in Vietnamese education curriculum (Heck, 2015); 4) the definition of biodiversity is complex and sometimes ambiguous, even among conservationists and ecologists (Mace et al., 2012); 5) the term ‘biology’ [sinh học] is relatively similar to the term ‘ecology’ [sinh thái] in Vietnamese, which might cause confusion among layresidents.

Also, because of the five reasons mentioned above, Vietnamese urban residents might have low awareness of biodiversity loss impacts on their lives and obtain some scientifically inaccurate perceptions about the utility of genetic engineering techniques. Some residents were over-optimistic about the utility of genetic engineering in raising biodiversity without knowing the existing adverse effects of genetically modified species on the biodiversity and ecosystem. Even though genetic engineering has some benefits in biodiversity conservation practices, it can create devastating consequences without stringent monitoring (Landry, 2015).

It is recommended that policymakers should focus on education and public communication activities about environmental issues, especially biodiversity. Sufficient education and public communication about biodiversity’s impact on humans would facilitate the conservation effort and decelerate the biodiversity loss rate in Vietnam (Chung et al., 2018; Nuwer, 2018; Tapper, 2006; Wyler & Sheikh, 2013). As

shown in this study that some residents were aware of the significance of multi-stakeholders' participation in solving biodiversity loss, promoting cooperation projects, programs, and campaigns among government, private sectors, researchers, and the public is a potential approach for effectively conserving biodiversity. The first step could be accomplishing the 11th progressive cultural value – the environment-healing element or eco-surplus culture (Vuong, 2021; Vuong, 2021), which supplements to Harrison (2000)'s list of ten values. For aiding evidence-based policy-making, quantitative studies with larger and more representative samples have to be conducted. Moreover, the associations between urban residents' biodiversity perceptions and their willingness to pay for conservation programs, attitudes towards wildlife trading, and nature-based tourism behaviors need to be further explored.

13.1.3. Study 2

The current dissertation's second study is one of the first research to examine the effects of urban residents' biodiversity loss perceptions on the support for the prohibition of illegal wildlife consumption and bushmeat consumption frequency. It employed the BMF on 535 Vietnamese urban residents for the investigation.

First of all, the study found that all the perceptions about the negative impacts of biodiversity loss are positively associated with the attitude towards the preventive measure. In other words, urban residents who think that biodiversity loss negatively affects the environmental quality, economic growth, nature-based recreation opportunities, health, and knowledge are more likely to agree with the prohibition of

illegal wildlife consumption. These results validate the assumption that subjective cost-benefit judgments influence an individual's attitude toward a subject. According to the Mindsponge mechanism, the cost-benefit judgements are made using previously accepted pieces of information into the mind; the closer those pieces are to the mindset, the more influences they have within the cost-benefit judgement process (Nguyen, La, et al., 2022a). In this case, the distance can be proxied by the degree of agreement towards the information (or negative impacts of biodiversity loss).

The findings somewhat align with a recent study regarding Chinese public opinions on revising legislation and policy related to wildlife consumption and trade management. Due to the perceived threat of the Covid-19 outbreak, more than 90% of the respondents support more stringent policies and legislation on wildlife trade, consumption, and commercial exhibitions (Shi et al., 2020). Shi et al. also note that the support is more prevalent among educated and urban people. In this case, the perceived risk of a pandemic can also be deemed a cost of biodiversity loss that drive Chinese urban people to support stringent policies and legislation.

Nevertheless, not all perceptions about the negative impacts of biodiversity loss could predict the reduced bushmeat consumption frequency. To elaborate, while people perceiving economic growth and knowledge losses as consequences of biodiversity loss consume bushmeat less frequently, people with other perceptions do not, or even consume more frequently. Particularly, people perceiving environmental degradation

as a consequence of biodiversity loss tend to consume bushmeat more frequently. There are several explanations for such conflicting findings.

One of them is because of the high level of cultural additivity among Vietnamese urban people. According to Vuong et al. (2018), cultural additivity is "a mechanism whereby people of a given culture are willing to incorporate into their culture the values and norms from other systems of beliefs that might or might not logically contradict with principles of their existing system of beliefs." Due to the high level of resilience towards conflicting values induced by cultural additivity (Small & Blanc, 2020), Vietnamese urban residents can still consume bushmeat while being aware of the consequences of biodiversity loss and supporting the prohibition of illegal wildlife consumption. Although conflicting values with the mindset (or set of core cultural values) are often ejected, many types of information (or values), even conflicting ones, can exist simultaneously. That circumstance happens when the individual's multi-filtering system perceives both types of values to be beneficial. On the one hand, urban residents might consider supporting the prohibition of illegal wildlife consumption beneficial since it helps reduce biodiversity loss's consequences. On the other hand, eating bushmeat is still perceived to provide them with other types of benefits, like social status, prestige, nutritional value, health, or taste (Drury, 2011; Shairp et al., 2016).

It is noteworthy that people consuming bushmeat frequently and supporting the prohibition of illegal wildlife consumption tend to have similar characteristics: high

income and educational level. The results seem to be paradoxical. However, as people with high income and education were identified as major bushmeat consumers (Drury, 2011; Sandalj et al., 2016; Shairp et al., 2016), they would be targeted by social marketing and demarketing campaigns, which encouraged them to support the prohibition of illegal wildlife consumption. Perhaps, they might not consider their consumed bushmeat to be "illegal." In any sense, this result again hints at the existing effect of cultural additivity on urban residents' perceptions and behaviors related to wildlife consumption. The paradox also exists in the wildlife tourism industry, where animal encounters are found to foster the connection to wildlife and pro-conservation behaviors (Clayton, Prévot, Germain, & Saint-Jalme, 2017; Skibins & Powell, 2013). Still, participation in such encounters is also strongly associated with increased wildlife consumption behaviors (Rizzolo, 2021). Cultural additivity can be a potential concept capitalized to understand such paradoxes, so further studies exploring this concept in wildlife consumption and tourism settings should be conducted.

If the cultural additivity really affects the existence of conflicting ideas within individuals' minds, policymakers and conservationists have to pay more attention to the effectiveness of social marketing and demarketing campaigns. In Vietnam's urban settings, for example, making residents realize the consequences of biodiversity loss on the economy and knowledge is useful to reduce bushmeat consumption frequency, while other consequences are not. In case those campaigns are insufficient for urban people to recognize the "cost" of bushmeat consumption, tougher measures (e.g.,

financial punishment) have to be put into perspective. Besides future studies regarding the effectiveness of social marketing campaigns, it is also essential to explore how social marketing and demarketing campaigns' contents (e.g., narratives, communication methods) affect the psychology and actual behaviors of the consumers.

Based on the current study's findings, the Mindsponge mechanism can supplement the explanation of the association between knowledge and public support for biodiversity conservation practices. Many studies have shown that increasing environmental knowledge can positively affect environmental attitudes and behaviors (Bradley et al., 1999; Faize & Akhtar, 2020; Polonsky et al., 2012). Still, Clayton et al. (2017) find that higher conservation knowledge cannot influence zoo visitors' environmental concerns and behavioral intent. Such distinction might result from the types of knowledge that are examined among those studies. Specifically, in Clayton et al.'s study, the conservation knowledge being asked does not make respondents relate to their subjective cost-benefit judgements; for example, "can you cite three endangered species?", "what are threats toward them?", etc.

The pieces of knowledge being asked in other studies, in contrast, are those that can be used as input for the cost-benefit judgements of the respondents, such as questions related to the ecological system, pollution, greenhouse gases, population growth and urbanization, climate change, waste management, etc. (Bradley et al., 1999; Faize & Akhtar, 2020; Polonsky et al., 2012). Therefore, whether the respondents can relate conveyed knowledge to their subjective cost-benefit judgements towards a particular

environmental (or biodiversity conservation) topic can be a critical factor affecting the impacts of environmental (or biodiversity conservation) knowledge on attitudes and behaviors. Future social marketing, demarketing, and educational campaigns are suggested to include the elements that help receivers relate to their cost-benefit judgements, which eventually drives them to build up an environmental-healing culture (a.k.a. eco-surplus culture), or so-called the 11^{th} progressive cultural value (Vuong, 2021; Vuong, 2021). One of the potential approaches is treating biodiversity and biodiversity loss following the ecologist's perspective during the social marketing, demarketing, and educational campaigns (Mace et al., 2012).

The contradicting predictions of biodiversity loss perceptions on the preventive measure attitude and consumption behavior highlight the limitation of the Mindsponge mechanism in examining the associations between ideations and behaviors. The translation from individuals' ideations to their actual behavior requires further theoretical research to expand the framework or provide a more transparent view of the transition between ideations and behaviors. Perhaps, individuals' behaviors result from complex information processing systems of multiple prioritized ideations in the mindset and receptive information from the external environment right before the behavior takes place. The objective of that process is to determine the behavior that is subjectively perceived to lead to the most beneficial outcome.

13.1.4. Study 3

The current dissertation's third study is one of the first studies examining how the urban residents' biodiversity loss perceptions associate with their conservation-related attitude and willingness to pay for the entrance fee and conservation in protected areas. The analysis was performed using the BMF on 535 urban residents across Vietnam. Overall, there are three main findings: 1) most biodiversity loss perceptions (*EnvironmentalDegradation*, *EconomicGrowthLoss*, *NatureRecreationLoss*, and *KnowledgeLoss*) have direct positive impacts on conservation-related attitude and indirect impacts on willingness to pay; 2) perceiving loss of health as a consequence of biodiversity loss has negative influence the conservation-related attitude; 3) perceiving loss of knowledge as a consequence of biodiversity loss has a direct positive influence on conservation-related attitude and indirect positive influences on willingness to pay for entrance fee and conservation.

Evidence from this study suggests that there can be a novel way to improve protected areas financing actively. It is to build an eco-surplus culture among potential visitors to protected areas (to be more specific, urban residents) by making them perceive the adversities of biodiversity loss.

For building an eco-surplus culture, improving the accessibility of urban residents to information regarding biodiversity and biodiversity loss is vital. Without accessibility to biodiversity-related information, the urban residents cannot know that biodiversity loss problems exist no matter how crucial and severe it is to their lives. Social

marketing and demarketing programs, public awareness-raising campaigns, educational activities, and pro-environmental entertaining platforms (e.g., commercial games) are potential methods to create "touchpoints" between urban residents and the biodiversity-related information (Haq, Cambridge, & Owen, 2013; Veríssimo, 2019; Veríssimo et al., 2018; Vuong, Ho, et al., 2021; Vuong, 2022). In addition, the effectiveness of biodiversity-related information in changing perceptions, attitudes, and behaviors is required. As shown in this study's results, the message that can stimulate the subjective cost-benefit judgements of urban residents towards biodiversity loss might help build eco-surplus attitude (or supporting conservation as a preventive measure of biodiversity loss). Ryan, Mellish, Dorrian, Winefield, and Litchfield (2020) stipulate that the effectiveness of biodiversity-conservation marketing is still a nascent field with only 28 studies. For effectively building an eco-surplus culture, more knowledge regarding the effectiveness of the messages' content, narrative, and design in changing perceptions, attitudes, and behaviors is indispensable.

Building an eco-surplus culture is also a potential way to ease the funding allocation problems faced by the domestic government (e.g., widespread but insufficient budget allocation, lack of priority) and international organizations (e.g., large but site-specific funding) (Bovarnick et al., 2010; Bui et al., 2021). By financing social marketing and demarketing programs, public awareness-raising campaigns, educational activities, and pro-environmental entertaining platforms (e.g., commercial games), the government and international organization can increase the aggregate pool of money that the

visitors are willing to pay at a regional scale, which indirectly generates finance for protected areas in the region. To elaborate, assuming that 5000 urbanites visit protected areas nearby the city every month. Before implementing pro-eco-culture campaigns and activities, 60% of them are willing to pay for the entrance fee and conservation initiatives, generating $60,000 a month for protected areas in the region aggregately (each person pays $20). It should be noted that $20 per person is only an assuming number. After implementing pro-eco-culture campaigns and activities, 80% are willing to pay, generating $80,000 ($20,000 surplus) for protected areas in the region. When the aggregate pool of money increases, all protected areas in the region will have an equal chance of benefiting through nature-based tourism (Dharmaratne et al., 2000; Thomas E. Jones et al., 2021). The shifting demographics, rapid urbanization, exacerbating effects of climate change, increasing diffusion of media technologies, and changing psychological drivers will likely increase the demand for nature-based tourism swiftly in Asia-Pacific Region, especially developing countries like Vietnam (Frost et al., 2014). In addition, the visitors with better informed knowledge about the effects of biodiversity and biodiversity loss might have more respect for nature and cause less impact to protected areas (Marion & Reid, 2007).

Implementing social marketing and demarketing programs, public awareness-raising campaigns, educational activities, and pro-environmental entertaining platform design (e.g., commercial games) does not only help increase the aggregate pool of finance for protected areas in the region but also facilitates other conservation campaigns in urban

areas, like tackling illegal wildlife trade. Evidently, perceiving the consequences of biodiversity loss is found to influence the support towards prohibition of illegal wildlife consumption positively and negatively influence bushmeat consumption frequency among urban residents (Nguyen & Jones, 2022). Given the mentioned merits, I strongly recommend policymakers, international organizations, and conservation activists conduct targeted social marketing and demarketing programs, public awareness-raising campaigns, educational activities, and pro-environmental entertaining platform design (e.g., commercial games) to build an eco-surplus culture among urban residents for biodiversity conservation. Furthermore, enhancing the effectiveness of these campaigns and problems are promising research directions for scientists to contribute evidence-based insights.

The effects of biodiversity loss perceptions on paying willingness validate our assumptions about the role of the subjective cost-benefit evaluation process in accepting or rejecting information of the individuals. However, most of the effects of biodiversity loss perceptions on willingness to pay are indirect (except for the perceived loss of knowledge) and mediated by the attitude towards conservation, showing that the information evaluation process is sequential. In other words, it takes steps for a person to process information and eventually arrive at the ideations and behaviors that are beneficial for the environment or pro-environmental attitudes and behaviors. The impact of perceived knowledge loss is relatively special because it influences the willingness to pay both directly and indirectly through support for

conservation. It is unclear why the effect of perceived knowledge is more direct than others, so investigating the link between perceived knowledge loss and support for conservation in general and willingness to pay in particular is a potential direction for later research. Regardless of the causes, the importance of knowledge about nature should be concentrated in public awareness-raising campaigns, social marketing and demarketing programs, and educational activities.

Regarding the negative effect of perceived health loss resulting from biodiversity loss on conservation-related attitude, it is paradoxical with other biodiversity loss perceptions' effects. Following the Mindsponge thinking, which assumes that people try to maximize their perceived benefits and reduce perceived cost, might help explain this finding (Vuong, 2023; Vuong, Nguyen, et al., 2022a). In particular, urban residents who perceive health loss as a consequence of biodiversity loss are sensitive to health-related issues. In Vietnam, many perceived "nutritional" and "healthy" traditional medicines are made from wildlife products, such as pangolin scales, tiger bones, bear bile, etc. (Davis et al., 2019; Davis et al., 2020; Sexton et al., 2021). The term "conservation" might be perceived as a tool for protecting "a subset of biodiversity that includes charismatic species and those on threatened species lists" (Mace et al., 2012), so people sensitive to their health issues might be less likely to support conservation.

Moreover, the complex and sometimes ambiguous definition of biodiversity might also contribute to this contradiction. Apart from *goods in an ecosystem*, Vietnamese urban people also perceive "biodiversity" as *an ecosystem itself* (Nguyen & Jones,

2021). People with this perception might consider the lack of fresh air (e.g., due to deforestation) as a health problem generated by biodiversity loss. It should be noted that the explanation here is speculative, so further studies are needed for validation. One potential approach is to look at how the subtle differences in people's perceptions (e.g., *goods in an ecosystem, an ecosystem itself, a stage of equilibrium, its regulatory function, a final ecosystem service,* etc.) about biodiversity might influence their environment-related thinking and behaviors (Bakhtiari et al., 2014; Mace et al., 2012; Nguyen & Jones, 2021).

13.2. Conclusion

Biodiversity provides many benefits to humans in general and urban humans in particular. However, the rising population, income, and wildlife product consumption demands contribute to the deliberately organized illegal wildlife trade expansion. Protected areas are places that are designated mainly for biodiversity conservation but currently face financial constraints for management activities. The increased illegal wildlife trade and lack of financing in protected areas can negatively affect biodiversity levels. Thus, the current dissertation is dedicated to answering how urban residents can get involved in biodiversity conservation.

To do so, the dissertation comprises three studies and a data collection about the psychology and behaviors related to biodiversity and conservation among urban humans. As most studies about mental constructs about biodiversity are conducted in developed Western countries and among people living in non-urban areas, little is

known about the mental constructs of urban humans in Vietnam – a developing Asian country. Thus, the first study aims to explore urban humans' mental constructs about biodiversity, setting the ground for designing a questionnaire to serve the subsequent two studies. Semi-structured interviews and Grounded Theory were used to acquire and analyze the responses of 38 residents in Ho Chi Minh city and Hanoi capital city, respectively. The results are displayed following these mental constructs: i) biodiversity and biodiversity loss, ii) impacts of biodiversity and biodiversity loss on humans, and iii) human reaction towards biodiversity and biodiversity loss. Besides identifying important conceptual dimensions, the influence of cultural value, the awareness of multistakeholders' participation, and some misunderstandings were also found in the urban residents' perceptions. These findings offer in-depth knowledge of biodiversity mental constructs in an understudied context: urban areas in an Asian developing country. Moreover, they also provide insights to design a data collection that serves future studies about the interactions between urban humans and biodiversity concepts.

Based on the first study, web-based data collection was carried out among urban residents in major cities across Vietnam. The dataset consists of 535 urban residents' responses about their wildlife consumption behaviors, multifaceted perceptions and interactions with biodiversity-related concepts, and nature-based recreation demand. The data set is constructed with six major categories: 1) wildlife product consumption, 2) general biodiversity perceptions, 3) biodiversity at home and neighborhood, 4)

public park visitation and motivations, 5) national park visitation and motivations, and 6) socio-demographic profiles. These resources are expected to support researchers in enriching the lax literature regarding the role of urban residents in biodiversity conservation and preservation and help policymakers to find insights for building up an "eco-surplus culture" among urban residents through effective public communication and policymaking.

The second and third studies performed the Bayesian mindsponge framework (BMF) on the dataset to eventually answer this dissertation's main questions. However, BMF is not fully developed, so the dissertation extended the BMF by explaining the advantages of Bayesian inference and the mindsponge mechanism and how they are well-matched with each other in studying psychological and behavioral issues.

The second study applied BMF to 535 urban residents' responses to investigate the associations between biodiversity loss perceptions, attitudes towards the prohibition of illegal wildlife consumption, and bushmeat consumption behaviors. It found that people perceiving environmental degradation, losses of economic growth, nature-based recreation opportunities, health, and knowledge as consequences of biodiversity loss were more likely to support the prohibition of illegal wildlife consumption. Although urban residents tended to consume bushmeat less frequently if they perceived losses of economic growth and knowledge as consequences of biodiversity loss, the perception of environmental degradation had the opposite effect on the behavior. Additionally, people consuming bushmeat frequently and supporting the biodiversity loss preventive

measure seemed to share similar features: high income and educational levels. These paradoxical results hint at the existence of cultural additivity effects on psychology and behavior among Vietnamese urban residents.

The third study applied BMF to 535 urban residents' responses to examine the associations between biodiversity loss perceptions, conservation endorsement attitude, and willingness to pay in protected areas. It was found that perceived environmental degradation, loss of economic growth, loss of nature-based recreation opportunity, and loss of knowledge as consequences of biodiversity loss has indirect effects on paying willingness through the mediation of the attitude towards conservation. Especially, the perceived knowledge loss also has a direct positive influence on the willingness to pay for the entrance fee and conservation. In contrast, perceived loss of health is negatively associated with the attitude towards conservation.

13.3. Implications

The current dissertation's findings indicate that it is possible to involve urban humans in tackling biodiversity loss in protected areas. This can be done by financing social marketing and demarketing programs, public awareness-raising campaigns, educational activities, and pro-environmental entertaining platforms (e.g., commercial games) to make urban residents perceive the tremendous consequences of biodiversity loss among urban residents (including their self-interest). Given the influence of cultural additivity, it is recommended to sometimes put tougher measures (e.g. financial punishment) into perspective so that urban people can recognize the high

perceived “cost” of biodiversity loss and change their attitude and behaviors accordingly. If these programs, campaigns, and activities are repeated with a sufficient number, they can help build an eco-surplus culture among urban residents.

Recently, the USAID Biodiversity Conservation Activity, a joint project implemented by the World Wide Fund for Nature (WWF) and the Ministry of Agriculture and Rural Development, has initiated a $1.4 million Species Conservation Fund to support Vietnam in species conservation efforts through local Non-Governmental Organizations and other independent organizations (SCF Team, 2022). Insights from this dissertation will provide directions for those efforts to be implemented effectively and novel approaches to be implemented. Other projects conducted by WWF in countries with analogous socio-cultural and environmental characteristics to Vietnam might also benefit from the dissertation’s findings.

Before the Covid-19 pandemic, the Vietnamese government only fined those involved in hunting, killing, capturing, and trading wildlife illegally. For shops and restaurants, the fines range from 1,000,000 VNĐ ($42.42) to 360,000,000 VNĐ ($15,272.03) depending on the monetary value of the wildlife and their classification by CITES. Due to the threat of zoonotic diseases, the government issued Directive No. 29/CT-TTg to prohibit illegal wildlife consumption, especially among governmental officers and relatives. Although the Directive indicates the need to include sanctions against those who consume illegal wildlife products, no particular sanctions have been implemented until now. The current study’s findings recommend policymakers hasten the

implementation of sanctions against the illicit consumption of wildlife to make the consumers (primarily urban residents) perceive the cost of consuming wildlife products in general and bushmeat in particular.

13.4. Limitations

The dissertation is not without limitations, so they are presented here for transparency (Vuong, 2020). In the first study, as a majority of samples did not have sufficient knowledge about biology and ecology, their answers were relatively confusing and even illogical sometimes (Temple & Young, 2004). Thus, the structures of several unclear responses were rewritten and rearranged during the translation to improve the comprehension and coherence for later coding, analysis, and presentation in the manuscript. Although I tried our best to keep the interviewees' meaning unchanged during the translation and restructure, there was still the possibility that the presented results were not completely similar to the original answers. Furthermore, the qualitative analysis in this current study could not offer representative findings due to the low number of samples. Nevertheless, the first study's in-depth knowledge would lay a foundation for future studies related to urban residents' perceptions about biodiversity conservation and even the natural environment.

In the second and third countries, the convenient sampling strategy due to the prolonged social distancing for COVID-19 containment may lead to selection bias, which reduces the generalization of the findings. By employing the Bayesian analysis, I could provide precise estimations based on the current dataset, facilitating later replicative studies and

comparisons with findings analyzed using randomly. Moreover, given the diverse residencies and background of participants (from cities across Vietnam), the dissertation's findings are still representative to some extent and should be used with caution.

Additionally, in the second study, the bushmeat consumption frequency employed as a dependent variable was quite ambiguous as the question was asked without a time frame. Usually, consumption frequency is referred to the frequency within the last month or two months. In our case, as the social distancing had been enacted for almost two months before the survey collection, it was plausible to think that urban residents rarely consumed any bushmeat during the last two months. As a result, a general question was used to ask the respondent: "How often do you eat bushmeat?" Given this ambiguity, the findings involved in bushmeat consumption frequency should be interpreted with caution.

Another limitation is that there is no evidence that the willingness to pay before and after arriving at the protected areas will remain the same. Although there are possibilities that urban visitors' paying willingness decreases due to protected areas' characteristics and trip features, to some extent, the direct and indirect effects of biodiversity loss perceptions on willingness to pay are still reliable evidence for that improving awareness and knowledge among urban residents can lead to higher willingness to pay in protected areas.

Appendix 1

On developing a management system for the nation's protected areas, the Vietnamese government stated the following objectives (Ministry of Natural Resources and Environment, 2019):

> *(1) Identify critical ecosystems and prepare plans for expanding the system of protected areas; continue to implement the plan to establish marine and wetland protected areas; establish biodiversity corridors connecting natural habitats of threatened species prioritized for protection;*
>
> *(2) Conduct a comprehensive review of biodiversity-related provisions in the current legal documents, and make proposals for revision to ensure consistency; conduct research on institutional structures in order to propose a model for one management authority for protected areas (highlighting the involvement of, and benefits to, communities living in the buffer zones);*
>
> *(3) Improve the management system for protected areas, ensuring they are all established with a Management Board; review the functions, and enhance the capacity of Management Boards; implement policies for incentives for staff working in protected areas; upgrade infrastructure to support activities; provide field equipment for all protected areas, including biodiversity monitoring and reporting systems;*
>
> *(4) Develop and improve regulations on the decentralization, ranking and classification of protected areas, and the procedure for establishing new*

protected areas; prepare and implement management and financial plans, monitoring and regulations for protected areas, with the target to have these in place for all protected areas by 2015;

(5) Conduct investigations and assess the values and ecosystem services of natural protected areas;

(6) Develop long-term plans for investment in the buffer zones of protected areas and implement a sustainable economic model for households in these zones.

Appendix 2

- **English-version questionnaire**

Perceptions towards Biodiversity of Urban People

Time: _____

Date: _____ 2021

Please spend 10-15 minutes to help us fill out this survey.

Part 1: Your experience

1. Do you like eating bushmeat?

☐ 0. No, I don't ☐ 1. Yes, a little ☐ 2. Yes, very much

2. How often do you eat bushmeat?

☐ 0. Never ☐ 1. Sometimes ☐ 2. Often ☐ 4. Very often

3. Have you ever used any of the following products for medical treatment?

Animal bones	**0.** Never	**1.** Yes, a few times	**2.** Yes, quite often
Bear bile	**0.** Never	**1.** Yes, a few times	**2.** Yes, quite often
Pangolin scales	**0.** Never	**1.** Yes, a few times	**2.** Yes, quite often

4. Where did you hear of these products? (*select all that fit*)

☐ Family and friends ☐ Newspaper ☐ Social Media

☐ Book ☐ Doctor ☐ Others: _____

5. Between Chinese traditional and Western medicines, which one is more effective?

☐ Chinese medicine ☐ Equally effective ☐ Western medicine

6. Do you like wearing products made from animal skin/leather/fur? (e.g. snake, crocodile, etc.)

☐ 0. No, I don't ☐ 1. Yes, a little ☐ 2. Yes, very much

7. How many products made from animal skin/leather/fur do you have?

☐ Nothing ☐ 1-3 products ☐ 3-5 products ☐ More than 5 products

8. Do you like having a pet(s) other than dog and cat (e.g. primate, reptiles, birds, etc.)?

☐ 0. No, I don't ☐ 1. Yes, a little ☐ 2. Yes, very much

9. Have you ever nurtured a pet(s) other than dog and cat (e.g. primate, reptiles, birds, etc.)?

☐ 0. No, never ☐ 1. Yes, in the past ☐ 2. Yes, I'm nurturing now

Part 2: Perceptions towards biodiversity/biodiversity loss

10. How do you assess your knowledge about "biodiversity"?

☐ 0. Never heard about ☐ 1. Poor ☐ 2. Adequate ☐ 3. Good

11. What is your thinking of biodiversity loss?

☐ 0. Biodiversity loss is not a reality

☐ 1. Biodiversity loss is real but unimportant

☐ 2. Biodiversity loss is real but only a small problem

☐ 3. Biodiversity loss is real and a major environmental problem

12. To what extent do you agree that the following problems are potential consequences of biodiversity loss:

☹ *1. Strongly Disagree/ 2. Disagree* ☹ ☺ *3. Agree/ 4. Strongly Agree* ☺	
Environmental pollution (air pollution, water pollution, etc.)	**1 – 2 – 3 – 4**
Climate change	**1 – 2 – 3 – 4**
Loss of life balance	**1 – 2 – 3 – 4**
Loss of daily product variety (food, medicine, etc.)	**1 – 2 – 3 – 4**
Negative impacts on economic growth	**1 – 2 – 3 – 4**
Loss of green space	**1 – 2 – 3 – 4**
Loss of natural aesthetics	**1 – 2 – 3 – 4**
Loss of opportunities for nature-based recreation	**1 – 2 – 3 – 4**
Loss of knowledge about nature	**1 – 2 – 3 – 4**
Reduction of quality of life	**1 – 2 – 3 – 4**
Reduction of health	**1 – 2 – 3 – 4**
Reduction of mental well-being	**1 – 2 – 3 – 4**
Reduction of life expectancy	**1 – 2 – 3 – 4**

13. To what extent do you agree that the following methods are potential preventive measures of biodiversity loss:

☹ *1. Strongly Disagree/ 2. Disagree* ☹ ☺ *3. Agree/ 4. Strongly Agree* ☺	
Species conservation in protected areas	**1 – 2 – 3 – 4**
Reduction of deforestation and exploitation	**1 – 2 – 3 – 4**
Environmental law enactment	**1 – 2 – 3 – 4**
Scientific research	**1 – 2 – 3 – 4**
Public communication about biodiversity (loss)	**1 – 2 – 3 – 4**
Education about biodiversity (loss)	**1 – 2 – 3 – 4**
Prohibition of illegal wildlife consumption	**1 – 2 – 3 – 4**
Environmental tax	**1 – 2 – 3 – 4**
Donation for biodiversity conservation	**1 – 2 – 3 – 4**

14. To what extent do you agree with the following statements about the impacts of biodiversity loss:

☹ *1. Strongly Disagree/ 2. Disagree* ☹ ☺ *3. Agree/ 4. Strongly Agree* ☺	
Biodiversity loss adversely affects my daily life	**1 – 2 – 3 – 4**
Biodiversity loss adversely affects my family	**1 – 2 – 3 – 4**
Biodiversity loss adversely affects my neighborhood	**1 – 2 – 3 – 4**
Biodiversity loss adversely affects the city that I'm living	**1 – 2 – 3 – 4**

15. To what extent do you agree with the following statements about the possibility to prevent biodiversity loss:

☹ *1. Strongly Disagree/ 2. Disagree* ☹ ☺ *3. Agree/ 4. Strongly Agree* ☺	
I can do something to reduce biodiversity loss	**1 – 2 – 3 – 4**
My family members can do something to reduce biodiversity loss	**1 – 2 – 3 – 4**
My neighbors can do something to reduce biodiversity loss	**1 – 2 – 3 – 4**
My municipal government can do something to reduce biodiversity loss	**1 – 2 – 3 – 4**

Part 3: Perceptions about biodiversity in/near your house

16. Do you plant plants in your house?

☐ 0. Not at all ☐ 1. Yes, but only a few ☐ 2. Yes, I plant many

17. How many types of plant do you plant?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ More than 5

18. If you have chance, would you plant more plants in your house?

Perceptions towards Biodiversity of Urban People

Time: _____

Date: _____ 2021

Please spend **10-15 minutes** to help us fill out this survey.

☐ 0. No, I wouldn't
☐ 1. Yes, I would plant more plants from the same type
☐ 2. Yes, I would plant more plants from the various types

19. Do you have any pet? ☐ Yes ☐ No

20. What kind of pet do you have? (*select all that fit*)

☐ Cat ☐ Dog ☐ Fish ☐ Others: _____

21. How many types of pet do you have?

☐ 0 ☐ 1 ☐ 2 ☐ More than 2

22. If you have chance, would you obtain more pet?

☐ 0. No, I wouldn't
☐ 1. Yes, I would plant more trees from the same type
☐ 2. Yes, I would plant more trees from the various types

23. Do you feel comfortable when you are in the house?

☐ 0. Very Uncomfortable ☐ 1. Uncomfortable
☐ 2. Comfortable ☐ 2. Very comfortable

24. How does the presence of plants/pets affect the aesthetic of your house?

☐ 0. Very negative effects ☐ 1. Negative effects
☐ 2. Positive effects ☐ 2. Very positive effects

25. Are there many plants around your house?

☐ 0. Not at all ☐ 1. A few ☐ 2. Many ☐ 3. Abundant

26. The local government is planning to plant more trees in the neighborhood, and ask local people to contribute financially. Are you willing to contribute?

☐ 0. Not at all ☐ 1. Unlikely
☐ 2. Likely ☐ 3. Definitely

27. If more plants to be planted in your neighborhood, which aspects do you think would be important? (*select all that fit*)

☐ Amount ☐ Variety ☐ Aesthetics
☐ Location ☐ Utilities (shades, etc.) ☐ Others: _____

Part 4: Public parks near your house

28. Is there any public park near your house?

☐ 0. No ☐ 1. Yes, less than 500 m ☐ 2. Yes, more than 500 m
☐ 0. No ☐ 1. Yes, less than 500 m ☐ 2. Yes, more than 500 m

29. How often do you go to that park?

☐ 0. Never ☐ 1. Almost never ☐ 2. Sometimes
☐ 3. Almost every day ☐ 4. Everyday

30. What are your main reasons of going to the public park near your house? (*select all that fit*)

☐ Relaxation ☐ Physical activities ☐ Meeting with friends
☐ Spending time with family ☐ Educational activities for children
☐ Enjoying nature ☐ Community events ☐ Others: _____

31. The local government is planning to plant more trees in the public park, and ask people who enter the park to contribute financially. Are you willing to contribute?

☐ 0. Not at all ☐ 1. Unlikely
☐ 2. Likely ☐ 3. Definitely

32. If more plants to be planted in the public park, which aspects do you think would be important? (*select all that fit*)

☐ Amount ☐ Variety ☐ Aesthetics
☐ Location ☐ Utilities (shades, etc.) ☐ Others: _____

Part 5: Perceptions about biodiversity in national park

33. How often do you visit a national park/protected area?

☐ 0. Never ☐ 1. Less than once a year
☐ 2. Once a year ☐ 3. Twice a year
☐ 4. More than twice a year

34. What are your main reasons of visiting a national park/protected area? (*select all that fit*)

☐ Escape and Relaxation ☐ Enjoying nature
☐ Watching wild animals ☐ Meeting with friends
☐ Spending time with family ☐ Educational activities for children
☐ Seeking new knowledge (animals, plants, etc.)
☐ Outdoor activities (hiking, trekking, etc.) ☐ Others: _____

35. If you have chance, are you willing to visit a national park/protected area in the next 12 months? (*select all that fit*)

☐ 0. No, I don't even think about it ☐ 1. No, but maybe later
☐ 2. Yes, but I'm still not sure ☐ 3. Yes, certainly

36. When visiting a national park/protected area, are you willing to Very positive effects **pay for the entrance fee?**

☐ 0. No, I'm not ☐ 1. Yes, I'd pay around _____VNĐ/turn

37. When visiting a national park/protected area, are you willing to donate for biodiversity conservation activities?

☐ 0. No, I'm not ☐ 1. Yes, I'd pay around _____VNĐ/month

Part 6: Socio-demographic information

38. Gender: ☐ Male ☐ Female ☐ Other

39. Age: _____ **40. Occupation:** _____

41. What is the highest education level you completed?

☐ Primary school ☐ Secondary school ☐ Highschool
☐ Undergraduate ☐ Post-graduate

42. Monthly income: _____thousand VNĐ

43. Have you ever lived near the following areas? (*select all that fit*)

☐ Forest ☐ Ocean ☐ River ☐ Cropland ☐ Pond

44. What are your main sources of environment-related information? (*select all that fit*)

☐ Newspaper ☐ Online newspaper ☐ Social Media
☐ Lecture ☐ Word of mouth (friends, family etc.)
☐ Books ☐ Textbooks ☐ Documentary movies
☐ Observations ☐ Local government ☐ Others: _____

45. Where did you spend the majority of your life time?

☐ Urban ☐ Sub-urban ☐ Rural ☐ Other

This is the end of the survey. Thank you for your help

- **Vietnamese-version questionnaire**

Quan điểm về Đa dạng sinh học của người thành thị

Thời gian: _____

Ngày: _____ 2021

Hãy dành **10-15 phút** giúp chúng tôi trả lời khảo sát dưới đây

Phần 1: Trải nghiệm của bản thân

1. Bạn đã từng ăn thịt động vật hoang dã chưa?

☐ 0. Chưa từng ☐ 1. Có, ăn ít ☐ 2. Có, ăn nhiều

2. Bạn có thường xuyên ăn thịt động vật hoang dã không?

☐ 0. Chưa ăn bao giờ ☐ 1. Thỉnh thoảng ☐ 2. Thường xuyên
☐ 4. Rất thường xuyên

3. Bạn đã từng sử dụng các sản phẩm dưới đây để chữa bệnh chưa?

Xương hổ	**0.** Chưa từng	**1.** Có, vài lần	**2.** Có, khá thường xuyên
Mật gấu	**0.** Chưa từng	**1.** Có, vài lần	**2.** Có, khá thường xuyên
Vảy tê tê	**0.** Chưa từng	**1.** Có, vài lần	**2.** Có, khá thường xuyên

4. Bạn được nghe về các sản phẩm này từ nguồn nào (*chọn tất cả các đáp án thích hợp*)

☐ Gia đình và bạn bè ☐ Báo chí ☐ Mạng xã hội
☐ Sách ☐ Bác sĩ ☐ Khác: _____

5. Giữa Đông Y và thuốc tây, theo bạn loại nào hiệu quả hơn?

☐ Đông Y ☐ Hiệu quả như nhau ☐ thuốc Tây

6. Bạn có thích mang những sản phẩm làm từ da/lông động vật không (ví dụ: rắn, cá sấu, v.v.)

☐ 0. Không thích ☐ 1. Có, khá thích ☐ 2. Có, rất thích

7. Bạn sở hữu bao nhiêu sản phẩm làm từ da/lông đông vật?

☐ Không có ☐ 1-3 sản phẩm ☐ 3-5 sản phẩm ☐ Hơn 5 sản phẩm

8. Bạn có thích các loài thú cưng nào khác ngoài chó mèo không (ví dụ: linh trưởng, bò sát, chim, v.v.)

☐ 0. Không thích ☐ 1. Có, khá thích ☐ 2. Có, rất thích

9. Bạn đã từng nuôi các loài thú cưng nào khác ngoài chó mèo chưa (ví dụ: linh trưởng, bò sát, chim, v.v.)

☐ 0. Chưa từng ☐ 1. Có, đã từng nuôi trước đây ☐ 2. Có, hiện đang nuôi

Phần 2: Quan điểm về đa dạng sinh học/ mất đa dạng sinh học

10. Bạn đánh giá kiến thức của mình về "Đa dạng sinh học" như thế nào?

☐ 0. Chưa từng nghe tới ☐ 1. Yếu ☐ 2. Khá ☐ 3.Tốt

11. Bạn nghĩ thế nào về mất đa dạng sinh học?

☐ 0. Mất đa dạng sinh học không có thật

☐ 1. Mất đa dạng sinh học có thật nhưng không gây ra vấn đề gì to tát

☐ 2. Mất đa dạng sinh học có thật và gây ra vấn đề lớn đến môi trường

12. Theo bạn, đâu là hậu quả do mất đa dạng sinh học gây ra?

☹ *1. Rất không đồng ý/ 2. Không đồng ý* ☹ ☺ *3. Đồng ý/ 4. Rất đồng ý* ☺	
Ô nhiễm môi trường (ô nhiễm không khí, nguồn nước, v.v.)	**1 – 2 – 3 – 4**
Biến đổi khí hậu	**1 – 2 – 3 – 4**
Mất cân bằng cuộc sống	**1 – 2 – 3 – 4**
Mất sự đa dạng của các loại sản phẩm tiêu dùng (thức ăn, thuốc, v.v.)	**1 – 2 – 3 – 4**
Ảnh hưởng tiêu cực đến phát triển kinh tế	**1 – 2 – 3 – 4**
Mất các không gian xanh	**1 – 2 – 3 – 4**
Mất cảnh quan thiên nhiên	**1 – 2 – 3 – 4**
Mất cơ hội tham gia các hoạt động giải trí ngoài thiên nhiên	**1 – 2 – 3 – 4**
Kiến thức về tự nhiên bị mai một	**1 – 2 – 3 – 4**
Giảm chất lượng cuộc sống	**1 – 2 – 3 – 4**
Sức khỏe thể chất suy giảm	**1 – 2 – 3 – 4**
Sức khỏe tinh thần suy giảm	**1 – 2 – 3 – 4**
Giảm tuổi thọ	**1 – 2 – 3 – 4**

13. Bạn đồng ý ở mức độ nào với các phương thức phòng chống mất đa dạng sinh học dưới đây:

☹ *1. Rất không đồng ý/ 2. Không đồng ý* ☹ ☺ *3. Đồng ý/ 4. Rất đồng ý* ☺	
Bảo tồn các giống loài trong khu bảo tồn	**1 – 2 – 3 – 4**
Giảm khai thác và nạn phá rừng	**1 – 2 – 3 – 4**
Ban hành luật môi trường	**1 – 2 – 3 – 4**
Nghiên cứu khoa học	**1 – 2 – 3 – 4**
Tăng cường truyền thông đại chúng về (mất) đa dạng sinh học	**1 – 2 – 3 – 4**
Giáo dục về (mất) đa dạng sinh học	**1 – 2 – 3 – 4**
Cấm tiêu thụ động vật hoang dã trái phép	**1 – 2 – 3 – 4**
Thuế môi trường	**1 – 2 – 3 – 4**
Quyên góp bảo vệ đa dạng sinh học	**1 – 2 – 3 – 4**

14. Theo bạn, mất đa dạng sinh học đang ảnh hưởng đến khu vực nào sau đây?

☹ *1. Rất không đồng ý/ 2. Không đồng ý* ☹ ☺ *3. Đồng ý/ 4. Rất đồng ý* ☺	
Cuộc sống của tôi	**1 – 2 – 3 – 4**
Gia đình của tôi	**1 – 2 – 3 – 4**
Khu vực tôi đang sống	**1 – 2 – 3 – 4**
Thành phố tôi đang sống	**1 – 2 – 3 – 4**

15. Theo bạn, ai có thể đóng góp cho việc ngăn chặn mất đa dạng sinh học?

☹ *1. Rất không đồng ý/ 2. Không đồng ý* ☹ ☺ *3. Đồng ý/ 4. Rất đồng ý* ☺	
Cá nhân tôi	**1 – 2 – 3 – 4**
Gia đình tôi	**1 – 2 – 3 – 4**
Những người trong khu vực tôi sống	**1 – 2 – 3 – 4**
Chính quyền	**1 – 2 – 3 – 4**
Các tổ chức quốc tế	**1 – 2 – 3 – 4**

Phần 3: Quan điểm về đa dạng sinh học trong/gần nhà của bạn

16. Bạn có trồng cây trong nhà không?

☐ 0. Không ☐ 1. Có, nhưng chỉ vài cây ☐ 2. Có, trồng nhiều

17. Bạn trồng bao nhiêu giống cây

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ Hơn 5

18. Nếu có cơ hội bạn có muốn trồng thêm nhiều cây trong nhà không?

☐ 0. Không có ý định

Quan điểm về Đa dạng sinh học của người thành thị

Thời gian: _____

Ngày: _____ 2021

Hãy dành **10-15 phút** giúp chúng tôi trả lời khảo sát dưới đây

☐ 1. Có, sẽ trồng thêm nhiều cây cùng giống

☐ 2. Có, sẽ trồng thêm nhiều cây khác giống nhau

19. Bạn có nuôi thú cưng không? ☐ Có ☐ Không

20. Bạn nuôi loại thú cưng gì? (*chọn tất cả các đáp án thích hợp*)

☐ Mèo ☐ Chó ☐ Cá ☐ Khác: _____

21. Bạn nuôi bao nhiêu loại thú cưng khác nhau?

☐ 0 ☐ 1 ☐ 2 ☐ Hơn 2

22. Nếu có cơ hội, bạn có muốn nuôi thêm nhiều thú cưng không?

☐ 0. Không có ý định

☐ 1. Có, muốn nuôi thêm nhiều con cùng loại

☐ 2. Có, muốn nuôi thêm nhiều con khác loại nhau

23. Bạn có cảm thấy thoải mái khi ở nhà không?

☐ 0. Rất không thoải mái ☐ 1. Không thoải mái

☐ 2. Thoải mái ☐ 2. Rất thoải mái

24. Việc có cây trồng/ thú cưng có ảnh hưởng đến mỹ quan của nhà bạn không?

☐ 0. Ảnh hưởng rất tiêu cực ☐ 1. Ảnh hưởng tiêu cực

☐ 2. Ảnh hưởng tích cực ☐ 2. Ảnh hưởng rất tích cực

25. Quanh nhà bạn có nhiều cây không?

☐ 0. Không ☐ 1. Có vài cây ☐ 2. Nhiều ☐ 3. Rất nhiều

26. Giả sử chính quyền địa phương dự định trồng thêm cây trong khu bạn sống, và đề nghị bạn đóng góp tiền. Bạn có sẵn lòng đóng góp không?

☐ 0. Hoàn toàn không ☐ 1. Không sẵn lòng lắm

☐ 2. Sẵn lòng ☐ 3. Rất sẵn lòng

27. Nếu khu bạn sống được trồng thêm nhiều cây, bạn nghĩ yếu tố nào dưới đây là quan trọng? (*chọn tất cả các đáp án thích hợp*)

☐ Số lượng ☐ Độ đa dạng ☐ Mỹ quan

☐ Vị trí ☐ Ứng dụng (bóng râm, v.v.) ☐ Khác: _____

Phần 4: Công viên công cộng gần nhà bạn

28. Gần nhà bạn có công viên công cộng nào không?

☐ 0. Không ☐ 1. Có, cách dưới 500m ☐ 2. Có, cách hơn 500m

29. Bạn có thường ra công viên đó không?

☐ 0. Không bao giờ ☐ 1. Thỉnh thoảng

☐ 2. Gần như hàng ngày ☐ 3. Hàng ngày

30. Lý do khiến bạn đi công viên công cộng gần nhà là gì (*chọn tất cả các đáp án thích hợp*)

☐ Thư giãn ☐ Hoạt động thể chất ☐ Gặp gỡ bạn bè

☐ Dành thời gian với gia đình

☐ Hoạt động mang tính giáo dục cho trẻ nhỏ

☐ Tận hưởng thiên nhiên ☐ Hoạt động cộng đồng

☐ Khác: _____

31. Giả sử chính quyền địa phương dự định trồng thêm nhiều cây trong công viên, và đề nghị những người dân vào công viên đóng góp tiền. Bạn có sẵn lòng đóng góp không?

☐ 0. Hoàn toàn không ☐ 1. Không sẵn lòng lắm

☐ 2. Sẵn lòng ☐ 3. Rất sẵn lòng

32. Nếu có thêm nhiều cây được trồng trong công viên, bạn nghĩ yếu tố nào dưới đây là quan trọng (*chọn tất cả các đáp án thích hợp*)

☐ Số lượng ☐ Độ đa dạng ☐ Mỹ quan

☐ Vị trí ☐ Ứng dụng (bóng râm, v.v.) ☐ Khác: _____

Phần 5: Quan điểm về đa dạng sinh học trong Vườn Quốc gia

33. Bạn có thường đi thăm Vườn Quốc gia/khu bảo tồn không?

☐ 0. Không bao giờ ☐ 1. Dưới 1 lần/năm

☐ 2. Một lần/năm ☐ 3. Hai lần/ năm

☐ 4. Hơn 2 lần/năm

34. Lý do khiến bạn đi thăm Vườn Quốc gia/khu bảo tồn là gì? (*chọn tất cả các đáp án thích hợp*)

☐ Giải tỏa và thư giãn ☐ Tận hưởng thiên nhiên

☐ Xem các loài động vật hoang dã ☐ Gặp gỡ bạn bè

☐ Dành thời gian với gia đình ☐ Giáo dục cho trẻ nhỏ

☐ Học hỏi thêm kiến thức mới (động vật, thực vật, v.v.)

☐ Hoạt động ngoài trời (leo núi, đi bộ, v.v.) ☐ Khác: _____

35. Nếu có cơ hội, bạn có muốn đi thăm Vườn Quốc gia/khu bảo tồn trong vòng 12 tháng tới không? (*chọn tất cả các đáp án thích hợp*)

☐ 0. Không, không nghĩ tới ☐ 1. Không, nhưng sẽ đi sau đấy

☐ 2. Có, những vẫn chưa chắc ☐ 3. Có, chắc chắn

36. Khi đi thăm Vườn Quốc gia/khu bảo tồn, bạn có sẵn lòng trả tiền vé vào cửa không?

☐ 0. Không ☐ 1. Có, tôi sẽ trả khoảng _____VNĐ/lượt

37. Khi đi thăm Vườn Quốc gia/khu bảo tồn, bạn có sẵn lòng quyên góp cho hoạt động bảo tồn đa dạng sinh học không?

☐ 0. Không ☐ 1. Có, tôi sẽ trả khoảng _____VNĐ/tháng

Phần 6: Thông tin cá nhân

38. Giới tính: ☐ Nam ☐ Nữ ☐ Khác

39. Tuổi: _____ **40. Nghề nghiệp:** _____

41. Trình độ học vấn cao nhất của bạn là gì?

☐ Tiểu học ☐ Cấp 2 ☐ Cấp 3

☐ Đại học ☐ Sau đại học

42. Thu nhập tháng: _____**nghìn VNĐ**

43. Bạn có từng sống gần những khu vực nào dưới đây không? (*chọn tất cả các đáp án thích hợp*)

☐ Rừng ☐ Biển ☐ Sông ☐ Cánh đồng ☐ Ao

44. Bạn biết tới các thông tin liên quan đến môi trường thông qua các nguồn nào là chính? (*chọn tất cả các đáp án thích hợp*)

☐ Báo chí ☐ Báo mạng ☐ Mạng xã hội

☐ Bài giảng ☐ Truyền miệng (bạn bè, gia đình, v.v.)

☐ Sách ☐ Sách giáo khoa ☐ Phim tài liệu

☐ Quan sát ☐ Chính quyền địa phương ☐ Khác: _____

45. Bạn dành phần nhiều thời gian sống ở đâu?

☐ Thành thị ☐ Vùng cận thành thị

☐ Nông thôn ☐ Khác:_____

Bảng khảo sát đến đây là kết thúc. Cảm ơn sự giúp đỡ của anh/chị

Supplementary

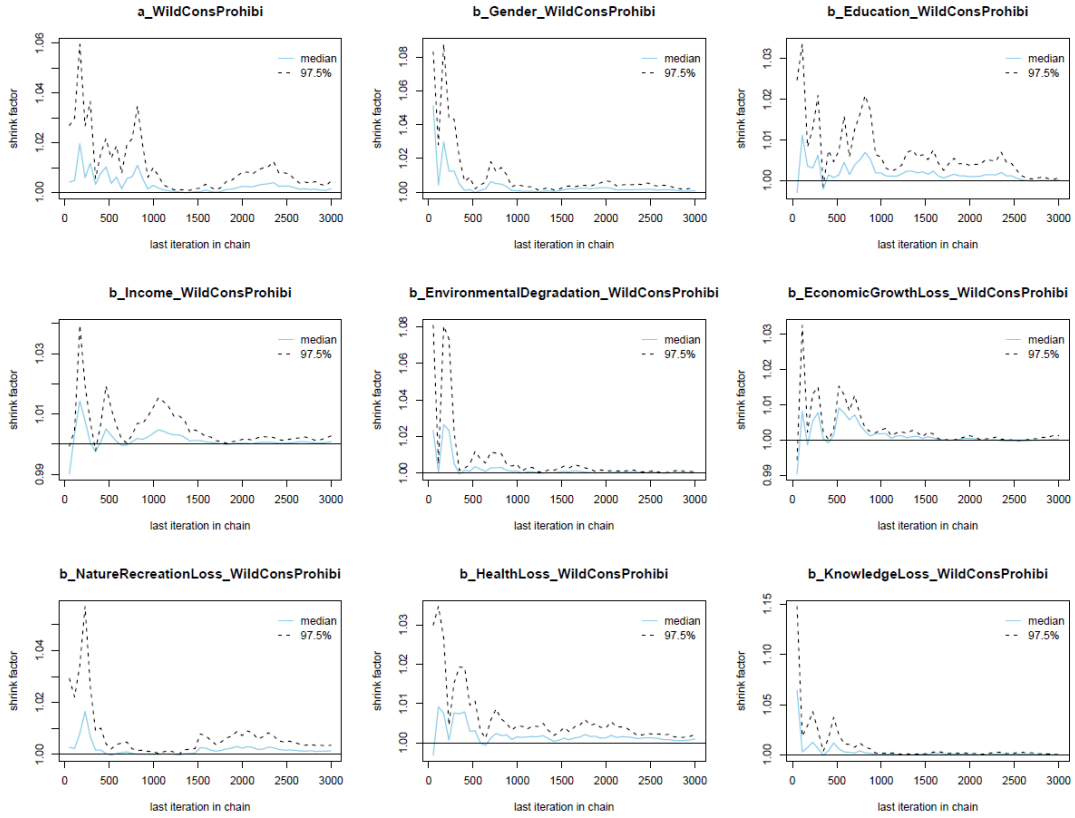

Figure S1: Model 1.b's Gelman plots with priors as norm (1,0.5) (second study)

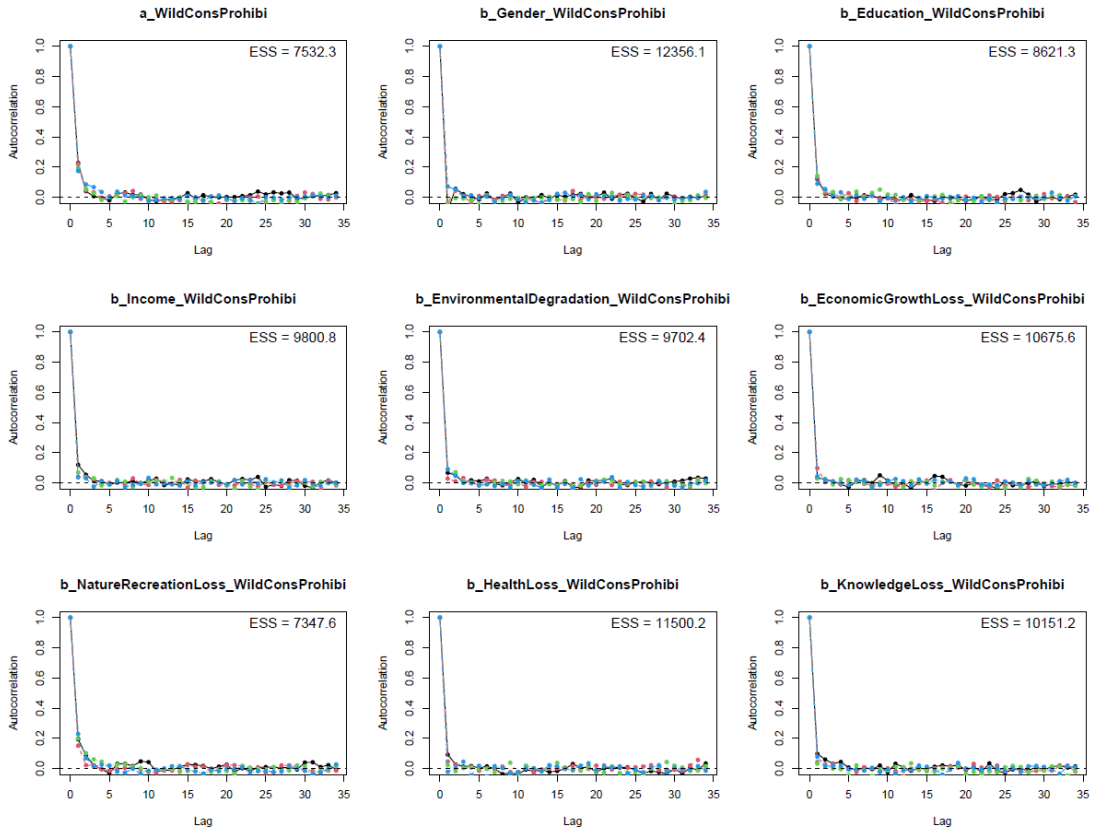

Figure S2: Model 1.b's autocorrelation plots with priors as norm (1,0.5) (second study)

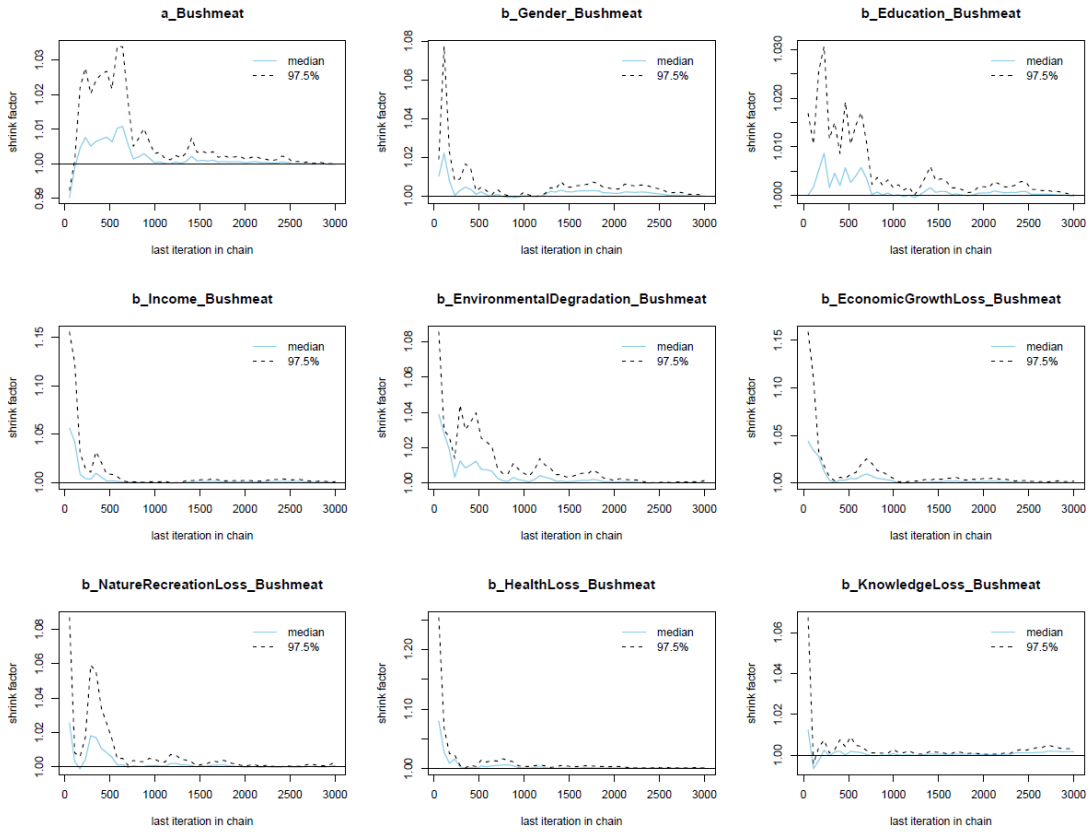

Figure S3: Model 2.b's Gelman plots with priors as norm (1,0.5) (second study)

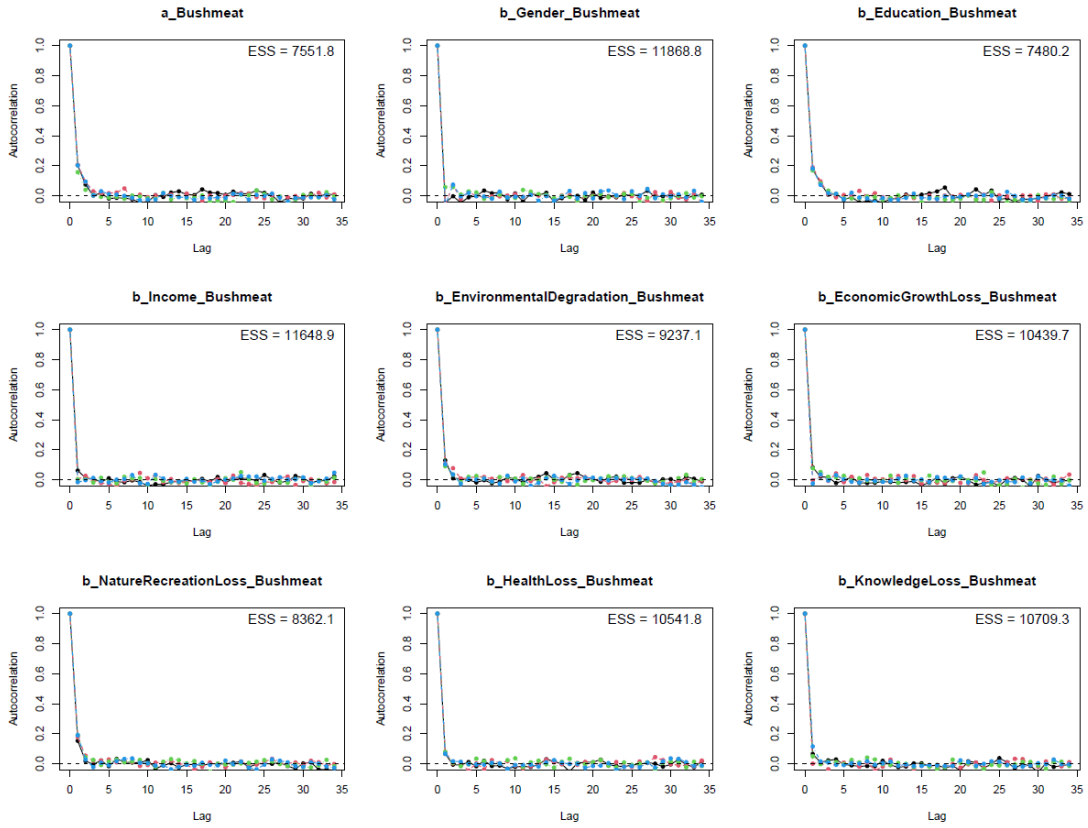

Figure S4: Model 2.b's autocorrelation plots with priors as norm (1,0.5) (second study)

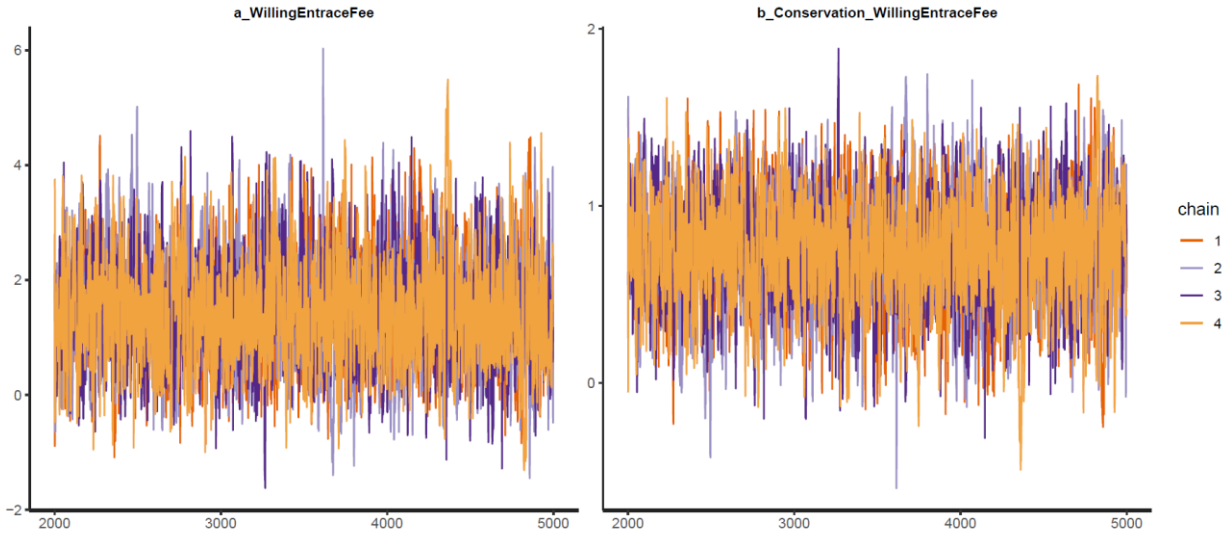

Figure S5: Model 2a's trace plots with priors as norm (1,0.5) (third study)

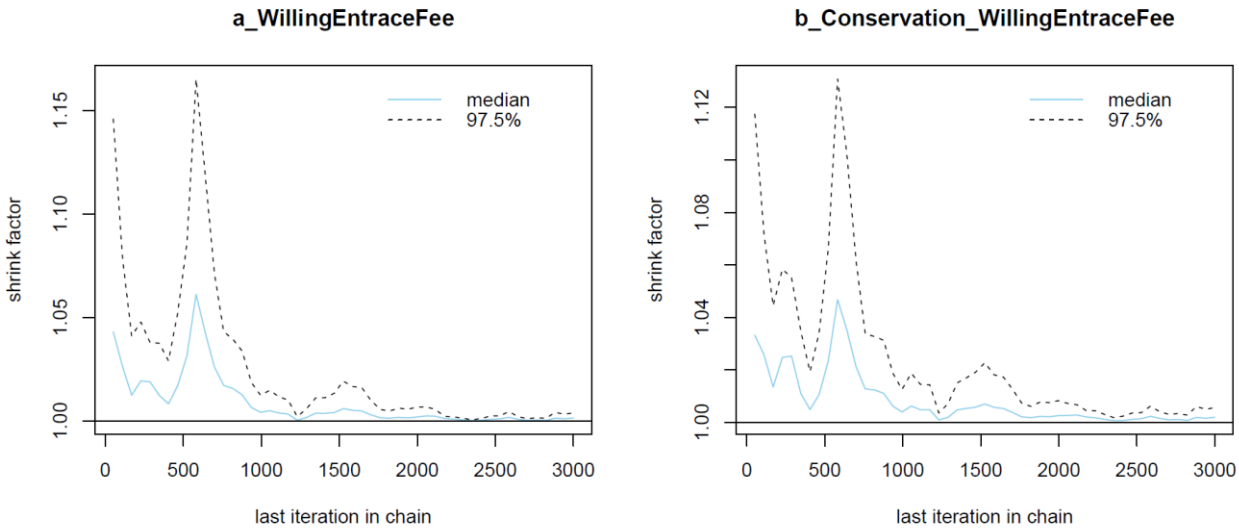

Figure S6: Model 2a's Gelman plots with priors as norm (1,0.5) (third study)

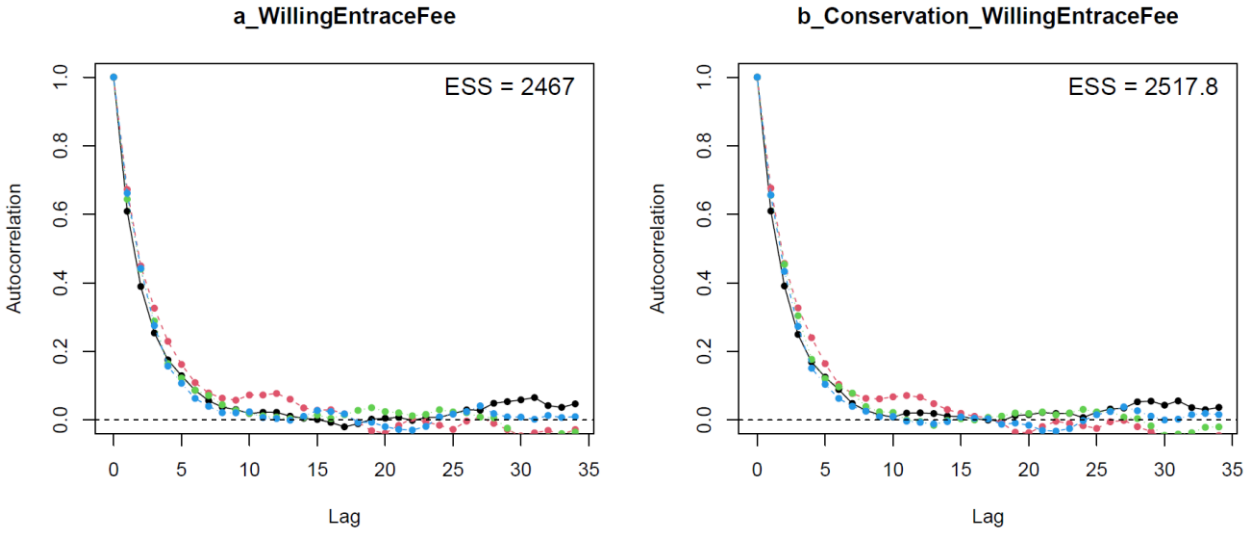

Figure S7: Model 2a's Gelman plots with priors as norm (1,0.5) (third study)

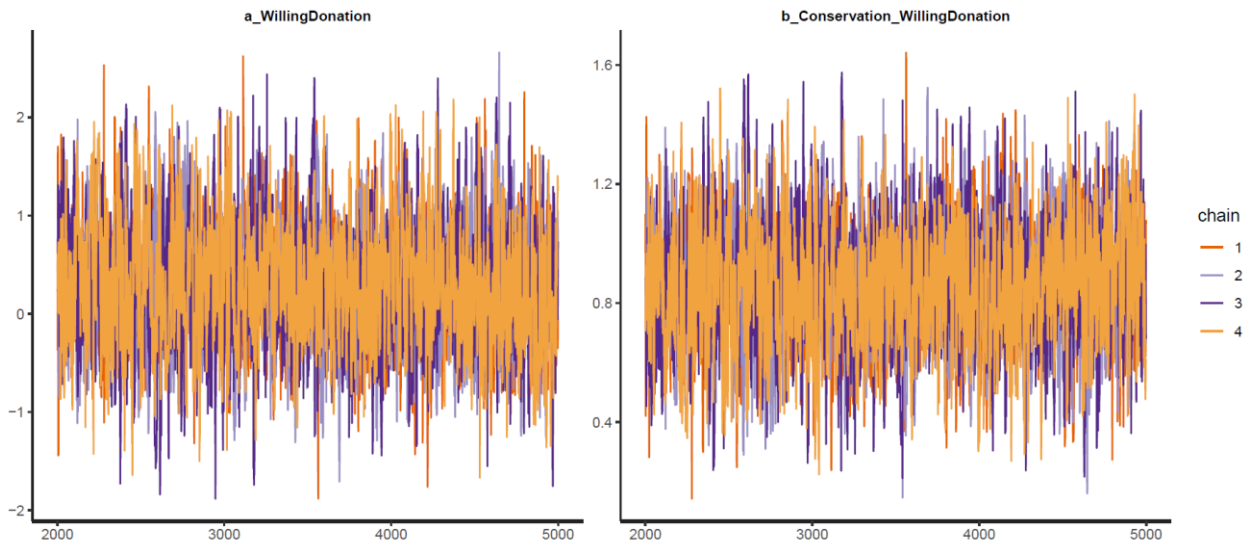

Figure S8: Model 2b's trace plots with priors as norm (1,0.5) (third study)

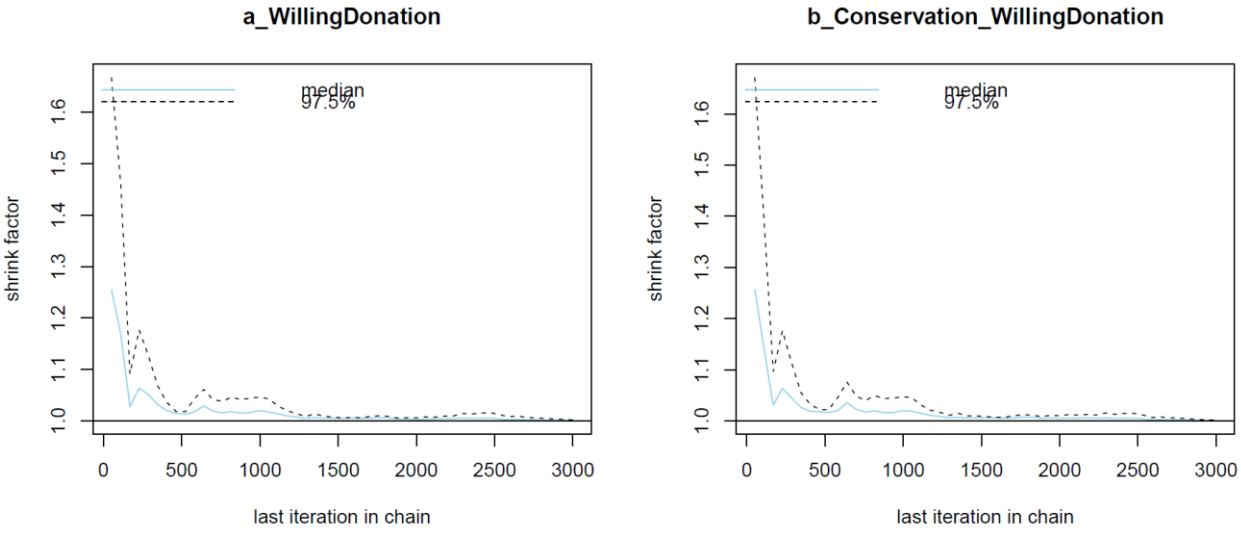

Figure S9: Model 2b's Gelman plots with priors as norm (1,0.5) (third study)

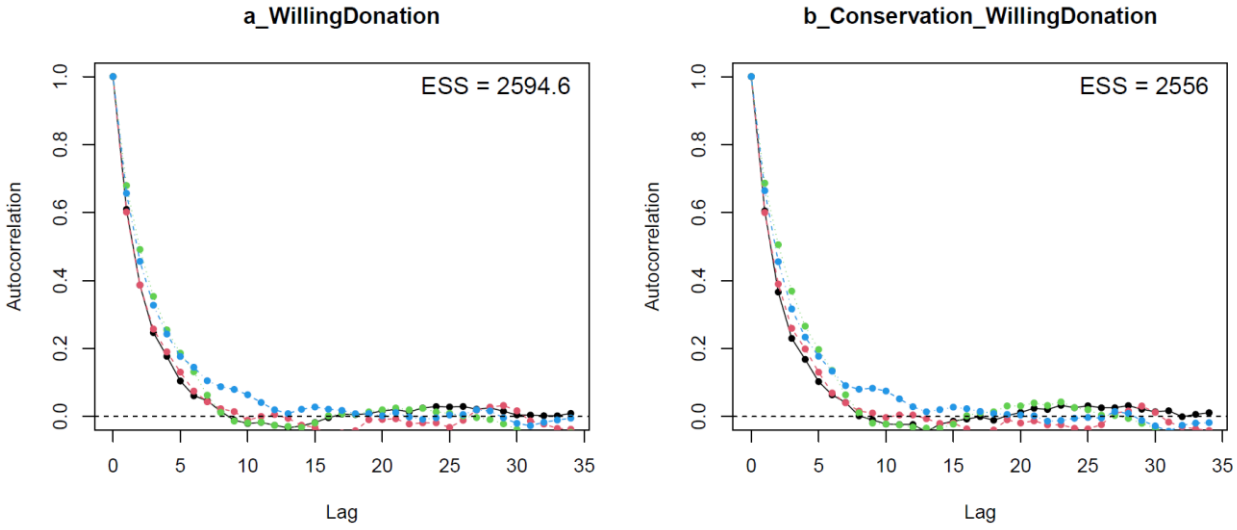

Figure S10: Model 2b's autocorrelation plots with priors as norm (1,0.5) (third study)

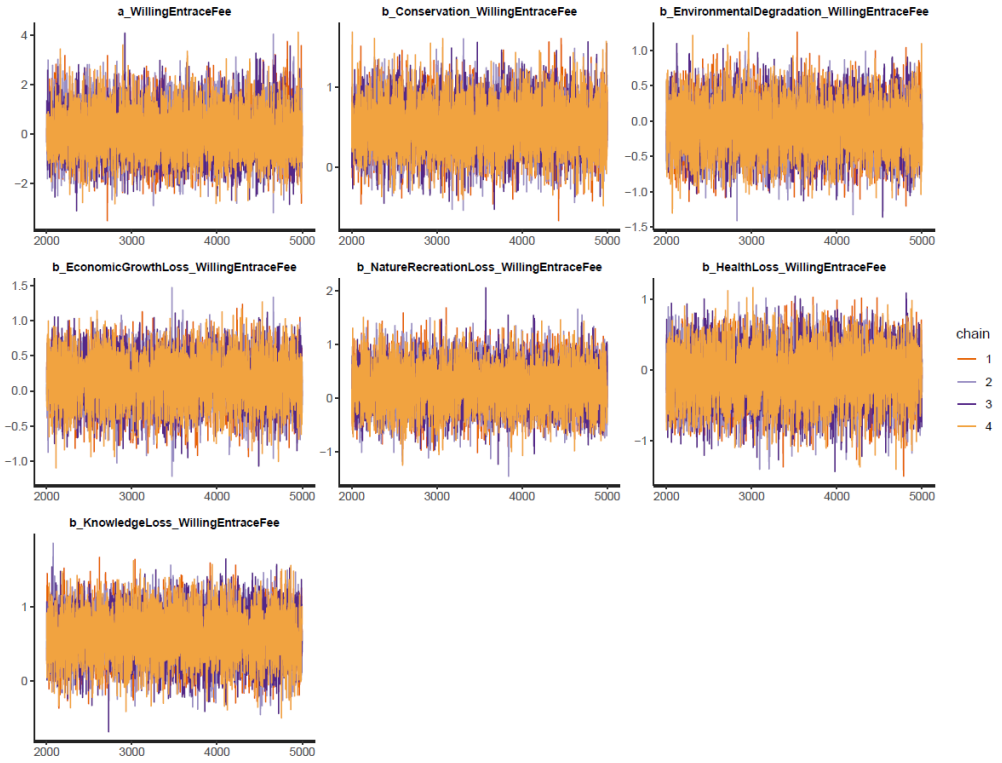

Figure S11: Model 3a's trace plots with priors as norm (1,0.5) (third study)

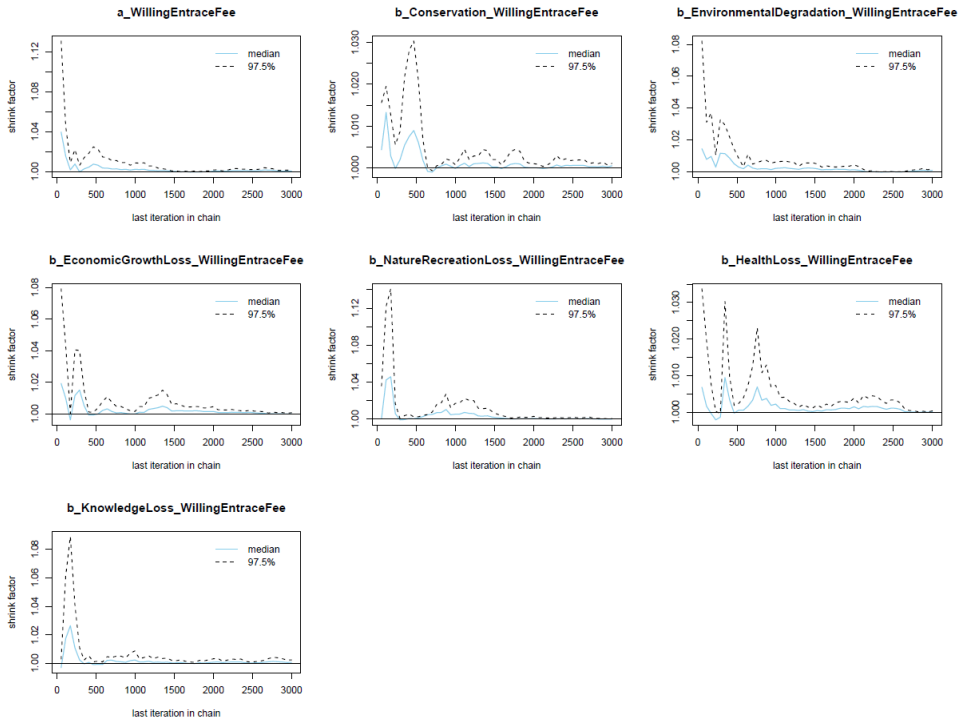

Figure S12: Model 3a's Gelman plots with priors as norm (1,0.5) (third study)

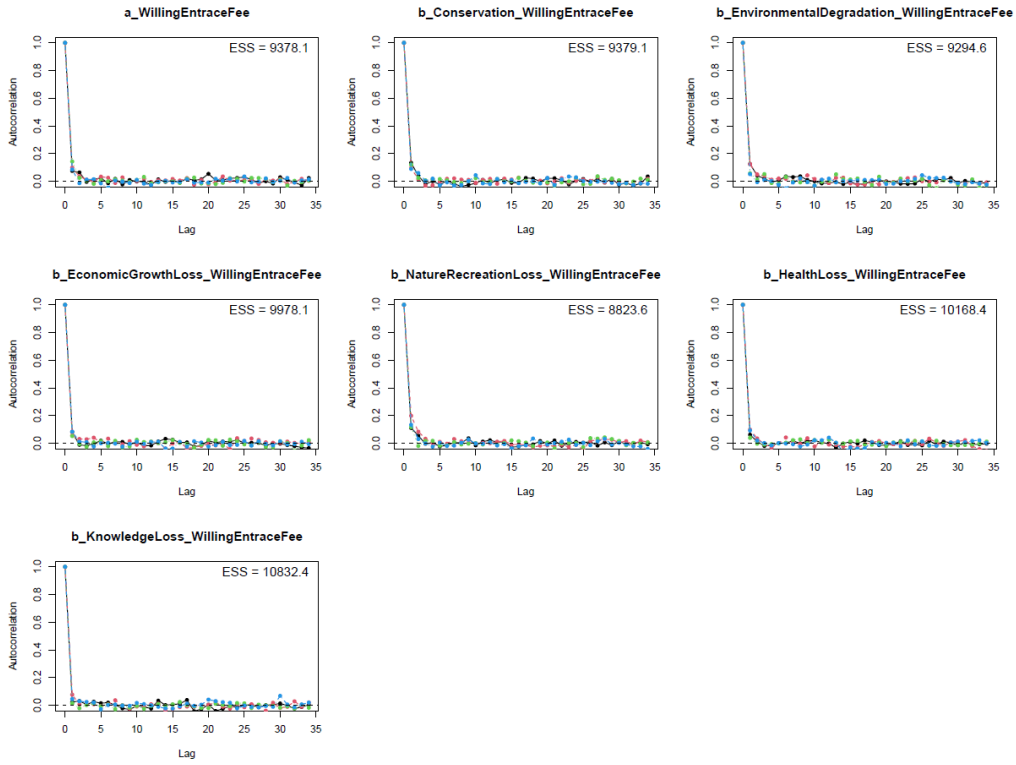

Figure S13: Model 3a's autocorrelation plots with priors as norm (1,0.5) (third study)

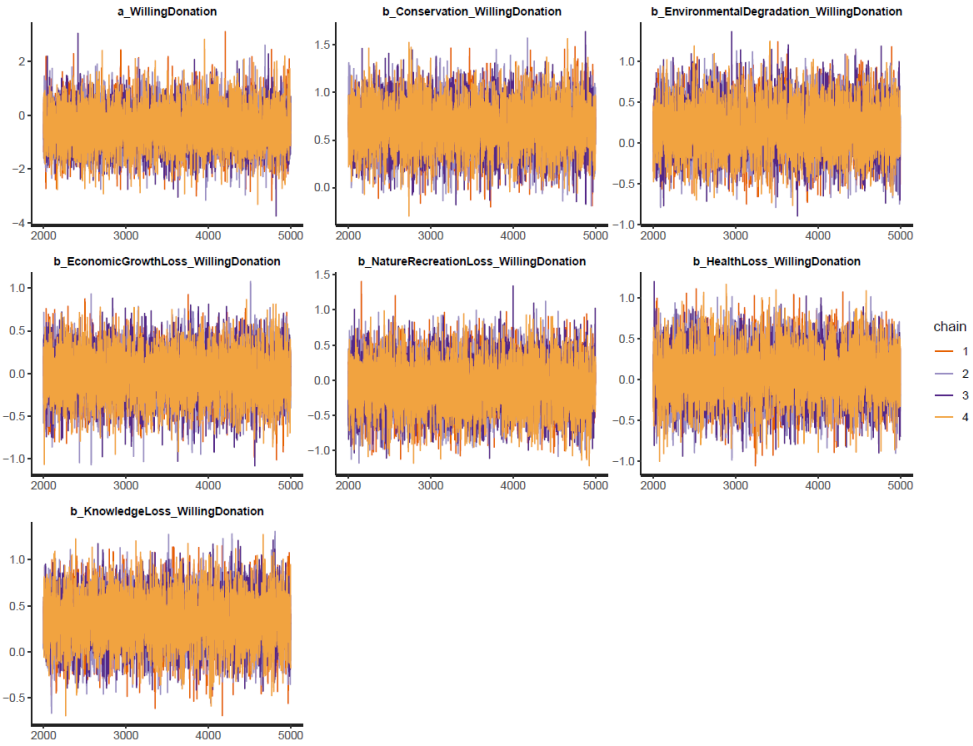

Figure S14: Model 3b's trace plots with priors as norm (1,0.5) (third study)

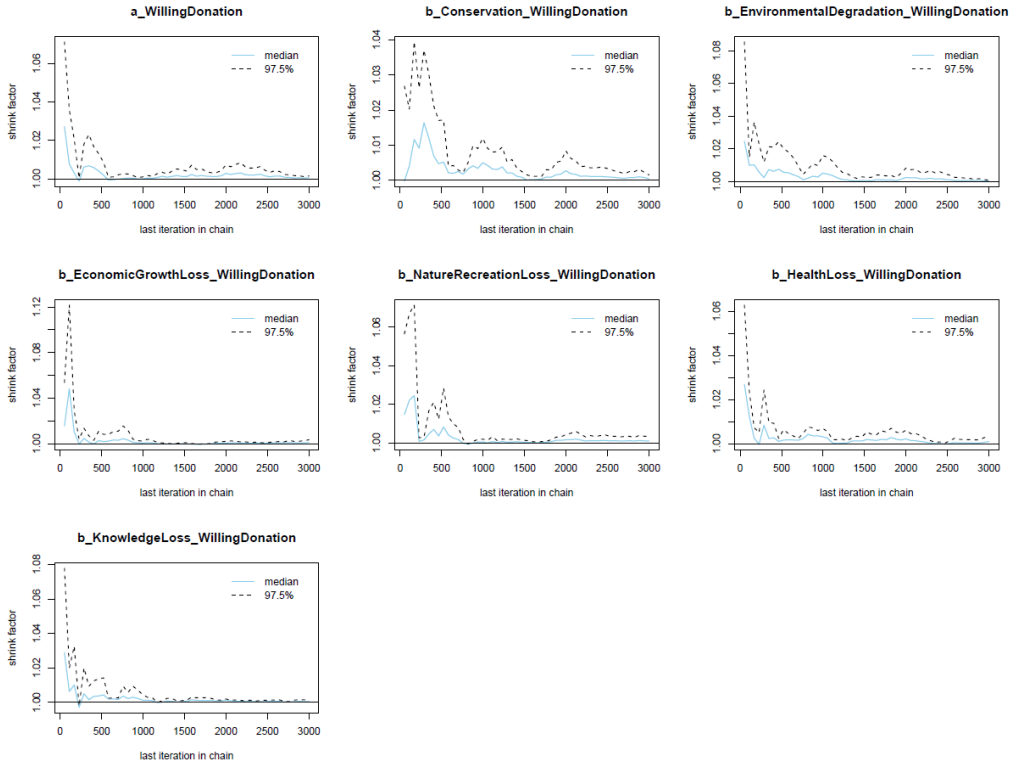

Figure S15: Model 3b's Gelman plots with priors as norm (1,0.5) (third study)

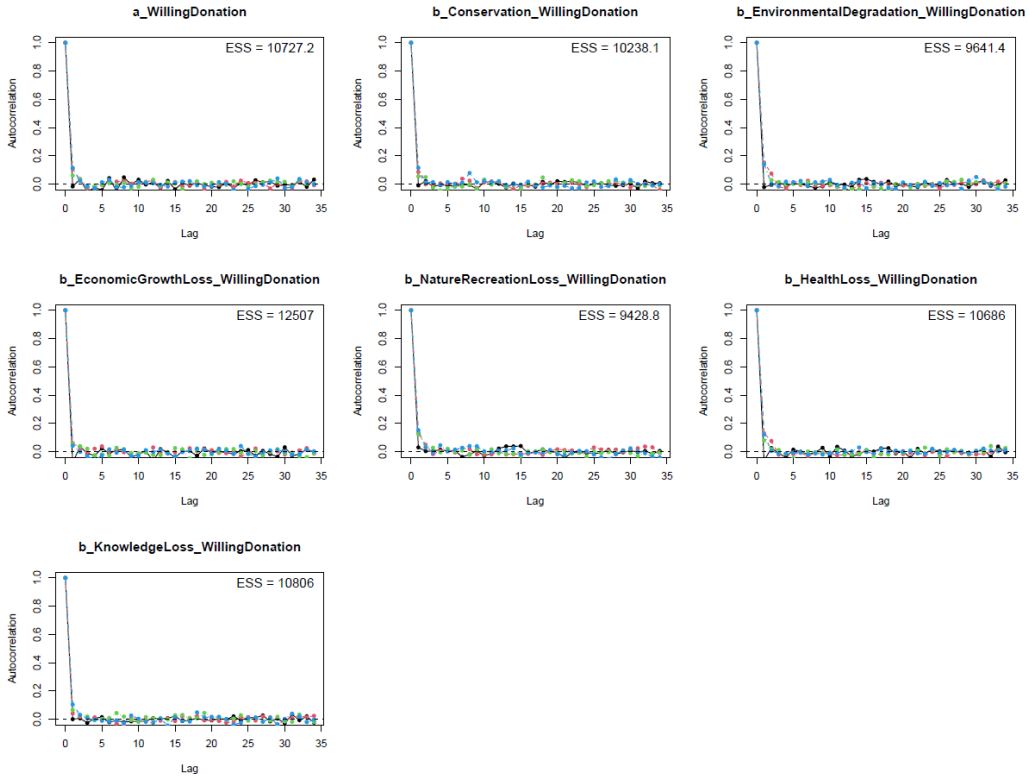

Figure S16: Model 3b's autocorrelation plots with priors as norm (1,0.5) (third study)

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