Perceived ecosystem services in wetland parks: the case of Guangzhou, China

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Abstract

Wetlands are essential for maintaining the regional water balance, regulating the regional climate and preserving biodiversity. In China, natural wetlands have declined due to urban sprawl. In recent years though, new wetland parks (WPs) have been designed and constructed to compensate for the loss of natural wetlands and to help reduce the risk of urban flooding. WPs have also been created to improve urban resilience and enhance well-being. However, the benefits people get from these WPs are not well understood.

This thesis examines the Chinese public's perceptions of the ecosystem services (ESs) provided by wetland parks and compares them with the ESs measured using technical knowledge. The study location is Guangzhou, a megacity located in the Pearl River Delta. Guangzhou has been a pioneer in creating wetland parks in China. All citizens benefit from WPs through their capacity to reduce flood risk to nearby communities, but additional benefits may accrue to those who visit the parks. Visitors were the participants in this study and their views on ESs were noted. Based on a literature review, content analysis of social media data and an online survey, it is found that the most valued ecosystem services include wildlife habitat, aesthetics and recreation. The perception of these three ESs were analysed using mixed methods including a questionnaire, semi-structured interviews, participatory mapping and a discrete choice experiment, through a case study of two WPs in Guangzhou. For the purpose of augmenting the benefits that visitors receive from WPs, perception-influencing variables were identified and the relationship between the three ESs was addressed. The findings indicate that the importance of wildlife habitat service was highlighted by visitors as having health benefits and leading to aesthetic appreciation but the species richness of WPs was underestimated. The perception of the three ESs were correlated; when the three ESs cannot be enhanced at the same time, the majority of visitors prioritise the aesthetic service, which benefits them the most. Improving wildlife habitat service and aesthetic value while maintaining the recreation service could provide the best utility. The results provide empirical evidence for managing ESs provided by WPs and encourage the development of similar urban wetlands.

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Declaration

I, the author, confirm that the Thesis is my own work. I am aware of the University's Guidance on the Use of Unfair Means (*www.sheffield.ac.uk/ssid/unfair-means*). This work has not been previously been presented for an award at this, or any other, university.

Some portions of this thesis have been published in peer-reviewed publications. Copyright permissions are included in Appendix - D.

1. Zhai, X., Cameron, R. and Lange, E. (2023) 'Wetland Parks in Guangzhou: Ecosystem Services and Perception', in Nijhuis, S., Sun, Y., and Lange, E. (eds) *Adaptive Urban Transformation*. Cham: Springer International Publishing (The Urban Book Series), pp. 285–299. doi: 10.1007/978-3-030-89828-1_15.

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Glossary and abbreviations

Terminology	Abbreviation	definition
Ecosystem Service(s)	ES(s)	The direct or indirect benefits that people get from the ecosystem.
Perceived Ecosystem Service(s)	PES(s)	The benefits (i.e., ecosystem services) that people perceive and assign value to from the ecosystem.
Technical Understanding of Ecosystem Service(s)	TUES(s)	Ecosystem services that offered by ecosystems no matter whether humans perceived those benefits.
Perceived Wildlife Habitat service	PWH	The benefits that people perceive and assign value to as a result of the habitat for wildlife residents and transient populations.
Perceived Aesthetic Value	PAV	The perceived benefits and value attributed to the enjoyment of beautiful scenery.
Perceived Recreation Service	PRS	The perceived benefits and assigned value of engaging in recreational activities.
wetland		This research adapts the definition by the Ramsar Convention, which is the basis for national wetland classification and survey in China: 'wetlands are 'areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of with at low tide does not exceed six metres'(RSC(Ramsar Convention Secretariat), 2016).
Wetland Park(s)	WP(s)	Specific areas or parkland within the urban area defined and administrated for wetland protection, restoration, education, research, ecotourism and recreation (Ministry of Housing and Urban-Rural Development of the People's Republic of China, 2017; National Forestry and Grassland Administration, 2017).
Tianhe (Daguan) Wetland Park	TDWP	One of the case study sites of this thesis. (In Chinese: 天河湿地公园)
Haizhu National Wetland Park	HNWP	One of the case study sites of this thesis. (In Chinese: 海珠国家湿地公园)

Quality Improvement Project	QIP	An engineering renovation project conducted between 2019 and 2022 to improve the quality of the HNWP.
Kruskal-Wallis H test	K-W H test	A nonparametric test used to assess whether there are significant differences between groups of an independent variable on a continuous or ordinal dependent variable.
Mann-Whitney U test	M-W U test	A nonparametric test used to assess whether there are significant differences between two groups of an independent variable on a continuous or ordinal dependent variable.
Kaiser–Meyer–Olkin test	KMO test	A statistical measure used to assess the data's suitability for factor analysis.
Geographically Weighted Regression	GWR	A spatial statistical technique used to model and analyse the spatial relationships between variables in geography. It is an extension of the conventional linear regression model that takes into account spatial heterogeneity.
emergy		(spelled with an 'm') The amount of energy used in direct and indirect processes to create a product or service (Tennenbaum, 2015). It is a measure of the differences in quality between various forms of energy.
synaesthesia		A perceptual phenomenon whereby stimulation of one sensory or cognitive pathway induces involuntary experiences in a second sensory or cognitive pathway.
Citizen Science	CS	An inclusive and cooperative methodology for scientific study, wherein individuals from the general public, commonly known as 'citizen scientists,' actively engage in the scientific process.
Discrete Choice Experiment	DCE	A research method examines how individuals make choices between options or alternatives, with a focus on understanding their preferences and the trade-offs they are willing to make in different scenarios.

Discrete Choice Model	DCM	A statistical framework for analysing and modelling individuals' choices in the discrete choice experiment.
utility		The degree of happiness or satisfaction an individual derives from his or her situation. Wellbeing is measured.(Mankiw, 2016, p. 410)
marginal utility		An increase in utility caused by a gradual enhancement of an attribute.
Willingness-to-pay	WTP	The maximum amount that a buyer will pay for a good (Mankiw, 2016, p. 134).
Compensating Variation	CV	An economic concept that measures the perceived benefit consumers received from a good or service before and after a policy change.
Multinomial Logit	MNL	A statistical technique in econometrics and choice modelling to analyse and predict discrete choices among multiple alternatives.
Random Parameter Logit	RPL	An extension of the MNL model by incorporating heterogeneity through the inclusion of randomly varying individual-specific parameters.
Independence from Irrelevant Alternatives	IIA	The restrictive assumption in the MNL model. It states that the ratio of choice probabilities remains the same regardless of the presence of other alternatives in a choice set.
Chinese Yuan	CNY	The official currency of the People's Republic of China.

Chapter 1. Introduction

1.1 Background

Human activities have resulted in the loss of at least 33 percent of the world's wetlands as of 2009. The area affected by wetland loss has been highest in Asia, while Europe has seen the most severe losses (Hu *et al.*, 2017, p. 319). China's wetland area decreased by approximately 33% between 1978 and 2008, in dramatic contrast to the 122% increase in the number of artificial wetlands (Niu *et al.*, 2012, p. 2813). In the remaining natural wetlands, ecological functions are disappearing, and the ecosystems have deteriorated (Yin, 2003).

Within this context, since 2004, a large number of wetland parks (WPs) have been built in China to protect, compensate, and rationally utilise wetland resources (Ma, 2016). Up to the end of 2017, in Chinese Mainland, a total of 1,699 WPs based on natural wetlands have been created (China Wetland Conservation Association, 2018). The design and construction of WPs often employ three strategies: 1) inspired by natural wetlands (e.g., constructed vertical flow or subsurface wetlands, floating raft systems); 2) supported by natural wetlands (e.g., the Lake Tai National Wetland Park in Suzhou); 3) imitating natural wetlands with low-tech or easily operated measures (e.g., free-water surface constructed wetlands).

The surging number of WPs can be a result of the widely held belief that the construction of WPs is one of the direct and effective ways to maintain and expand the protected area of wetlands under the rapid urbanisation; it contributes to the ecological restoration in the unbalanced development of urban ecosystems (Zhang *et al.*, 2012). In addition, as a specific type of natural or man-made wetland, WP was intended to contribute to flood control and function as a component of the 'Sponge City', as did the Sustainable Urban Drainage System (SuDS) (Yu, 2015). And they are considered to play an important role in improving the ecological situation, providing recreational facilities, conserving urban water sources, maintaining regional water balance, regulating regional climate, reducing pollutants, and protecting biodiversity (Lei, 2005).

The rapid growth of WPs has raised concerns, emphasising the importance of evaluating their actual role. For example, are WPs genuinely effective at improving ecological function and saving/regulating water supply (Sang, 2009)? Researchers also suspect that WPs with their simple design, short development cycle and lack of regional cultural characteristics might face difficulties in meeting both ecological and cultural requirements (Zhang, Zhou and Gao, 2012). Further, current regulations emphasise only the area of wetlands, and no other aspects of quality. In addition, it is hard to tell whether a new-born WP plays a better role than the land that was there before: for example, digging dike-ponds and river to an artificial lake, or diverting the natural river and destroying nearby forests to build a new riverine wetland park (Figure 1-1).

There are studies that evaluate WPs from either a biophysical or human standpoint, yet WPs contribute to both biophysical ecosystems and human well-being. Considering that wetlands contribute to both perspectives and that assessment from either perspective could favour one and dismiss the other, and that understanding how people interact with ecosystems and what benefits they receive from ecosystems is crucial for gaining public support for wetland restoration (Scholte et al., 2016), a more comprehensive approach – ecosystem services (ES) – will be investigated.

ESs can be simply understood as direct or indirect benefits that human get from ecosystems (Millennium Ecosystem Assessment, 2005). It is a method for establishing a connection between healthy biophysical ecosystems and human well-being. The effect of ESs (such as air purification, microclimate regulation, noise reduction, rainwater drainage, sewage treatment, recreational and cultural values) provided by urban ecosystems (including wetlands) on the quality of urban living was highlighted (Bolund and Hunhammar, 1999).

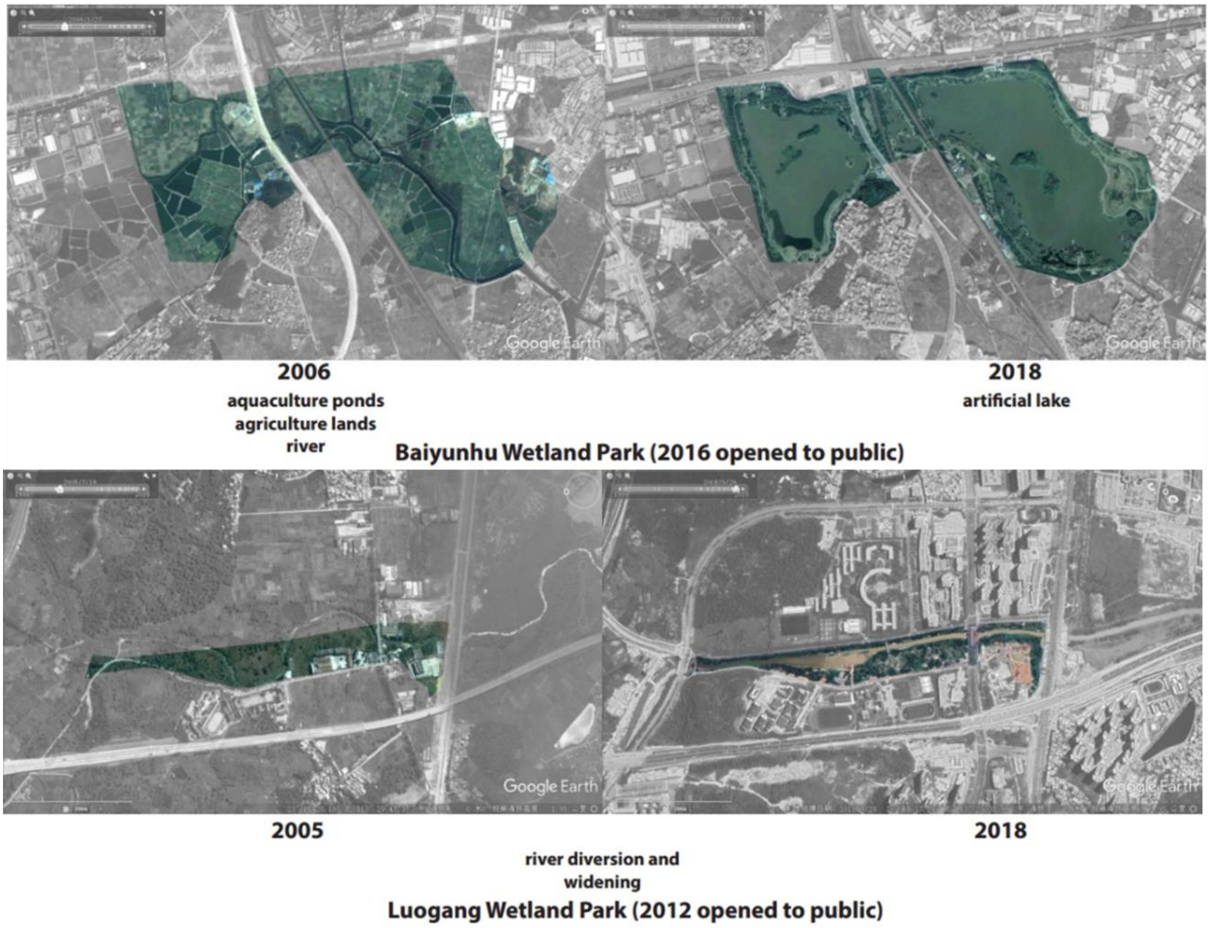


Figure 1-1 Wetland parks: past and present

It has been demonstrated that ESs approach facilitates biodiversity conservation, decision making, site management, and spatial planning. Biodiversity conservation does not necessarily constitute a trade-off between ‘environment’ and ‘development’ (de Groot et al., 2010, p. 270). The ESs approach aids in biodiversity conservation by generating evidence for gaining public and policy support, enhancing the value of protected areas, and sustaining managed ecosystems beyond protected areas (Ingram, Redford and Watson, 2012). The evaluation of ESs can also contribute to the process of decision-making within a cyclical framework: (1) decisions and actions can influence ecosystems; (2) ecosystem structure and functions are translated into the provision of services; (3) services generate values; (4) information about values is embedded in institutions; and (5) institutions motivate discussions and decision-making (Daily *et al.*, 2009). Further, ES assessment can facilitate a shift in the way that decision-makers think (Posner, Getz and Ricketts, 2016). In addition, it is significant to incorporate ESs into land-use and land-management decisions, and coupling these decisions to incentives that appropriately reflect social returns (Polasky *et al.*, 2011). Hence, ES approach is a valid method for enhancing the sustainability of ecosystems and decision making.

Most ESs studies primarily examine rural landscapes, with limited attention given to urban ecosystems that are closer proximity to human society. Furthermore, there is even less research specifically addressing the delivery of ESs by urban wetlands. A study on global wetlands found that human-made wetlands are highly valued for their positive impacts on biodiversity enhancement, water quality improvement, and flood control (Ghermandi *et al.*, 2010). However, rivers and shallow lakes were excluded in their study because of their controversial classification as wetland ecosystems. From the perception perspective, it was found that users engage in urban green space in China because of the visual-scenic and recreation aspects, while wildlife habitat, species conservation and other ESs draw limited attention (Jim and Chen, 2006). The existing literature on urban ecosystems or wetlands also lacks thorough coverage of wetland types and ESs types.

1.2 Research aim, objectives, and hypothesis

In order to relate the biophysical world of wetland park (WPs) and human well-being, and to understand what roles do WPs actually play, **this research aims to investigate the characteristics and influencing factors of ecosystem services (ESs) delivery in WPs, bridging the physical environment and public perception.** The following research objectives would facilitate the achievement of this aim. A hypothesis toward each objective is presented following each objective.

Objective 1: To identify ESs that are more critical to WPs, especially those valued by the public (i.e., focal ESs).

1) WPs do not supply all of the ESs outlined in the framework; some ESs are more critical to WPs than others.

2) Certain ESs are more easily recognised or deemed to be more significant by the general public.

Objective 2: To determine the extent to which public perceptions of ESs are consistent with technical understanding.

ESs that are perceived by the public might be underestimated or overestimated, or similar to that supplied by the ecosystem.

Objective 3: To determine the factors that influence ESs perception in WPs.

1) Influence of landscape characteristics:

   a) Certain landscape characteristics enhance perceptions of specific ESs.

   b) The same landscape characteristics could contribute to the delivery of multiple ESs

   c) The current assessment framework for ESs may not align closely with the Chinese cultural background. Some landscape features that are commonly used as indicators for the assessment of ESs may not be important in the Chinese cultural background, while some landscape features that are important may be ignored in current assessment framework.

2) Influence of demographic factors:

Certain demographic features (such as age or income) may enhance perceptions of specific ESs.

3) Influence of spatial factors:

The delivery of ecosystem services has some commonality across geographic space.

4) Influence of temporal factors:

Seasonal variations exist in the delivery of ESs. For example, in the subtropical monsoon climate zone, summer may be more conducive to flood control service delivery.

Objective 4: To explore the relationships and interactions between perceptions of focal ESs.

1) There exist trade-offs and synergies between perceptions of focal ESs, in values and throughout spatial

extent.

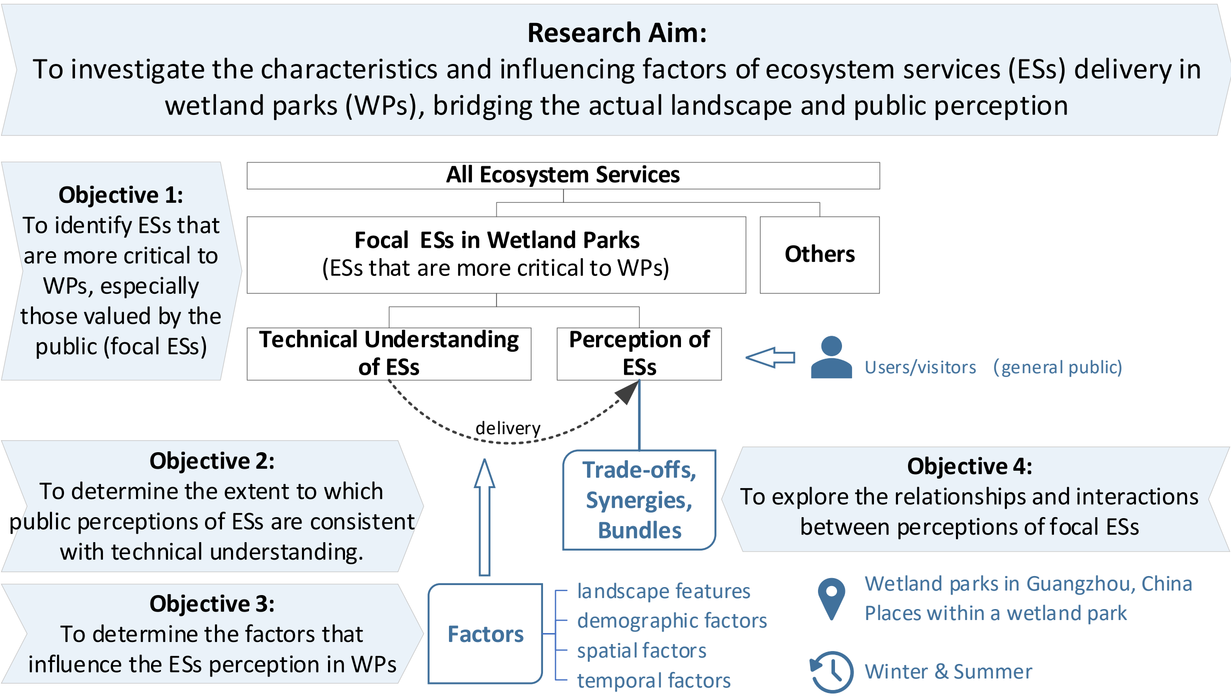


Figure 1-2 Conceptual framework

Objective 1 is the overarching (umbrella) objective (Figure 1-2). Objective 2 is primarily a preparation for Objective 3. Besides, Objective 2 itself would suggest implications to enhance the perception of critical ESs that were underestimated by public. By achieving Objective 3, ESs delivery can be enhanced by improving certain landscape features, and the benefits obtained by specific visitor groups could be enhanced. Besides, measures that can enhance ESs delivery can be targeted for different populations. By achieving Objective 4, an ES could be enhanced by improving another ES that synergizes with it, and decision making could be more reasonable when ESs trade-offs are understood.

1.3 Scope of the thesis

This thesis studies ecosystem services (ESs) delivery in wetland parks (WPs), spanning the real landscape and public perception. Except for the section on the influence of covid-19 (Chapter 6), this study was restricted to **visitors' perceptions of wetland parks in Guangzhou, China**. And this thesis's data set is confined to the years **between 2018 and 2023**. It is important to note that this study focuses on the ESs (not the disservices) of **inland watershed WPs** due to their prevalence and significance to urban areas. Since both national and urban WPs are found in urban or suburb areas, with similar goals and names, this thesis does not differentiate between the two types. This study primarily examines the man-made wetland parks in Guangzhou, as they constitute the majority of the city's wetland parks. When analysing the factors that influence ESs delivery, only landscape features, demographic data, spatial factors, and temporal factors are addressed, even if there may be additional remarkable elements.

1.3.1 Guangzhou as the research area

This thesis focuses on Guangzhou, which is a mega-city in southern China (Figure 1-3), covering a total area of 7,434.4 km^2, with 1874.03 million residents (by the end of 2020) (Guangzhou Statistics Bureau, 2020). As a region where the rivers of the Pearl River system meet and flow to the South China Sea, Guangzhou has abundant water resources, but is extremely vulnerable to floods. Over the past 40 years, the area of wetlands in Guangzhou has decreased dramatically; large areas of mudflats have been replaced with urban development (Zhao *et al.*, 2016). Most remaining wetlands in the Pearl River Delta (excluding permanent rivers and shallow marine waters) are artificial wetlands including fish ponds and reservoirs, thus the wetlands lose their resilience (State Forestry and Grassland Administration, 2015). To protect wetland resources and strengthen the city's resilience to floods, 20 WPs have been created in Guangzhou in the last decade (Bureau of Forestry and Landscaping of Guangzhou Municipality, 2017, 2018).

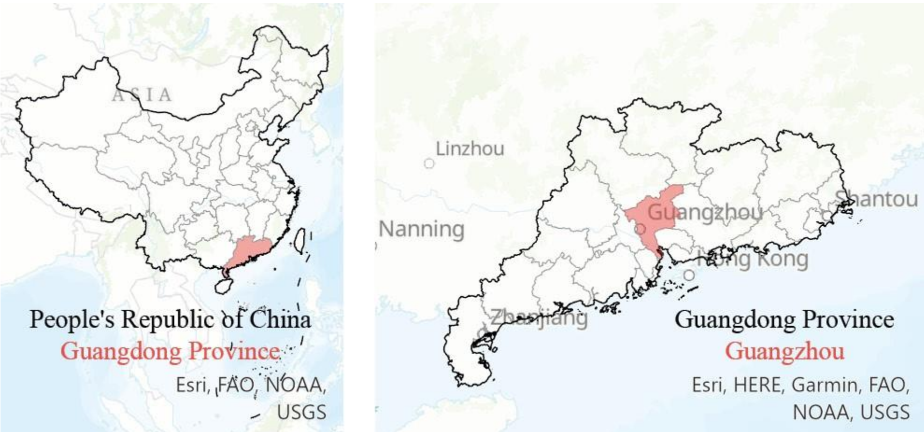
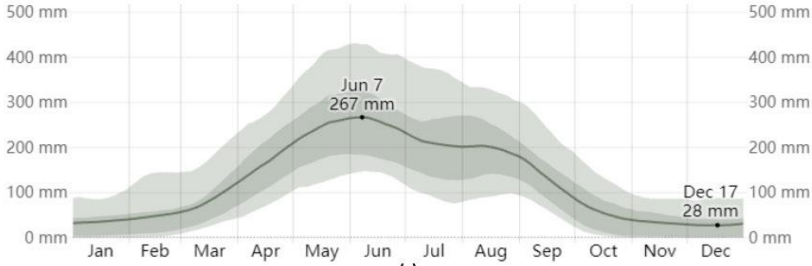


Figure 1-3 Location of Guangzhou

Guangzhou has a **humid subtropical climate** influenced by the East Asian monsoon. Due to the climate, Guangzhou experiences two main seasons: a rainy season and a dry season, without distinct four seasons. The summers are moist (Figure 1-4), with high temperatures (Figure 1-5), high humidity, and a high heat index, lasting from April to September, with July and August being the hottest months. Guangzhou has short and warm springs and autumns. Winters are short and mild, moderately dry, sunny, and snowless.



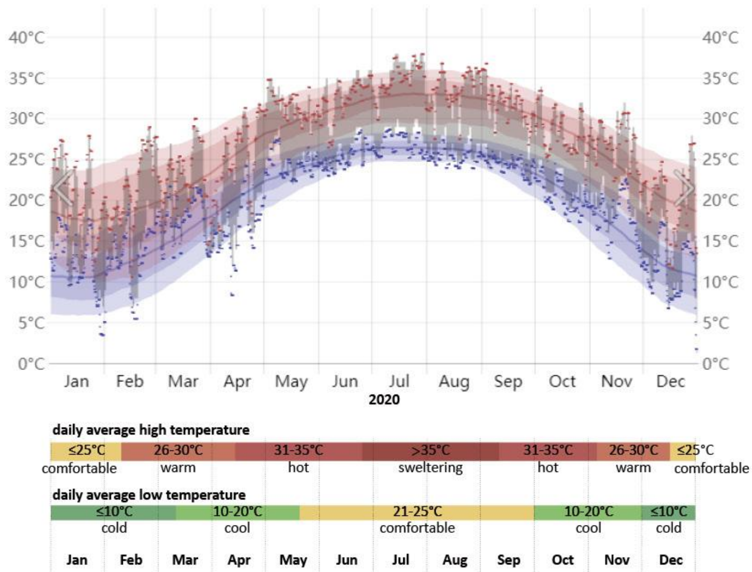
(a)

The average rainfall (solid line) accumulated over the course of a sliding 31-day period centered on the day in question, with 25th to 75th and 10th to 90th percentile bands.

(b)

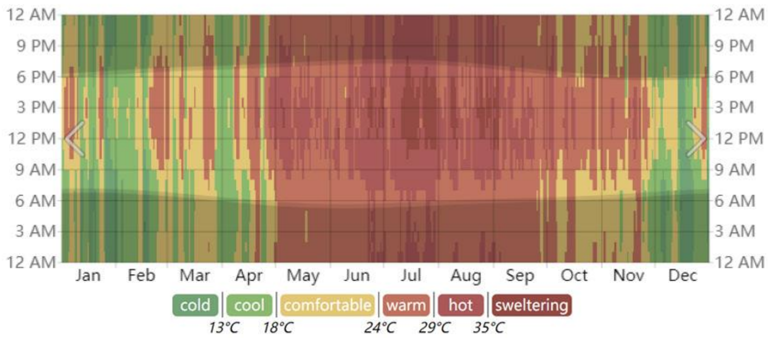
The percentage of days in which various types of precipitation are observed, excluding trace quantities: rain alone, snow alone, and mixed (both rain and snow fell in the same day).

Figure 1-4 Annual precipitation of Guangzhou (an example of 2020) © WeatherSpark.com



(a)

The daily range of reported temperatures (gray bars) and 24-hour highs (red ticks) and lows (blue ticks), placed over the daily average high (faint red line) and low (faint blue line) temperature, with 25th to 75th and 10th to 90th percentile bands.



(b)

The hourly reported temperature, color coded into bands. The shaded overlays indicate night and civil twilight.

Figure 1-5 Annual and hourly temperature of Guangzhou (an example of 2020) © WeatherSpark.com

1.4 Research significance and contribution to knowledge

This thesis contributes to our understanding of ecosystem services (ESs) associated with wetland parks (WPs), and the extent to which people are aware of, and value those services. It links landscape features to specific ESs, and citizen's perceptions of those services. Theoretically, this thesis compares the technical understanding and public perception of ESs to clarify the ESs flow from biophysical ecosystem to human wellbeing. By involving seasonal variation and the influence of the covid-19 pandemic, this thesis broadens the temporal scale of ESs research. This thesis evaluates ESs on site scale, a scale that not covered by most research, thus extending our spatial understanding of ESs. Further, findings of the characteristics and influencing factors of ESs delivery contribute to a better understanding the mechanisms underlying the generation of ESs, and provide evidence for optimization of current ESs assessment methodology as well. Therefore, evidence from this thesis would facilitate sustainable management, planning and design of WPs in regions beyond Guangzhou that with similar climate and cultural context.

1.5 Thesis structure

This study is structured as follows in order to develop and provide insights to meet the objectives of the research:

In the beginning, the first two chapters of this thesis are dedicated to providing context and reviewing relevant literature, followed by an outline of the research design. Chapter 1 provides a background introduction, proposes the research aims, objectives, and hypotheses of this thesis, outlines the scope of the thesis, and clarifies the significance of this study and its contribution to knowledge. Chapter 2 offers an overview of the literature on wetland parks (WPs) and ecosystem services (ESs). Due to the iterative nature of this thesis's development, separate chapters will be devoted to a comprehensive literature review of each of the focal ES. Methodological frameworks for evaluating ESs in WPs are outlined in Chapter 3, along with the study's research design, which is based on a few specific written step-by-step tools. In the same chapter, the research design methodology that are employed consistently throughout the thesis are described, whereas in the following chapters, the specific approaches that were used to evaluate the featured ES are presented.

Based on literatures, Chapter 4 describes the changing urban wetland landscape in Guangzhou and the transition of any ESs, as well as identifies the beneficiaries of WPs. Chapter 5 and Chapter 6 identify priority ESs for evaluation. In particular, Chapter 5 includes a survey on the perceived health effects of WPs during the peak of the covid-19 pandemic in 2020. This chapter examines the impact of the severity of the pandemic and pandemic prevention strategies using data from Chinese cities including Guangzhou. Chapter 6 examines the public's perception of ESs within WPs in Guangzhou through the use of social media, and which of these are most appreciated by the public. These three chapters establish the basis for the case studies that follow.

Chapter 7 outlines the delivery of ESs in WPs using case studies in order to meet Objectives 2 to 4. This chapter evaluated key ESs that have been identified in Chapter 5 and Chapter 6, namely aesthetics, recreation, and wildlife habitat.

Finally, Chapter 8 summarises and concludes this study, proposes implications for practise, discusses the limitations of this research, and provides an outlook for future research.

Chapter 2. Literature review

This chapter examines studies that provide the theoretical and methodological foundation for this research. In the first section, it describes the characteristics and classification of wetland parks (WPs), pertinent legislation and governance, and assessment methods. In the second section, it examines the theoretical foundation and evaluation approaches of ecosystem services (ES). It investigates the challenges and problems of existing studies as well as the tendencies of ESs research in order to indicate the direction of this thesis.

2.1 Literature review: wetland parks

2.1.1 Characteristics and classification of wetland park

Wetland parks (WPs) consist of (1) wetland-themed green space within urban built-up area that are open to the public and have certain recreational and service facilities (classification code G139); and (2) green areas outside urban built-up area that are based on good wetland ecological environment and diversified wetland landscape, with functions such as ecological protection, science education, field research, ecological leisure, etc., with recreation and service facilities (classification code EG13) (Ministry of Housing and Urban-Rural Development of the People's Republic of China, 2017). This thesis defines WPs narrowly as the union of these two types of green space.

However, several riverine parks and early-built lake parks were not referred to be 'wetland parks', and the general public is confused about the difference between the WP in narrow definition and the wetland-themed parks (Zhang, Zhou and Gao, 2012). Therefore, for the online survey regarding the health benefits of WPs conducted during the peak of the COVID-19 pandemic (Chapter 6), the broad definition of WPs as public green space containing a significant proportion of wetlands was used to avoid ambiguity. Except for this chapter, the rest of the thesis uses the narrow definition of WPs.

Since Guangzhou is located on where the rivers of the Pearl River system meet and flow to the South China Sea, Guangzhou include both inland watershed WPs and coastal WPs. Given that the majority of WPs in Guangzhou are located in inland watersheds, with only three being coastal WPs with mangroves (as shown in Figure 4-1), this thesis focuses on the inland watershed WPs. These WPs primarily rely on rivers, rainfall, and urban runoff as their main sources of water, although they may also be partially influenced by irregular semi-diurnal tides.

Since the Ming Dynasty, the population influx migrants to Lingnan has prompted the reclamation of river plains to satisfy the rising need for food, leading to the emergence of paddy fields and dyke-ponds (Zhang, 2019). Consequently, wholly natural wetlands are now scarce in Guangzhou; with the exception of a few wetland parks that contain natural rivers, the majority of wetlands are man-made. Many megacities in China encountered the same circumstances as Guangzhou. Thus, this study specifically examines man-made WPs.

2.1.2 Strategies similar to wetland parks

For the purposes of ecological conservation and sustainable urban water management, a wide range of strategies are typically employed. These strategies either include or overlap with wetland parks (Figure 2-1). Established in the Chinese context, wetland parks are specific types of green infrastructure, blue-green systems, urban wetlands, and nature-based solutions. Large-scale wetland parks, which are typically national in scope, share certain similarities with Ramsar sites and nature reserves in that they are legally protected areas that promote biodiversity conservation. Wetland parks with smaller dimensions primarily serve as areas for stormwater treatment. They share similarities with wetlands found in the sponge city concept and other concepts utilised in various countries worldwide, such as Low Impact Development, Sustainable Urban Drainage System, and Water Sensitive Urban Design. In relation to ecological recreation, science education, ecological protection, and field research, wetland parks are comparable to WWT wetland centres in the United Kingdom.

In China, wetland parks are a component of nature parks that possess ecological, scenic, cultural, and scientific significance. These parks facilitate sustainable utilisation and effectively safeguard a wide range of natural resources. They are part of a comprehensive system of nature protection areas, which also includes national parks and nature reserves.(Office of State Council, 2019)

Table 2-1 strategies similar to wetland parks and their definitions

Strategies	Definitions
Green Infrastructure	'a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services.'(European Commission, 2013)
Blue-green Infrastructure	It is characterised by its emphasis on connectivity, access to nature, green and blue space networks, and the integration of natural with built and engineered environments.(Mell and Scott, 2023)
Blue-green system	'The strategic and systematic planning, modelling, quantifying and optimising of Blue Green Infrastructure, its interactions with the built environment and practices that ensure the space and water availability required to provide various ecosystem services'(Bozovic *et al.*, 2017; Probst *et al.*, 2022)
Nature-based solutions	'Actions which are inspired by, supported by, or copied from nature' (European Commission, 2015)
Ramsar Site	Wetlands that have been designated by the Contracting Parties of the Ramsar Convention for listing in the List of Wetlands of International Importance are recognised as having significant international ecological, botanical, zoological, limnological, or hydrological value.(Ramsar, 2023)
WWT Wetland Centre (WC)	The Wildfowl and Wetlands Trust (WWT) oversees a network of wetland reserves with the goals of preserving habitat for migratory birds, providing a safe haven for endangered species, and educating the public about nature.(WWT, 2023)
Urban Wetlands	Wetland ecosystems that locate within or in close proximity to urban areas
Nature Reserves	Areas that are reserved and managed with the intention of conserving flora, fauna, or features of geological or other special interest, while also offering unique opportunities for research and study. Regarding nature reserves, classification, legislation, and administration vary by countries. Effective conservation areas and protected areas are analogous concepts.
Low Impact Development (LIC)	A term employed in North America and New Zealand to denote a landscape planning and engineering design strategy aimed at attaining a more natural hydrological system through the implementation of site layouts and integrated control measures. These measures typically involve the incorporation of smaller-scale stormwater treatment devices, such as bioretention systems, green roofs, and swales.(Fletcher *et al.*, 2015)
Water Sensitive Urban Design (WSUD)	An approach employed in Australia, the UK and New Zealand to plan and design urban areas to minimize the hydrological impacts of urban development on the surrounding environment. It encompasses all aspects of integrated urban water cycle management, such as water supply, sewerage and stormwater management. (Fletcher *et al.*, 2015)
Sustainable Drainage System (SuDS)	A range of technologies and techniques used in the UK to drain stormwater or surface water in a manner that is more sustainable than conventional solutions
Sponge City (SC)	A concept established in China to tackle urban surface-water flooding and related urban water management issues, such as purification of urban runoff, attenuation of peak run-off and water conservation. It is similar to Low Impact Developments approach. (Chan *et al.*, 2018)

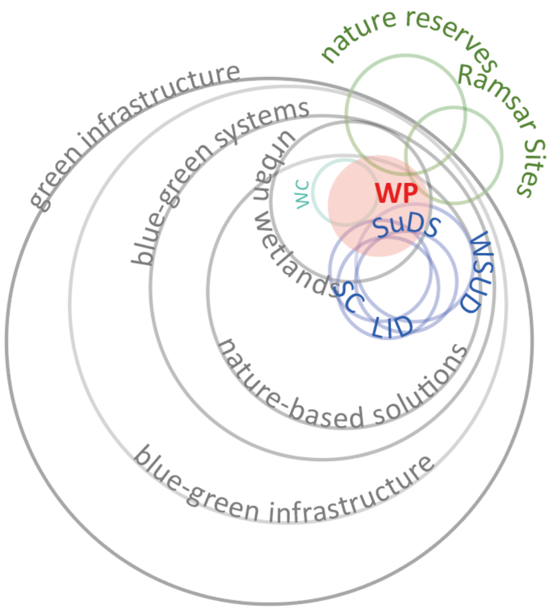


Figure 2-1 relationships between wetland parks and other similar strategies (The associated abbreviations and terms are listed in Table 2-2)

2.1.3 Legislation and governance of wetland parks

The State Council, National Forestry and Grassland Administration[1] and Ministry of Housing and Urban-Rural Development of the Peoples Republic of China have issued a series of laws, regulations, standards and official documents (Appendix A - 1) to strengthen wetland protection, making it clear that WPs are an important part of China's wetland protection system and nature conservation system, emphasising the importance of functions of WPs (i.e., biodiversity conservation, science education, scientific research, recreation). <u>These legislations distinguish WPs from general parks in terms of policy and management.</u>

2.1.4 Assessment of wetland parks

Researchers have developed index systems for assessing the performance of WPs to ensure their healthy and sustainable development. For example, to qualify as a national wetland park, WPs must pass an evaluation by groups of experts using a standard including following indicators: (1) typicality, representativeness, uniqueness, diversity, and ecological function of the wetland ecosystem; (2) outstanding biodiversity; (3) little human activities interference; (4) good water quality; (5) well-controlled invasive species; (6) clear ownership, use and management of land; (7) well-established protection management facilities and institutions; (8) well-established ecological monitoring stations and environmental education facilities; (9) good community and stakeholder involvement; (10) well-established recreation and reception services and facilities; and (11) good coordination with local characteristic landscape (National Forestry and Grassland Administration, 2010). Besides, an evaluation index system using a hierarchical analytic approach that tailored to the unique characteristics of National WPs was proposed; it is constituted of five primary indicators (i.e., ecological effect, social effect, economic effect, basic construction effect, and sustainable effect) and 25 secondary indicators (Wu *et al.*, 2014). Similarly, an evaluation index system combining expert-based Analytic Hierarchy Process method and site investigation was conducted; index include diversity of wetland types, regional water resource, water quality, biodiversity, and landscape resource (Huang *et al.*, 2013).

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[1] the previous State Forestry Administration

Specifically, from biophysical perspective, health and emergy[2] analysis are usual approaches for assessing wetlands and WPs. Health, including health from individuals to ecosystem, can describe the condition of wetland ecosystems. Measurements including (1) the description of the symptoms of ecosystem disruption, the emergence of human or animal disease, and the capacity to recover from disturbance (i.e., resilience) (Rapport, Costanza and McMichael, 1998); (2) indicator species demography (e.g., waterfowl, microbial, submerged aquatic vegetation, algae, Odonata) (Hornung and Rice, 2003; Péron *et al.*, 2013; Sims *et al.*, 2013); emergy accounting and life cycle assessment (Duan *et al.*, 2011).

From human perspective, although many studies have shown that natural environment or urban blue-green space is beneficial to human physical health (Lachowycz and Jones, 2011; Richardson *et al.*, 2013) and mental health (Helbich *et al.*, 2018), evidence of WPs contribute to human health is limited. As for other well-being aspects, it was found that urban wetland environments were perceived by public as at least somewhat good for being physically active, enjoying beauty, being close to animals and nature, learning about nature, interacting with family and friends, and being alone (Pedersen, Weisner and Johansson, 2019, p. 1319). These well-being aspects were usually assessed using questionnaire (e.g.,(H. Wang *et al.*, 2019)). The enjoyment of aesthetics was usually assessed by using approaches such as Scenic Beauty Estimation (Sun *et al.*, 2018), questionnaire (Dobbie, 2013), photograph-rating (Cottet, Piégay and Bornette, 2013), and photograph-sorting/ranking (Dobbie and Green, 2013).

Some studies have explored the relationship between ecology and aesthetics in wetlands. For example, studies explored the impact of water transparency and colour, the presence and appearance of aquatic vegetation and trees, the presence of sediments, and perceived wetland health to aesthetic preference (Cottet, Piégay and Bornette, 2013; Dobbie, 2013). And a study found that throughout the spring and fall, an evaluation of Fujin National Wetland Park’s surface water input and exit in Northeast China showed consistency between measured water quality and water pollution-related aesthetic preference of experts (Sun *et al.*, 2019). However, other aspects bridging biophysical environment to human perception are overlooked.

2.1.5 Challenges and problems that wetland parks are facing

Throughout the development of WPs over the previous decade, challenges and problems were identified or discovered. For instance, WPs in China is confronting challenges such as unequal distribution, a lack of funds, a conflict between national preservation and local utilization, and inadequate legacies (Wu *et al.*, 2015). In addition, landscape architects are concerned that WPs may not be able to adapt to local conditions and cultural norms due to their simple design, rapid expansion, and lack of local characteristics (i.e., the design of WPs is similar everywhere) (Zhang, Zhou and Gao, 2012). In addition, it was revealed that the spatial distribution of visitors in the Xixi National Wetland Park is uneven, with severe spatial overload in certain locations; and that the low level of visitors’ perception and preference of the wetland landscape has increased the carrying capacity overload at certain locations, such as around decks, stores, and iconic attractions (Pan and Sun, 2015). The overloading of carrying capacity in certain locations of WPs may threaten their ecological integrity. If we had a deeper understanding of the biophysical and human value of WPs, we might be able to overcome challenges such as unequal distribution and lack of funding. If we had a more robust insight into the visiting habits and preferences of locals, we could better adapt the design of

[2] Emergy (spelled with an “m”) is the amount of energy used in direct and indirect processes to create a product or service (Tennenbaum, 2015). It is a measure of the differences in quality between various forms of energy.

WPs to the local natural and cultural setting and create more visitor-preferred areas within WPs to prevent carrying capacity overload at specific locations.

2.1.6 Summary: literature review of wetland parks

Wetland parks (WPs) are recognised as significant urban blue-green spaces in China. They are expected to play a role in wetland preservation, biodiversity conservation, and enhancing human well-being. Documents, regulations, standards, and laws have been enacted for the building and development of WPs in a sustainable way. In addition to methods for evaluating natural wetlands either from a biophysical perspective (e.g., wetland health and emergy analysis) or a human perspective (e.g., Scenic Beauty Estimation, photograph ranking, questionnaire and interview), a number of expert-based index systems for evaluating WPs have been proposed and tested.

However, no study has been discovered that compares and evaluates the biophysical and social benefits of WPs at the same time period and location. In addition, human-wellbeing that benefits from WPs other than enjoyment of beauty is little known, particularly in terms of how they are seen and experienced when visited. In addition, there is no standardized index method for evaluating WPs. In this thesis, the requirement for a comprehensive evaluation of WPs is emphasized. It is anticipated that ESs, which encompass the biophysical environment and human well-being and emphasize the benefits humans receive from ecosystems, would bridge present research gaps in WPs and assist in overcoming the issues WPs now faces. The next section will offer an overview of ESs and their evaluation methodology.

2.2 Literature review: landscape perception

2.2.1 Perception theories

To efficiently sustain and develop our own lives through successful interaction with others, we depend on three fundamental and interconnected human capacities: affect, behaviour, and cognition. Affect is an emotional response, a gut reaction, or sympathetic nervous activity; it can be measured by monitoring physiological responses such as heart rate or by collecting verbal repots of feelings or mood. Behaviour comprises explicit actions, behavioural intentions, and verbal descriptions regarding behaviour. Cognition comprises perceptual responses and verbal statements of belief.(Breckler, 1984) Since perception provides the informational and causal basis for our higher cognitive functions (Cahen and Tacca, 2013), it is crucial to comprehend how people perceive the world.

The question of whether perception is direct or indirect is a fundamental topic that theories within the field of philosophy of perception focus on. The theory of direct perception, such as James Gibson’s ecological approach to visual perception, posits that perception is the process of extracting information from the surrounding array of light, without the need for intermediaries such as retinal pictures, neural pictures, or mental pictures (Gibson, 2015). In contrast, the indirect theory of perception, such as the Representative Theory of Perception, asserts that the perceiver does not directly perceive tangible elements in the environment, but rather mental representations or intermediates (Maund, 2003). The question of whether perception is direct or indirect lacks a conclusive answer and remains a topic of philosophical investigation and discussion.

The Information Processing Model, a fundamental framework in cognitive psychology, has greatly influenced our understanding of human perception. In 1956, George Miller proposed that information processing in humans involved gathering and representation of information, information storage, and information retrieval when required. Later, in 1968, Richard C. Atkinson and Richard Shiffrin proposes that there are three stages involved in memory: input or sensory registry, short-term memory, and long-term memory (Rosnov and Roberts, 2005). Based on these theories, the information processing model was developed. Perception plays a vital role in the information processing model, linking sensory input to our cognitive understanding of the world (Cahen and Tacca, 2013).

Senses serve as the physiological foundation for perception. Perception involves the brain's selection, organisation, and interpretation of sensations. And sensations encompass various experiences, such as visual, auditory, olfactory, gustatory, tactile, and others. Perception is a multisensory process, while visual dominance over other senses is a widely recognised knowledge. Consequently, visual dominance provides a substantial explanation for the human inclination towards vision and their nature as visual beings (Stokes and Biggs, 2014). Hence, this study employs multisensory perception of field experiences in conjunction with visual stimuli to investigate people’s perception on wetland parks.

It is noteworthy that enhanced intersensory communication has the potential to induce synaethesia, an involuntary percept-like phenomenon wherein a sensory stimulus presented to one of the modalities elicits simultaneous sensations in all modalities. For instance, the phenomenon of synaesthesia involves perceiving colours linked to specific letters and numbers, and experiencing colours in response to certain sounds or music. An inducer (the stimulus that initiates synaesthesia) and a concurrent (the elicited synaesthetic experience) are the components of synaesthesia. The variability in the number of synaesthesia types a person has may be indicative of cognitive differences in various dimensions such as mental imagery, sensory sensitivity, and attention to detail (Ward, 2019).

2.2.2 Landscape perception

Landscape perception pertains to the particular context in which individuals experience and perceive the landscape. Landscape perception plays a crucial role in determining preferences (Kaplan and Kaplan, 1989). Research on landscape perception has addressed legislative mandates as well as challenges related to landscape management, planning, and design in numerous countries.

Evolutionarily, the Prospect-Refuge Theory suggests that environments are advantageous for humans when they offer the optimal conditions for survival, namely by allowing individuals to see (prospect) while remaining not be seen (refuge) (Appleton, 1975). The Attention Restoration Theory asserts that individuals' attentional ability could undergo restoration following exposure to natural environments or even through the observation of nature scenes (Kaplan and Kaplan, 1989). Culturally, the Topophilia hypothesis highlighted the influence of factors such as age, gender, hobbies, educational background, and past experience in developing individual preferences for landscapes (Tuan, 1990). Further, four general paradigms of landscape perception during 1965 to 1982 was identified based on the human-landscape-interaction-outcome model, namely expert, psychophysical, cognitive, and experiential paradigm (Zube, Sell and Taylor, 1982). The vast majority of subsequent research falls into one of the following four paradigms. The significance and methodological foundation of this work have been established by these highly influential studies on landscape perception.

The literature pertaining to the perception of ecosystem services (Section 2.3.4 and 2.3.5.2), biodiversity or wildlife habitat (Section 7.5.1), aesthetics (Section 7.6.1 and 7.6.2), and recreational activities (Section 7.7.2) in landscapes is elaborated upon in the next section and Chapter 7. To avoid redundancy, additional information on these topics is excluded here.

2.3 Literature review: ecosystem services

2.3.1 Concept and classification systems of ecosystem services

When the concept of ecosystem services (ESs) was initially introduced, Daily (1997, p. 3) described it as the conditions and processes by which natural ecosystems support and fulfil human life. Costanza *et al.* (1997) defined ESs as ecosystem goods and services together, combining material, energy, and information flows from natural capital stocks that are integrated with manufactured capital and human capital services to provide human welfare. Millennium Ecosystem Assessment (2005) simplifies the definition of ES as the direct or indirect benefits that people receive from ecosystems and classifies ESs into four categories (i.e., supporting, provisioning, regulating, and cultural services); this is the most widely accepted definition worldwide. It also identified five main aspects of human well-being (incl. material minimum, social relations, freedom and choice, security, and health) and summarised that they are affected directly and indirectly by changes in ecosystems and ESs (Millennium Ecosystem Assessment, 2005, p. 14).

Together with the concepts, classification systems have been proposed by scholars in the past three decades; the most commonly adopted ones are shown in Table 2-2. Besides these classification systems, there are alternatives that are not commonly adopted. For example, Wallace (2007) advocated classifying ESs according to the category of human values including adequate resources, protection from threats (e.g., predators, disease, or parasites), a favourable physical and chemical environment, and sociocultural satisfaction. Zhang et al. (2010, p. 66) proposed a new classification of ESs based on human needs: material needs, means of livelihood, and production materials correspond to provisioning services; safety requirements (including atmospheric safety, water safety, soil safety, and biological safety) correspond to supporting services and regulating services; spiritual needs correspond to cultural services. The classification system used in this thesis is a synthesis of the four main ESs classification systems used worldwide and add the cultural heritage value as Fagerholm et al. (2012) indicated (Table 2-3). An explanation of these ESs is given following the above-mentioned literatures.

2.3.2 Ecosystem disservices

Although ecosystems are beneficial to humans from multiple perspectives, occasionally they have detrimental effects on human well-being; that is, ecosystem disservices. Ecosystem disservices, for example, include safety problems in dark parks, pollen creating health issues, and pest damages, nutrient runoffs, or competition by unwanted species that reduce crop yields or increase production costs (Lyytimäki *et al.*, 2008). Specifically, diseases including schistosomiasis and dengue fever are more likely to occur in wetlands where are susceptible to becoming breeding sites for the parasite (Hu *et al.*, 2014; de Jesús Crespo, Méndez Lázaro and Yee, 2019).

Table 2-2 Main classification systems of ESs (literature)

	(Costanza et al., 2017)	(Millennium Ecosystem Assessment, 2005)	TEEB (2010)	CICES v5.1 (Haines-Young and Potschin, 2010)
P	Food production	Food	Food	Biomass - nutritional purpose
	Water supply	Fresh water	Fresh water	Water (incl., drinking water, used as a material / an energy source, other)
	Raw materials	Fibre, etc.	Raw materials	Biomass – materials (e.g., fibres)
	Genetic resources	Genetic resources		
		Ornamental resources		
		Biochemicals and natural medicines	Medicinal resources	
				Biomass – source of energy
R	Gas regulation	Air quality regulation	Local climate regulation and air quality regulation	Atmospheric composition and conditions (i.e., chemical composition, temperature and humidity)
	Climate regulation	Climate regulation	Carbon sequestration and storage	
	Disturbance regulation	Natural hazard regulation	Moderation of extreme events[3]	Hydrological cycle and water flow regulation
	Water regulation[4]	Water regulation		Regulation of the chemical condition of fresh water
	Waste treatment	Water purification and waste treatment	Waste-water treatment	Mediation of wastes or toxic substances
	Erosion control & sediment retention	Erosion regulation	Erosion prevention and maintenance of soil fertility	Control of erosion rates, buffering and attenuation of mass movement
	Soil formation	Soil formation		Regulation of soil quality
	Pollination	Pollination	Pollination	Life cycle maintenance (incl., pollination and seed dispersal)
	Biological control	Regulation of pests & human diseases	Biological control	Pest and disease control
				Noise attenuation
				Fire protection
S	Nutrient cycling	Nutrient cycling & photosynthesis, primary production		
	Refugia	'biodiversity'	Habitats for species	Maintaining nursery populations and habitats

[3] e.g., floods, storms, landslides

[4] e.g., natural irrigation and drought prevention

			Maintenance of genetic diversity	(incl. gene pool protection)
C	Recreation[5]	Recreation & eco-tourism	Recreation; mental & physical health	Physical and experiential interactions with natural environment
			Tourism	
	Cultural[6]	Aesthetic values	Aesthetic appreciation and Inspiration for culture, art, design	Intellectual and representative interactions with natural environment
		Cultural diversity		
		Knowledge systems		
		Educational values		
		Spiritual & religious values	Spiritual experience and sense of place	Spiritual, symbolic and other interactions with natural environment
				Other biotic characteristics that have anon-use value
Abbreviations: P: provisioning services; R: regulating services; S: supporting services; C: cultural services				

[5] incl., eco-tourism & outdoor activities

[6] incl. aesthetic, artistic, spiritual, education, & science)

Table 2-3 ESs classification and their explanations (this thesis)[7]

Ecosystem Services		Explanation
P	**food**	food products that derived from plants, animals and microbes (e.g., crops, wild fruits, fishing)
	water supply	fresh water storage, retention and supply by watersheds, reservoirs, aquifers
	raw materials	get raw materials, including fibre (e.g., wood, silk), construction materials (e.g., lumber), fuel (e.g., firewood) and fodder.
	ornamental resources	collect ornamental animal and plant products for decorative use
	genetic resources	genes and genetic information used for animal and plant breeding and biotechnology
	biochemicals and natural medicines	get natural medicines from the ecosystem
R	**air regulation**	regulation of atmosphere chemical composity (e.g., CO2/O2 balance, SOx levels control)
	climate regulation	regulation of local and global temperature, precipitation and other biologically mediated climatic processes（e.g., feeling cooler in ecosystems)
	disturbance regulation	e.g., storm protection, flood control, drought recovery, hurricane reduction
	water regulation	the timing and magnitude of runoff, flooding and aquifer recharge, (e.g., Natural irrigation, drought prevention)
	water purification and waste treatment	filter out and decompose organic wastes or nutrients introduced to water related ecosystems; better water quality /cleaner water
	erosion control and sediment retention	soil retention (e.g., prevention of landslides; prevention of loss of soil by wind, runoff, or other removal processes; storage of silt in lakes and wetlands)
	soil formation	soil formation process (e.g., weathering of rock and the accumulation of organic material)
	pollination	movement of floral gametes for the reproduction of plant populations
	biological control	disease regulation, pest regulation, Trophic-dynamic regulations of populations (predator control)
	noise reduction	noise reduction; quieter
S	**nutrient cycling, photosynthesis, primary production**	the process of nutrient cycling (e.g., nitrogen fixation, phosphorus or nutrient cycles)
	Wildlife habitat	habitat for wildlife resident and transient populations.
C	**recreation**	conduct recreational activities (e.g., eco-tourism, sport fishing, and other outdoor recreational activities)
	aesthetic values	enjoy beautiful scenery or fragrance
	cultural diversity	landscape features that reflect regional culture
	spiritual and religious values	regard the place as a religious or sacred place.
	educational values and knowledge system	gain knowledge from the wetland park (i.e., formal and informal education)

[7] Abbreviations: P: Provisioning services, R: Regulating services, S: Supporting services, C: Cultural services

	social relations	organizing or attending events to interact with other people or make friends; mark the places recommended by web celebrity and share with friends to gain social belongings
	cultural heritage values	landscape features that reflect local history, traditions and wisdom
	inspiration	get inspiration for art, poems, and so on
	sense of place	a person's special experience in a specific environment (feeling stimulating, happy, etc.)
Abbreviations: P: provisioning services; R: regulating services; S: supporting services; C: cultural services		

2.3.3 Interrelationships between ecosystem services

Relationships between ESs are mostly characterized by trade-offs or synergies. Trade-offs are produced when the greater usage of one ES reduces the availability of another ES, whereas synergies are described as the opposite; they vary over place and time and have varying degrees of reversibility (Rodríguez *et al.*, 2006). There may be trade-offs between different ESs, as well as between present and future service supply (Li *et al.*, 2013, p. 1380). However, trade-offs are not unavoidable; taking into account the reason why trade-offs arise is more likely to result in synergies (i.e., win-win scenarios) than aiming for synergies (Howe *et al.*, 2014). Understanding the trade-offs between ESs will therefore facilitate the development of synergies and the promotion of management strategies that optimize the benefits for stakeholders.

ES bundles are groups of ESs that commonly appear together throughout place or time (Raudsepp-Hearne, Peterson and Bennett, 2010, p. 5242). ES relationships varied over time (Renard, Rhemtulla and Bennett, 2015, p. 13413) and across regions (Raudsepp-Hearne, Peterson and Bennett, 2010, p. 5244). The ES bundles consist of positively correlated ESs that may or may not exhibit causal relationships (Renard, Rhemtulla and Bennett, 2015, p. 13411). Understanding the interconnections between ESs could facilitate the synergy of ESs, encourage management practices that increase the benefits to people (Kong *et al.*, 2018; Plieninger *et al.*, 2019), and enable the forecast of crucial ES trade-offs and synergies on the landscape (Raudsepp-Hearne, Peterson and Bennett, 2010, p. 5245).

2.3.4 Ecosystem service flow

The ES paradigm's underlying logic has been extensively discussed and developed. There are two schools of thought among academics regarding this issue: those who believe ESs are objective and unaffected by the benefits or values assigned by people, and those who believe there are flows/cascades from the bio-physical realm of ESs to values benefiting humans.

Since the introduction of ESs, Daily (1997, pp. 3–6) emphasized the gap between the real and perceived value of ESs because modern urban life obscures the presence of ESs; although once explained the significance of ESs is often easily recognized, the actual assignment of value to ESs may provoke tremendous doubt. Besides, Haines-Young and Potschin (2010) proposed a cascade model from ecological functions to ESs, and they recognized that subsequently to benefits and services do not exist in isolation from human demands. A year later, they distinguish 'benefit' and 'value' in the cascade model, making it apparent that benefits are those items to which individuals attach value (Potschin and Haines-Young, 2011). Similarly, Tallis *et al.* (2012) distinguish between the 'supply' (i.e., the structure and function of ecosystems), the 'service' (i.e., the function actually used or enjoyed by humans), and the 'benefits' (i.e., the resulting change in human well-being). In addition, the 'supply' is further subdivided to supply capacity and supply potential. For example, it has been spatially estimated that with the exception of the carbon sequestration service, the proportion of regions that actually provided services to people ranged from 16 to 66% of those theoretically capable of supplying services (Bagstad *et al.*, 2014). However, Costanza *et al*. (2017) insisted that there is no distinction between ESs and benefits, and that ESs exist whether or not people perceive the advantages.

This debate shows that there might be discrepancy between the objective existing services that are independent of human intervention and the subjective perceived services that individuals attach value to. This thesis assume that there is a non-linear and dynamic cascade relationship between biophysical structure or process, ecological functions, ESs, benefits, and values, following the ESs cascade model proposed by Potschin and Haines-Young (2011). Holding this assumption, this thesis intends **to examine the theoretical supply and public perception of ESs in an effort to comprehend the gap between them**.

2.3.5 Bridging technical understanding and perceptions

Beside the research context discussed in the previous section, the necessity of incorporating socio-cultural values of ESs into WPs assessment have been emphasized for facilitating human well-being and fostering wetland restoration (Scholte *et al.*, 2016), indicating the need to bridge technical understanding and perception of ESs in wetlands.

A few studies have attempted to comprehend the gap between theoretical supply and public perception of ESs. A study assessed the spatial potential supply and actual use of cultural ESs in mountain protected areas and their surroundings (at a scale of approximately 2km^2) by aligning geometrically modelled cultural ESs potential supply based on six biophysical indicators with participatory maps generated by visitors and local experts (Crouzat *et al.*, 2022). Their research provides evidence that cultural factors go beyond a purely physiological explanation. Besides, a study compared local residents' perceptions of biological value with scientifically identified biologically significant areas at an larger scale and found moderate spatial coincidence between the two (Brown *et al.*, 2004). Further, it was discovered that the chemical evaluation and public perception of the surface water quality of urban rivers were spatially consistent (Juan Li *et al.*, 2023). Nevertheless, current research is insufficient to address the research gap at multiple spatial scales and does not yet encompass a variety of ESs.

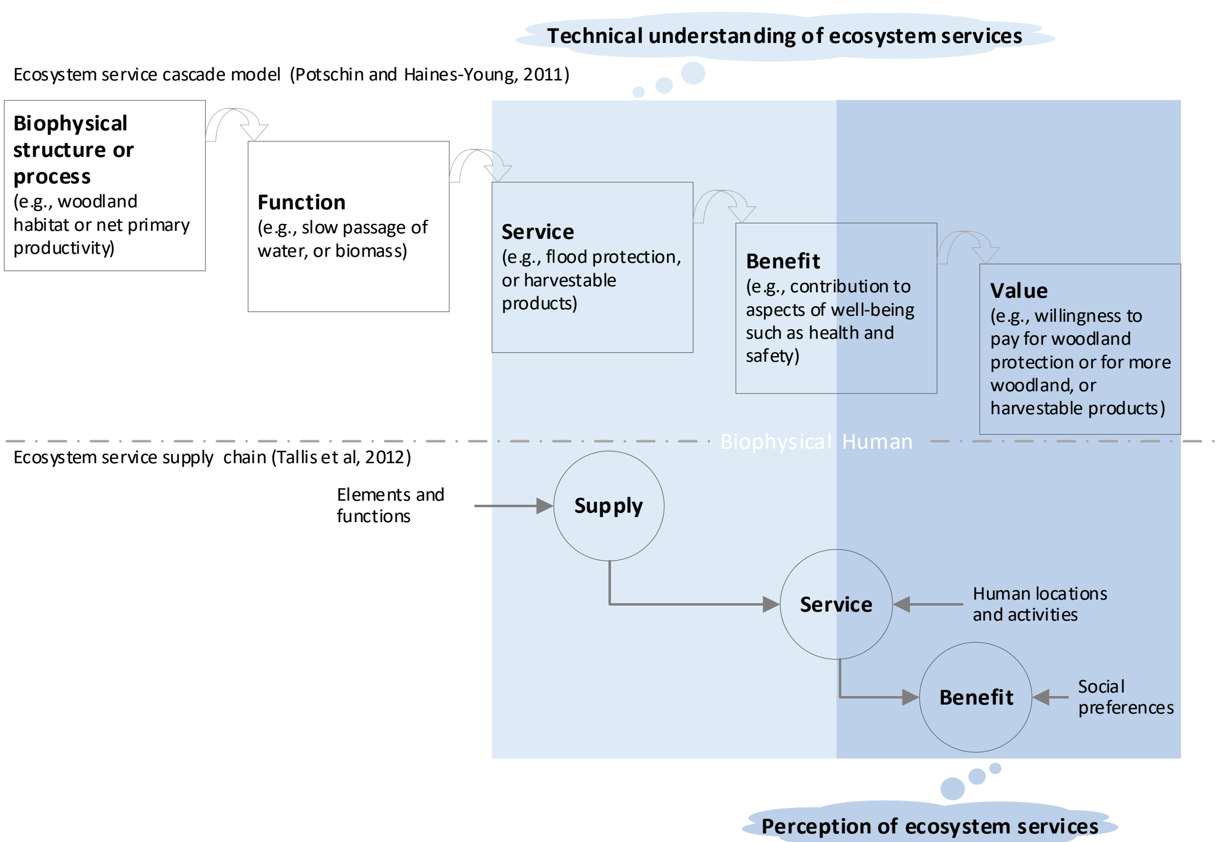

Figure 2-2 Relate 'technical understanding of ecosystem services' and 'perception of ecosystem services' to existing frameworks in the literature

In this thesis, the term 'technical understanding of ESs' (TUESs) is equivalent to the 'service (flows)' in the cascade model (Potschin and Haines-Young, 2011) and the 'supply and service' in the ES supply chain (Wallace, 2007), which refers to ESs that offered by ecosystems no matter whether humans perceived those benefits (Figure 2-2). 'Technical understanding' is the way to understand and assess ESs based on theories and experiences, using measurement or modelling techniques. The term 'perception of ESs' (PESs) in this thesis is equivalent to the 'benefits (values)' in the cascade and the 'service and benefit' in the supply chain, refer to benefits that are perceived by people and assigned value to.

Some studies reveal relationship between TUES and PES. For example, it was found that actual and perceived biodiversity is correlated in some ecosystems (Brown *et al.*, 2004; Southon *et al.*, 2017) while in some are not always correlated (Dallimer *et al.*, 2012). Season could influence the synergies as well: an assessment of the surface water inlet and outlet of Fujin National Wetland Park in Northeast China revealed consistency between measured water quality and water pollution-related aesthetic preference throughout the spring and autumn but not in the summer (Sun *et al.*, 2019).

However, the comparison between TUES and PES is still not sufficient. Although we understand TUES, if people cannot perceive and assign value to the ESs, the ESs can be underestimated. We already know some demands, tastes, and preference of ESs, but these can vary throughout time and place (Norton, Costanza and Bishop, 1998); therefore it is not sustainable to evaluate the ES only from a human perspective. Thus, research takes both TUES and PES into consideration and comparison is needed.

2.3.5.1 Technical understanding of ecosystem services

Numerous investigations have been conducted on either TUESs or PESs. Various approaches for assessing TUESs were established in studies. ESs can be quantified in terms of money (i.e., the monetary approach), emergy[8], and the actual service supply unit (e.g., x m^3 clean water provisioning, x m^3 carbon storage). Written step-by-step tools and computer-based tools have been developed to make the evaluation more accessible to professionals and non-experts, hence facilitating ESs-relevant decision making.

(1) Monetary approach

The concept of ESs is initially strongly relevant to 'natural capital', using the broad concept of capital as a stock that generates a flow of services over time. ESs refer to the relative contribution of natural capital to the production of diverse human benefits, in conjunction with other forms of capital (incl., manufactured capital, human capital, and social or cultural capital) (Costanza *et al.*, 2017). Therefore, it is no wonder that many ES assessment projects attach monetary values to ESs. The monetary method estimates the 'incremental' or 'marginal' value of ESs, i.e., the impact that relatively minor changes in these services have on human welfare. Changes in the quality or quantity of ESs have value to the extent that they alter either the benefits or costs associated with human activities (Costanza *et al.*, 1997).

[8] Emergy (spelled with an "m") is the amount of energy used in direct and indirect processes to create a product or service (Tennenbaum, 2015). It is a measure of the differences in quality between various forms of energy.

(2) Emergy accounting approach

ESs are generated by a set of solar-powered natural cycles (Daily, 1997). Therefore, emergy[9] analysis, which is based on the energy stocks and flows in ecosystem, was used to account ESs. It is totally objective and analyses from the perspective of the supplier only, so the evaluation is not influenced by human preferences and market contingency (Costanza *et al.*, 1997, p. 254; Duan *et al.*, 2011). For example, emergy analysis has been used to examine the changes in ESs before and after the transition of a desert shrub system to a plantation system in typical arid regions (Z. Xu *et al.*, 2020). Generally, the computation requires the area of the specific ecosystem that provides a particular service (land use land cover data) or the measured actual amount of service the ecosystem provides. Emergy analysis is more objective, but when assessing cultural services, emergy should be converted from the monetary analysis (Yang and Liu, 2018).

(3) Written step-by-step tools

Written documents with step-by-step guidance have been developed for decision-makers, stakeholders and researchers to identify and estimate ESs and benefits provided by a particular site. For example, the Protected Areas Benefits Assessment Tool (PA-BAT) (Dudley and Stolton, 2009) is a workshop-driven tool based on questionnaire data. Toolkit for Ecosystem Service Site-based Assessment (TESSA) (Peh *et al.*, 2013) and the Ecosystem Services Toolkit (EST) (Value of Nature to Canadians Study, 2017) which contains step-to-step guidance on, for example, defining the issue and context, identifying all possible ESs in the study area, the benefit they provide beneficiary groups, and confirming priority ESs. Step-by-step tools make the assessment process faster and easier, and they lay the foundation of the research design of this thesis.

(4) Computer-based tools

Besides written step-by-step tools, there has been a surge presence of computer-based tools to quantify, model and visualise ESs, to support decision making. By entering information of the examined ecosystem, such as area of habitat, vegetation type, land use cover, and slope degrees, the computer-based tools calculate ESs that the ecosystem supply in biophysical terms or in monetary benefits. In addition to these biophysical- and monetary-analysis tools, spatial analysis tools have been developed considering the special dynamics of ESs (Millennium Ecosystem Assessment, 2005) and the potential for promoting the collaboration between ecologists and others (Haines-Young and Potschin, 2010). The most widely used computer-based tools include Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) (Natural Capital Project, 2022), Multiscale Integrated Models of Ecosystem Services (MIMES)(Boumans et al., 2015), Artificial Intelligence for Ecosystem Services (ARIES)(Bagstad et al., 2014), and Social Values for Ecosystem Services (SolVES)(Sherrouse and Semmens, 2020). Except MIMES which can be used to assess any ES, tools can only assess some of the ESs (Appendix A - 2). Some tools are worldwide applicable (e.g., InVEST), whilst others are only applicable in specific nations or areas due to reliance on internally given input data that is confined to local. Despite the availability of these tools, it remains challenging to select a tool that corresponds to this study's scale of landscape, target ESs, and available data. Therefore, although these tools have been reviewed, the review will not be presented in this thesis.

[9] Ibid.

2.3.5.2 Perception of ecosystem services

Studies have investigated which ESs are perceived to be more or less significant to the public. For example, Wardropper *et al.* (2020) conducted a survey and found that residents in the urban and agricultural Yahara Watershed in the United States placed the highest value on the region's provision of drinking and surface water quality, clean lakes and rivers for wildlife, and a reliable supply of drinking and surface water. Using the Q methodology, Buchel and Frantzeskaki (2015) demonstrate that aesthetic appreciation is the most valued ES for Rotterdam urban park visitors, followed by recreation, air quality control, and social settings.

Other studies examine how individuals bundle or trade off multiple sorts of value when questioned about the significance of an ES. For example, Plieninger *et al.* (2019) discovered two strong synergies of PESs (i.e., cultural heritage and social interactions, cultural heritage and existence values) and sixteen moderate synergies of PESs which are mostly among cultural ESs using participatory mapping approach. Based on questionnaire data, Martín-López *et al.* (2012) discovered a clear trade-off between provisioning services (including recreational hunting), and regulating services or nearly all cultural activities, in the Iberian Peninsula. Edwards *et al.* (2012) conducted a Delphi survey and discovered that regional variation in the perception of the importance of forest structural attributes that contribute to the perception of recreation services in local forests in four European regions.

2.3.6 Challenges and trends of ecosystem services research

Researchers have highlighted obstacles for future research of ESs after reviewing the relevant literature over the previous two decades. For instance, Birkhofer *et al.* (2015) note that studies relating biodiversity to ESs usually focus on services at small geographical or short temporal scales, while research on the conservation of services focuses on services that bring benefits at large spatial scales. And they recommend that ESs research examine several **geographical and temporal dimensions** in order to create a holistic understanding of how nature promotes human well-being. Besides, it is suggested that integrating ESs and natural capital into mainstream economic policy necessitates **a greater public dialogue and engagement** (Costanza *et al.*, 2017, p. 14). Further, to better quantify the physical quantity of ES supply, it is recommended that the biological processes and mechanisms driving its production from ecosystems be understood, and a more systematic evaluation of the **relationships (i.e., synergies and trade-offs)** between different ESs provided by an individual ecosystem is required (Jiang, Wu and Fu, 2021). These highlighted research challenges and tendencies indicate the direction for this thesis.

2.3.7 Summary: literature review of ecosystem services

Ecosystem services (ESs) are the direct or indirect benefits that people get from ecosystems, however their detailed definition, namely their relationship to supply, benefit, and value, is still being clarified by academics. Whether there is a gap between objective ESs that are independent of human intervention and the ESs that people perceived and assign value to, need further clarification. This thesis assumes the gap exists, and by proposing and comparing technical understanding and perception of ESs, verify the existence of this gap.

Researchers have proposed various ESs classification systems in the past years. Most items in these classification systems overlap while some differ. The most widely used classification systems were reviewed and a classification system with 26 items were synthesis for this thesis. Ecosystems that are generally advantageous to humans can yet possess components that negatively impact human well-being, referred to as ecosystem disservices. One such example is the occurrence of arboviral diseases like malaria. Ecosystem disservices may occur in wetland parks, but this thesis excludes those from the analyses.

Interrelationships between ESs are mostly characterized by trade-offs or synergies. Throughout place or time, groups of ESs could appear together as ES bundle, which can be discovered using geographical data. Understanding the trade-offs between ESs and the bundles of ESs will facilitate the development of synergies and the promotion of management strategies that optimize the benefits for stakeholders.

There are numerous ways to evaluate ESs. This thesis adopts some assessment approach in the research design to evaluate ESs. And hopefully findings of this research could provide empirical evidence to optimize the assessment tools.

In summary, the challenges and trends identified by other researchers for future ESs research that indicate the direction for this thesis include the need for (1) constant clarification of definition, (2) broader spatial and temporal scales of ESs research, (3) broader public discourse and participation, (4) a better understanding of the biological processes and mechanisms underlying the generation of ESs, and (5) a more systematic evaluation of the relationships between ESs.

Chapter 3. Research Design

3.1 Methodological framework

This thesis was developed using a mixed methods approach based on the pragmaticism paradigm, which proposes that researchers should use the methodological approach that works best for the specific issue that is being investigated, focusing on the results of research and the research questions rather than the methods (Kaushik and Walsh, 2019).

Learning from the evaluation steps of the written step-by-step tools EST (Value of Nature to Canadians Study, 2017) and TESSA (Peh *et al.*, 2013), this thesis identifies and evaluates ecosystem services (ESs) delivery of wetland parks (WPs) following the steps shown in the framework in Figure 3-1. Chapters relevant to each step is also shown in the framework. This chapter gives an overview of the methodological framework, and briefly introduce methodology for each step. **Specific and detailed methods for each theme (e.g., questionnaire design for each theme) is introduced in each relevant chapter (e.g., Section 5.2, 6.2, 7.2, 7.5.2, 7.6.4, and 7.7.1).**

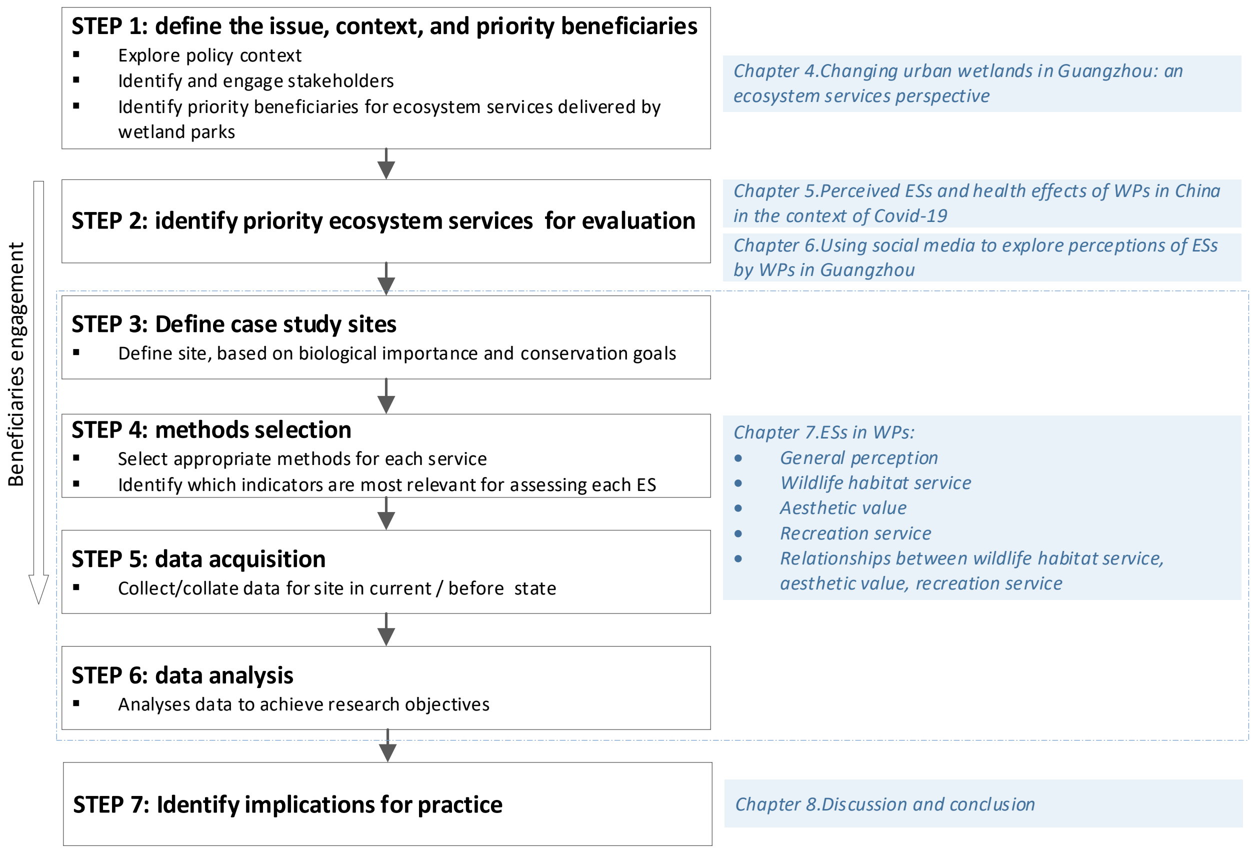

Figure 3-1 Methodological framework: steps and relevant chapters

Firstly, this research reviewed the changing urban wetlands in Guangzhou to develop an understanding of the context and identify the beneficiaries of the ESs. The identification of beneficiaries who make actual use of prospective final ESs is a fundamental prerequisite for generating supply and use accounts for ESs (Haines-Young and Potschin, 2018), because ecosystems and their beneficiaries are frequently not co-located (Fisher, Turner and Morling, 2009). The broad definition of WPs was adopted in this step to define the issue, context and main beneficiaries on a broader scale. Considering the aim of creating WPs, the primary beneficiaries are visitors of WPs. Therefore, this study focusses on perception of visitors of WPs. Besides literature review presented in Section 2.1, works relevant to this step is presented in Chapter 4.

Secondly, the focal ESs for examination were determined. The procedure of filtering the focal ESs is illustrated in the flowchart (Figure 3-2). In this step, a literature study, an analysis of social media content, and an online questionnaire were utilized. Each study's data collection and analysis methods are described in detail in the corresponding chapter. Studies conducted at this stage also serve as pilot studies, laying the groundwork for the case studies' in-depth research design. As a result of studies in this step, the focal ESs for in-depth evaluation was defined: habitat, recreation and aesthetic values.

Thirdly, two inland watershed WPs, Haizhu National Wetland Park (HNWP) and Tianhe Daguan Wetland Park (TDWP), were chosen as case study sites following a literature review and site visits of WPs in Guangzhou. Both case study locations are located in urbanized areas and have been assessed by other researchers and supported by a relevant literature base. When this research began, HNWP was the only national wetland park in Guangzhou, while TDWP was a typical urban wetland park constructed for flood control and water purification. The two WPs represent two distinct design styles for WPs in China and they were the only two projects chosen to be presented at the Guangzhou Urban Planning Exhibition Hall, demonstrating their representativeness. Although these two WPs are contrasting in terms of scale, type of wetlands they contain, and level of Government management, they are highly complementary and collectively encompass nearly all the qualities that WPs have in Guangzhou. Common themes of these two WPs include the same cultural context, relationship with urban built-up areas, and accessibility to citizens. Due to these commonalities, there will be shared perceptions of ESs that WPs provide, while differing perceptions can indicate effects arising from distinctions in the characteristics of WPs. In Section 7.1, the selection criteria for these two WPs as case studies and comprehensive descriptions of the two WPs themselves will be provided.

Having identified primary beneficiaries and focal ESs and determined case study sites, this thesis determined appropriate methods for estimating each ESs and their relationships. Methods for assessing perceptions of ESs are presented in Section 7.2, while methods for technically understanding each ESs are presented in their respective sections in Chapter 7.

Finally, this thesis suggests implications for practice in Chapter 8.

3.2 Ethics

Following the University of Sheffield's protocol for any experiment involving human participants, the proposed research was subjected to an ethics review. Before ethical permission was given, the research proposal was examined by a faculty member from the Department of Landscape Architecture at the University of Sheffield, and all requested adjustments were made.

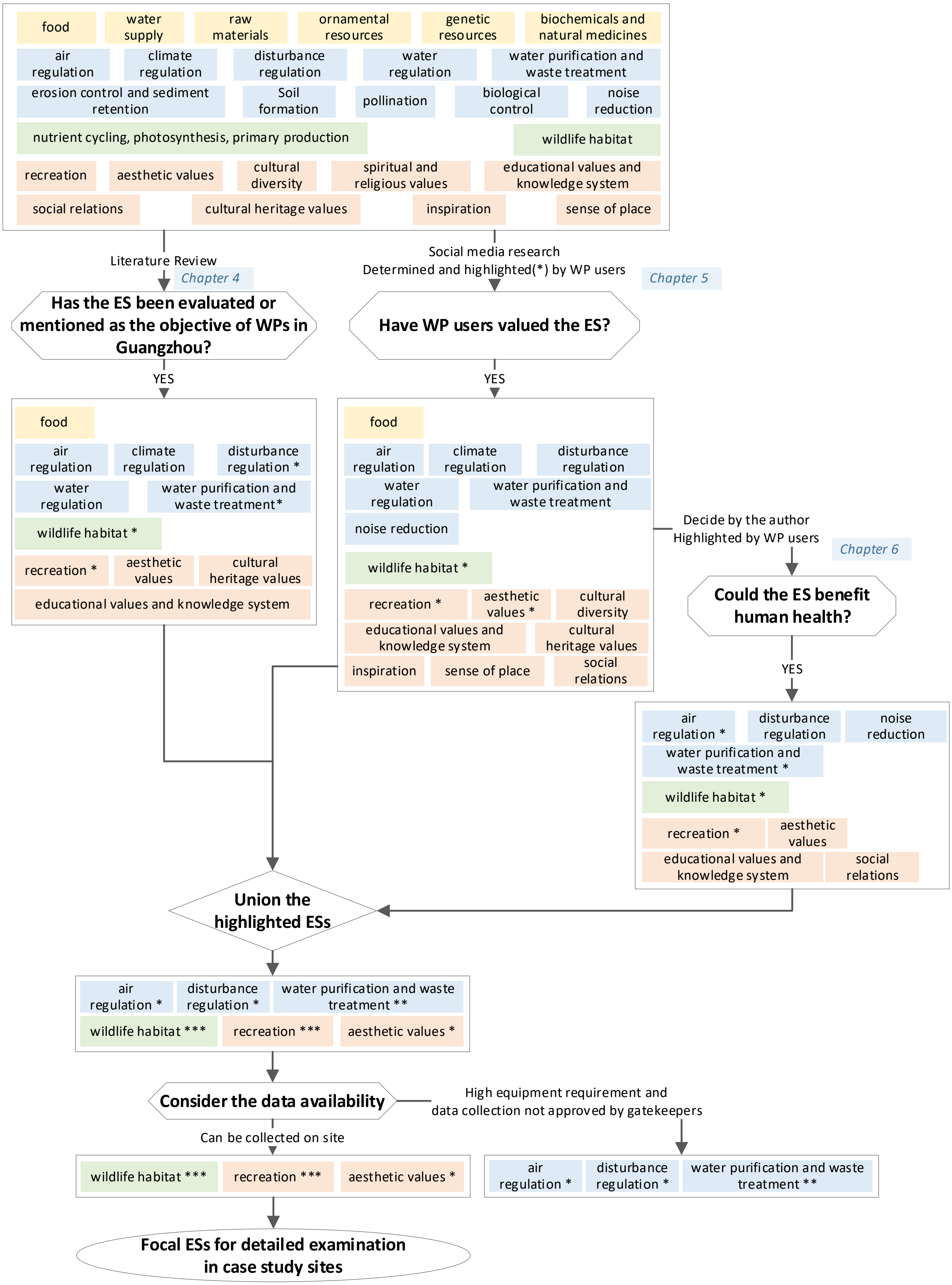

Figure 3-2 Determine the focal ecosystem services in wetland parks (: ESs that were emphasised)*

Chapter 4. Changing urban wetlands and their ecosystem services

Some parts of this chapter have been published:

Zhai, X., Cameron, R. and Lange, E. (2023) 'Wetland Parks in Guangzhou: Ecosystem Services and Perception', in Nijhuis, S., Sun, Y., and Lange, E. (eds) *Adaptive Urban Transformation*. Cham: Springer International Publishing (The Urban Book Series), pp. 285–299. doi: 10.1007/978-3-030-89828-1_15.

Authors' contributions: XZ conceived and designed the study, reviewed the literature, and drafted the initial stages of the manuscript, with input and guidance of RC and EL. RC and EL commented on and provided revisions of the manuscript.

4.1 Wetlands and their ecosystem services in transition, Guangzhou

Guangzhou is situated in the central region of the Pearl River Delta, with a gradual north-to-south slope. In the mountainous north, water catchments are depicted largely by lakes and streams, but are dominated by wider rivers and coastal wetlands in the south. Most places of Guangzhou were still coastal or seascapes until the Ming and Qing dynasties (about six hundred years ago), when the current landscape pattern of Guangzhou began to take shape (Li, 1983). It was also during this period that mulberry-dyke-fishpond began to develop as an efficient agricultural system for fish and silk production (Liu, 2016). Until 1954, the built-up area of Guangzhou was still small, with a large area of surrounding wetlands (e.g., rice paddy, rivers, dyke-ponds, and coastal wetlands), orchards, and woods (U.S. Army Map Service, 1954).

From the 1950s, Guangzhou began its economic development and the population has grown: there are 18.7 million permanent residents, nearly ten times the population in 1953 (Guangzhou Statistics Bureau, 2020). The rise in population and urbanisation has resulted in a significant loss of wetlands, including paddy fields, aquaculture ponds, shallow marine water and rivers (Zhao *et al.*, 2016). Meanwhile, highly intensive aquaculture replaced the traditional and ecological dyke-pond system (Hehl-Lange and Lange, 2019). Moreover, many river branches (e.g., Liwan River and Donghao River) have been covered over and/or polluted since the 1950s

New wetland parks (WP) have been designed and constructed recently, in response to more frequent flood disasters in the city and the increasing demand for recreational space. These landscapes are believed to be an effective nature-based solution to provide a compromise between wildlife protection and human utilisation. The development of WPs in Guangzhou covers the following four stages:

Germinating (1958–2003)

Four lake parks (LPs) were built in 1958. Labour was organised to excavate four artificial lakes, i.e., Liwan Lake (17 ha), Liuhua Lake (32 ha), Lu Lake (21 ha) and Dongshan Lake (23 ha) and to create parks that could maintain ecological balance, retain floods and provide cultural services (Wu, 2013; Li, Tan and Qiu, 2018; Wu and Lin, 2018).

On joining the Ramsar Convention in 1992, the Chinese government agencies have gained relevant experience of legal, technical and management aspects associated with wetlands from cases abroad and thus laid the foundations for developing a new generation of WPs (Ma, 2016).

Forming (2004-2012)

Recognising the local and regional environmental significance of wetlands, from 2004 to 2005, the State Council issued a series of documents to strengthen wetland protection and point out the development direction of WPs (Ma, 2016, p. 6). After Xixi National WP in Hangzhou, the first national WP in China was opened in 2005 and the number of WPs accelerated rapidly (Ma, 2016, p. 7).

Maturing (2012-2019)

In the following years, many more artificial lakes or wetlands were created. Improved knowledge and advanced technology about constructed wetlands was utilised in the development of these wetlands, making WPs more mature in terms of habitat structure and ecological complexity.

Currently within Guangzhou, there are 12 large lakes and eight artificial wetlands for stormwater storage as a nucleus for WPs (Bureau of Forestry and Landscaping of Guangzhou Municipality, 2017, 2018).

Developing and upgrading (2020 onwards)

More WPs are still under construction, and some existing WPs are currently being renewed or re-designed. For example, renewal of the Haizhu National WP includes expanding the water area, expanding the size of the area of floral displays, adding food courts, adding a museum etc., to improve recreation and aesthetic experience supporting natural education.

Considering the abundant river resources in Guangzhou (with 30 large rivers and 1338 river branches, with a total length of 5000 kms), the Ecological Belt programme along rivers was proposed for urban water treatment, ecological restoration and recreational and aesthetics services (Guangzhou Water Authority 2020). The 14th five-year plan (2021–2025) of Guangzhou emphasised the importance of the Ecological Belt and pointed out the necessity to upgrade three WPs (i.e., Baiyun WP, Haizhu National WP and Nansha WP) by strengthening the landscape and recreational facilities while protecting ecological resources. From a historical perspective, the ESs provided by the early wetlands in Guangzhou under human intervention changed from water supply services to regulation services. Then more emphasis was placed on cultural services and support services while ensuring regulation services, indicating the transitions within wetland and human needs. In the future, WPs will play an essential role in the development of Guangzhou.

4.2 Wetland parks and their ecosystem services in Guangzhou

WPs in Guangzhou vary considerably in area and width (Figure 4-1), and they usually originated in three ways:

- Designation of existing park space for wetlands management.
- Transfer of natural wetlands for use as new park space because they contain wetland characteristics worthy of protection and restoration in a more public setting.
- Creation of park space with constructed wetlands for surrounding run-offs retention or water quality improvement.

Some ESs associated with WPs in Guangzhou have been evaluated through multiple methods by local experts. WPs in Guangzhou can provide ESs, including wildlife habitat, flood regulation, air regulation, water purification, recreation, aesthetics, and natural-based education (Table 4-1).

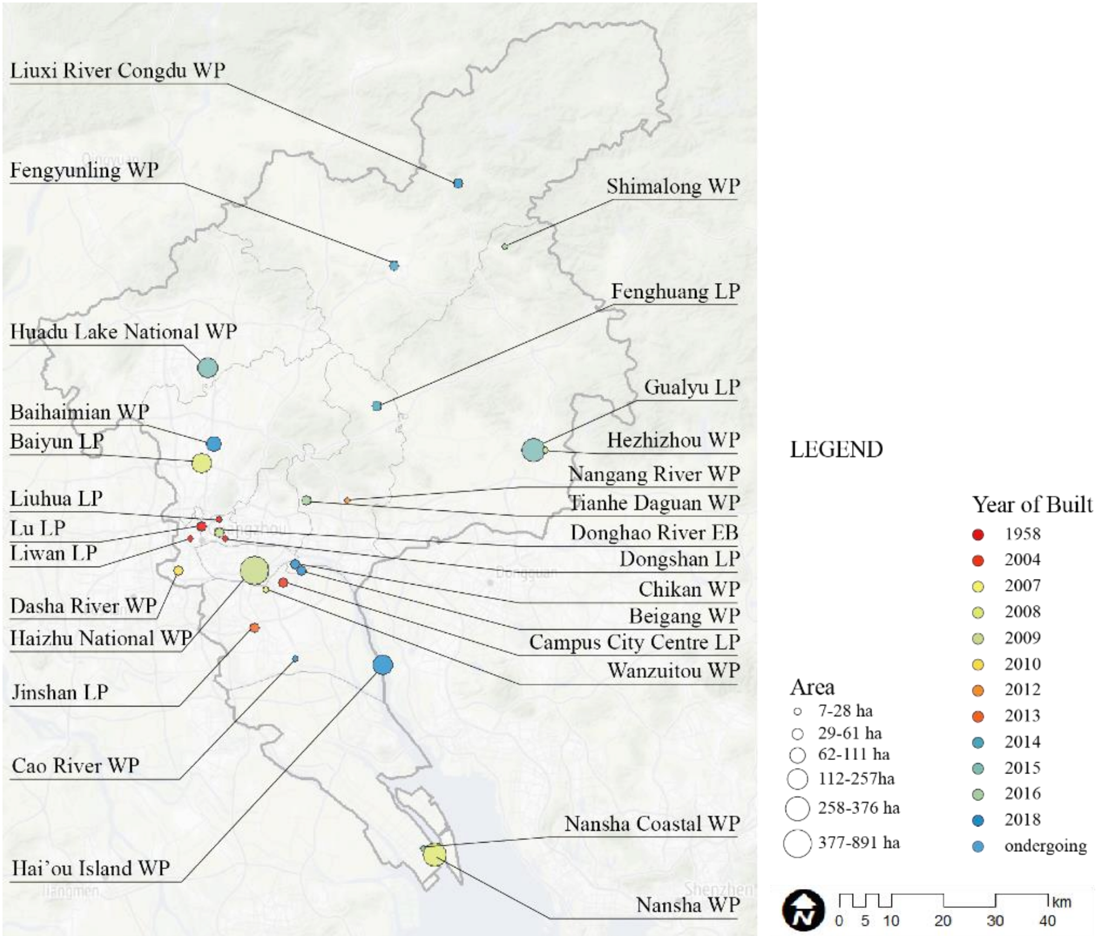

Figure 4-1 Wetland parks in Guangzhou

Table 4-1 Ecosystem services associated with wetland parks in Guangzhou

	S1	S2	P1	R1	R2	R3	R4	R5	C1	C2	C3	C4
Liwan LP	+					√						+
Liuhua LP				+		√			+			
Dongshan LP						√						
Lu LP						√						
Wanzuitou WP	+	√							√			
Baiyun LP				+		+			+			
Nansha WP	+	+	+	+		+	+	+	+		+	
Haizhu National WP	+	+		+	+	+		+	+	+	+	+
Dasha River WP	+					+			+			
Nangang RiverWP	+					+			+			
Tianhe Daguan WP	+			+		√			+			

S1: flora habitat, S1: fauna habitat; P1: food provision; R1: water purification, R2: air regulation, R3: flood regulation, R4: climate regulation, R5: water regulation; C1: recreation, C2: aesthetics, C3: environmental education, C4: cultural heritage;
+: ESs that have been assessed, √ : ESs that the WP aim to provide
Only the WPs and ESs mentioned in the literature were listed in the table

Wildlife habitat

Wetland Parks provide habitat for wildlife. Several studies have evaluated habitat services of WPs for plants and birds. Imported and invasive plant species account for a large proportion of WPs in Guangzhou. For example, there are a total of 625 species of vascular plants recorded in the Haizhu Wetland, including 320 species (51.2%)

of introduced plants, 268 species (42.88%) of native plants and 37 species of invasive alien plants (5.92%) (Huang *et al.*, 2018). It is estimated that the habitat service value is 2.1 million CNY per year, accounting for 1.83% of the total ESs value of this WP using the Benchmarking Method according to unit value of wetland wildlife habitat of global ESs assessment (Xie and Guo, 2018, p. 30). In the Tianhe Daguan WP, the 2017 survey showed that there are 66 plant species, and that there is a slight increase in the number of plant species compared to before the WP was created (Wang L. *et al.*, 2019). Mangroves are mainly distributed in two coastal WPs in Nansha, and there is also a small area in Haizhu National WP.

WPs provide habitats for many birds in Guangzhou: there have been 392 species of birds recorded in Guangzhou in recent years, of which 258 have been recorded in WPs (Kunming Vermilion Bird Research Institute, 2022). Among the 258 species, 24 are National Secondary Protected species, including five near-threatened species, two vulnerable species, two endangered species (i.e., black-faced spoonbill (*Platalea minor*) and great knot (*Calidris tenuirostris*)) and two critically endangered species (i.e., Baer's pochard (*Aythya baeri*) and yellow-breasted bunting (*Emberiza aureola*) (defined by IUCN)). Nansha WP plays a vital role in providing habitat for migrating waterfowl, especially endangered species such as black-faced spoonbill and great knot.

Water Purification

Wetlands can filter nutrients and pollutants from surface water and upstream water. After sedimentation and filtration of the Pearl River water flowing into the Haizhu National WP, the water quality improves and reaches the standard for recreation. The value of the water purification is estimated to be 17.7 million CNY per year, accounting for 15.47% of the total ESs value (Xie and Guo, 2018, pp. 29–30). The water quality at Daguan improved after it became a WP, with almost all sampling points reaching water quality standards for recreation, with water purification correlating with increased vegetation coverage in the water (Wang L. *et al.*, 2019).

Flood regulation

Low-lying wetland areas work as sinks that retain flood water. However, the actual flood regulation performance and storage capacity of WPs has not been studied yet in detail.

Air regulation

Theoretically, vegetation in WPs could regulate the atmospheric CO_2 and O_2 balance and absorb air pollutants. However, there is no quantitative survey on air regulating service in WPs in Guangzhou. According to vegetation type and area, the annual atmospheric regulation value of the Haizhu Wetland is estimated to be about 6.5 million CNY (Liu, 2019).

Recreation

The Haizhu National WP attracts approximately 10 million visitors. It is estimated that the recreation value of Haizhu National WP is about 507 million yuan per year (Liu *et al.*, 2019). About 14.5 million people used Liwan LP in 2009, for taking walks, sitting, exercising and watching Cantonese Opera (Zhang and Huang, 2016).

Environmental Education

Information is provided to visitors through signs which convey information about wetland functions and wetland habitats in WPs. Several well-known WPs with high quality habitats also hold some nature-based education activities. Haizhu Wetland Nature School offers popular courses and activities, e.g. for family groups at weekends (Fan, Zhong and Cai, 2017). Environmental education companies provide fee-based nature study tours and wildlife watching activities in Haizhu National WP and Nansha WP, allowing participants to learn about plants, birds and insects in the daytime and amphibians at night. Most of these activities are only aimed at children, and there are few specific activities for adults; however, the willingness of adults to participate in nature observing activities is not low. From June 2019, Guangzhou Nature Observation Association organised a half-year wild bird observation and education activity in three WPs (i.e., Haizhu National WP, Lu LP and Liuhua LP); in June alone, more than 5,000 participants (mostly adults) were involved (Luo, 2019).

4.3 Changing of ecosystem services and beneficiaries of the land

ESs have been shifted in response to the altering land cover. Prior to the establishment of WPs, the sites of the current WPs were primarily agriculture land (e.g., Haizhu National WP, Wanzuitou WP), wasteland (e.g., Tianhe Daguan WP), and natural wetland (e.g., Nansha WP, Nangang River WP) in regions that were relatively unknown to the general public. The WPs that were developed from agricultural land experienced a shift from food providing services to more diverse services. The WPs that were reclaimed from wastelands saw an increase in ESs. WPs transformed from natural wetland in locals' little-known locations saw an increase in cultural ESs.

Meanwhile, beneficiaries, which considered to affects the realization of ESs (Haines-Young and Potschin, 2018), have also been shifted. In the past, farmers and the buyers of food benefit from the agriculture land, whereas ambiguous beneficiary groups could be identified for the wasteland and natural wetlands in locals' little-known locations due to the lack of documents. Currently, local / regional / downstream inhabitants, visitors to WPs, and a few institutions could benefit from WPs. As a trade-off, farmers lose their arable land and receive the same type of benefit as visitors or local residents. Notably, this thesis only covers the existing beneficiary groups; descendants who may benefit from ESs like habitat, climate management, and cultural heritage are not included.

As indicated in Table 4-2, beneficiary groups of the analysed ESs from WPs were identified by a literature review and site visits. Beneficiary groups on-site and off-site were identified. For instance, habitat indirectly benefits local residents as a supporting service and as an aesthetic source for visitors (especially wildlife watchers). **Food** is the only listed provisioning service and only offered by Haizhu National Wetland Park (HNWP). Specifically, HNWP provides tropical fruits grown in orchards. This WP annually delivered longans to the social welfare institute and nursing homes in its district, and invited visitors who purchase tickets for the collecting activity to taste and collect longans (Haizhu Wetlands, 2016). **Air regulation** that reduces respiratory disease is beneficial for both visitors and local residents. **Climate regulation** has a broader impact that benefits visitors, locals, and regional residents by preventing climate-related damage costs and enhancing thermal comfort in WPs and the city. **Regulation of disturbances and water** could save damage costs and benefit local and downstream populations. **Water purification** could benefit tourists by lowering the nuisance effect of odors from polluted water and enhancing visual amenity, therefore benefiting visitors as well as local and downstream residents. The primary beneficiaries of cultural services, which include **recreation, aesthetic values, educational values and knowledge system, and cultural heritage values**, are tourists. In addition, schools (particularly elementary and secondary schools) and educational institutions benefit from the educational values and knowledge system by teaching environmental education programs in WPs. And cultural heritage values that demonstrate local identity and cultural icons that promote social cohesion, to the advantage of local and regional residents. As a result, due to the fact that the majority of visitors are also locals, visitors to WPs have been designated as the priority beneficiary group for this study.

Table 4-2 Beneficiary groups of wetland parks in Guangzhou

	Example goods and benefits	Beneficiary groups
Wildlife habitat	Support other services Source of aesthetic appreciation Source of environmental education	Local inhabitants Visitors (especially wildlife watchers)
Food	(Haizhu National WP only) fruits including longan, lichee, star fruit, etc.	(Haizhu National WP only) social welfare institute and nursing homes that receive fruit donations Paid visitors (paid for cultivation activities)
Air regulation	Reduction in respiratory disease	Local inhabitants Visitors
Climate regulation	Avoided climate-relevant damage costs Increased thermal comfort in cities	Local and regional inhabitants Visitors
Disturbance regulation	Reduction in damage costs	Local and downstream inhabitants
Water regulation	Reduction in damage costs	Local and downstream inhabitants
Water purification	Reduction in nuisance effect of smells from polluted water Visual amenity	Local and downstream inhabitants Visitors
Recreation	Recreation, fitness, destressing	Visitors
Aesthetic values	Mental wellbeing	Visitors
Educational values and knowledge system	Knowledge about the environment and nature	Visitors Schools / educational institutions
Cultural heritage values	Tourism, local identity, social cohesion, cultural icon	Local and regional inhabitants

Chapter 5. Using social media to explore perceptions of ecosystem services by wetland parks in Guangzhou

This chapter has been published:

Zhai, X. and Lange, E. (2020) 'Using social media to explore perceptions of ecosystem services by nature-based solution projects', *Landscape Architecture Frontiers*, 8(3), p. 58. doi: 10.15302/J-LAF-1-020030.

Authors' contributions: XZ conceived and designed the study, collected and analysed data, and drafted the initial stages of the manuscript, with input and guidance of EL. EL commented on and provided revisions of the manuscript.

5.1 Introduction

Massive data collection from the Internet enables us to access unprecedented amounts of self-reported data across geographic domains in a short period of time (Sloan *et al.*, 2020). In recent years, more and more Chinese citizens express their opinions, post travels, and share moments and experiences via social media such as Weibo and WeChat. Such self-reported data have been used to study people's perception on environmental elements. For example, scholars modelled the perceived boundaries of the city centre and identified popular landmarks in Vienna (Huang, Gartner and Turdean, 2014); online feedback data were used for a post-occupancy evaluation of urban historic conservation areas in Beijing (Wang and Zhuang, 2019) ; photos posted on social media can be a source for exploring the relations between cultural ESs (e.g., aesthetics, recreation, and local identity) and landscape features (Oteros-Rozas *et al.*, 2018).

Sina Weibo, one of the most popular social media in China, is used as the data source for this research. It is a microblogging platform similar to Twitter. In 2019, Sina Weibo served 465 million active users monthly and 216 million daily (Sina Weibo Data Center, 2019). Users can post texts, pictures, videos, and links openly[10] , which are accessible to all users. The users of Sina Weibo can register their accounts as individuals and institutions. Institution users, in this research, include government departments, park management offices, public media, academic institutes, NGOs, and NPOs, which usually have a large number of followers. Apart from official WP management entities, other institutions do not directly involve the management or operation of WPs. Still, their publicity will, to some extent, reflect the management of WPs as well as citizens' feedback on related aspects, and could provide guidance to the public. This research compares the microblogs by individual and institution accounts, to probe into the similarities and differences between the general public's (i.e., individuals) perceptions of ESs, and the value of ESs expected by the professionals (i.e., institutions).

Although a user's comment may not cover all the perceived values or benefits of the ecosystems, what a person is willing to record or share could be the most noteworthy ESs. This research attempts to answer 4 questions: 1) What ESs do the public perceive from WPs? 2) What are the interconnections between PESs? 3) Do the public perceive the same ESs as what professionals identify? and 4) What factors could affect people's perceptions on ESs?

[10] This study excluded the microblogs that set as "to me only" and "to followers only," because such data might involve privacy concerns, and the use of these data would violate ethics and be not allowed by the Terms and Conditions and Personal Information Protection Policy of Sina Weibo.

5.2 Methods

5.2.1 Data collection

This research used GooSeeker as web crawler to crawl the data from Sina Weibo throughout the year of 2019. The names of the 20 WPs were used as keywords to search the microblogs on the Advanced Search Engine of Weibo with their Uniform Resource Locator copied to GooSeeker for data collection. The search location was set as Guangdong Province, to which the City of Guangzhou belongs, to screen out the WPs with same names in other provinces in China (e.g., there is another Baiyun Lake Wetland Park in Shandong Province)[11]; only for those with similar names in Guangdong Province (e.g., there is another Dasha River Park in Shenzhen), the search location was set as Guangzhou. Text content, post date and time, user ID, and user type (individual or institution), were collected. The research obtained text contents of 10,633 public microblogs (picture and video contents will be analyzed in future studies).

All data collection and analyses relied on anonymous data (i.e., no personally identifiable data was collected or analyzed) and adhered to the Terms and Conditions and Personal Information Protection Policy of Sina Weibo. Additionally, the GooSeeker strictly abides by the Robots Agreement.

5.2.2 Data pre-processing

Social media data is often noisy, unstructured, or heterogeneous (Huang, Gartner and Turdean, 2014); inevitably, irrelevant data will be collected because of the incorrect segmentation of the search engine. Only original microblogs, expressing the users' experience, perception, or feedback of visiting the WPs, were regarded as 'relevant data'. Thus, the searched irrelevant microblogs and reposted messages by individuals or institutions were excluded manually. Duplicated messages posted by the same individual or institution were also excluded. However, considering different institutions have different followers, non-repost messages with the same or almost the same content posted by different institutions were included.

The study further screened out the irrelevant information from the relevant microblog texts. Besides, sometimes cyber language causes confusion with keywords for identifying ESs. For example, the character '鸭' (duck) can be a signpost to the refugia / habitat services (an ES), but recently microbloggers tend to use it as an alternative to the modal particle '呀' ('ah'). Therefore, the analysis might be biased if depending merely on words filtering. The basic unit of meaning analysis in natural language processing is sentence, which yet is not a simple linear sequence of words (Dale, 2010).

Hence, the irrelevant information of the collected relevant microblogs was also manually excluded, and the sentences were manually audited and coded according to their meaning.

The categories and coding criteria of ESs (Table 5-1) were generated under the most-adopted ESs classification systems (Costanza *et al.*, 2017). Each ES sub-category was coded with its corresponding category and a number. Microblogs that stated the value of a perceived ES as low were coded with a negative mark (-). For example,

[11] The location setting up is for another reason that many people visiting the WPs in Guangzhou live or post microblogs in the city or other adjacent cities. Admittedly, though this setting verified the locations of the WPs studied in this research, the microblogs that "disable location services" may be omitted.

when a microblog described that a WP has a low aesthetics value (e.g., messy, not attractive), it was coded with 'C2-' (negative perception of aesthetics service); when one mentioned the harm caused by an invasive species, it was coded with 'S2-' (negative perception of refugia / habitat service)[12].

Table 5-1 Categories and coding criteria of ESs for microblogs

Ecosystem Services		Codes	Coding Criteria （when a microblog mention following contents)
P	food	P1	name of food products that derived from plants, animals and microbes (e.g., crops, wild fruits, fishing); activities to harvest food
	water supply	P2	fresh water storage, retention and supply by watersheds, reservoirs, aquifers
	raw materials	P3	get raw materials, including fibre (e.g., Wood, silk), construction materials (e.g., lumber), fuel (e.g., firewood) and fodder.
	ornamental resources	P4	collect ornamental animal and plant products for decorative use
	genetic resources	P5	genes and genetic information used for animal and plant breeding and biotechnology
	Bio-chemicals and natural medicines	P6	get natural medicines from the ecosystem
R	gas regulation	R1	regulation of atmosphere chemical composity (e.g., CO2/O2 balance, SOx levels control); the place has better air quality
	climate regulation	R2	regulation of local and global temperature, precipitation and other biologically mediated climatic processes（e.g., feeling cooler in ecosystems)
	disturbance regulation	R3	e.g., storm protection, flood control, drought recovery, hurricane reduction
	water regulation	R4	the timing and magnitude of runoff, flooding and aquifer recharge, (e.g., Natural irrigation, drought prevention)
	water purification	R5	filter out and decompose organic wastes or nutrients introduced to water related ecosystems; better water quality /cleaner water
	erosion control and sediment retention	R6	soil retention (e.g., prevention of landslides; prevention of loss of soil by wind, runoff, or other removal processes; storage of silt in lakes and wetlands)
	Soil formation	R7	soil formation process (e.g., weathering of rock and the accumulation of organic material)
	Pollination	R8	movement of floral gametes for the reproduction of plant populations
	biological control	R9	disease regulation, pest regulation, Trophic-dynamic regulations of populations (predator control)
	noise reduction	R10	noise reduction; quieter
S	nutrient cycling, photosynthesis, primary production	S1	the process of nutrient cycling (e.g., nitrogen fixation, phosphorus or nutrient cycles)
	refugia/habitat	S2	habitat for wildlife resident and transient populations; do activities related to wildlife
C	recreation	C1	Do recreational activities (e.g., eco-tourism, sport fishing, and other outdoor recreational activities)

[12] Although the appearance of invasive species shows that the WP provides a habitat for invasive species, the possibility of providing habitats for a lot more native species is reduced considerably (Charles and Dukes, 2007). For example, Mikania micrantha and Bidens alba, common invasive plant species in Guangzhou, could threaten the survival of native plants and result in a reduction in biodiversity.

	aesthetic values	C2	enjoy beautiful scenery or fragrance
	cultural diversity	C3	landscape features that reflect regional culture
	spiritual and religious values	C4	Regard the place as a religious or sacred place.
	educational values and knowledge system	C5	Gain knowledge from the wetland park (i.e., Formal and informal education)
	social relations	C6	organizing or attending events to interact with other people or make friends; mark the places recommended by web celebrity and share with friends to gain social belongings
	cultural heritage values	C7	Landscape features that reflect local history, traditions and wisdom
	inspiration	C8	get inspiration for art, poems, and so on
	sense of place	C9	A person's special experience in a specific environment (feeling stimulating, happy, etc.)
Ecosystem Disservices		ES-	functions of ecosystems that are perceived as negative for human well-being
Abbreviations: P: provisioning services; R: regulating services; S: supporting services; C: cultural services			

5.2.3 Analysis of the popularity of wetland parks

This analysis audited the occurrence frequency of various WPs (i.e., microblogs relevant to WPs). Generally, the higher the relative occurrence frequency of a WP on Weibo is, the more popular it will be (Teng *et al.*, 2015). Thus, in this study, the popularity, i.e., the relative occurrence frequency of each WP was obtained by dividing total relevant microblogs by its area. The names (Bureau of Forestry and Landscaping of Guangzhou Municipality, 2017, 2018), wetlands types, and area of WPs were sourced from official documents (including masterplans) of each WP. To examine whether the ESs occurrence is correlated to popularity, the proportion of microblogs which mentioned ESs associated with relevant microblogs was also counted. The influence of wetland type was also examined. Furthermore, the location data (i.e., longitude and latitude) of the WPs, sourcing from Baidu Map[13] were processed with ArcMap to visualize the spatial distribution and the popularity of the WPs.

5.2.4 Semantic analysis

Semantic analysis of the microblog texts relevant to each ES in a WP was conducted by using Python 3.7 to identify the key factors (i.e., keywords for perception) that affect the perception of ESs. All microblogs relevant to an ES sub-category in a WP were analyzed as an analysis unit.

Unlike English, which delivers text in the form of words neatly delimited by spaces, Chinese texts require first a segmentation process to identify the words that make up an utterance (Dale, 2010). Jieba, a Chinese word segmentation module in Python 3.7, was used in this study. Although Jieba can recognize and record new words, editing customized terms (i.e. user dictionary) ensures a higher audit accuracy (Song, Huang and Wang, 2019). Text sets sometimes contain high-occurrence but meaningless words, which causes noise and increases the confusion between texts. Using these meaningless words to construct a stop-word dictionary can increase keyword density and make the keywords more concentrated and prominent (Chen, 2005).

[13] Baidu Map is a web mapping service application in China that offers the widest covering and dynamic map information.

According to the microblog contents, this study manually expanded the user dictionary, stop-word dictionary, and synonym dictionary, to improve the accuracy and validity of the segmentation (Pan, 2019). The user dictionary is constituted of proper nouns (e.g., names of scenic spots, animal and plant species, technological terms), idioms (e.g., visitors in a steady stream, '络绎不绝'), and phrases (e.g., storm water regulation and retention, '雨洪调蓄'). The stop-word dictionary includes function words (i.e., adverbs, connectives, structural particles, modal verbs and particles, conjunctions, prepositions, and quantifiers) and some notional words (i.e., names of WPs; names of districts, cities, regions, and countries; dates; time). The synonym dictionary consists of different expressions with the same meanings.

The text data was visualized in form of a word cloud with the WordCloud Library in Python 3.7. Important text information was accurately and quickly extracted (Pan, 2019). The most frequent 20 words of each WP were extracted and visualized in this research.

5.2.5 Interconnections among perceived ecosystem services

Association rule mining was then conducted to explore the interconnections between the PESs. The association rule is 'an expression of the form X→Y that whenever X seems, Y also tends to appear' (Mythili and Mohamed Shanavas, 2013)[14]. Here, the Frequent-Pattern growth (FP-growth) algorithm, the most efficient algorithm to identify frequent item sets for association rule mining (Yuan and Ding, 2012), was adopted.

The output of the FP-growth algorithm is an FP tree. The root node is an empty set, and each node is a single element, which stores its occurrence frequency in the dataset. Besides, the nodes with similar elements are inter-connected by links, which can be regarded as a linked list. A same element can appear multiple times in the FP tree, corresponding to different frequent item sets depending on the location[15] . In this research, the FP tree was built with Python 3.7 according to a script proposed by Peter Harrington (Harrington, 2012).

5.3 Results

5.3.1 Dataset description

In total, 10,633 microblogs generated in 2019 were crawled; approximately 50% of them (5,358) posted by 3,602 individuals and 125 institutions were audited as relevant. Specifically, 112 individuals posted more than one message for a single visit; 275 individuals posted about a same WP more than once; 43 individuals posted more than one microblog for one trip and visited a same WP for more than once; and 172 individuals posted about more than one WP (90% of these individuals visited two WPs). Among the relevant microblogs, on average, 46% mentioned ESs in each WP. As shown in Table 5-2, among the 20 examined WPs, 4 were not open to the public in 2019, and only 6 had enough relevant microblogs (> 100) for analysis, i.e. Haizhu National

[14] Initially association rule mining was used to identify the inner links between different goods that customers bought to understand customer buying habits. It has been widely used in relational databases, data warehouses, and text databases (Source: (Agrawal, Imieliński and Swami, 1993)) .

[15] For example, in dataset {A, B, C, D}, {A, D}, {A, B, C}, {B, C}, {B, D}, and {A, B}, A appears 4 times, which is expressed as {A: 4}; among these 4 times, B appears simultaneously 3 times, which is expressed as {A: 4, B: 3}. Here, B: 3 is the branch of A: 4.

Wetland Park, Baiyun Lake Wetland Park, Tianhe (Daguan) Wetland Park, Huadu Lake Wetland Park, Nansha Wetland Park, and Gualyu Lake Wetland Park, which are scrutinized in this study.

5.3.2 Popularity of wetland parks

Throughout the year, the popularity of each WP varied considerably. As can be seen from Table 5-2 and Figure 5-1, among the 5 relatively popular WPs (popularity > 0.5) regarding the 6 WPs, 4 are located in the central area of Guangzhou and the other, Nansha Wetland Park, is situated at the city border; 5 of them are with inland constructed open water bodies, including lakes, reservoirs, and ponds. Less attention was paid to riverine and coastal WPs. According to Figure 5-1, no obvious conclusion could be made about the relation between the rate of mentioned ESs (i.e., microblogs mentioned ESs divided by total relevant microblogs) and the popularity of the WPs[16] .

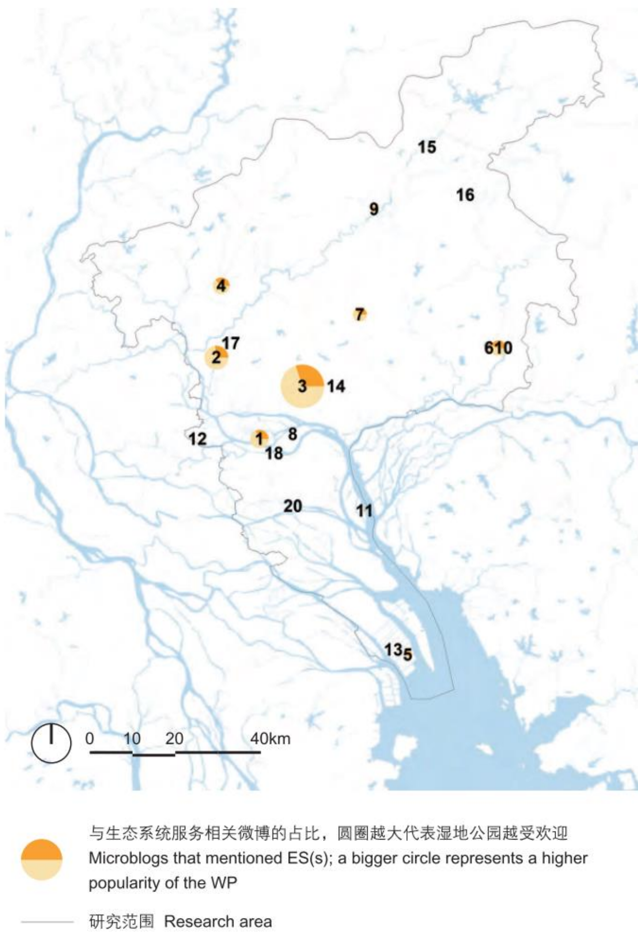

Figure 5-1 Wetland Parks in Guangzhou and their popularity

[16] A bivariate Pearson Correlation analysis was also run in SPSS. As a result, the correlation was not statistically significant (Sig. = 0.548).

Table 5-2 Overview of wetland parks in Guangzhou and related microblogs to them

NO	Name	Type	Area (ha)	Relevant Microblogs	popularity	Microblogs Mentioned ESs	ESs mentioned rate	Master Plan]	Photo
1	Haizhu National WP	artificial lake, river, orchard fish ponds	891	2538	2.85	1201	47.32%		
2	Baiyun Lake WP	artificial lake	187	904	4.83	335	37.06%		
3	Daguan/Tianhe WP	reservoir and ponds	46.8	756	16.15	325	42.99%		
4	Huadu WP	artificial lake, riverine	256.6	606	2.36	359	59.24%		
5	Nansha WP	coastal, mangroves	376	234	0.62	122	52.14%		
6	Gualyu Lake WP	artificial lake	307	109	0.36	94	86.24%		

(Continued)

NO	Name	Type	Area (hm2)	Relevant Microblogs	popularity	Microblogs Mentioned ESs	ESs mentioned rate
7#	Fenghuang Lake WP	artificial lake	34	55	1.62	31	56.36%
8#	Beigang WP	riverine, artificial lake	38.4	2	0.05	0	-
9#	Fengyunling WP	artificial lake, riverine	33.69	2	0.06	8	80.00%
10#	Hezhizhou WP	riverine	7	14	2.00	11	78.57%
11#	Haiou Island Mangrove WP	coastal, mangroves	186	11	0.06	9	81.82%
12#	Dasha River WP	riverine	55	1	0.02	0	-
13#	Nansha Coastal Greenway WP	coastal, mangroves	13	1	0.08	1	100.00%
14#	Nangang River WP	riverine	15	0	0.00	0	-
15#	Liuxi Spring WP	riverine	46	0	0.00	0	-
16#	Shimalong WP	reservoir	22	0	0.00	0	-
17*	Baihaimian WP	artificial lake	110.5	1	0.01	0	-
18*	Wanzuitou WP	artificial lake	19.5	1	0.05	0	-
19*	Chikan WP	riverine, artificial lake	61	0	0.00	0	-
20*	Cao River WP	riverine	28	0	0.00	0	-
NOTE 1. Information of the WPs were sourced from Ref. [27][28]; site plans of the WPs were sourced from Google Earth; and photos of the WPs were shot by the authors; 2. '#' means WPs with insufficient data for analysis, '*' means WPs that were not open to the public in 2019.							

5.3.3 Perceived ecosystem services in wetland parks

Figure 5-2 presents the results of the percentage frequency of PESs in the 6 WPs, by both individuals and institutions. The percentage frequency is the microblogs which mentioned a given ES divided by the total number of microblogs that mentioned ESs. 8 types of ESs, namely water supply (P2), raw material (P3), genetic resource (P5), soil formation (R7), pollination (R8), biological control (R9), nutrient cycling, photosynthesis, and primary production (S1), and spiritual value and religious value (C4), never mentioned by any of the relevant microblogs. Cultural services were the most PESs: 1) 35.0% ~ 66.4% of the microblogs mentioned recreation (C1) in each WP; comparatively, the recreation services of the Nansha Wetland Park had the lowest percentage frequency of PESs; 2) In terms of aesthetics services (C2), Tianhe (Daguan) Wetland Park had the highest percentage frequency (73.5%), while Baiyun Lake Wetland Park, Huadu Lake Wetland Park, Nansha Lake Wetland Park, and Gualyu Lake Wetland Park had a lower percentage frequency (less than 22.0%); 3) 9.0% ~ 25.5% of the microbloggers who PESs in the WPs mentioned about social relation services (C6); 4) The percentage frequencies of perceived education and knowledge system services (C5) and sense of place services (C9) were less than 5% in all WPs; and 5) Cultural diversity (C3), cultural heritage (C7), and inspiration (C8) were rarely perceived in most WPs.

Only a minority of the microbloggers (less than 10%) perceived provisioning, regulating, and supporting services as noteworthy. The provision of food (P1) was mostly perceived in the Gualyu Lake Wetland Park and relevant microblogs were mainly about fishing activities. The provisioning services of ornamental resources (P4) and natural medicines (P6) were rarely perceived as noteworthy—only two individual microbloggers showed the collages made with fallen leaves collected from the Haizhu National Wetland Park and Huadu Lake Wetland Park; another individual posted the bookmark made with the flowers collected from the Haizhu National Wetland Park; a microblog recorded the medical use of *Plumeria rubra* found in the Huadu Lake Wetland Park. The percentage frequency of perceived air quality regulation (R1) was relatively high across all the regulation services. Disturbance regulation (R3) and water purification (R5) services were little perceived, even in WPs designed for flood control and water purification, such as Tianhe (Daguan) Wetland Park. Noise reduction (R10) was casually perceived in all the 6 WPs. Water regulation (R4) as well as erosion control and sediment retention (R6) were only perceived once in Haizhu National Wetland Park and Nansha Wetland Park. The perception of refugia / habitat services (S2) showed a vast disparity among the 6 WPs: 70.5% for the Nansha Wetland Park, while only less than 5.0% for the Tianhe (Daguan) Wetland Park, Huadu Lake Wetland Park, and Gualyu Lake Wetland Park.

Although the percentage frequency of perceived ecosystem disservices (ES–), i.e., the negative impacts on human well-being accompanied the ESs, was low, it was sometimes perceived in all the WPs.

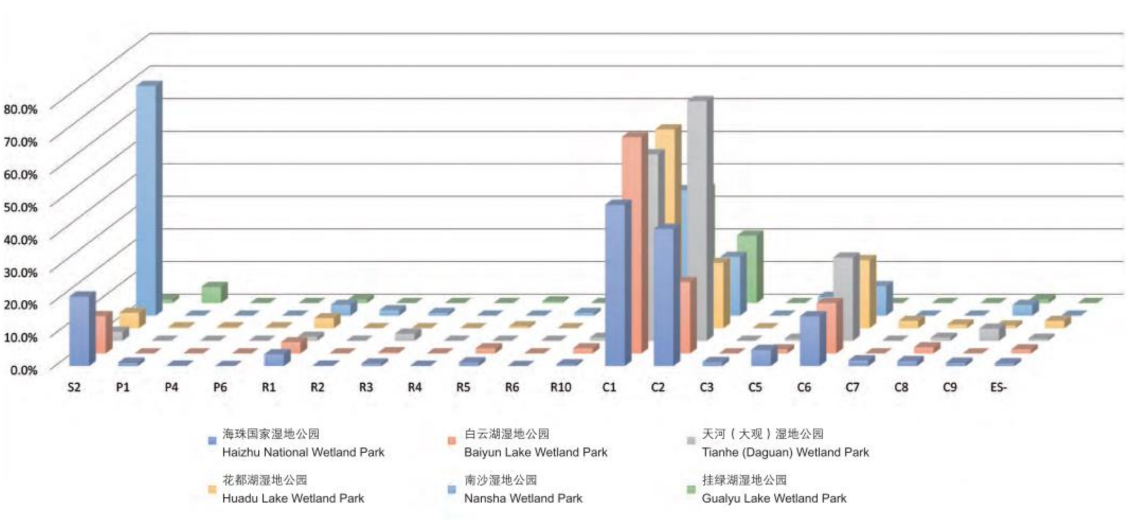

Figure 5-2 Percentage frequency of perceived ecosystem services in the six wetland parks

5.3.3.1 Interconnections among Perceived ecosystem services

The analysis of association rules (Figure 5-5) shows a strong interconnection between aesthetics (C1) and recreation (C2) services in 5 of the 6 WPs (except the Nansha Wetland Park). Sometimes social relation services (C6) were related to recreation services (C1): 31 times in Haizhu National Wetland Park, 11 times in Baiyun

Lake Wetland Park, 26 times in the Tianhe (Daguan) Wetland Park, and 27 times in Huadu Lake Wetland Park. In Tianhe (Daguan) Wetland Park, recreation services (C1), aesthetics services (C2), and social relation services (C6) were mentioned 17 times simultaneously. In Haizhu National Wetland Park and Nansha Wetland Park, refugia / habitat services (S2) were often perceived along with aesthetics services (C2). Sometimes, air quality regulation service (R1) and recreation (C1) or aesthetics (C2) services were perceived simultaneously (for R1 and C1: 13 times in Haizhu National Wetland Park, 6 times in Huadu Lake Wetland Park; for R1 and C2: 12 times in Haizhu National Wetland Park). The interconnections among other ESs were not obvious (i.e., frequency less than 6 times).

5.3.4 Individuals' Perceptions versus Institutions' Publicity

Figure 5-3 and compares the percentage frequency of PESs by individuals and institutions. The percentage frequency of perceived recreation services (C1) ranked top for both individuals and institutions, seconded by aesthetics services (C2); whereas, the disparity between individuals and institutions was significant—33.1% versus 93.3% and 23.3% versus 73.7%, respectively. The other two most frequently mentioned ESs were refugia / habitat services (S2) (perceived by 7.7% of individuals and 64.8% of institutions) and social relation services (C6) (perceived by 8.5% of individuals and 58.1% of institutions). 26.8% of microblogs posted by institutions mentioned the education and knowledge system service (C5), which was rarely perceived as noteworthy by individuals (0.7%). This study further selected three ESs, namely recreation (C1), aesthetics (C2), and refugia / habitat (S2), due to the sufficient data collected, to compare the perception differences between individuals' perception and institutions' publicity throughout the year. There was no obvious monthly distribution pattern found in frequency of PESs. The ratio of the number of microblogs posted by institutions, compared with individuals, is higher in refugia / habitat services (S2), especially in the Nansha Wetland Park and Baiyun Lake Wetland Park. In Baiyun Lake Wetland Park, the number of microblogs related to negative perception of refugia / habitat services (marked with '–') was high, especially indicated by individuals. Institutions posted little about ESs in the case of Gualyu Lake Wetland Park.

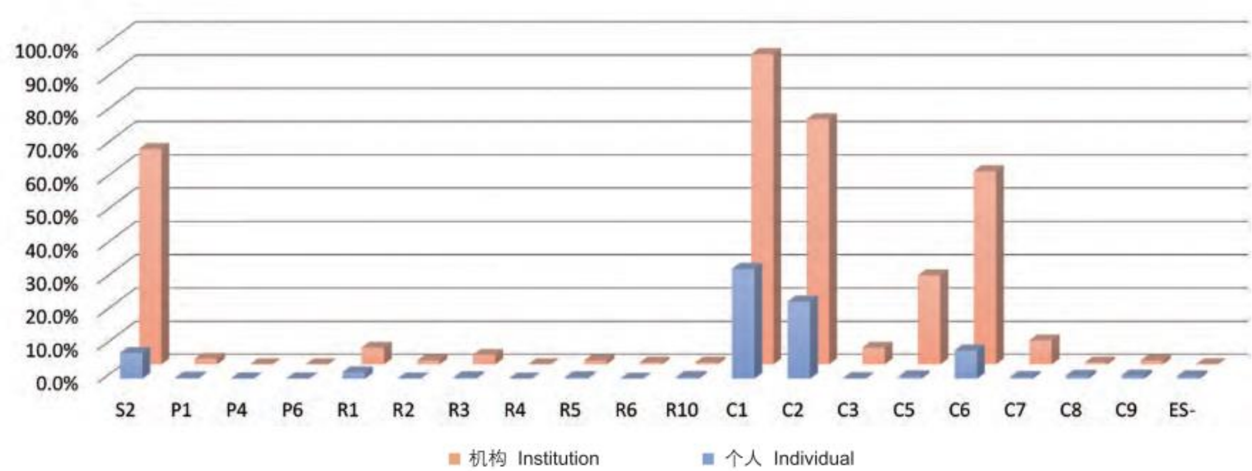

Figure 5-3 Overall comparison between individual's perceptions and institutions' publicity of recreation (C1), aesthetics (C2), and habitat service (S2) in the six wetland parks

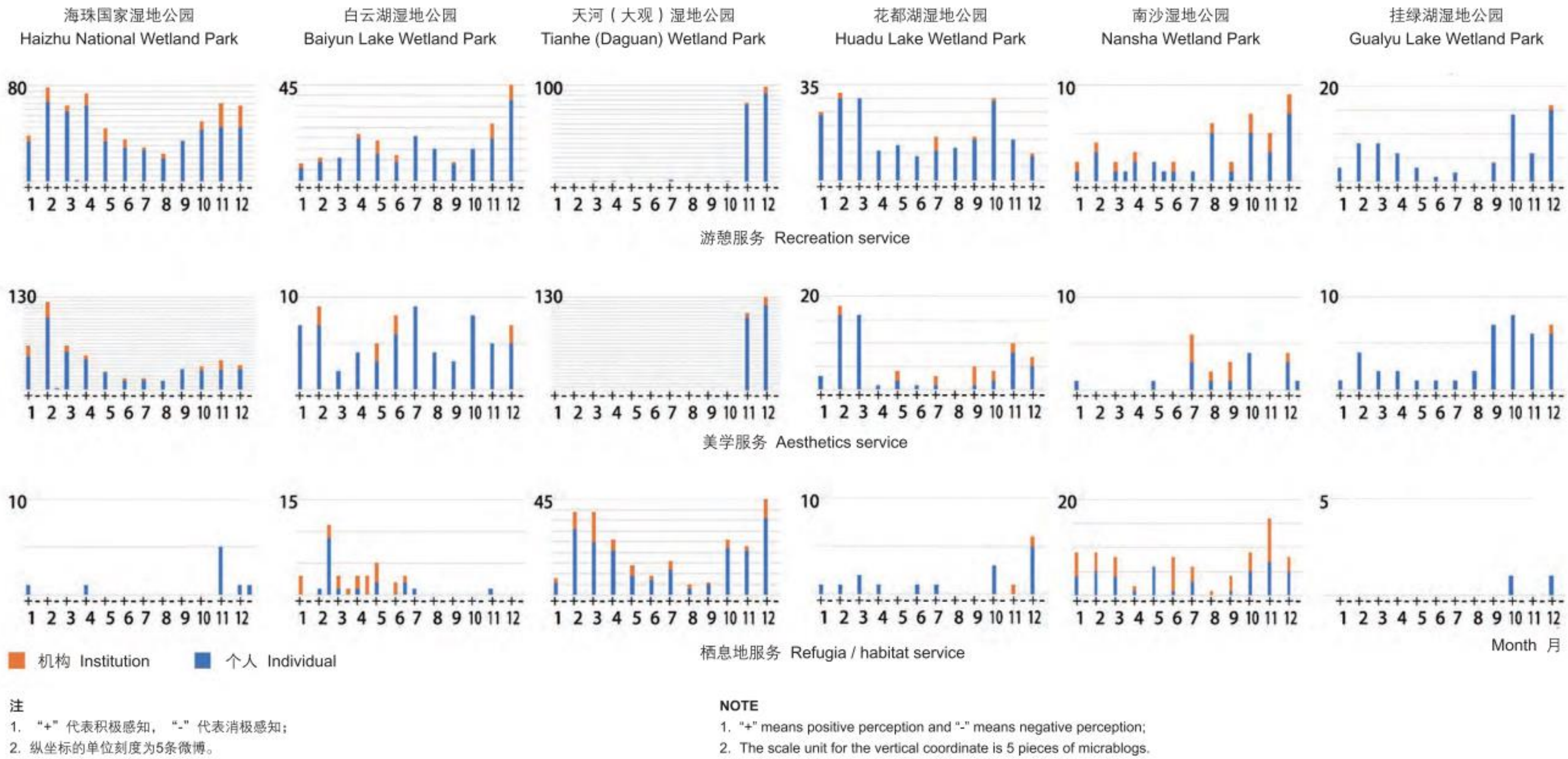

Figure 5-4 Monthly comparison between individual's perceptions and institutions' publicity of recreation (C1), aesthetics (C2), and habitat service (S2) in the six wetland parks

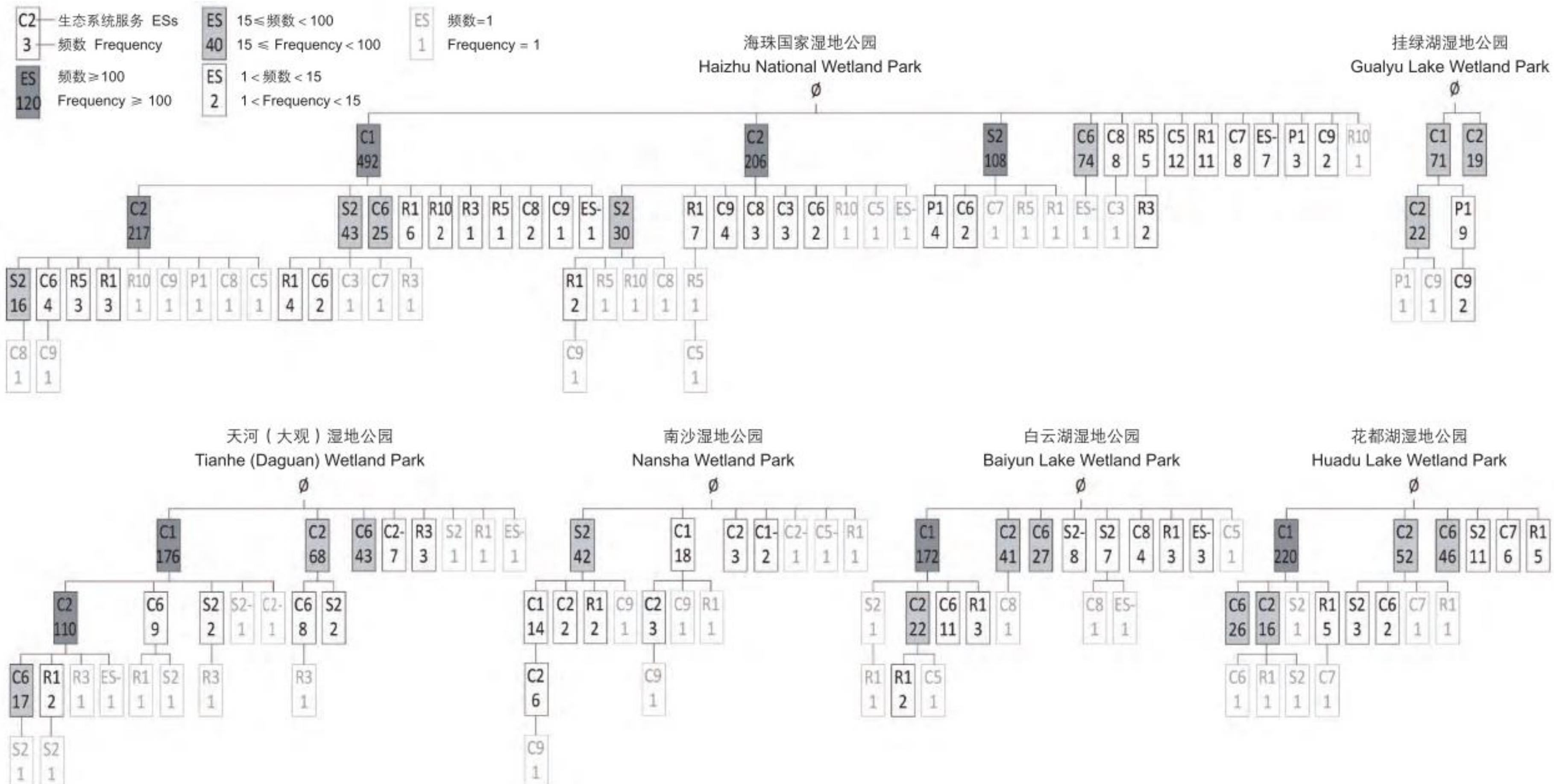

Figure 5-5 FP-tree of ecosystem services perceived in the six wetland parks

5.3.5 Stimuli to ESs Perceptions

The word cloud analyses (Figure 5-6) display the stimuli to the positive perception of ESs varied across the 6 WPs. The larger the size of a word is, the more frequently it occurs and the more important it is. The identified stimuli were commonly found in the WPs but seeing a varied degree of influence—for instance, *Ardeidae* as a stimulus for the perceptions of refugia / habitat services(S2) was more important in Huadu Lake Wetland Park than in Nansha Wetland Park. Stimuli to recreation services (C1) saw a variety among different WPs, i.e., people reported that they took part in varied recreational activities: stimuli were more diverse in the Haizhu National Wetland Park and Gualyu Lake Wetland Park, compared with Baiyun Lake Wetland Park where most microbloggers reported about 'running.' For individuals, 'taking photos' was the most frequently mentioned activity in Haizhu National Wetland Park, Tianhe (Daguan) Wetland Park, and Gualyu Lake Wetland Park; in Nansha Wetland Park, 'boating' was the most frequently mentioned activity. Comparatively, institutions mainly posted about games, events, and special recreational programs (e.g., marathon and public welfare activities).

'Photography' and 'flower-viewing' were the activities most frequently mentioned in the perceptions of aesthetics value (C2) in the WPs. Colored-leaf trees (e.g., *Taxodium distichum*) and flowering species (e.g., *Zinnia elegans*, *Cosmos bipinnatus*, *Nelumbo florida*, and *Tabebuia chrysantha*) were the stimuli for the perception of aesthetics services (C2) in 5 WPs, except for the Nansha Wetland Park. For the Nansha Wetland Park, birds, mangroves, and *Phragmites australis* were the most important stimuli.

Birds were the most important stimulus for the individuals' perception and institutions' publicity of refugia / habitat services (S2) in the WPs, except for the Baiyun Lake Wetland Park. Institutions mentioned a more diverse range of bird species. The most mentioned bird species for individuals were *Anatidae* in Haizhu National Wetland Park, Ardeidae in the Huadu Lake Wetland Park, and *Platalea minor* in Nansha Wetland Park. Butterflies, bees, and plants were also the major stimuli for some WPs. Besides, refugia / habitat services (S2) mentioned in the Baiyun Lake Wetland Park related mainly to the negative perception of the large invasive predatory fish species *Atractosteus spatula* (S2–).

Only the data collected about Tianhe Daguan Wetland Park was sufficient for the word cloud analysis of disturbance regulation services (R3). 'Sponge city' and 'ecological landscape' were the dominant stimuli for both types of microbloggers, revealing that there was a similarity between the public's perception and the institutions' publicity. Suffering mosquito bites was the key factor for the perceptions of ecosystem disservices (ES–) in Haizhu National Wetland Park, Baiyun Lake Wetland Park, and Tianhe Daguan Wetland Park.

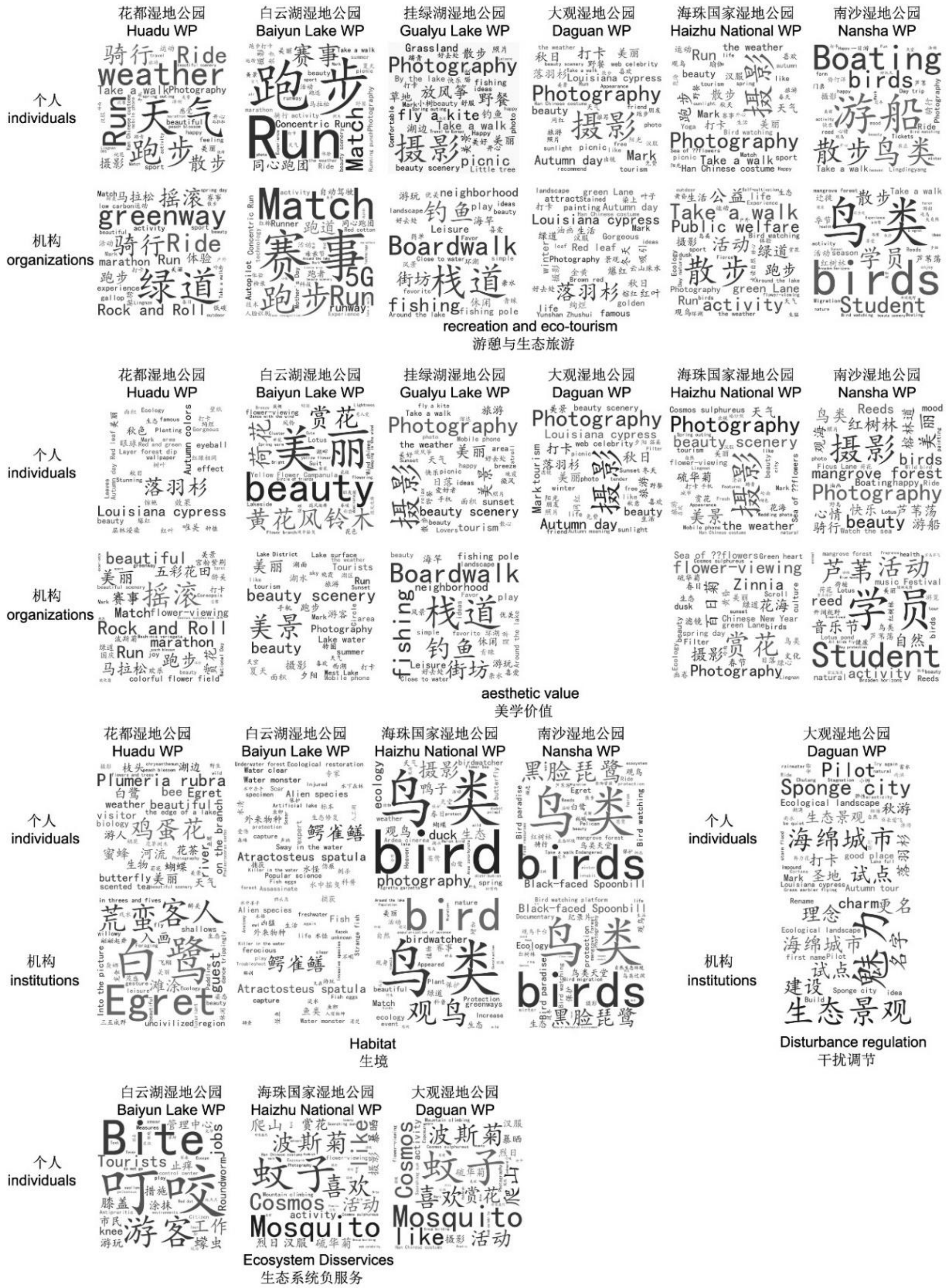

Figure 5-6 Word clouds of perceived ecosystem services in different wetland parks

5.4 Discussion

5.4.1 Thoughts on the Perceptions of ESs in WPs

It was found that most of the popular WPs are located in the central area of Guangzhou. The easy accessibility in the central area could be an explanation for this. Also, the quality of WPs and the delivered ESs could affect people’s visits. The popularity of WPs reflects public’s preferences to some extent: the WPs with open inland water bodies (e.g., lakes) are more popular than the ones that only contain rivers or mangroves. A possible reason might be that the public are aesthetically influenced by Chinese Fengshui ideas or traditional waterscape styles (Chen, 2014). This finding pointed to a research gap: although it has been proved that the presence of vegetation and sediment (Cottet, Piégay and Bornette, 2013), water colour and transparency (Cottet, Piégay and Bornette, 2013; Dobbie, 2013), and amount of water (Dobbie, 2013) can impact people's perceptions and preferences for wetlands, research about the impact of wetland forms is scarce.

The research results corroborated the proposition that cultural services can be more easily and intuitively understood by people in the city (Andersson *et al.*, 2015). The most interesting finding was that, although the refugia / habitat services (S2), were often considered to not directly benefit human well-being (Haines-Young and Potschin, 2010; Costanza *et al.*, 2017), they were perceived by many people in the 6 studied WPs. Results were insufficient to infer whether refugia / habitat services (S2) can directly benefit human well-being or whether it is just because of the association with recreation (C1) and aesthetics (C2) services that many people perceived them as noteworthy. It is also interesting to note that ornamental resource (P4), noise reduction (R10), sense of place (C9), and other ESs which were little studied among previous research on ESs of wetlands or parks (Maltby and Acreman, 2011; Mao, Huang and Wu, 2015; Liu, 2019) were considered noteworthy in some WPs. Spiritual value and religious value (C4), water supply (P2), and raw material (P3) services are usually not considered to be provided by wetlands and WPs (Yang *et al.*, 2008; Moore and Hunt, 2012; Zhang *et al.*, 2019); this research indicated that the other 5 ESs-genetic resource (P5), soil formation (R7), pollination (R8), biological control (R9), and nutrient cycling, photosynthesis, and primary production (S1)-were hardly perceived in the 6 WPs, the perception of which is often stimulated by ecological knowledge or concerns[51] . Another finding was that only a minority of individuals perceived some of the expected ESs by WPs, such as education and knowledge system (C5) and disturbance regulation (R3). These findings may result from that the public often lack knowledge about ESs (Barkmann *et al.*, 2008). Inevitably, people tend to comment more on visually attractive ESs, like aesthetics (C2). Thus, such a gap between the supply and demand of ESs could be bridged by improving public education (Martín-López *et al.*, 2012).

The results further showed that the recreation (C1) and aesthetics (C2) services are strongly interconnected, and sometimes connect to social relation (C6) or refugia / habitat (S2) services, which support the ESs bundle theory that ESs can repeatedly appear together (Raudsepp-Hearne, Peterson and Bennett, 2010) and be perceived together (Martín-López *et al.*, 2012). However, the same interconnections are not found in other studies about PESs in WPs, wetlands, or NBS, because of the paucity of research on ESs bundles through social preference. The finding that there was no obvious interconnection among other ESs may result from the limited data collection; a larger amount of data is needed to verify this finding.

This study explored the stimuli to the perception of ESs: for example, flowers and coloured-leaf trees to the aesthetics (C2) services, and birds, mangroves, and Phragmites australis to the refugia / habitat services (S2). The stimuli are varied in different WPs, and the composition and design of blue-green spaces could influence people's perception of ESs (Jim and Chen, 2006) . Moreover, the research found the overlaps between the ESs that the public perceived and that the professional institutions expected. A possible explanation for this is that the institutions often have a greater influence on the Sina Weibo, which means that institutions can play a more influential role in public education about ESs.

5.4.2 Methodological Implications

Existing landscape perception studies have been carried out by understanding professionals and public interpretations of landscape of which the studies on public's landscape perceptions were mainly conducted through visual assessment of landscape, or aural sometimes (Lange and Legwaila, 2012; Dobbie and Green, 2013; Lindquist, Lange and Kang, 2016). In visual landscape assessment, photographs (Dobbie and Green, 2013) and immersive virtual reality techniques (Lim, Honjo and Umeki, 2006; Gao *et al.*, 2019) can be used as stimuli. However, people perceive the environment by all senses. Only a few of studies used actual landscapes as stimuli for assessment, but such on-site surveys are often time-consuming and costly. Thus, this research relies on collecting social media users' authentic experience to report a more realistic perception of ESs time- and cost-efficiently. Moreover, compared with previous ESs perception studies which usually employed participatory mapping to identify the perceived distribution of given ESs (Fagerholm *et al.*, 2019), or ratings on given ESs through questionnaires or interviews (Raymond *et al.*, 2017; Deka, Tripathi and Paul, 2019) , this method using self-reported data from social media could help researchers find the ESs that have been less focused on in previous studies.

Methodologically, this study first applied association rule mining to reveal the interconnections among ESs, instead of the hierarchical cluster analysis to explore ESs bundle distribution in large-scale spaces according to the land cover typologies and ESs spatial distribution (Martín-López *et al.*, 2012; Plieninger *et al.*, 2019) commonly employed in previous research. The method in this study makes it possible to explore the ESs bundle and interconnections among ESs without specifying the ESs spatial distribution.

There are also some limitations to the methodology. Coding manually upon semantic analysis of sentences, instead of analyzing adjectives, so as to effectively extract relevant information, might compromise the opportunity to quantify the PESs, e.g., if using the semantic differential method. In addition, though social media are accessible to everyone, young adults are more likely than people of other ages to use them: Sina Weibo is used by about a quarter of the Chinese population, and 90% of the users are adults aged 18 to 40 (Sina Weibo Data Center, 2019) . In this research, using Weibo data would inevitably neglect perceptions from children under 18 and adults over 40 years old. Furthermore, activities specific to social programs, such as marking online popular places and sharing with friends, may have an impact on the results to some extent; for instance, the result of the perceived social relation services (C6) could be higher than using other methodology. Data collected over one year is not 'big' enough; multi-year comparative analysis may reveal more findings for understanding public perception and preferences on ESs.

5.4.3 Suggestions on Sustainable Landscape Management

The results in this study reinforce the future focus in planning and design to maximize the benefits for human well-being and ensure that these benefits could be perceived by the public, especially the overlooked ESs, such as noise reduction, and sense of place. And for some ESs that people can perceive, but may not be willingly offered by park managers (e.g., visitors picking flowers for ornamental use), design strategies to suggest proper ways for the public to interact with these ESs may work. In addition, when the designated ESs are less perceived, improving the quality of relevant landscape features may become a solution due to the interconnections among ESs. For instance, the synergy between aesthetic and refugia / habitat services may enhance the perception of the aesthetic value by improving the refugia / habitat services.

5.5 Chapter summary

This chapter used social media (i.e., Sina Weibo) to access large volumes of data and provide temporal and geographic granularity, and gives an overview of perceptions of ESs in WPs in Guangzhou. A semantic analysis of microblogs was performed to understand how the public perceives the ESs of WPs in Guangzhou. This study explored the public's perceptions and compared these with the ESs as communicated by professional institutions, and probed into the factors that affect these perceptions. The results showed that the top ESs perceived by both the general public and communicated by institutions are recreation, aesthetics, social relations, and refugia / habitat. There is a strong interconnection between the perceptions of recreation and aesthetics services. Flowering plant species and coloured-leaf trees are the most important stimuli affecting perceptions of aesthetics services, and birds are key to the perception of refugia / habitat services.

Chapter 6. Perceived ecosystem services and health effects of wetland parks in the context of covid-19

This chapter has been published:

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Authors' contributions: XZ conceived and designed the study, collected and analysed data, and drafted the initial stages of the manuscript, with input and guidance of EL. EL commented on and provided revisions of the manuscript.

6.1 Introduction

6.1.1 Background

Urban dwellers in China experienced profound levels of anxiety and poor perceived health during the peak of the COVID-19 (Peak) (Ni *et al.*, 2021) from January to March in 2020 (shown in Figure 6-1). During the worst month of the Peak, many cities were locked down, and most parks were shut down. After February -17th, some employees started to return to work, but non-essential travel was not encouraged. After February -21st, when Chinese Society of Landscape Architecture (2020) published a Group Standard for guiding operational management of urban parks during the pandemic, some parks began to reopen. Subject to compliance with the Standards, visitors were limited to 30–50% of the carrying capacity. Data for this study were collected from March 5th to March 8th, when the curve of the pandemic dropped steeply and hit the bottom in terms of new confirmed cases. It was just a few days before the official announcement[17] of the end of the Peak on March 12nd (Zou, 2020) , when the case numbers were similar to the end of the Peak and most epidemic prevention measures were lifted.

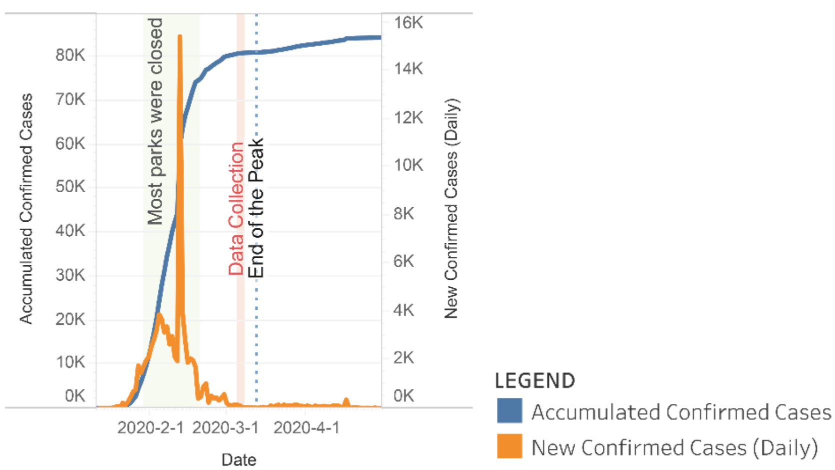


Figure 6-1 Timeline of the COVID-19 in China[18], milestones relevant to this study, and the data collection period

[17] The spokesperson of the National Health Commission of the People's Republic of China declared that "China has passed the climax of the novel coronavirus outbreak, with the number of new infections continuing to decline" on March 12nd,2020.

[18] Data source: DX Doctor COVID-19 Pandemic Real-time Report

In this study, according to the Classification Standard for Urban Green Spaces (Ministry of Housing and Urban–Rural Development of the People's Republic of China (MOHURD) 2017), wetland parks (WPs) include not only ecological parks with 'wetland parks' in the name but also public green spaces containing rivers, lakes and other wetlands.

6.1.2 Wetland Parks, health, and human well-being

In this study, the broad definition of WPs is adopted. That is, wetland parks (WPs) include not only ecological parks with 'wetland parks' in the name but also public green spaces containing rivers, lakes and other wetlands.

6.1.2.1 Health Effects of Wetland Parks and Ecosystem Services

Many studies have shown that natural environment can be beneficial to physical and mental health. For example, exercising in natural environments brings higher levels of happiness than exercising in indoor and street environments (Bowler *et al*., 2010; Olafsdottir, Cloke and Vögele, 2017). Contact with nature could affect health in many ways, e.g. fresh air, physical exercise, social cohesion, and stress reduction (Hartig *et al*., 2014).

For most people living in cities, urban green spaces are the most (sometimes the only) accessible natural resource (Maller *et al*., 2009). Many scholars have evaluated the health effects of green spaces around the living environment, and found that (1) there is a positive or weak correlation between green space and obesity-related health (Lachowycz and Jones, 2011); (2) the higher the ratio of green space in community, the lower the risks of mental health risks and cardiovascular disease (Richardson *et al*., 2013), and the higher the self-rated health status (Orban *et al*., 2017); (3) and the ratio of urban green space in a city is negatively correlated with the rate of local antidepressant prescriptions (Helbich *et al*., 2018). It also has been proved that urban green spaces can promote Chinese residents' physical activity so as to improve public health (H. Wang *et al*., 2019).

Urban blue space and proximity to water also promotes human health (Crouse *et al*., 2018). Specific to the wetland ecosystems, they can promote human well-being and health by provision of safe drinking water, improving resilience to natural disasters, and providing medicines; but it may also harm health by spreading diseases and releasing pollutants (Horwitz and Finlayson, 2011). Besides, experiencing the physical and mental health benefits of healthy wetlands can offset some of the stress and illness associated with disasters such as flooding, drought, and wildfires (Sutton-Grier and Sandifer, 2019). These health benefits can be attributed to ecosystem services (ESs) including provisioning, regulating and cultural, helping with e.g., malignant neoplasms, mental and behavioural disorders, and cardiovascular disease (Oosterbroek *et al*., 2016). Despite these fragmentary evidences, the health effects of WPs - a particular type of urban wetlands - are poorly understood, in particular regarding how they are perceived when visited and experienced. As Scholte et al. (2016) suggest, understanding how people interact with ecosystems is important to foster public support for wetland restoration; learning how the public perceive the health benefits from wetland parks could help with fostering public support for urban wetland restoration.

6.1.2.2 Perceived Health Effects

Urban environments and their perception significantly affect residents' self-evaluated health. Urban greening and infrastructure conditions are the main influencing factors (Wang, Sun and Wu, 2020). The expected benefits to human health, especially the expected improvement in psychological and social welfare, of visiting nature reserves are considered to be the main value of personal preference and choice of visiting nature reserves. Besides, people are increasingly aware of the positive relationship between visiting parks and nature reserves and related health benefits (Romagosa, Eagles and Lemieux, 2015). Also, different people may have different perceptions of the health effects of the same environment, so it is of great significance to study the perception of the health effects of diverse populations.

6.1.3 Objectives

The main aim of this part of research is to (1) determine which ESs the public believes WPs supply and are vital to human health; (2) explore the public's perception of the health effect of WPs before, during, and after the peak of the COVID-19 pandemic (Peak); and (3) explore the impact of the epidemic and other factors on people's perception of health effect of WPs.

6.2 Methods

6.2.1 Data Collection: Online Questionnaire

The data for the study was collected nationwide in China through online questionnaires using the Tencent Questionnaire platform. The differences in pandemic risks across provinces were used to study the impact of the epidemic on perceived health effects. The questionnaire was distributed using snowball sampling on the social media WeChat, which has the largest number of users in China (with 1.21 billion monthly active users in 2020) as the 'seed', from March 5th to 8th, 2020. We set the sample size to 1400 (one out of 100,000 of the total population of China), considering that when the sample size increases to 1000, the sharp increases in precision due to the growth of sample size becomes less pronounced (Bryman, 2012) . Also, after deducting non-wetland park users, the sample size could be large enough for a margin of error between 3 and 5 with a 95% confidence level (Hazra, 2017).

Once the target number of total valid responses (1,400) was reached, data collection was stopped.[19] After collecting demographic data, questions of 'whether you would like to visit a park/WPs after the pandemic is over?'[20] were asked separately; the survey would continue if the respondents indicated a willingness to visit WPs. At the beginning of the questionnaire and in the note of each question include 'WPs', the definition of WPs was given with examples of well-known WPs: The 'wetland parks' in this survey include both ecological theme parks with 'wetland parks' in their names (such as Hangzhou Xixi National Wetland Park, Suzhou Tai Lake National Wetland Park, Wuhan East Lake National Wetland Park, Guangzhou Nansha Wetland Park, etc.), as well as including parks dominated by wetlands such as rivers and lakes with good ecological functions (such as Shenzhen Dasha River Park, Guangzhou Lu Lake Park, Chengdu Living Water Park, etc.). Participants who were unwilling to visit parks and WPs were asked to give reasons, and then skip to the end of the survey.

[19] I set the questionnaire distribution on the Tencent Questionnaire Platform to send automatic reminders for every 50 new responses, and manually checked and eliminated invalid questionnaires (such as questionnaires answered by children) simultaneously with the collection of questionnaires. We closed the questionnaire immediately after receiving 1,400 valid responses

[20] When the survey was conducted, the epidemic was expected to end by April 2020. However, this epidemic subsequently developed into a global pandemic and has not yet ended. Therefore, in the questionnaire, "during the epidemic" refers to the Peak, and "after the epidemic" and "when the epidemic is over" mean "after the Peak". Because the survey period was when this new coronavirus was first identified after it had spread throughout China, cities across the country have taken the same epidemic prevention measures at almost the same time.

For respondents who would like to visit WPs, questions about the frequency of visit before and after the pandemic were asked: (1) ‘If wetland parks were not closed during the epidemic, and your community and nearby roads were not closed, would you visit wetland parks?’; (2) ‘After the outbreak, how often do you think you will visit wetland parks?’; (3) ‘After the epidemic, what do you think is the reason why your frequency of visiting wetland parks would be increased or decreased (Please skip this question if you would not change your frequency of visits)?’ The survey continued only when a respondent had been to wetland parks in the year before the outbreak. Also, respondents were asked to name their favourite WP, and reasons why this WP was preferred was asked using a multiple-choice question with an ‘others’ option for the participants to respond.

These were followed by a set of questions about willingness to visit WPs during the Peak: (1) ‘If the wetland park was not closed during the epidemic, and your community and nearby roads were not closed, would you visit wetland park? (a single choice question)’; (2) ‘Whether the wetland park you usually go to, or you last visited has been reopened? (a single choice question)’; (3) (multiple choice question with ‘other’ option only for respondents who chose the option ‘it has been opened orderly and you have been to’ in the last question) ‘After the orderly opening of wetland parks, even the procedures are complicated, and masks are needed, why do you still visit the wetland parks?’

Other independent variables (influencing factors at four levels) and dependent variables (perceived health effects related to WPs) were collected, as described in the following sections. Respondents spent an average of 6.5 minutes filling out the questionnaire. Two rounds of pre-tests were conducted before March -5th to ensure that respondents correctly understand the questionnaire.

6.2.1.1 Dependent Variable: Perceived Health Effects Associated with Wetland Parks

This study uses perceived health benefits or risks as dependent variables to characterize the impact of WPs on health perceived by citizens. A seven-point Likert Scale was used to evaluate the perceived mental and physical health effects of visiting WPs before, during, and after the Peak. Respondents were asked ‘Before/During/After the Peak, what do you think will be the impact of visiting WPs on your physical/mental health?’ respectively.

6.2.1.2 Independent Variables: Factors of Perceived Health Effects

This study included four levels of variables, namely city, community, WPs, and individual levels.

(1) City Level

During the Peak, the severity of the epidemic situation (i.e., the numbers of cumulative confirmed cases, newly confirmed cases and deaths) varied among provinces and cities in China, leading to different epidemic risks and emergency policies. These may affect the perceived health effects of WPs. The Response Level to Public Health Emergency (RLPHE) in a given region on a single day can reflect the risk level of an outbreak in that region on that day. The investigation period was at the end of the Peak, and some areas where the outbreak was not severe (i.e., there were not many confirmed cases and there had been no newly confirmed cases for a while) have lowered the RLPHE.

By asking about the main cities of residence at the peak of the epidemic, and according to the RLPHE of all provinces and cities across the country on March -6th (midpoint in the sampling period), these cities were classified into three categories: first-level response, namely the highest risk; second-level response, high risk; third-level response, medium risk.

(2) Community Level

During the Peak, many communities in cities with higher epidemic risk levels were locked down. Some communities were entirely locked down, and quarantine was required. Some communities were semi locked down, where residents could leave their homes and do activities in the communities, but could not go out of the community unless necessary. In low-risk cities, the communities were not closed. Information on the degree of community lockdown during the Peak was collected using a single-choice question.

(3) WPs Level

(a) Health Effects of Wetland Parks

Respondents were asked about the name of the wetland park they often visited or their favourite and why they like this WP. The WPs that the participants visited most or their favourites were coded according to the main wetland types they contain (e.g., lakes, rivers, coast, swamp), and the correlation analysis of preferred wetland types in the same corresponding level of regions with health effect perception (measured in Section 6.2.1.1) was carried out to study the perceived health effects of preferred wetland types.

(b) Health Effects of Ecosystem Services

This study explored the PESs from WPs and the health effect of these PESs, by asking participants to make multiple choices for PESs first, and then ranking their choices according to importance to the improvement of their physical and mental health. ESs including habitat, water purification, air purification, noise reduction, flood regulation, recreation, aesthetics, education, and social relations were involved. These examined ESs were selected according to previous studies on PESs in WPs (see Chapter 5). They belonged to the regulating, cultural and supporting category. The provisioning services were not examined in this study because WPs do not always deliver provisioning services (e.g., food, raw materials).

(4) Individual Level

This part first collected the respondents' socio-demographic details (such as age, gender, highest education level, professional, occupation status, and city of residence) through five single-choice questions and two drop-down questions. Respondents' self-reported physical and mental health status before and during the Peak was then collected through four five-point Likert scale questions.

6.2.2 Data Analysis

All statistical analyses were performed using SPSS Statistics 25. Descriptive statistics were used to analyze the respondents' profiles. The open-ended questions were coded for descriptive statistics. Analysis of variance (ANOVA) and one-way T-test were used to examine whether various factors affect perceived health effects. Bivariate correlation analysis was used to study the correlation between self-reported health status and perceived health effects.

6.3 Results

6.3.1 Respondents' Profiles

The majority of the respondents were young and middle-aged (65.43% of respondents were younger than 34 years old) and have a high level of education (graduate or higher) (Figure 6-1). 57.9% of the respondents were females. 63.0% of the respondents were employed, 27.8% were students, and others were retired or unemployed.

43.2% were engaged in architecture and built environment, and 6.14% were health experts (i.e., medical and nursing or psychology professionals). Respondents came from 31 provinces including 161 cities, and were evenly distributed in cities with the three levels of RLPHE (Figure 6-1). During the Peak, 75.3% of the respondents lived in semi-lockdown communities, 18.8% were quarantined at home, and 5.9% had free access to their homes and communities.

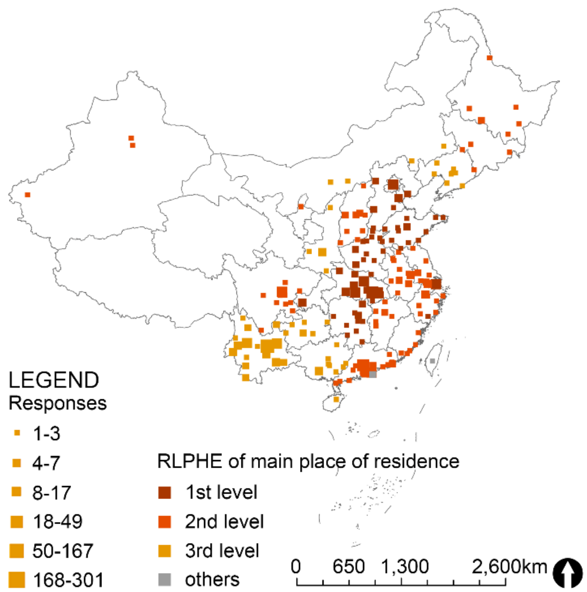


Figure 6-2 Geographical distribution of respondents

6.3.2 Willingness to Visit Wetland Parks

81.6% of the respondents were willing to visit parks after the Peak (N = 1142). 76.9% of those who wanted to visit parks also wished to visit WPs (N = 1077). The main reasons for not visiting WPs were poor accessibility (52.3%). After the Peak, 28.2% of the respondents would increase their visiting frequency, while 55.3% of respondents would keep their visiting frequency (Figure 6-3). Among the 1077 respondents who wished to visit WPs, 110 respondents had not been to WPs in the year before the outbreak. Considering that those 110 respondents may not be familiar with WPs, they were excluded from the following sections of survey. Thus, there were 967 respondents in total who took part in the whole survey (Figure 6-4).

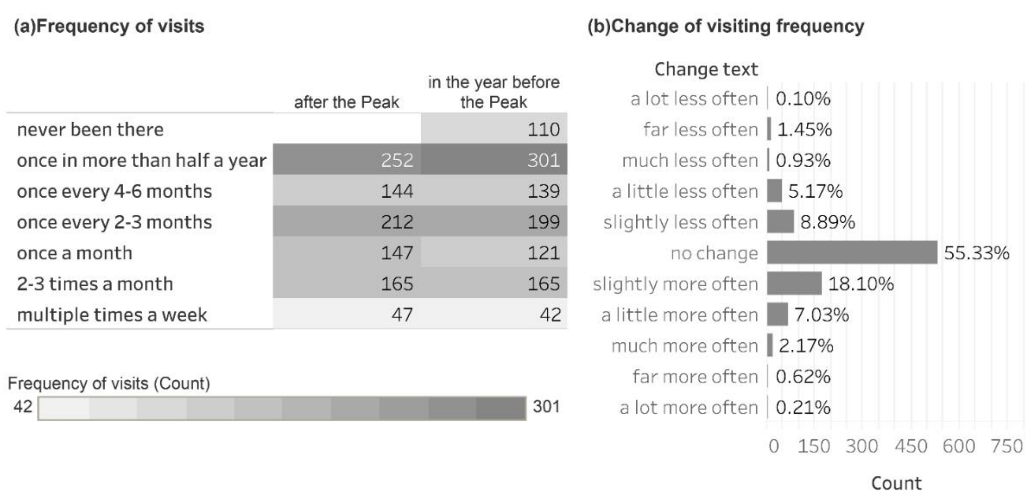


Figure 6-3 Frequency of wetland parks visits: in the year before the PEAK, expected after the PEAK, and the change

Table 6-1 Respondents' profile

	N = 1400	(%)	2010 Census (%)		N = 1400	(%)	2010 Census (%)
Age				Professional			
18-24	362	25.86	15.31	architecture & built environment	605	43.21	
25-34	554	39.57	18.21	art & design	129	9.21	
35-44	232	16.57	19.21	hydrology	21	1.5	
45-54	174	12.43	14.03	psychology	14	1	
55-64	65	4.64	9.34	medicine, nursing	72	5.14	
≥65	13	0.93	7.68	agriculture/forestry	56	4	
Gender				environmental science	27	1.93	
male	590	42.14	51.14	social science	73	5.21	
female	810	57.86	48.86	Economy & finance	60	4.29	
Highest Education Level				others	343	24.5	
middle school and below	20	1.43	46.56	RLPHE of main place of residence			
high school equivalent	80	5.71	22.43	1st level	473	33.79	34.32%
specialized college	118	8.43	11.65	2nd level	392	28.00	50.38%
bachelor's	655	46.79	9.37	3rd level	530	37.86	15.31%
master's and above	527	37.64	1.02	Community closure status			
Occupation Status				totally lockdown	263	18.79	-
student	389	27.79	-	semi lockdown	1054	75.29	-
employee	882	63	-	not lockdown	83	5.93	-
no occupation	62	4.43	-				
retiree	67	4.79	-				

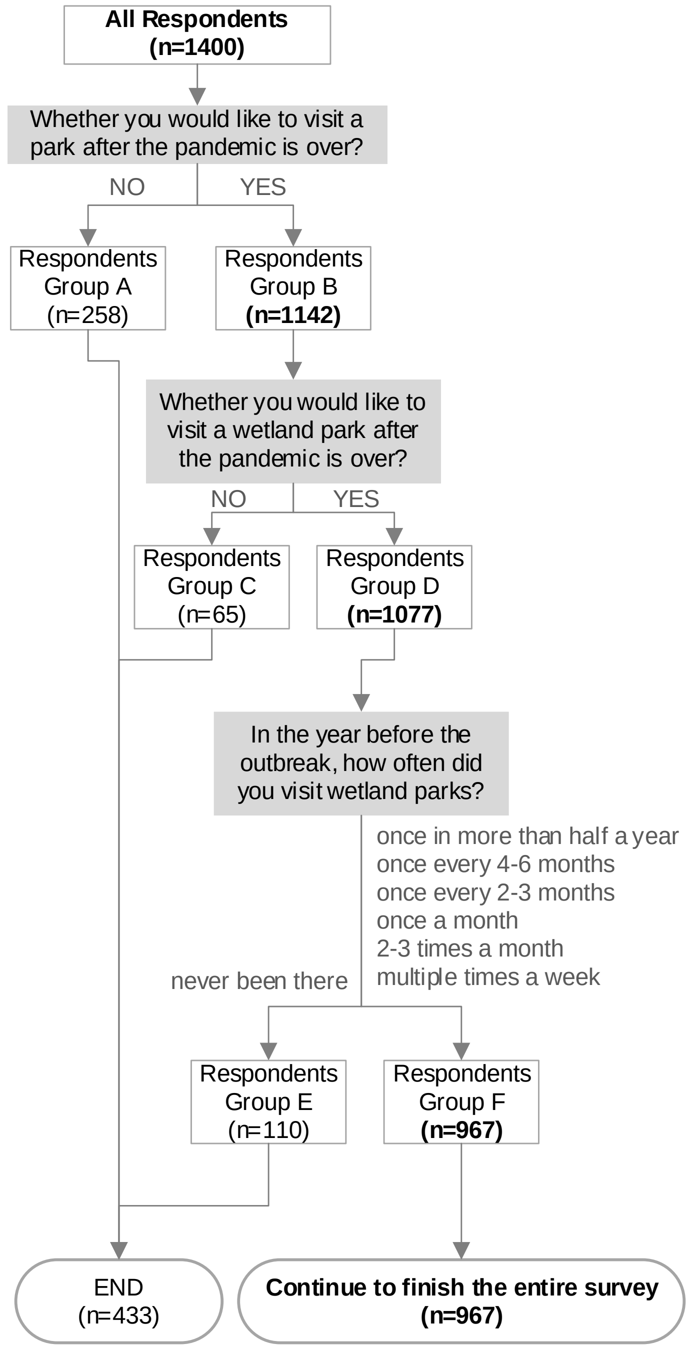


Figure 6-4 Responses filters

A total of 109 respondents had visited WPs (e.g., Figure 6-5) since they reopened after the peak of the epidemic within two weeks. Fresh air (57.8%), physical exercise (43.1%), and exposure to nature and wildlife habitats (42.2%) were the main motivations. ‘WPs are sparsely populated with low risk of infection’ (36.7%), ‘Basking in the sun and enjoy the breeze’ (35.8%) and ‘enjoy the beautiful scenery’ (29.4%) were important driving factors.

Figure 6-5 Wetland parks that respondents mentioned most frequently (Pictures marked with copyright are source from: www.720yun.com)

6.3.3 Dependent Variables: Perceived Health Effects

The set of health-relevant scale items passed the reliability test (Cronbach's alpha = 0.797) and the validity test (KMO measure of sampling was adequate (= 0.732), and Bartlett's test of sphericity was significant (P = 0.000)). The results (Figure 6-6) show that people perceive health benefits from WPs; even during the peak of the epidemic when the perceived benefits were the lowest, benefits still outweigh potential risks. The perceived benefits of visiting WPs on mental health were higher than that on physical health, especially during the peak of the epidemic. The perceived health benefits expected after the Peak were slightly higher than before the Peak: approximately 70% of the respondents perceived the same level of health effects from WPs before and after the Peak; about 20% of the respondents believed that health benefits have increased after the Peak; in contrast, about 10% of the respondents assumed that perceived health benefits decreased.

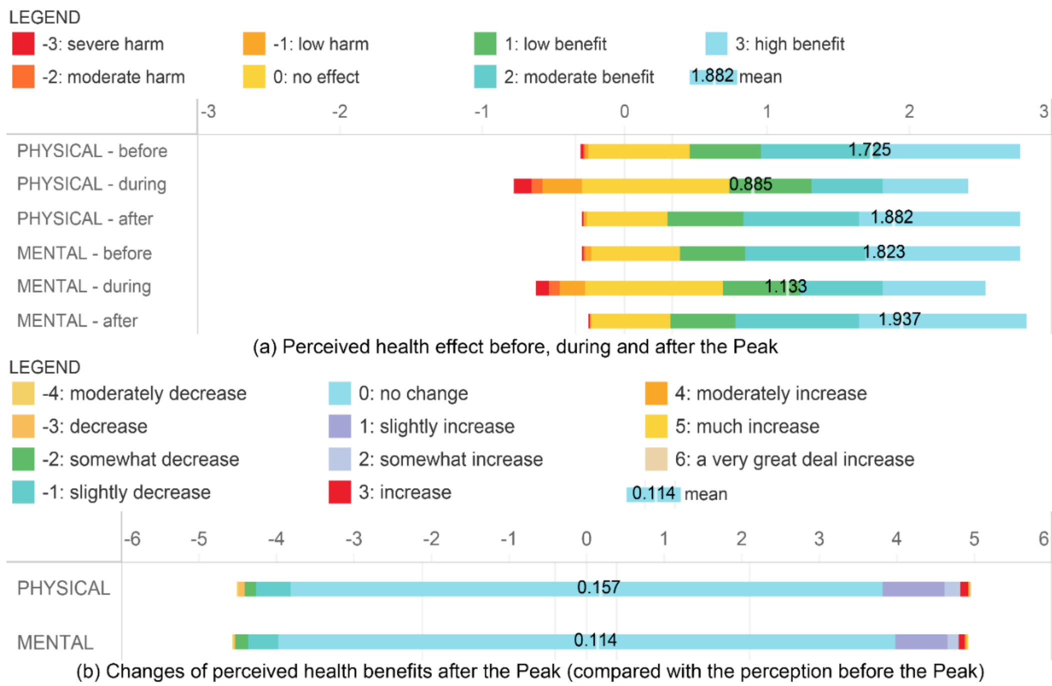


Figure 6-6 Perceived health benefit before, during and after the peak of the COVID-19 outbreak[21]

6.3.4 Independent Variables

6.3.4.1 City Level

As shown in Table 6-2, the RLPHE of the city of residence had a significant impact on the perceived physical and mental health benefits during the Peak and on the perceived mental health benefits after the Peak ($P < 0.05$). Respondents in the second RLPHE regions perceived the highest health benefits, and those in the first RLPHE areas (the highest-risk area) perceived the lowest physical health benefits during the Peak and the lowest mental health benefits after the Peak. In contrast, respondents in third RLPHE regions (medium-risk areas) perceived the lowest mental health benefits during the Peak. On average, the perceived health benefits from WPs after the Peak were slightly higher than before the outbreak in all the three types of regions, but there was no significant difference in the change of perceived health benefits in these regions.

6.3.4.2 Community Level

The lockdown level of the respondents' community during the Peak had a significant impact on the perceived physical and mental health benefits after the peak of the epidemic ($P < 0.01$) (Table 6-2). Surprisingly, as the degree of community lockdown level increased, the expected perceived physical and mental health benefits after the peak of the epidemic decreased. Because community lockdown occurred after the outbreak, the differences in the perceived level of mental health benefits before the Peak was not considered to be caused by community lockdown.

[21] Divergent Stacked Bar: The length of each colour represents the proportion of respondents who chose this attitude to the total number of respondents. The starting point of each bar graph is different, and the total length is 100%.

6.3.4.3 Wetland Parks Level

(1) ESs for Promoting Perceived Health Benefits

Most respondents thought that WPs provided habitat, recreation, air purification, and water purification services (Figure 6-7(a)). Habitat and water purification were the two ESs that respondents rated as having the greatest perceived physical and mental health benefits (habitat ranked the first and water purification ranked the second. Air purification was essential for physical health, and recreation was important for mental health (Figure 6-7(b)(c)). Education and social relations were least important for promoting perceived health benefits.

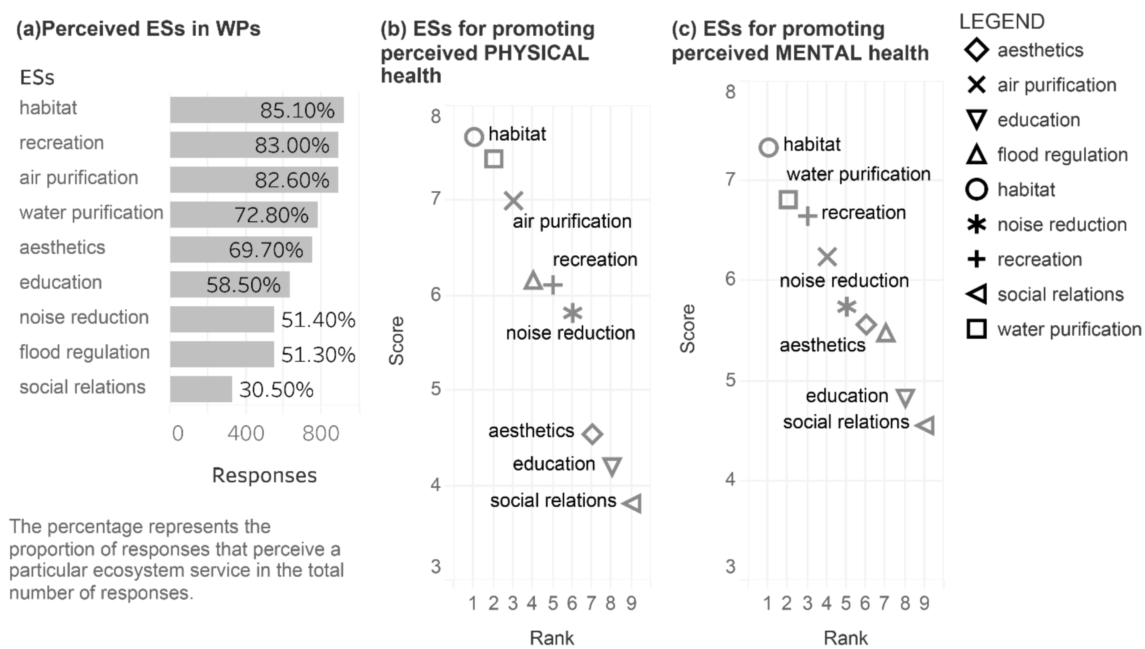


Figure 6-7 Perceived ecosystem services in wetland parks and ranking of their importance for promoting health benefits perception

(2) Wetland Types

Lake was the most popular type among the different wetland types in WPs. Wetland types did not influence the perception of health effects, except for the perception of physical health effects before the Peak and mental health effects during the Peak in regions with the 2nd level RLPHE (Table 6-3).

Table 6-2 Impact of the factors (city and community level) (: P<0.05, **: P<0.01)*

	N=967	before Peak		during Peak		after Peak		difference: after-before Peak	
		physical	mental	physical	mental	physical	mental	physical	mental
CITY LEVEL: RLPHE of main place of residence									
1st level	314	1.63±1.28	1.71±1.24	0.79±1.56	1.09±1.50	1.81±1.18	1.87±1.18	0.18±1.13	0.16±0.89
2nd level	260	1.82±1.20	1.97±1.13	1.12±1.55	1.43±1.43	2.01±1.10	2.08±1.04	0.19±1.03	0.12±0.87
3rd level	389	1.74±1.25	1.82±1.25	0.81±1.58	0.97±1.60	1.86±1.67	1.90±1.15	0.12±0.96	0.08±0.89
one-way ANOVA	F	1.73	3.145	3.864	7.167	2.413	3.059	0.406	0.7
	P	0.178	0.043	0.021*	0.001**	0.09	0.047*	0.666	0.497
COMMUNITY LEVEL: Community closure status									
totally lockdown	178	1.58±1.30	1.60±1.31	0.83±1.63	1.12±1.49	1.67±1.25	1.70±1.24	0.09±1.05	0.10±0.95
semi lockdown	732	1.75±1.23	1.86±1.19	0.88±1.56	1.14±1.54	1.91±1.14	1.98±1.11	0.16±1.04	0.11±0.86
not lockdown	57	1.81±1.25	2.00±1.18	1.09±1.57	1.09±1.53	2.19±0.99	2.19±0.99	0.39±0.92	0.19±0.91
one-way ANOVA	F	1.442	3.994	0.601	0.035	5.202	5.917	1.774	0.27
	P	0.237	0.019*	0.548	0.966	0.006**	0.003**	0.17	0.764

Table 6-3 Impact of the factors (wetland parks level) (: P<0.05, **: P<0.01)*

		before Peak		during Peak		after Peak		difference: after-before Peak	
	N=850[22]	physical	mental	physical	mental	physical	mental	physical	mental
1st level RLPHE (highest risk)	N=264								
rivers	36	1.81±1.14	1.81±1.24	0.92±1.73	1.28±1.68	1.75±1.18	1.86±1.27	-0.06±1.12	0.06±0.85
lakes	182	1.65±1.29	1.74±1.24	0.96±1.57	1.20±1.52	1.82±1.19	1.87±1.18	0.17±1.11	0.13±0.86
coastal/mangroves	11	1.45±1.04	1.36±1.21	0.73±1.19	0.91±1.30	1.73±1.19	1.73±1.19	0.27±0.65	0.36±0.50
ponds	5	2.00±0.71	2.20±0.45	0.20±1.30	0.40±1.14	1.80±0.45	2.00±0.00	-0.20±1.10	-0.20±0.45
rivers + lakes	24	1.96±1.04	2.00±1.02	0.58±1.44	1.17±1.37	2.25±0.74	2.25±0.74	0.29±0.86	0.25±0.79
mix (≥ 3 types of wetlands)	6	1.67±1.37	2.33±0.82	0.33±2.16	1.00±1.27	2.67±0.82	2.83±0.41	1.00±1.10	0.50±0.55
one-way ANOVA	T	0.474	0.85	0.61	0.393	1.305	1.337	1.226	0.729
	P	0.795	0.515	0.692	0.854	0.262	0.249	0.297	0.602
2nd level RLPHE (high risk)	N=228								
rivers	28	2.07±1.02	1.93±1.12	1.29±1.54	1.46±1.53	2.25±0.93	2.21±0.92	0.18±0.67	0.29±0.94
lakes	81	1.70±1.25	1.93±1.12	1.19±1.44	1.62±1.32	1.96±1.12	2.11±1.10	0.26±1.13	0.19±0.95
coastal/ mangroves	32	1.47±1.19	1.53±1.64	1.00±1.67	1.00±1.57	1.66±1.13	1.81±1.12	0.19±0.86	0.28±0.85
ponds	10	2.00±1.05	2.00±1.25	0.50±1.90	0.60±1.84	2.10±0.99	2.20±0.79	0.10±0.32	0.20±1.23
swamps	1	-	-	-	-	-	-	-	-
rivers + lakes	33	1.82±1.19	2.15±1.09	0.85±1.54	1.12±1.34	2.18±1.10	2.18±0.98	0.36±1.08	0.03±0.68
mix (≥ 3 types of wetlands)	43	2.30±0.94	2.26±1.00	1.37±1.57	1.74±1.33	2.23±1.00	2.21±0.99	-0.07±0.70	-0.05±0.69
one-way ANOVA	T	2.571	1.798	0.884	2.314	1.524	0.715	0.985	0.88
	P	0.028*	0.114	0.493	0.045*	0.183	0.612	0.428	0.496
3rd level RLPHE (medium risk)	N=358								
rivers	25	1.84±1.21	1.80±1.23	0.84±1.38	1.00±1.56	1.68±1.18	1.68±1.25	-0.16±0.94	-0.12±0.88
lakes	192	1.80±1.23	1.82±1.25	0.81±1.60	1.03±1.54	1.93±1.14	1.92±1.13	0.13±0.94	0.09±0.87
coastal/	3	2.00±1.00	1.67±1.16	2.00±1.00	2.00±1.00	2.33±1.16	2.33±1.16	0.33±1.53	0.67±1.15

[22] The names of WPs filled by some respondents failed to be found online due to typos or unclear descriptions. These responses were not included in this part of analysis.

mangroves									
waterfall	2	2.50±0.71	2.50±0.71	0.50±0.71	-1.50±0.71	3.00±0.00	3.00±0.00	0.50±0.71	0.50±0.71
ponds	9	1.56±1.01	2.00±1.00	1.56±1.13	1.89±1.27	2.11±1.05	2.11±1.05	0.56±0.73	0.11±0.33
terrace	1	-	-	-	-	-	-	-	-
mix (≥ 3 types of wetlands)	2	2.00±0.00	1.00±1.41	-0.50±0.71	-0.50±2.12	1.00±1.41	2.00±0.00	-1.00±1.41	1.00±1.41
rivers + lakes	125	1.73±1.21	1.96±1.15	0.80±1.55	0.97±1.56	1.84±1.08	1.96±1.06	0.11±1.03	0.00±0.90
one-way ANOVA	T	0.255	0.479	0.886	1.924	0.897	0.648	1.164	1.035
	P	0.957	0.824	0.506	0.075	0.497	0.692	0.325	0.402

6.3.4.4 Individual Level

As shown in Table 6-4, the 45–54 age group perceived the highest physical and mental health benefits, while the 18–24 age group perceived the lowest physical and mental health benefits ($P < 0.05$). Men perceived higher health benefits than women ($P < 0.05$). Education levels and occupational status had no influence on the perceived health effects level before, during and after the Peak. There is a significant difference in the change of perceived health benefits before and after the Peak among various occupational status: compared with before the Peak, the temporarily unemployed and retirees perceived higher mental health benefits than the other two groups after the Peak ($P < 0.05$).

Groups with various professional backgrounds had significant differences in the perceived health benefits before the epidemic ($P < 0.05$); groups with environmental science backgrounds had the highest level of perceived health benefits. In addition, health experts (i.e., persons with medical, nursing, and psychology backgrounds) had significantly lower perceptions of mental health benefits before the epidemic and physical and mental health benefits after the Peak than other professional groups ($P < 0.05$). Meanwhile, health experts believed that the health benefits after the Peak were slightly lower than those before the epidemic, which was opposite to other groups of people.

The self-reported physical health status before the epidemic was positively correlated with the perceived physical health benefits before the Peak (Pearson correlation $= 0.06$, $P < 0.05$, see Table 6-5). The perceived physical or mental health benefits during and after the Peak were not statistically correlated with the self-reported physical or mental health status on the survey day. Also, the change of perceived health benefits was not statistically correlated with the change of self-reported health status.

Table 6-4 Impact of the factors (individual level) (: P<0.05, **: P<0.01)*

	N=967	before Peak		during Peak		after Peak		difference: after-before Peak	
		physical	mental	physical	mental	physical	mental	physical	mental
Age									
18-24	222	1.54±1.33	1.74±1.22	0.61±1.63	0.92±1.57	1.76±1.19	1.85±1.17	0.22±1.29	0.11±0.96
25-34	360	1.73±1.18	1.80±1.19	0.82±1.46	1.08±1.49	1.85±1.11	1.93±1.10	0.13±0.92	0.13±0.88
35-44	189	1.82±1.18	1.84±1.17	1.10±1.50	1.30±1.41	1.92±1.14	1.92±1.13	0.10±0.83	0.07±0.85
45-54	141	1.82±1.25	1.96±1.22	1.23±1.63	1.41±1.55	2.02±1.19	2.05±1.17	0.20±1.00	0.09±0.68
55-64	46	1.85±1.46	1.78±1.49	0.78±1.76	0.98±1.76	2.13±1.15	2.07±1.16	0.28±1.26	0.28±1.07
≥65	9	2.22±1.64	2.44±1.33	1.00±2.35	1.33±2.18	2.00±1.32	2.33±1.12	-0.22±1.48	-0.11±1.36
One-way ANOVA	F	1.799	1.05	3.644	2.487	1.462	0.883	0.783	0.576
	P	0.11	0.387	0.003**	0.030*	0.2	0.492	0.576	0.719
Gender									
Male	416	1.69±1.27	1.81±1.24	1.06±1.51	1.25±1.48	1.90±1.14	1.92±1.12	0.21±1.04	0.11±0.92
Female	551	1.75±1.23	1.83±1.20	0.76±1.61	1.05±1.56	1.87±1.16	1.95±1.15	0.12±1.03	0.12±0.85
Independent samples T test	F	-0.812	-0.183	2.939	2.022	0.396	-0.386	1.42	-0.245
	P	0.417	0.854	0.003**	0.043*	0.692	0.699	0.156	0.807
Highest Education Level									
Middle school and below	12	1.42±1.31	1.50±1.51	1.00±1.76	0.58±1.83	1.25±1.29	1.58±1.24	-0.17±1.11	0.08±1.38
High school equivalent	50	1.42±1.70	1.62±1.59	0.86±1.86	0.84±1.82	1.82±1.49	1.86±1.43	0.40±1.51	0.24±1.06
Specialized college	87	1.95±1.18	1.84±1.35	0.93±1.72	1.15±1.65	1.98±1.24	2.03±1.18	0.02±0.83	0.20±0.96
Bachelor's	450	1.71±1.25	1.84±1.22	0.86±1.58	1.12±1.53	1.83±1.17	1.89±1.16	0.12±1.04	0.05±0.87
Master's and above	368	1.74±1.18	1.83±1.11	0.90±1.48	1.21±1.44	1.95±1.04	1.99±1.05	0.21±0.98	0.16±0.83
One-way ANOVA	F	1.699	0.599	0.072	1.075	1.639	0.907	1.757	1.287
	P	0.148	0.664	0.99	0.368	0.162	0.459	0.135	0.273
Occupation Status									
Student	235	1.60±1.26	1.84±1.15	0.69±1.61	1.04±1.61	1.80±1.14	1.92±1.14	0.20±1.20	0.08±0.92
Employee	647	1.77±1.22	1.83±1.20	0.95±1.53	1.17±1.49	1.89±1.15	1.92±1.14	0.12±0.94	0.09±0.82
No occupation	41	1.51±1.36	1.71±1.47	1.17±1.50	1.41±1.32	2.02±1.17	2.10±1.00	0.51±1.29	0.39±1.12
Retiree	44	1.89±1.37	1.68±1.55	0.64±1.91	0.84±1.89	2.05±1.22	2.07±1.23	0.16±1.12	0.39±1.19
One-way ANOVA	F	1.832	0.353	2.408	1.372	0.915	0.515	2.096	3.041
	P	0.14	0.787	0.066	0.244	0.433	0.672	0.099	0.028*
Professional									

Architecture & built environment	432	1.78±1.15	1.88±1.17	0.82±1.49	1.09±1.44	1.91±1.08	1.97±1.07	0.14±0.94	0.10±0.93
Art & design	81	1.35±1.49	1.56±1.31	0.64±1.60	0.98±1.59	1.74±1.24	1.78±1.20	0.40±1.51	0.22±0.96
Hydrology	16	1.50±1.27	1.69±1.25	1.00±1.37	1.31±1.14	1.63±1.46	1.69±1.49	0.13±0.72	0.00±0.63
Psychology	9	2.00±1.23	1.89±1.45	0.89±2.26	1.44±1.42	1.89±1.27	2.11±1.27	-0.11±0.78	0.22±0.44
Medicine, nursing	47	1.70±1.25	1.43±1.33	0.66±1.49	0.81±1.56	1.51±1.32	1.53±1.28	-0.19±1.04	0.11±0.96
Agriculture/forestry	45	1.44±1.16	1.62±1.19	1.07±1.25	1.22±1.43	1.67±1.17	1.80±1.08	0.22±0.74	0.18±0.81
Environmental science	21	2.24±0.83	2.33±0.86	1.24±1.76	1.29±1.77	2.43±0.68	2.38±0.74	0.19±0.51	0.05±0.38
Social science	51	1.53±1.35	1.61±1.33	0.76±1.77	0.96±1.71	1.75±1.16	1.90±1.15	0.22±1.24	0.29±1.17
Economy & finance	45	2.02±1.26	2.18±1.10	0.91±1.78	0.86±1.86	2.13±0.95	2.12±0.96	0.11±1.23	-0.02±0.80
Others	220	1.78±1.32	1.89±1.23	1.11±1.66	1.37±1.56	1.95±1.23	1.98±1.22	0.18±1.02	0.09±0.75
One-way ANOVA	F	2148	2.342	1.077	1.227	1.903	1.652	1.219	0.609
	P	0.023*	0.013*	0.377	0.274	0.048	0.096	0.279	0.79
Health experts (Medical and nursing, psychology)	56	1.75±1.24	1.50±1.35	0.70±1.62	0.91±1.54	1.57±1.31	1.63±1.29	-0.18±0.99	0.13±0.90
others	911	1.72±1.25	1.84±1.21	0.90±1.57	0.15±1.53	1.90±1.14	1.94±1.14	0.18±1.03	0.11±0.88
Independent samples T test	F	0.155	-2.052	-0.927	-1.124	-0.081	-2.122	-2.51	0.098
	P	0.877	0.040*	0.354	0.261	0.038*	0.034*	0.012*	0.922

*Table 6-5 Correlation between self-reported health status and perceived health benefit (N=967, *: P<0.05)*

Physical Health			**self-reported physical health status**		
			before Peak	current	Difference: current-before
perceived health benefit	before Peak	Pearson Correlation	0.069*	-	-
		Sig.(2-tailed)	0.031	-	-
	during Peak	Pearson Correlation	-	0.004	-
		Sig.(2-tailed)	-	0.903	-
	after Peak	Pearson Correlation	-	0.03	-
		Sig.(2-tailed)	-	0.356	-
	Difference: after-before	Pearson Correlation	-	-	-0.004
		Sig.(2-tailed)	-	-	0.91

Mental Health			**self-reported mental health status**		
			before Peak	current	Difference: current-before
perceived health benefit	before Peak	Pearson Correlation	0.062	-	-
		Sig.(2-tailed)	0.055	-	-
	during Peak	Pearson Correlation	-	-0.004	-
		Sig.(2-tailed)	-	0.893	-
	after Peak	Pearson Correlation	-	0.006	-
		Sig.(2-tailed)	-	0.85	-
	Difference: after-before	Pearson Correlation	-	-	-0.032
		Sig.(2-tailed)	-	-	0.314

6.4 Discussion

In general, the public perceives wetlands to be beneficial for physical and mental health, which is consistent with the conclusion of previous studies that urban green space and blue-green space are beneficial to people's physical and mental health (see 'Health Effects of Wetland Parks and Ecosystem Services' section). A possible reason for the lowest perceived health benefits during the Peak could be the higher risk of infection. Limited access to WPs during the Peak could also contribute to the low perception of health benefits. The increase in perceived health benefits after the Peak shows that inaccessibility to WPs for a period of time may improve perceived health benefits from WPs.

On the city level, results show that a moderate epidemic risk stimulates perception of physical and mental health benefits from WPs. Further investigation regarding health benefits and harm perception associated with epidemic risks is needed to draw more precise recommendations for further improvement of WPs from the perspective of public health.

On the community level, unexpectedly, the perceived level of physical and mental health benefits after the Peak is negatively associated with the lockdown degree of the community, suggesting that quarantine did not lead to an increase in health-related motivation for visiting WPs.

In terms of WPs level, habitat services were considered to be the most important ESs that promote the perceived health benefits. The possible reasons are: (1) self-reported happiness is positively correlated with the perceived species richness of birds, butterflies, and plants (Dallimer *et al.*, 2012) ; (2) the biologically diverse natural environment can improve health by exposure to a pleasant environment or encouraging health promotion behaviours (Lovell *et al.*, 2014); (3) there is a strong positive correlation between vegetation cover and personal well-being. The relationship between human well-being and nature is weakly correlated with changes in species richness, bird abundance, and plant density (Luck *et al.*, 2011). However, wildlife habitat was regarded as indirect health-related ES that affect human health through another service, and the mechanism of their effect on health is still unclear. The importance of habitat, air purification and recreation services align with the motivation for visiting WPs (e.g., being close to nature and wildlife habitat, enjoying fresh air and going out for exercises).

On the individual level, this study has found that men perceive higher health benefits than women when visiting urban blue-green spaces during the Peak. There is no significant gender difference before and after the epidemic. This is different from the result of a previous study based on two of Canada's blue-green spaces that women usually perceive higher health well-being than men from visiting nature reserves (Lemieux *et al.*, 2012). The phenomenon that housewives and the elderly are more dependent on the local environment and therefore are more susceptible to the local environment (de Vries *et al.*, 2003) could be a possible explanation to our result that the temporarily unemployed (e.g., housewives) and retirees (e.g., the elderly) perceived higher mental health benefits than the other two groups after the Peak. In addition, health experts' perception of mental health benefits before the epidemic and that of physical and mental health after the Peak were significantly lower than other professional groups, which indicate that lay people may have overestimated or health experts may have underestimated the health benefits of visiting WPs. Besides, health experts believe that the health benefits after the peak of the epidemic are slightly lower than before the outbreak, while other people have the opposite view. This may be because health experts believe that travel after the peak of the epidemic poses a higher risk.

This study is based on a large number of subjective responses regarding the perceived health effects of WPs. It does not objectively measure the health effects of WPs. Ecosystem disservices could negatively affect the perception of health benefits. For conducting the questionnaire, it was the assumption that there is little risk of infection by COVID-19 when visiting WPs after the Peak, which naturally excludes the effect of some infectious disease-related ecosystem disservices on health perception. Moreover, factors such as the quality, area, and naturalness of the WPs may affect health (Ekkel and De Vries, 2017), and perceived health benefits. This study is a general analysis based on national sampling. It does not provide a detailed analysis of specific WPs, including their quality, area, and naturalness. To control the number of questions and response time, this study did not use more detailed assessment scales (e.g., EQ-5D (Leidl, 2009) , General Health Questionnaire (White *et al.*, 2013)) to assess health status. This could have an influence on the respondents' self-reported health status. Most participants had a high level of education, suggesting that they understand the contents of the questionnaire well. Due to the restrictions in face-to-face survey and the suspended express delivery in high-epidemic-risk regions during the pandemic, face-to face and mail surveys were not applicable. Besides, telephone surveys were usually rejected as fraudulent calls. Thus, this study relies on the online survey which was the most feasible method for collecting as many data from all over the country as possible within a very short period of time, potentially making it difficult for the elderly and non-internet users to get involved.

6.5 Chapter summary

Chapter 6 explores the public's perception of the health benefits of visiting WPs and the impact of the covid-19 pandemic on the perception. A nationwide online survey was conducted. It was found that the perceived benefits from visiting WPs were higher in terms of mental health than in physical health. Also, the perceived health benefits of WPs after the Peak were slightly higher than pre-pandemic. The results highlight that wildlife habitat was considered to be the most important ES that promote the perceived health benefits. Interestingly, the perceived health benefits of WPs by health experts appear to be lower than in other groups, indicating that the health benefits of visiting WPs may be overestimated by lay-people or underestimated by health experts. The results provide empirical evidence for managing ESs as delivered by these urban wetlands, in the context of covid-19 or potential future pandemics, for promoting public health.

Chapter 7. Ecosystem services in wetland parks: case studies

Through case studies, this chapter aims to achieve Research Objectives 2 to 4, namely <RO2> to determine the extent to which public perceptions of ESs consistent with technical understanding, <RO3> to determine the factors that influence ESs delivery in WPs, and <RO4> to explore the relationships and interactions between perceptions of focal ESs. This chapter begins with an introduction to the case study sites and continues with a discussion of the common methodologies utilized throughout this chapter, including data collection procedures. The following sections are organized according to the focal ESs and their interrelationship.

7.1 Case study sites

It was discovered that nature reserves with an area greater than 42 hectares and surrounded by more than 40% urban land cover had the highest probability of hosting native forest species and synanthropic species, respectively (Donnelly and Marzluff, 2004). Following a literature review and site visits of WPs in Guangzhou, two inland watersheds wetland parks (WPs) that larger than 42 hectares and encompassed by urban land cover were selected as case study sites. Further, according to studies shown in Chapter 4 and Chapter 5, criteria of selecting these two WPs was summarized in a flowchart (Figure 7-1).

This chapter provide information of both case study sites, Tianhe Daguan Wetland Park (TDWP) and Haizhu National Wetland Park (HNWP) (Figure 7-2). The design of HNWP is a combination of traditional Chinese gardens and modern parks; it is well-maintained and has comprehensive facilities. While TDWP appeared to be wilder with fewer amenities. Majority of WPs in Guangzhou follow a similar style to that of HNWP. While the design group of TDWP, the TURENSCAPE, has numerous worldwide award-winning WP projects in China.

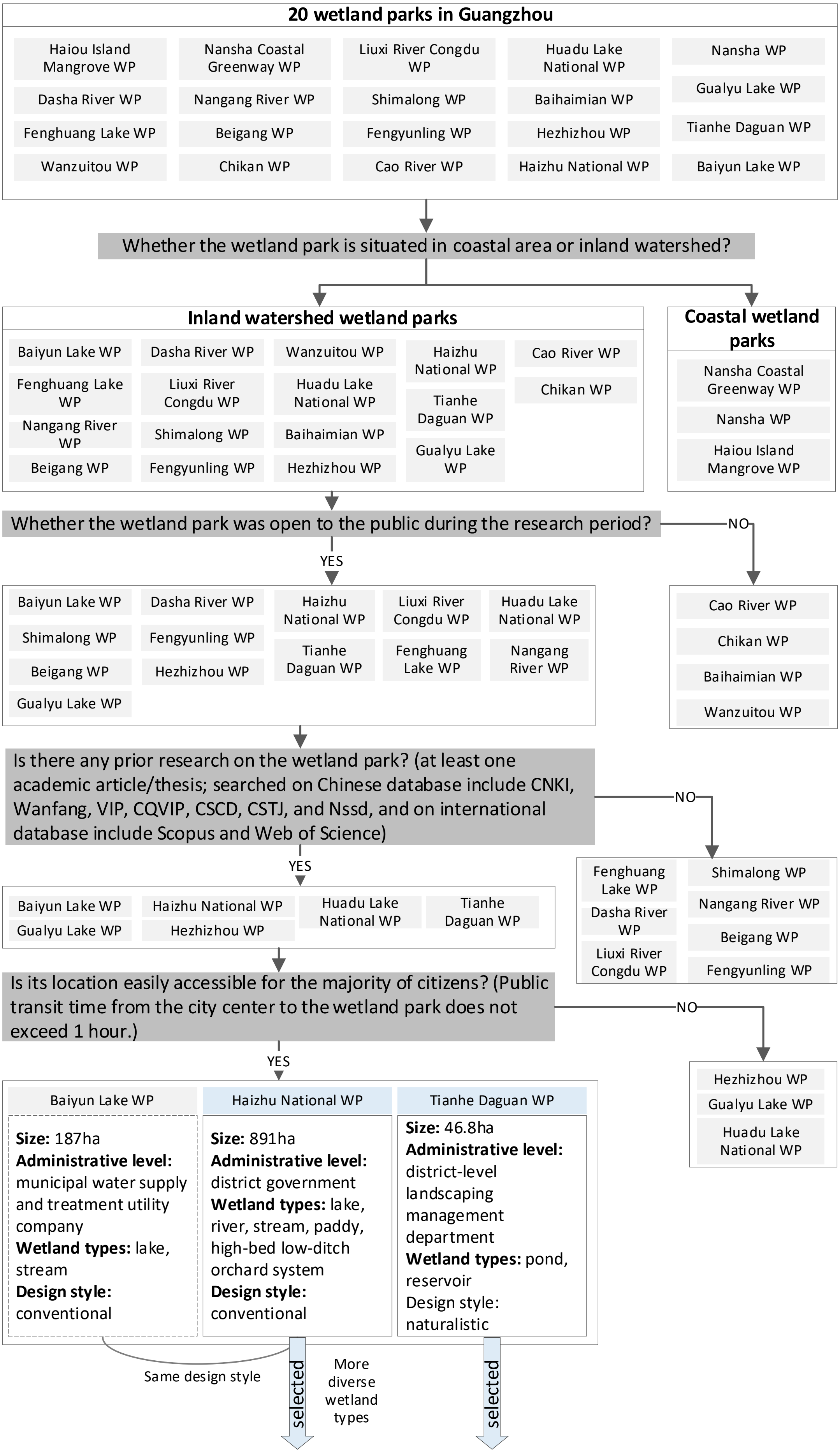


Figure 7-1 Criteria of selecting case study sites

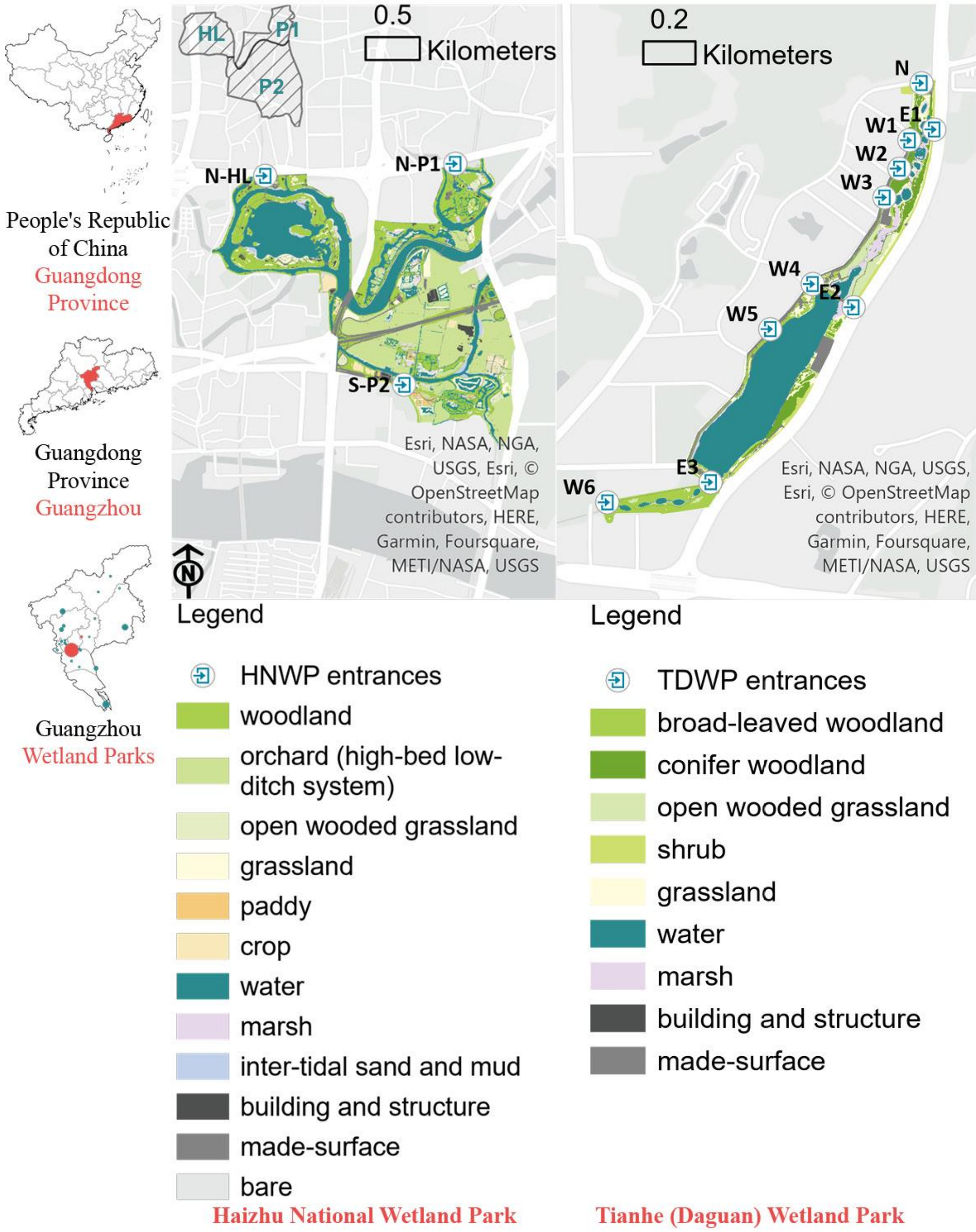


Figure 7-2 Two case study sites (HNWP: Haizhu National Wetland Park, HL: Haizhu Lake, P1: Wetlands Phase 1, P2: Wetlands Phase 2; TDWP: Tianhe Daguan Wetland Park, N: north gates, W: west gates, E: eastern gates)

7.1.1 Tianhe Daguan Wetland Park

Tianhe Daguan Wetland Park (TDWP) is located between E113°24' - E113°25' and N23°10' - N23°11'. It was designed in 2012 and built in 2015 and is located in the Tianhe District, where by many high-tech companies are located. It is a linear park approximately 120 metre wide and with a total area of 46.8 hectares. It consists of 23 cascade ponds and a reservoir to collect and purify stormwater. The water flows from northeast to southwest and then flows into a river. Area NO.9 (Figure 7-3) was not included in this study because it is separated from other areas by other sites.

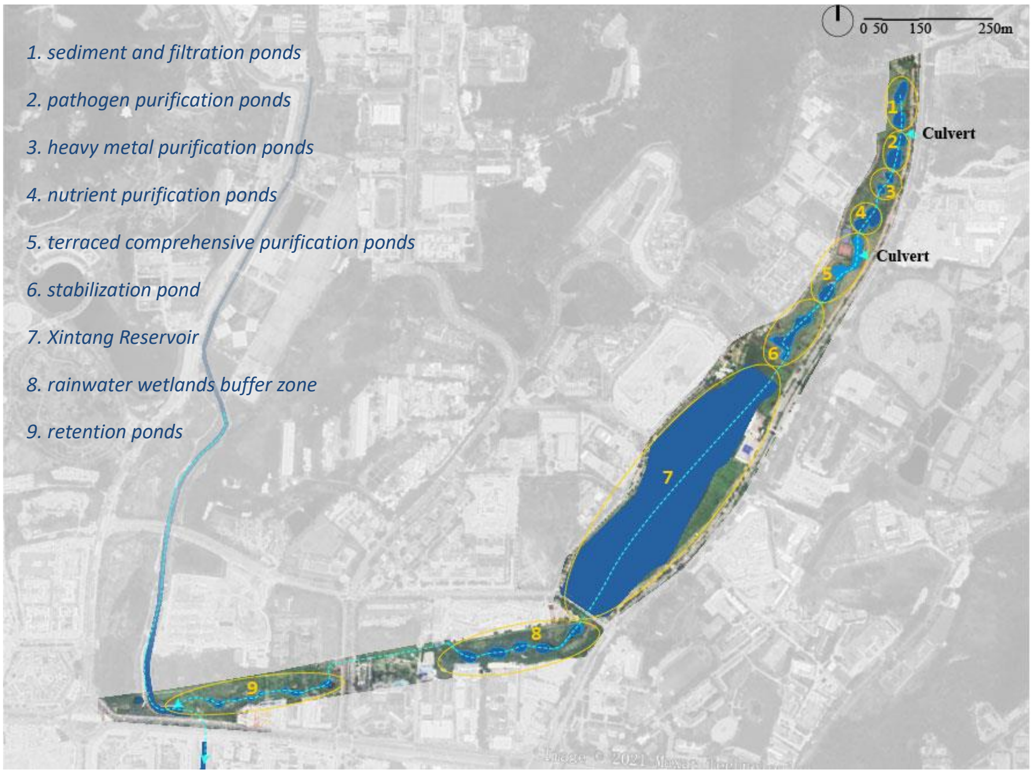


Figure 7-3 Wetland system of Tianhe Daguan Wetland Park[23]

The site was low-lying. Prior to its transformation into a WP, the land encompassed agricultural fields, fish ponds, and a reservoir; the water was polluted and the land was covered with weeds (Figure 7-4 and Figure 7-5). The design objectives of this catchment corridor are: (1) to function as a water storage system and reduce flood control pressure on the downstream river; (2) to enhance the water body's quality; (3) to cultivate plant communities that are adapted to water conditions; and (4) to offer recreational space for nearby residents. (TURENSCAPE, 2018). The design strategy involved extending the texture of the water pond and creating 'Wetland Bubbles' (ponds) by excavating soil in the centre of the site. Footbridges and paths were created along the ponds (Figure 7-6).

[23] Data source: signs on-site and (Wang L. *et al.*, 2019); base map: Google Earth

Figure 7-4 Site before the creation of Tianhe Daguan Wetland Park, December 2011 (TURENSCAPE, 2018)

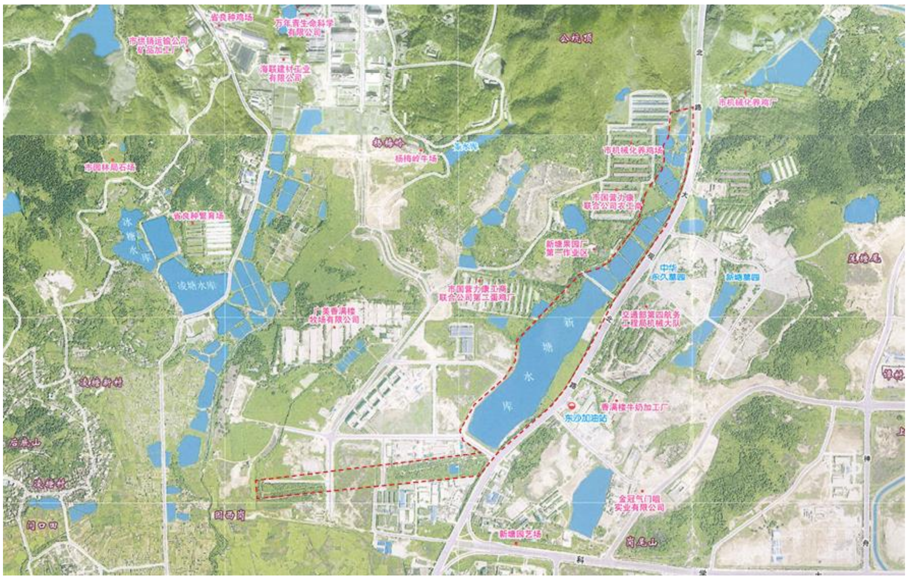


Figure 7-5 Land use and land cover map of and around the site before the creation of Tianhe Daguan Wetland Park, 2001-2003 (the red dot line shows the location of Tianhe Daguan Wetland Park) (Guangzhou Municipal Administration of Land Resources and Housing, 2006)

Figure 7-6 An aerial view of a part of Tianhe Daguan Wetland Park

The land cover map is shown in Figure 7-7. Almost half (46.42%) of TDWP consists of water and wetlands. The terrestrial vegetations comprises 41.06 percent of the total cover of TDWP. Buildings and made-surface, such as footbridges and plazas, account up to 12.52 percent of this WP.

It has been assessed that there are more plant species in TDWP than before it was created; the plant diversity of groundcover layer is rich but of tree layer is poor. And the ponds system has a substantial pollutant purification effect, which can greatly lower the nitrogen concentration in the catchment area (Wang L. *et al.*, 2019). This is the only research assessing the performance of this WP, and other ESs have not been assessed.

Figure 7-7 Land use land cover map of Tianhe Daguan Wetland Park

7.1.2 Haizhu National Wetland Park

Haizhu National Wetland Park (HNWP) is located at E113°18’ -E113°21’ and N23°2’ -N23°5’, at the southern end of the new central axis of Guangzhou (Figure 7-8). It is the largest national wetland park in the central area of any megacity in China. The river network in the park is crisscrossed. It is a compound wetland of rivers, lakes, and orchards, with a total area of 1,100 hectares, including areas open to public (Haizhu Lake, wetland phases 1 and 2), areas open to research or educational groups (phase 3) and conservation areas (Figure 7-9). This thesis only examines the areas open to public, namely Haizhu Lake (HL), wetland phases 1 and 2 (P1&2), which comprised approximately 370 hectares.

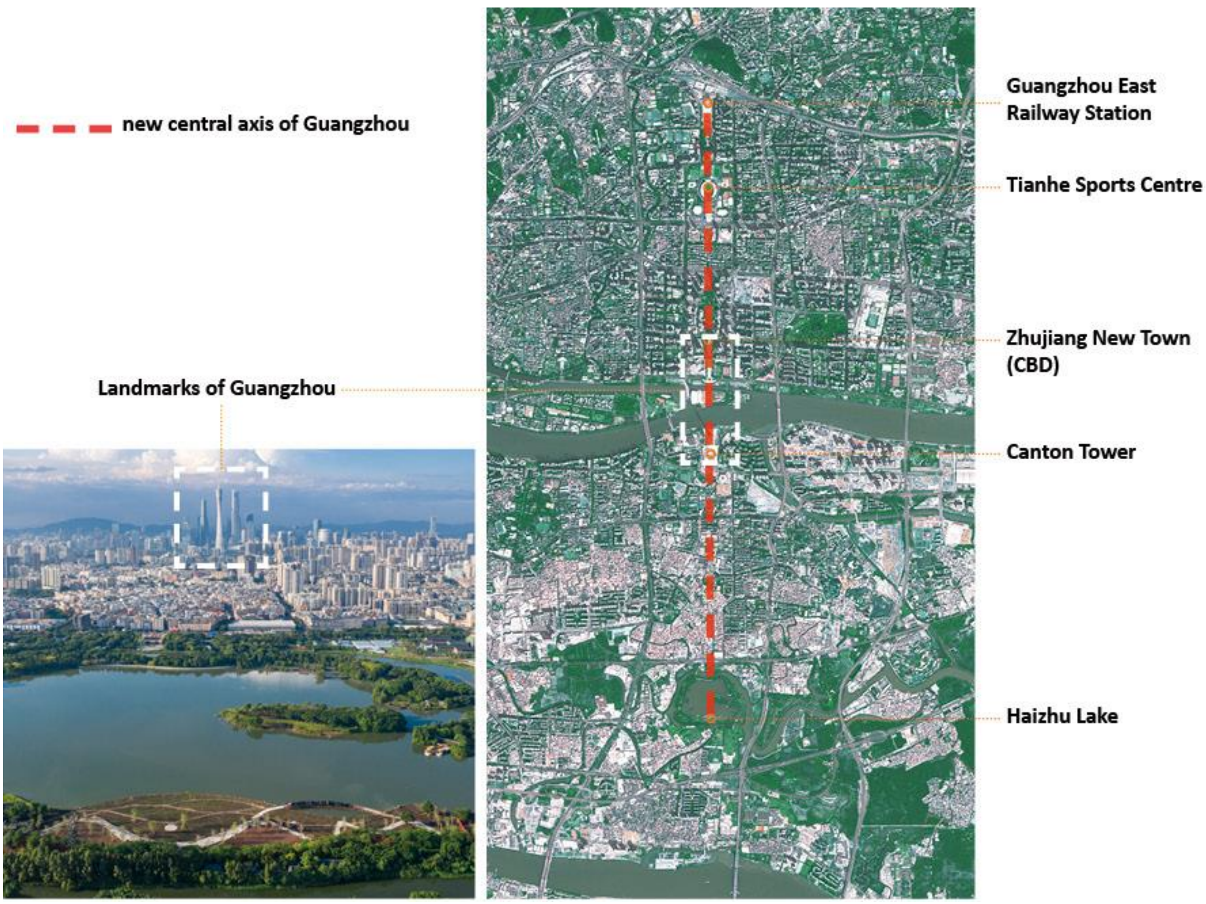


Figure 7-8 Haizhu National Wetland Park at the southern end of new central axis of Guangzhou

Figure 7-9 Map of Haizhu National Wetland Park[24]

Tidal water in tidal rivers, in addition to precipitation, are the source of water for HNWP. The tide is irregular semi-diurnal, with a yearly average tide difference of less than 2.0m between high and low tide. The tidal range has a moderate inter-annual variance, but it has a considerable intra-annual variation (Dai *et al.*, 2019). The tidal rivers' low self-purification ability has resulted in the accumulation of pollution over decades, as well as black and smelly water and sediments (Ni *et al.*, 2011). Therefore, the Guangzhou Water Authority has installed floodgates and a pumping automatic control system in the river network area where the Haizhu wetland is located to control the water level of the river gorge and replace the water body of the rivers: by using the irregular half-day tide, reciprocal flow has been turned into unidirectional flow, resulting in an increase in net discharge, allowing long-term reverberating sewage to be discharged on time, thus improving water quality (Gao, 2011) (see Figure 7-10).

[24] Data source: signs on-site; base map: GF-1 imagery,2021

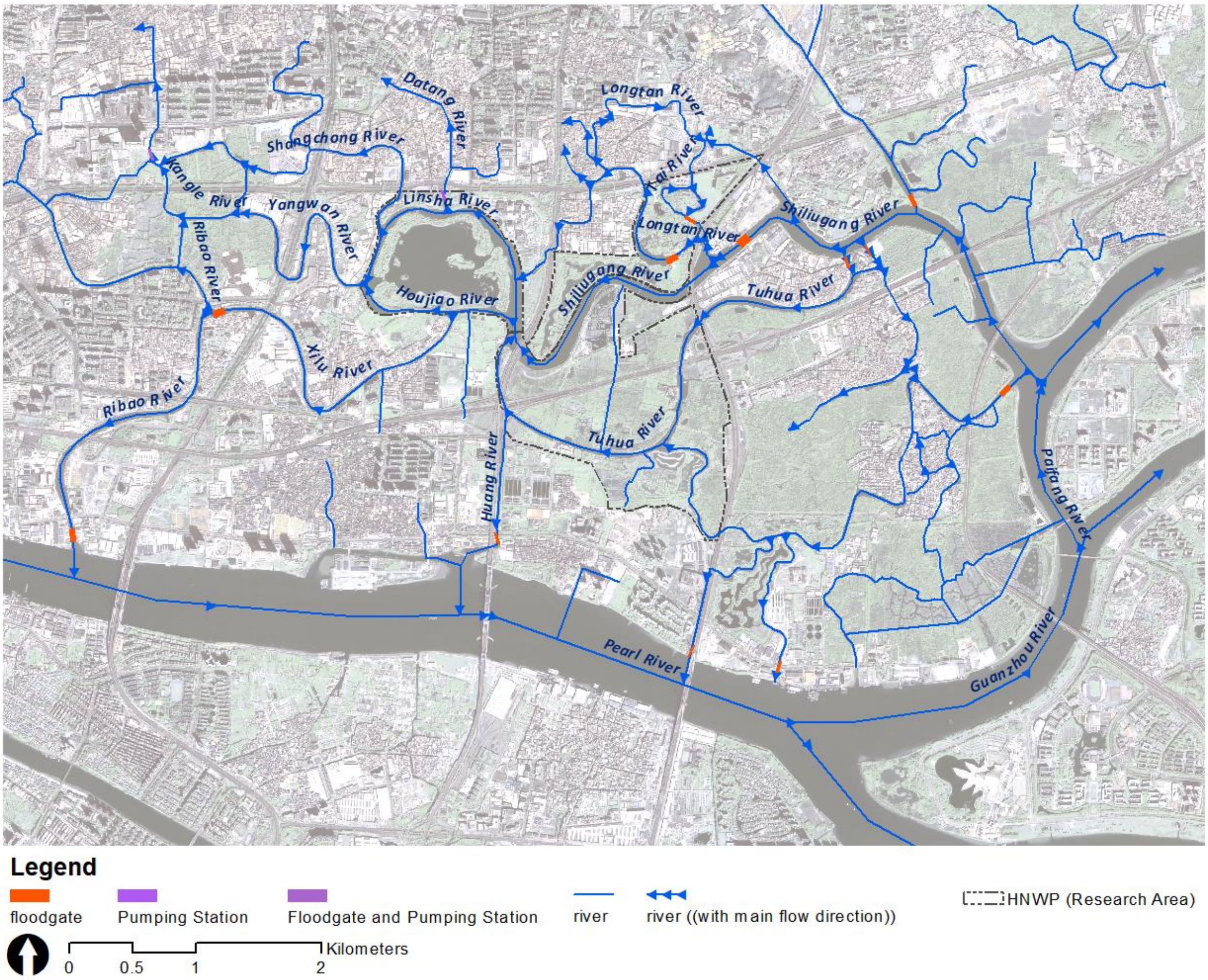


Figure 7-10 Layout of the river system, floodgates and pumping stations around HNWP [25]

Since 2010, the Haizhu District has been working on the River-Lake Linkage Project, which includes the excavation of Haizhu Lake. In March 2012, the State Council agreed to adopt the policy of 'Transfer only without expropriation'[26] for orchard wetlands (which was also called 'the high-bed low-ditch orchard system', Figure 7-11) for protective land acquisition. In September 2012, the Haizhu Wetland Phase 1 was completed. By 2014, the project had increased the water surface area and improved the water quality of the river by an average of 27.06% (Gao, Tang and Meng, 2015). The internal irrigation and drainage canals in the Phase 2 are about 5.3 kilometres long, with a width of 2-4 metres and a depth of 0.8-1.2 metres (Li and Chen, 2015). In February 2015, the Haizhu Wetland Phase 2 was completed. The number of visitors to the

[25] developed from (Luo, 2013; Lu and Li, 2015)

[26] The concept of "transfer only without expropriation" is a new method of converting non-construction agricultural land into state-owned property, while maintaining its original purpose without any alterations. That is, the land continues to be used for fruit production, but under state ownership rather than collective ownership. Hence, the land could serve as public parks or ecological conservation areas.

Haizhu Wetland throughout the year increased from 3.75 million in 2013 to 8.23 million in 2019. In 2017, the number of tour-bus departures reached approximately 720, and the number of battery boat departures was around 1,440. After dredging through rivers, the sediment returns to the high-bed low ditch orchard system, and was used as a pond mud fertilizer to be applied to various fruits (Appendix A - 3), and the total yield and quality were improved. The production has risen from about 21,000 tons of fruit per hectare of orchard in 2013 to about 24,000 tons of fruit per hectare in 2018. (Lin, 2020)

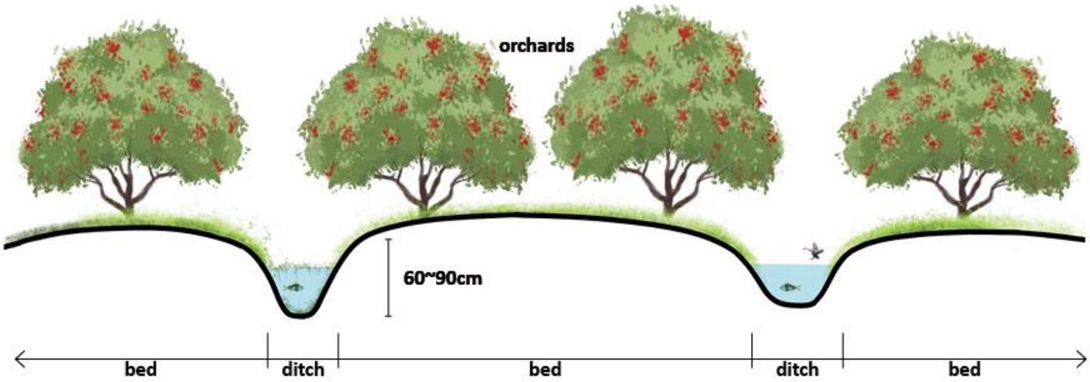


Figure 7-11 The high-bed low-ditch orchard system

In 2018, the economic value of seven ESs (including agricultural resources, water conservation, water purification, climate regulation, wildlife habitat, recreation, and environmental education) in HNWP was calculated, revealing that the total ESs value is around 114.38 million CNY per year, with provisioning and regulating services valued at the highest (69.35 million CNY per year), provisioning services and cultural services coming in second and third, respectively (33.81 million CNY and 11.22 million CNY per year) (Xie and Guo, 2018).

Between 2019 and 2022, a Quality Improvement Project (QIP) was conducted in HNWP. The QIP includes habitat transformations involve excavation and filling works (e.g., upgrading the largest island in the Haizhu Lake, improving the fluctuation zone landscape of the wetland in Wetlands Phase 2, and creating habitats at high tide level, improvement of habitat for egrets breeding), as well as the upgrading of hardscape system (e.g., pedestrians, bird-watching house, scientific research room, visitor centre at the south entrance of the Wetlands Phase 2, etc.), and the upgrading and transformation of the forest ground cover (Dai *et al.*, 2019). The area that transformed was 12.27 hectares in Haizhu Lake, 12.88 hectares in Phase 1, and 25.44 hectares in Phase 2; and it cost about 180 million CNY (Cai, 2021).

The timeline of the development of HNWP is summarised in Figure 7-12. And Figure 7-13 shows the satellite image before the creation of HNWP.

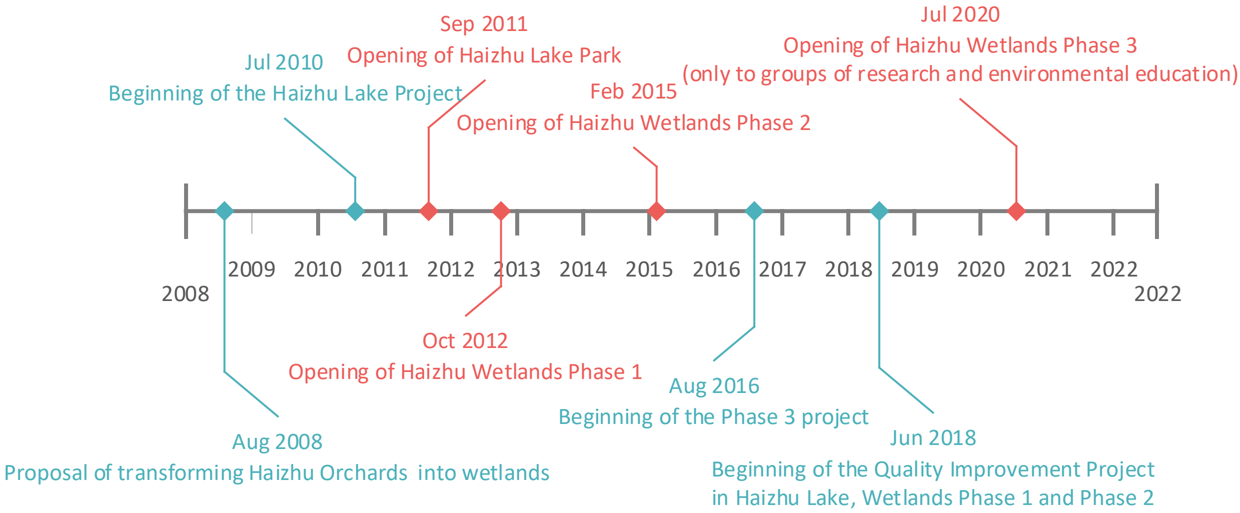


Figure 7-12 Development of Haizhu National Wetland Park

Based on two Worldview-2 images that contains HNWP and its surroundings, the land use and land cover (LULC) map was produced (Figure 7-14 and Figure 7-15). The process of producing the LULC map is presented in Appendix - B Land use and land cover data preparation for case study sites.

In 2021, 35.92% of HNWP consists of water and wetland, with a 2.09% increase in total wetland area compared to 2019 levels. Open water (lake and river), marsh, inter-tidal sand and mud, ditch in orchards, and paddy field, make up the wetland system in HNWP. Moreover, 34.70% of HNWP is comprised of orchards (beds alone) in 2019, decreasing to 26.03% in 2021. Currently, buildings and man-made surfaces, such as footbridges and pavilions, account for 9.47% of this WP; in 2019, this percentage was 8.92. Around 0.57% of HNWP was bare surface in 2019, and decreasing to 0.35% in 2021. The rest of the place is woodland, open-wooded grassland, grassland, field crops. Since the majority of trees in HNWP are evergreen broad-leaved trees mixed with a limited number of deciduous conifer trees (i.e., *Glyptostrobus pensilis* and *Taxodium distichum*), this study did not distinguish between the two types of woodland.

Figure 7-13 Land use and land cover map of and around the site of HNWP before the creation of the wetland park, 2001-2003 (Guangzhou Municipal Administration of Land Resources and Housing, 2006)

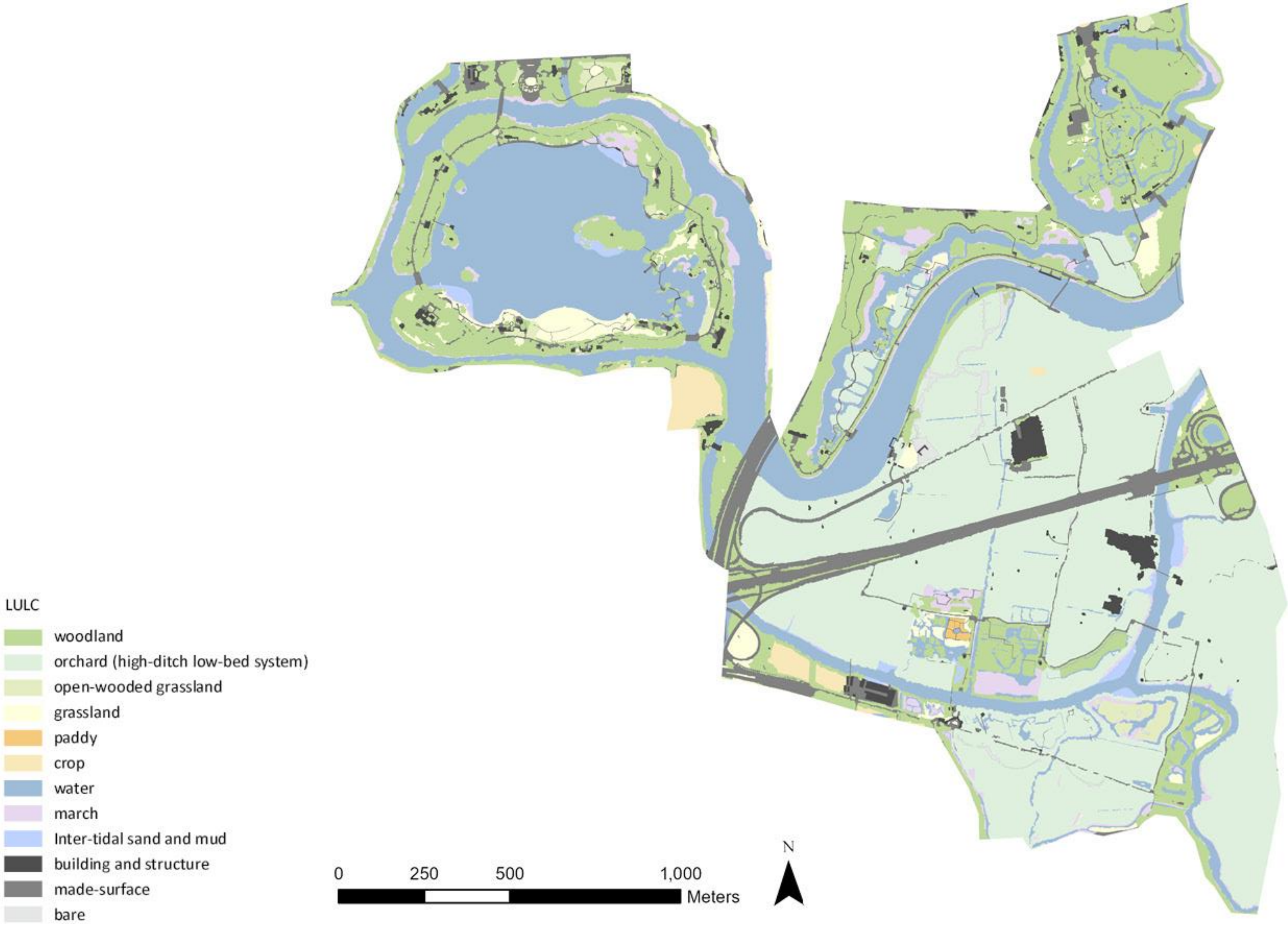


Figure 7-14 land use land cover map of Haizhu National Wetland Park (2019)

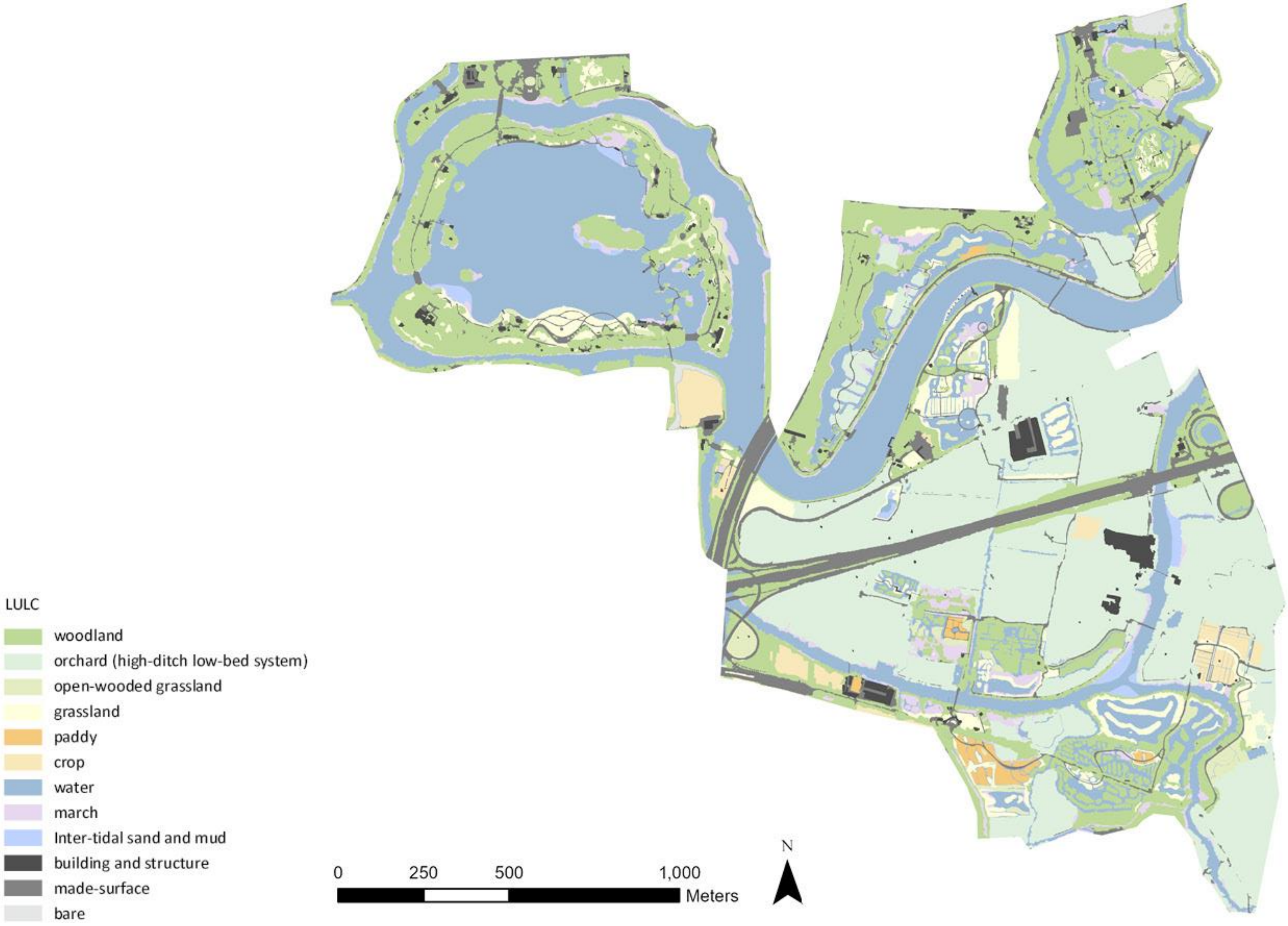


Figure 7-15 land use land cover map of Haizhu National Wetland Park (2021)

7.2 Overview of methods for assessing perceived ecosystem services

7.2.1 Survey design and data analysis

Self-completion questionnaires and face-to-face semi-structured interviews were designed to assess public perception of ecosystem services (PESs) in both WPs. Each onsite survey consisted of three phases: a warming-up interview, a questionnaire, and a follow-up interview. The content of the questionnaire and interview is presented in Table 7-1.

For surveys in Tianhe Daguan Wetland Park (TDWP), questions about the motivation and overall perception were asked at the beginning to avoid the impact of specific questions on the respondents' initial perceptions and judgments. After that, a questionnaire with 11 questions was filled by respondents. Questions about demographic data, visiting habits, cost for a visit, Likert scale questions regarding to perception of ESs and well-being, and preference of the three focal ESs (i.e., habitat, recreation and aesthetics) were included in the questionnaire. Further, two phases of an in-depth semi-structured interview regarding the questionnaire's answers, photo ranking task, and participatory mapping, were conducted.

For onsite surveys in Haizhu National Wetland Park (HNWP), after the motivation and overall perception questions, part A of the questionnaire with 23 questions was filled by respondents. Following that, photo ranking tasks were conducted. Further, part B of the questionnaire which consist of eight choice sets based on the result of the aesthetics preference, and six Likert-scale questions relevant to aesthetics was filled by respondents. The choice sets were for the choice experiment to measure the PES trade-offs and welfare, and details on the method is presented in 7.2.4 Discrete choice experiment. Finally, an in-depth semi-structured interview regarding the questionnaire's answers and including participatory mapping were conducted. The participatory mapping was undertaken solely in Haizhu Lake, where there is a single entry and exit and the main road forms a loop, allowing participants to visit nearly all parts of the park.

Table 7-1 Survey design

<table>
<tr><th>Phase</th><th>Tianhe Daguan Wetland Park</th><th>Haizhu National Wetland Park</th></tr>
<tr><td>**1**
Interview</td><td colspan="2">Motivations, visiting habits, and overall perceptions:
-Why did you choose here?
-How often do you use this WP?
-If very often, why?
-If the first visit was before the built of the WP: *Is there any difference between now and before the built of this WP?*
-Is there any difference when use here in different seasons?
-Is there other parks/WPs you used to go for the same purpose?
-Which place is better in which aspect?</td></tr>
<tr><td rowspan="8">**2**
Questionnaire</td><td colspan="2">**Demographic:**
(Q1) Gender [*male, female*]
(Q2) Age [*<18, 18-24, 25-34,35-44,45-54,55-64, ≥65*]
(Q3) highest education level [*middle school and below, high school/specialized school, specialized college, university/bachelors' degree, master's degree and above*]
(Q4) monthly disposable income [*0-2999, 3000-5999, 6000-8999, 9000-11999, 12000-14999, ≥15000, prefer not to say*]</td></tr>
<tr><td>(Q5) **time spent on site** [*0-1 hour, 1-3 hours, >3 hours*]</td><td>(Q5) **time spent on site** [*0-1 hour, 1-3 hours, 3-5 hours, >5 hours*]</td></tr>
<tr><td></td><td>(Q6) **Places have been visited** for this visit, (Q7) Places have been visited before today: [*Haizhu Lake (free), Haizhu Wetlands Phase 1 and 2 (CNY 20 for entrance fee), Haizhu Wetlands Phase 3 (currently only open to research groups or environmental education*]</td></tr>
<tr><td>Cost for a visit:
(Q6) cost for visit [*0, 1-20, 21-50, 51-100, ≥101, prefer not to say*]
(Q7) time spent for travelling [*<15min, 15-30min, 31-60 min, >60min*]</td><td>Cost for a visit:
(Q8) cost for visit [*0, 1-20, 21-50, 51-100, 101-200, ≥201, prefer not to say*]
(Q9) time spent for travelling [*<15min, 15-30min, 31-60 min, >60min*]</td></tr>
<tr><td colspan="2">**Level of PES/well-being:** 7-points Likert Scale, agreement
(Q8 | Q10) *I feel pleasant when I visit this WP.* -- perceived pleasantness
(Q9 | Q11) *Visiting this WP makes me healthier.* ---perceived health benefit
(Q10 | Q12) *The scenery of this WP is beautiful.* ---perceived aesthetic value
(Q11 | Q13) *There are sufficient recreational space and facilities in this WP.* --------perceived recreation service
(Q12 | Q14) *The air is clean in this WP.* ---perceived air purification service
(Q13 | Q15) *There are abundant and diverse animal and plants in this WP.* ---------perceived habitat service
(Q14 | Q16) *I learn more about nature/environment when visiting this WP.* ------- perceived educational value</td></tr>
<tr><td colspan="2">(Q15 | Q17) Activities that the respondent participated during this visit (multiple choices)
[*take a walk, jogging, other exercise, take a seat, lie down and rest, have a picnic, landscape photography, figure photography, make video or internet broadcast, bird watching and other natural observations, pick flowers and grasses for ornamental purposes, environmental education activities, fishing, pick wild vegetables and fruits, feed fish and birds, others (open-ended)*]</td></tr>
<tr><td colspan="2">(Q16 | Q18) 5-point Likert Scale: Air quality on site compared with nearby road [much worse, worse, similar, better, much better]</td></tr>
<tr><td></td><td>**Impact factors of PES**: 7-points Likert Scale, agreement
(Q19) *The number of signage boards with information about animal and plant in this WP is sufficient.*
(Q20) *The contents of the signage boards with information about animals and plants in this WP is easy to understand.*
(Q21) *There are rich and diverse plants in this WP.*</td></tr>
</table>

		(Q22) *There are rich and diverse fish, shrimp and crabs in this WP.* (Q23) *There are rich and diverse birds in this WP.*
		Aesthetically preferred pictures (Interview for onsite survey, questionnaire for online survey) Ranking task 1: eight photos show various wetland types Ranking task 2: two groups of photos show the different scenarios of the same place.
	Trade-offs between ESs (A: aesthetics, R: recreation, H: habitat) (Q17) Decision making on trade-offs [*A>R>H, A>H>R, R>A>H, R>H>A, H>A>R, H>R>A*]	**Trade-offs between ESs:** (Q24-Q31) Choice experiment
		Impact factors of PES: 7-points Likert Scale, agreement (relevant to aesthetics) (Q32) *Landscapes are diverse in this WP.* (Q33) *Landscapes are unique in this WP (compared to other parks/WPs in Guangzhou)* (Q34) *This WP has layering landscape.* (Q35) *The plants in this WP are exquisite and beautiful* (Q36) *The plants in this WP are thriving and vigorously* (Q37) *The water in this WP is clean and clear*
3 **Interview**	**Reasons of the choice in the Questionnaire:** *-Why don't you agree with Question X?* *-Why do you spend less than 1 hour or more than 3 hours in this WP?* *-Which activity do you most satisfied with today?*	 *-How did you decide where to do this activity?* *-Why do you make this decision?* *-Why do you think X is important or not important?*
		Follow-up question to the choice tasks: *-How did you make the choices?* (This question was also included in the online questionnaire) *-What were the most important choice attributes?* *-How difficult was it to do the choice tasks?* (This question was also included in the online questionnaire)
	ESs hotspots *-Where do you think has the most beautiful scenery in this WP?* *-Where do you like most for doing activities?* *-Where do you think have the highest biodiversity?*	**ESs hotspots:** participatory mapping, only for respondents at Haizhu Lake *-In your experience in Haizhu Lake, are there any places you like most for doing activities?* *-Are there any places you think have the most beautiful scenery?* *-Are there any places you think are the most ideal places for wildlife inhabit?*
	In-depth interview *-Is there any* ***smell or sounds*** *that make you feel pleasant?* *-How many different kinds of birds/plants do you think live in this wetland park? How do you come up with this number?*	
	photo ranking with two groups of panoramas -Aesthetics preference -Perceived biodiversity	

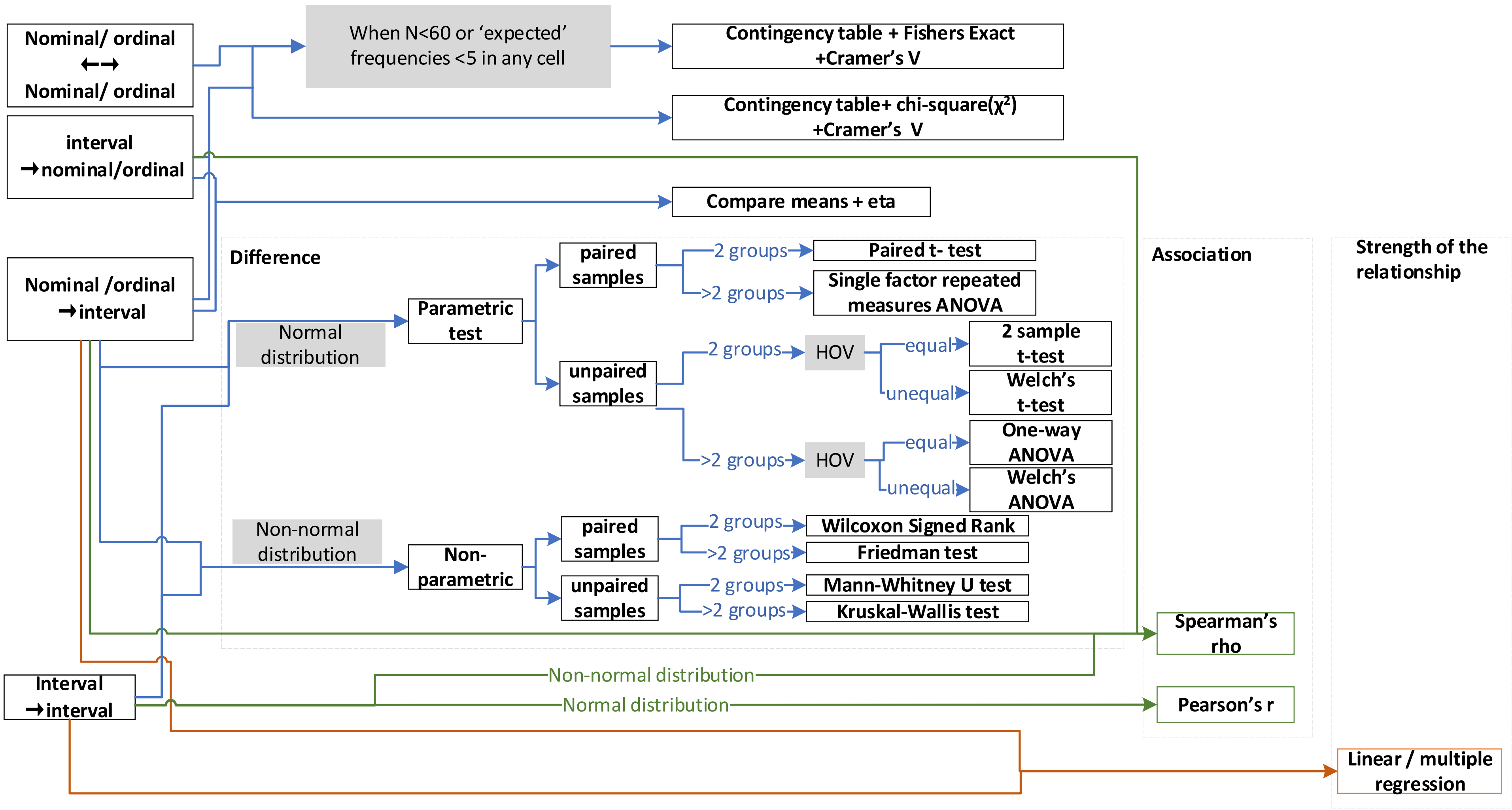
7.2.2 Questionnaire

All quantitative data except choice experiment data were analysed using SPSS Statistics 25. Ratings on ESs, decision-making when ESs conflict, and the influence of demographic factors were analysed statistically. Demographic variables except age, gender, and education, were not included in the questionnaire because a previous study showed that only the three variables have statistically significant impact on urban wetland perception (Torres-Lima, Conway-Gómez and Buentello-Sánchez, 2018). The income status was included to assess its influence on PESs and choices in the choice experiment. The online questionnaire contained the same questions as the on-site questionnaire, but the demographic questions were moved to the end to prevent respondents from stopping to answer because they had seen the income and cost questions prior to learning the purpose of the questionnaire and were suspect of its rationality on information collection.

Table 7-2 Nature of variables

Variables	Sub-groups	Nature of variables
gender	2	nominal
age	7	ordinal
highest education level	5	ordinal
frequency	5	ordinal
monthly disposable income	7	ordinal
time spent on site	3	ordinal
cost for visit	6	ordinal
time spent for travelling	4	ordinal
PES	7 or 5	interval
number of activities	≥1	interval
decision making (TDWP)	6	nominal
season (TDWP)	2	nominal
source (HNWP)	2	nominal

Raw data was coded to quantifiable data, and organized according to the nature of variables (Table 7-2). Descriptive statistics and inferential statistics were conducted to describe the patterns of the data, and examine the differences and relationships between variables; statistical tests were chose based on the nature of variables following the flowchart shown in Figure 7-16. Frequencies and cross tabulation analysis was performed for nominal data, while central tendency and normality analysis for ordinal data, and central tendency, normality and dispersion analysis for interval data. To avoid too many cells having an expected count of less than 5, elements that consist of more than three categories were reclassified for further analysis. The normality distribution of scale variables was examined through the Shapiro-Wilk test (Ghasemi and Zahediasl, 2012). Since persons in each group of independent variables were different from those in other groups, unpaired samples were fitted in this study. Association between variables were examined using Pearson's r or Spearman' rho correlation test according to the nature and normality of variables (Schober, Boer and Schwarte, 2018).



Note: independent variable → dependent variable ; HOV: Homogeneity of variance

Figure 7-16 Flowchart of conducting inferential statistics

7.2.3 Semi-structured interview

Following each interview, all comments mentioned during the interviews were subsequently transcribed. Each respondent was given a nickname with the most common male and female English names. Due to the fact that all interviews were conducted in Chinese, the data were initially documented and analysed in Chinese to preserve the originality of interviewees' responses.

Combining thematic analysis and content analysis, the interview data was analysed. Similar descriptions were classified in NVivo as 'meaning units' under grouped themes. Combining a deductive (theory-driven) and inductive (data-driven) strategy was utilised to develop coding themes. The frequency of each presented theme and subtheme was quantified. Further, conceptual models were developed to comprehend how the factors influence the perception of ESs and to comprehend the perceived relationship between ESs.

7.2.3.1 Photo ranking and photo elicitation interview

This study uses the photo ranking method to determine the preferred images, as the ranking method reveals the distinctions between levels with greater clarity than the rating method (Sayadi, Gonzalez Roa and Calatrava Requena, 2005). The task becomes more complex as the number of items to be ranked increases (Smyth, Olson and Burke, 2018). Therefore, the number of items in ranking tasks in this study was limited to three to make the tasks easier. When there were more than three items, respondents were asked to rank their top three preferred items. Photos were scored based on their preference ranking: 3 for the most preferred, 2 for the second preferred, and 1 for the least preferred. The total and average score for each photo was computed.

In TDWP, selection of photos that were used as stimulus is presented in Section 7.5.4.5 and 7.6.3.2. Two groups of photos comprise three panoramas respectively were printed on professional photo paper at 254×305mm, shown to participants, and were ranked (Figure 7-44 and Figure 7-45). In HNWP, three groups of photos printed on professional photo paper at 152×114mm were shown to the participants to assess their visual aesthetics preference. Two groups of photos contain two pictures respectively, showing two different scenarios[27] looking from the same point of view in Haizhu Lake (Figure 7-47). One group of photos contain eight pictures of various wetland types in this WP was shown for photo ranking (Figure 7-46). Respondents were asked to select the three most appealing images from the set of eight and then rank them. All photos were presented at random. The ranking and photo elicitation interview reveals the visual characteristics that respondents appreciate the most.

After the photo ranking, photo elicitation interview, which is the use of photos in an interview to generate verbal discussion to develop data and knowledge, was used to elicit deeper aspects of human consciousness, enhance informants' memories, and lessen areas of misunderstanding that words do (Harper, 2002). Photo elicitation interviewing has been used in a range of disciplines, including psychology, education, organizational studies (Shao and Liu, 2016). The participants' preferences and the factors that influenced their preferences were revealed through the act of ranking photographs and explaining the motivations behind their rankings.

[27] The two different scenarios are actually scenarios before and after the Quality Improvement Project respectively. Because the gatekeeper considered this is sensitive information and did not allow it to be mentioned to the interviewees, this research use Scenario 1 and 2 to distinguish the pictures.

7.2.3.2 Participatory mapping

Participatory mapping (also referred to as Public Participatory GIS (PPGIS or PGIS)) is commonly used to engage participants in the identification and valuation of ES to determine where and how the public perceives ES. They have been proved to be efficient approaches for examining relationships between human landscape values (i.e., perceived ES) and physical landscape characters (De Vreese *et al.*, 2016). Further, PPGIS with spatially intersections of PESs have been utilized to examine relationship between ESs and encouraged replication to strengthen the external validity of the ESs – physical landscape associations (Brown and Brabyn, 2012).

Participatory mapping often includes qualitative and quantitative methodologies (Brown *et al.*, 2017). Typically, qualitative mapping use semi-structured interviews with a limited sample size to investigate place values and meanings in the absence of a predetermined typology. Lowery and Morse (2013) integrates PPGIS within a focus group format to study place meanings and attachments, and synergy among participants. Klain and Chan (2012) involved maps and semi-structured interviews to explicate non-monetary values of ESs. Quantitative studies, on the other hand, typically employ survey research techniques with larger samples and produce a list or typology of geographical qualities for mapping. For example, Ancona *et al.* (2022) combined the tool SolVES to modelling the social ESs in a coastal national park. In addition, researchers undertook a mixed-method study in which digital, internet-based maps and hardcopy maps were used for mapping (Pocewicz *et al.*, 2012).

The printed (hardcopy) maps, which could result in a higher response rate, reduce participant bias (Brown and Fagerholm, 2015, p. 128), and are more friendly to the 40 years and above groups of people (Rosley, Lange and Thwaites, 2018), were used in this research. In participatory mapping, whether to mark points or draw polygons has a potential impact on data quality; the utilisation of points mapping generally yields a higher level of precision in the interpretation of location characteristics compared to the use of polygons (Brown *et al.*, 2017, p. 155). Besides, participants usually prefer the making points method which request less mapping effort (Brown and Fagerholm, 2015, p. 128). Additionally, the point method require larger sample size than the polygon method: a minimum of 350 respondents were required to achieve the point densities that make meaningful inferences about place significance, while a minimum of 25 respondents were advised for polygon-based method assuming 4-5 polygons identified per attribute per respondent on average (Brown and Pullar, 2012, p. 244). Considering the small scale of the study area, in which there are large areas of similar spaces (e.g., the flower sea, lake islands), this study adopted the polygon approach instead of the point approach. On a literature review searched between 2013 and 2014, sample size of participatory mapping studies varies from 22 to 1905 (Brown and Fagerholm, 2015, p. 125). Hence, the sample size of this study was decided to be larger than 25.

(1) Data collection

For participatory mapping, A3-sized hardcopy maps (1:3000-scale) of Haizhu Lake (HL) with photo references to attractions were used to assist participants find their important locations (Figure 7-17). Respondents were encouraged to mark as many important locations for each ES as they preferred as polygons on the colour map, regardless of shape or spatial extent. The questions were worded: 'in your experience in Haizhu Lake, are there any places you like to have a rest or do activities the most? For example, some place you often visit and do activities when you visit Haizhu Lake? Please mark as many important locations as you preferred as polygons on the map, regardless of shape or spatial extent. If you find it is difficult for you to place on the map, you can describe the place and I will help you to find it'; 'what about places you think with the most beautiful scenery?'; 'and what about places you think are the most ideal places for wildlife inhabit?'

Figure 7-17 A map of Haizhu Lake, used for participatory mapping

(2) Data processing and analysis

ArcGIS and SPSS were used to analyse data. Initially, ArcGIS Pro was used to digitise each respondent's hand-drawn polygons representing each ES. Then, overlapping polygons were joined. Next, the polygons were spatially joined to a 5-metre fishnet that covered the HL, so that each grid (i.e., fishnet) of HL received a score based on an ES indicating the number of overlaps. Following these procedures[28] in ArcGIS Pro, the attribute tables containing the grid scores were exported and subsequently analysed in SPSS.

Spearman correlation, linear regression, and multiple regression were performed in SPSS. The regression analysis was conducted on the premise that perception of habitat services could influence perceptions of aesthetics and recreation services; perception of aesthetic services could influence perceptions of recreation services. Additionally, descriptive statistics were computed using SPSS.

To determine the effect of spatial dependence on the ES variables, geographically weighted regression (GWR), a global spatial regression model which integrated local coefficient estimates, was performed using MGWR V2.2 (Oshan *et al.*, 2019). To avoid the multicollinearity which obstruct the GWR analysis, redundant variables with null value (i.e., there was no participant mapped that grid) were removed. Therefore, in this part of analysis, only grids that have been mapped with at least two ESs were kept.

[28] With the following steps in ArcMap: (1) <union> the shapefile with itself, (2) convert outputs to single part using <multipart to singlepart>, (3) use the <spatial join> tool to count overlaps (use the ARE_IDENTICAL_TO match option), and (4) symbolize using the <join_count> field

7.2.4 Discrete choice experiment

Discrete choice experiment (DCE) with discrete choice model (DCM) is usually used to explain or predict the probability of a choice from a set of two or more discrete alternatives; it assumed that when confronted with a discrete set of options, people choose the option of maximal benefit or utility from consuming goods or services subject to a budget constraint. That is, the decision maker faces a choice among J alternatives, and alternative j provides utility U_j $(where\ j = 1, \ldots, J)$; the decision maker n chooses the alternative i in choice occasion if and only if $U_i > U_j, \forall j \neq i$. Utility U_j contains observed factors and often known as the representative utility (V_j) and unobserved factors (ε_j, the random factors that affect U_j but are not included in V_j, also known as alternative-specific parameter (ASP) in some literature (Hensher, Rose and Greene, 2015; L. Xu *et al.*, 2020)). V_j is usually assumed to be linear in parameters, namely $V_j = \beta_j x_j$, where x_j is a vector of attributes of the alternative, and β_j is an unknown coefficient that express the decision-maker's taste (Hensher, Rose and Greene, 2015; Mariel *et al.*, 2021) Usually there are more than one attribute that influence the choice of an alternative. The total utility of the alternative (j) is the sum of the utility that a decision maker gets from attributes (h), that is:

$$U_j = \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_h x_h + \varepsilon \qquad (1)$$

The equations give each predicted value that determines the relative utility specified for each option. Researchers then uses these predicted values and probabilities to estimate which option will be selected (Hensher, Rose and Greene, 2015). Based on prior research (Hanley, Mourato and Wright, 2002; L. Xu *et al.*, 2020; Mariel *et al.*, 2021), the following steps were used to design and implement the DCE.

7.2.4.1 STEP1: Attributes and Levels Determination

The three examined ESs were defined as attributes in this study. The aesthetics attribute was determined to be a two-level attribute, with 'high' and 'low' values based on a selection of preferred photographs from before and after the Quality Improvement Project (QIP) (Figure 7-47). Although it will be at the cost of losing some information using two attribute levels, if the experiment is used as an explanatory tool, then a design with only two attribute levels per attribute is very useful (Hensher, Rose and Greene, 2015). Recreation and habitat attributes were determined to be three-level attributes, with 'maintain the current', '20% improved', and '20% deteriorate'.

Additionally, cost attribute is included to explore the willingness-to-pay (WTP) which relevant to welfare. The cost attribute was determined after define the payment vehicles (e.g., income tax, entrance fees, donations) and cost vector (Mariel et al., 2021, pp. 27–28). 'Total cost for a visit' (incl. travel cost, entrance fee, consumptions in the WP, and donation) was used as the payment vehicle to estimate respondents' WTP. According to annual total expenditures and number of visits of HNWP from 2013 to 2021 (Appendix A - 4), if the management and operation of HNWP only rely on visitors' payment, a visitor have to pay approximately 13 CNY per visit for general operation and extra 29 CNY for the QIP.

The cost vector was determined after selecting the payment vehicle. The typical lower bound of the cost vector is zero when the survey aims to estimate WTP, and the upper bound usually use the choke price. In this case, the choke price was set to 150 CNY, according to findings that when the average travel cost to HNWP exceeds 150 CNY, the probability of tourists visiting it dropped below 10% (Liu *et al.*, 2019). Typically, between 4 and 8 levels in addition to zero were used for the cost attribute; these levels could be evenly distributed or spaced exponentially apart. And unevenly spaced levels may help estimate the cost coefficient (Mariel *et al.*, 2021, p. 28). Therefore, according to the 33.24 CNY of average WTP (after removal extreme values) in 2017 (W. Zhu *et al.*, 2020) and the annual expenditure for general operation, levels of the cost attribute was determined as {0, 18, 37, 75, 150}.

7.2.4.2 STEP2: Experimental Design

In this research, two alternatives were provided in each choice set to reduce the complexity of making decisions. Therefore, the chosen attributes and levels produced a full factorial design with 90（=2×3×3×5）possible choice tasks, which are too heavy workloads for respondents. Assuming the four attributes may not have interaction effect (i.e., the decision make's preference for a level of an attribute does not depend on the level of another attribute), this study only estimate the main effects. The minimum number of choice tasks was calculated to be eight, following methods stated by Hensher, Rose and Greene (2015, p. 218).

D-optimal design, which has a sufficiently low error and is the most commonly used criterion in the literature, was used to reduce the number of tasks (Mariel et al., 2021, p. 42). The Ngene Software was used to process the D-optimal design. This study uses the D-optimal design with eight choice tasks when the D-error is at an acceptable level (0.026). 'Neither of the scenarios' was accounted for in the D-optimal design, as it retains utility when translating individual choices into individual requirements (Hensher, Rose and Greene, 2015). Table 7-3 presents the results of D-optimal design.

Table 7-3 Choice tasks as a result of D-optimal design

Choice	**Alternative 1**				**Alternative 2**			
	Aes	Rec	Bio	cost	Aes	Rec	Bio	cost
1	-	0	+	0	+	0	-	75
2	-	+	-	150	+	-	0	0
3	-	+	0	0	+	-	0	75
4	-	+	-	18	+	-	0	37
5	-	-	+	18	+	0	-	37
6	-	0	+	18	+	0	-	37
7	-	-	+	150	+	0	-	0
8	-	+	0	18	+	-	0	37

Aes: scenic beauty; Rec: recreation facilities and activities; Bio: biodiversity
[0]: maintain; [+]: high in Aes or 20% improved of Rec or Bio; [-]: Low in Aes or 20% deteriorate of Rec or Bio.
MNL efficiency measures; D error = 0.026

7.2.4.3 STEP3: Measurement of Preferences

(1) Survey formation

In addition to the usual information sheets, consent form, and questions on the socio-demographic background in questionnaires, following contents were included in the survey: (1) preference of two groups of photos of before and after the Quality Improvement Project (QIP) at the same location (respondents were not informed which sets of photos appeared prior to or subsequent to the QIP); (2) DCE tasks (an example is shown in (Table 7-4); (3) rating the level of difficulty of completing the DCE tasks; (4) open-ended question on relevant attitudes that help to explain preferences. For on-site surveys, the open-ended question was posed and answered orally.

Table 7-4 An example of choice task

	Scenario A	Scenario B
Scenic beauty	The same quality as your less preferred sceneries in the Question 14 ♥♥♥  	The same quality as your preferred sceneries in the Question 14 ♥♥♥♥♥  
Recreation	20% more recreational facilities (e.g., seats) / 20% More activity types 	20% less recreational facilities (e.g., seats) / 20% less activity types 
Biodiversity	Maintain the current biodiversity 	Maintain the current biodiversity 
Cost	37 CNY	18 CNY
Your choice	☐	☐
	☐Neither of the scenarios	

(2) Determine sample size

The minimum sample size was determined to be 139 using the following equation:

$N > 500c/(t \times a)$ (In this case: $c = 5, t = 8, a = 2$)

Where, c represent the largest number of levels for any of the attributes, t represent the number of choice tasks, and a represent the number of alternatives of each choice set (not including the none alternative). (Orme, 2010; de Bekker-Grob *et al.*, 2015; Bostan *et al.*, 2020)

7.2.4.4 STEP4: Estimation Procedure

(1) Econometrics models

Due to the complicated form and estimation of the probit model, most DCE research choose logit extended model for analysis. This research applied the most commonly used multinomial logit (MNL) and random parameter logit (RPL) models for analysis. MNL is derived from random utility model and holds the Independence from Irrelevant Alternatives (IIA) hypothesis which states that the introduction or removal of alternatives has no effect on the relative probabilities of two options being chosen (Hanley, Mourato and Wright, 2002). The representative utility V_{ij} can be expressed as:

$$V_{ij} = ASC + \beta_a x_{ia} + \beta_r x_{ir} + \beta_h x_{ih} + \beta_c x_{ic}$$

Where ASC is alternative specific constant. β_a, β_r, β_h, and β_c are coefficients expressing respondents' taste of aesthetics, recreation, biodiversity and cost, respectively. And x_{ia}, x_{ir}, x_{ih}, and x_{ic} are the independent variables of the attributes. And the probability that respondent i chooses alternative j:

$$Prob[choice\ ij] == \frac{\exp\,(\beta'_{i}x_{ij})}{\sum_{n=1}^{J}\exp\,(\beta'_{i}x_{in})};\ n = 0, \ldots, j, \ldots J$$

In MNL model, the coefficients are assumed to be constant among all respondents (Train, 2003). However, heterogeneity between individuals matters. Therefore, the RPL model which allows for random variations in various utility parameters to capture the heterogeneity of individual's preference was used (Hensher, Rose and Greene, 2015, p. 106) The model includes both observed and unobserved variation in the preference characteristics of individual i. Observed heterogeneity is reflected in the term Δz_i whereas the unobserved heterogeneity is represented by Γv_i, where z_i is a set of characteristics of individual i that influence the mean of the taste parameters, and v_i is a vector of random variables with zero means and known variances and zero covariances. Therefore, the vector of coefficients of those variables for respondent i that person's taste can be presented as:

$$\beta_{ih} = \beta\ + \Delta z_i + \Gamma v_i$$

Where β is a constant vector. And the RPL model is summarized as:

$$Prob\left[choice_i = \ j \mid x_{ij}, z_i, v_i\right] == \frac{\exp\,(\beta'_{ih}x_{ij})}{\sum_{n=1}^{J}\exp\,(\beta'_{ih}x_{in})};\ n = 0, \ldots, j, \ldots J$$

Further, the MNL and RPL with interactions model was developed to better understand preference heterogeneity following (Hensher, Rose and Greene, 2015). The widely used econometric software NLogit was used to analysis the DCE data. Data for analysis was prepared in Microsoft Excel and imported to NLogit.

(2) Welfare analysis

A key output of DCM is the marginal rate of substitution between specific attributes of interest, with a financial variable typically involved. The marginal rate of substitution is also known as an estimate of willingness to pay (WTP). In this research, the trade-off between improvement of aesthetic value and cost, improvement of recreation service and cost, and improvement of wildlife habitat service and cost, were measured by the marginal WTP, describing how much the cost attribute x_c would be required to change given a 1-unit change in a service attribute x_k, such that the change in total utility will be zero. The marginal WTP was calculated by the following equation:

$$WTP_k = \frac{\Delta x_k}{\Delta x_c} = \frac{\beta_k}{\beta_c}$$

Where β_k and β_c are the coefficients of the attributes (Hensher, Rose and Greene, 2015). The WTP values were estimated using the Wald procedure (Delta method) in NLogit 6.

Although WTP is a useful estimate for the perceived utility benefits of improvements to the quality and/or quantity of wetland ES, compensating variation (CV) is a more specific welfare measure that could be calculated (Dias and Belcher, 2015, p. 41). CV measures the consumer surplus[29] before and after a policy

[29] Consumer surplus, which is the difference between the amount buyers are willing to pay for a good and the amount they actually

change. To estimate the respondents' CV for potential decision-making of HNWP for future development, six alternative scenarios were created:

1) Inaction Scenario: the recreation facilities and activities and biodiversity remain the status quo, no matter how the quality of the scenery is (because the scenic beauty is subjective);
2) Park-like Scenario[30]: the more preferred scenery and 20% increased recreation facilities and activities, with 20% deteriorated biodiversity;
3) Rewilding Scenario 1: 20% improved biodiversity, with a less preferred scenery and 20% decreased recreation facilities and activities;
4) Rewilding Scenario 2: 20% improved biodiversity, with a more preferred scenery and 20% decreased recreation facilities and activities;
5) 'Harmonious Co-existence between Human and Nature' Scenario: the more preferred scenery and 20% improved biodiversity, with the recreation facilities and activities remain the status quo;
6) Ideal Scenario: the more preferred scenery and 20% increased recreation facilities and activities, with 20% improved biodiversity.

7.2.5 Pilot study

Prior to the formal survey and interview, eight pilot surveys were conducted in each WP. All participants in the pilot study who agreed to participate refused to sign the Consent Form for Anonymity, and thought the Information Sheet and Consent Form were too long and required too much time to read; consequently, the Information Sheet and Consent Form were shortened to include only essential information, and the signature was replaced with a checkbox: if the respondent agreed to participate, he or she only needs to check the box instead of signing. The radio recording was not employed in the formal interview since the majority of respondents in the pilot interviews rejected it. Notes served as the sole foundation for the recordings, which were quickly arranged following each interview. The questionnaire and interview questions were revised for improved clarity and comprehension following the pilot study.

7.2.6 Data collection procedure

This study surveyed TDWP first, and then HNWP with additional questions to acquire more comprehensive data (Table 7-5). Random sampling was used for on-site data collection. The author walked slowly in the WPs and talked with every visitor who was not busying with other activities such as had intense discussions with peers, eating, engrossed in exercising or taking pictures. The author showed the information sheet and introduce this project briefly to invite people to participate. More information about the project (i.e., an information sheet and consent form) was provided if the respondent exhibited interest in the survey. If the respondent agreed to participate, the consent form was signed, and the survey began. The information sheet, consent form and questionnaire sheet presented to participants and their translations is presented in Appendix – C Questionnaire and interview sheets.

pay, measures the perceived benefit consumers receive from a good or service.

[30] The park-like scenario referred to the process that wetland park being more like a normal urban park that kept for ornament and recreation.

WenJuanXing (Questionnaire Star), an online survey software, was applied for online questionnaire creation in this research. Compared to the Tencent questionnaire, another of China's most popular online questionnaire platforms, it is more image-friendly, allowing users to click and zoom on pictures. Online survey was disseminated through social media including Weibo[31] and XiaoHongShu[32], the two public platforms where people like to share their travels and daily life on. The author searched on both platforms with the keywords 'Haizhu Lake' or 'Haizhu Wetland Park' in Chinese to find contents that involve HNWP. Users who posted their travelogue after visiting HNWP during the survey period were contacted. Information Sheet and Consent Form was presented in the beginning of the online questionnaire.

For both on-site and online surveys, many individuals opted not to speak with the author for safety reasons, presumably owing to the present high number of frauds. Therefore, the response rate was low (around 5%). As a result, totally there were 120 responses from TDWP and 200 responses from HNWP.

Table 7-5 Data collection records

	TDWP	HNWP
Survey period	2020-12-26~2021-02-05 (winter) 2021-04-18~2021-08-22 (Summer) (Paused between 2021-05-22~2021-07-04 due to the COVID-19 outbreak	2022-01-16 ~2022-07-05 (Onsite: 2022-01-16~2022-03-09; online:2022-02-11~2022-03-31) (The onsite survey paused between 2022-01-30~2022-02-10 due to Chinese New Year holiday, and stop collecting from 2022-03-10 due to the COVID-19 outbreak; the onsite survey restart from 2022-05-25)
Survey time	9:30 to 12:00, 13.30 to 17:30. When it was not raining	
Sample size	120 (70 in winter, 50 in summer)	200 (104 on site, 96 online)
Survey subjects	Visitors to TDWP (general public)	Visitors to HNWP (general public)

[31] Weibo is a China social media like Twitter; more details about Weibo can be found in Chapter 5.

[32] XiaoHongShu also is called the Little Red Book. XiaoHongShu is a Chinese social media like Instagram. As of 2019, XiaoHongShu had over 300 million registered users and the number of monthly active users is over 100 million,70% of its users were born after 1990 (Xingyin Information Technology Co, Ltd, 2023).

7.3 Overview of respondents

7.3.1.1 Tianhe Daguan Wetland Park

A total of 123 surveys were completed across seasons in Tianhe Daguan Wetland Park (TDWP), with the exception of three children (high school students). As a consequence, 120 valid responses were available, including 70 in the winter and 50 in the summer (Figure 7-18). It took around two to three minutes to complete the questionnaire. The majority of interviews lasted between 15 and 40 minutes. A few interviews lasted 40-60 minutes.

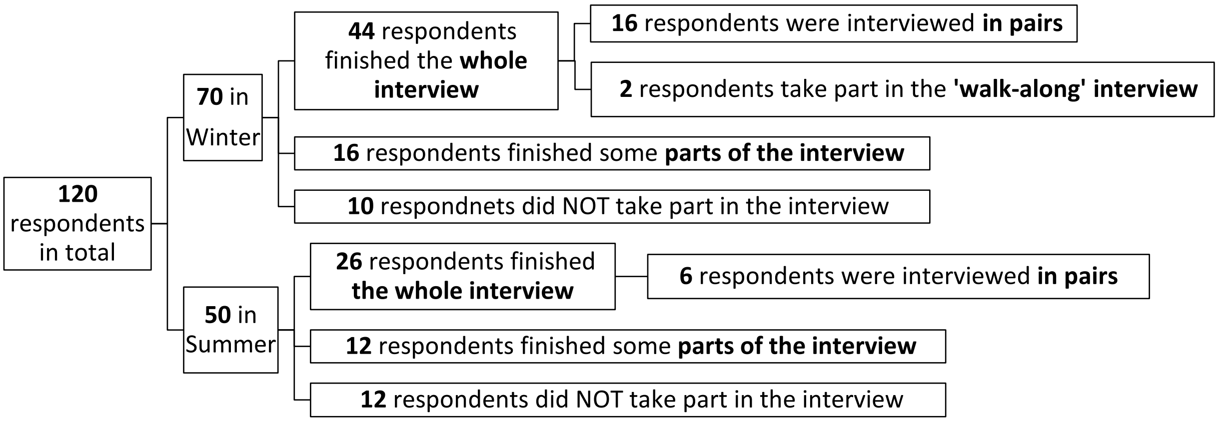


Figure 7-18 Responds in the Tianhe Daguan Wetland Park

Overall, male (n=61) and female (n=59) respondents were approximately evenly distributed. Younger respondents dominated older respondents, with around 45% of respondents being younger than 35 years old. The majority of respondents hold a high school diploma or higher; respondents' highest education level was mainly concentrated in high school to undergraduate. There was no respondent with a master's degree or higher in the winter survey. Monthly discretionary income levels of respondents were dispersed (except for 15 respondents who chose not to specify their income), with an average income slightly higher (6585.71 CNY, calculated using the median of each category) than the entire Guangzhou population (5761.5 CNY). 49.5% of participants had a monthly discretionary income below 6000 CNY, while 51.5% had a monthly discretionary income above 6000 CNY. There was no significant difference in gender, age, highest education level, monthly discretionary income, and time spent on site between seasons. However, a significant difference in visiting habits between seasons was found. A larger proportion of winter respondents paid 1-20 CNY for a visit, spent more than 30 minutes on the way to TDWP, and visit TDWP less frequently (especially for the first time). However, a larger proportion of summer respondents made no purchase for a visit, spent less than 30 minutes (especially less than 15 minutes) on the way, and visit more frequently (especially many times per week). (Appendix A - 5)

Overall, 98 respondents took part in the interview, including 70 respondents took part in the whole interview. At the later stage of the interview, when some interview questions had already been saturated, not all questions were asked: only unsaturated questions and questions regarding respondents' special answers in questionnaires were asked.

7.3.1.2 Haizhu National Wetland Park

A total of 200 valid questionnaires were completed in Haizhu National Wetland Park (HNWP), with 96 responses via online and 104 via on-site surveys (Figure 7-19). It took approximately five to ten minutes to complete the questionnaire. The majority of on-site interviews lasted between 20 and 40 minutes; a few lasted 1 hour.

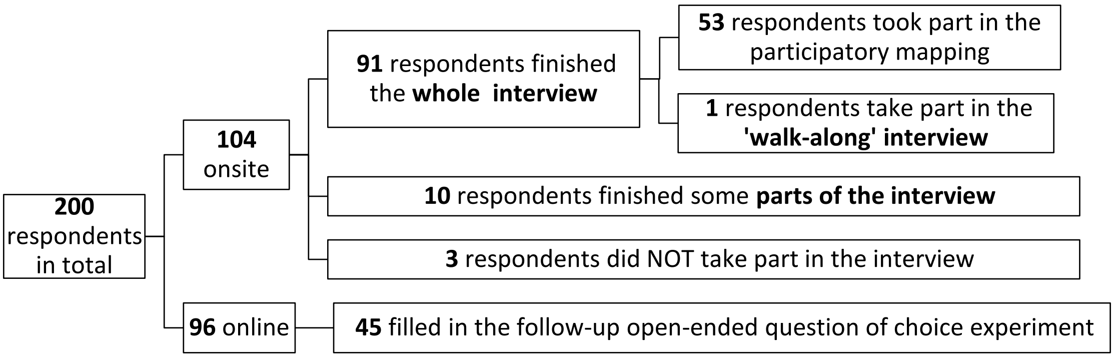


Figure 7-19 Responds in the Haizhu National Wetland Park

There were significantly more female respondents (n=117, 58.5%) than male respondents (n=83, 41.5%). 55.5% of respondents were under the age of 35, outnumbering the older respondents. 67.2% of respondents were well-educated with a college diploma, bachelor's degree, or higher education. With the exception of 36 respondents who chose not to disclose their income (14 from the onsite survey and 22 from the online survey), respondents' monthly discretionary income levels were dispersed, with a slightly higher average income (6878 CNY, calculated using the median of each group) than the entire Guangzhou population. 53.7% of respondents who disclosed their incomes reported a monthly discretionary income of less than 6000 CNY.

As a result of crosstabulation analysis with pairwise z-test, it demonstrates significant difference in gender, age, highest education level, cost for a visit, travel time and visiting frequency between online and on-site survey (Appendix A - 6). The online survey engaged a significantly greater proportion of female, younger and well-educated respondents. Besides, respondents from the online survey spent longer traffic time, spent more money for a visit, and visited less frequently. It also reveals that there is no statistically significant difference between the sources for monthly discretionary income, time spent on site, and regions visited.

Half of respondents had visited both regions, compared to 28.5% who had just visited Haizhu Lake and 21.5% who had only visited Wetlands Phase 1 and 2 (P1&2). No respondent had visited Wetlands Phase 3. As a result of crosstabulation analysis with pairwise z-test, it demonstrates significant difference in gender, age, highest education level and visiting frequency between regions a visitor had been (Appendix A - 7). A greater percentage of respondents who had only been to P1&2 were female, young-age people and well-educated people, and those who visited HNWP less frequently than once a month. A larger proportion of respondents who had only been to one part of HNWP were young people (18-34 years old), while a larger proportion of respondents who had been to both parts were seniors.

7.3.1.3 Comparison between two wetland parks

There was no significant difference in respondents' gender and income between the two WPs; however, there were disparities in the distribution of respondents' age, highest education level, cost, travel time, time spent in the WP, and visiting frequency (Appendix A - 8). It was found that the proportion of respondents aged 18-34 in TDWP was 69.3%, which is larger than that in HNWP. Spontaneously, HNWP has a greater proportion of respondents older than 45 years, at 21.5 percent. The proportion of respondents had college diploma in TDWP was found to be 29.2 percent, which is greater than in HNWP; while a greater percentage of respondents in HNWP had master and above degree (11.5%) than those in TDWP (2.5%). A greater percentage of TDWP respondents (72.4%) spent less than 20 CNY every visit compared with HNWP respondents (61.5%).

7.4 Overview of perceived ecosystem services and well-being

For Tianhe Daguan Wetland Park (TDWP), the set of perceived ecosystem services (PESs) and well-being items passed the reliability test (Cronbach's alpha = 0.858) and the validity test (KMO measure of sampling was adequate (= 0.825); and Bartlett's test of sphericity was significant ($P = 0.000$)). For Haizhu National Wetland Park (HNWP), the number of valid questionnaires for the reliability and validity test was 198 because two questionnaires left the question comparing the air quality in the WP and the nearby road with a blank because the respondent had not been to the road. The set of PESs questions passed both the reliability (Cronbach's alpha = 0.894) and validity tests (KMO sampling was satisfactory (= 0.906), and Bartlett's test of sphericity was significant ($P < 0.001$).

Overall, majority of respondents from both WPs agreed with the Likert scale questions (Table 7-6). However, the degree of agreement is not very high, mainly partial agreement or agreement. In both WPs, the perceived health benefits and perceived air quality received highest average rating scores, while perceived educational value received the lowest average rating scores. Average perceived habitat service was the second lowest in TDWP, while perceived recreation service was the second lowest in HNWP.

All tests of non-normality for Likert scale items were significant (Shapiro-Wilk, all $P<0.05$) in both WPs. With a large enough sample size (typically >30), the central limit theorem suggests that testing with parametric methods is still feasible, despite the violation of the normality assumption. However, given that the majority of WP users experienced some type of ES (as they would not visit WPs without perceiving any benefits), it is evident that the sample was not truly random. Choosing to ignore the data's distribution was risky. Hence, the safer non-parametric procedures (Mann-Whitney U and Kruskal-Wallis tests) were employed to analyse differences across independent variable groups.

7.4.1 Factors influencing the perception

In TDWP, respondents recruited in summer perceived more pleasantness (M-W U test, $P = 0.022$), more health benefits ($P = 0.002$), higher aesthetic value ($P = 0.001$), higher recreation service ($P=0.003$), and better air quality ($P = 0.005$).

In HNWP, the source (online or on-site) did not impact perceptions of the listed ESs (M-W U test, $P > 0.05$) except for the 5-point Likert scale question of air purification services (compared) ($P=0.003$). On-site respondents perceived much better air quality in the WP than on the nearby road. The parts of HNWP that respondents had visited did not have a significant effect on their PESs (M-W U test, $p > 0.05$).

Gender (M-W U test, $P>0.05$) had no effect on PESs in both WPs.

Age was found to be related to perceived pleasantness and perceived health benefits in TDWP, while related to perceived aesthetic value, wildlife habitat, and comparative air quality (the 5-point Likert scale question) in HNWP. A positive correlation between age and perceived **pleasantness** ($r = 0.207$, $P = 0.023$) and **health benefits** ($r = 0.286$, $P = 0.002$) was discovered in TDWP; specifically, older respondents (≥45 years old) feel more pleasant and perceived more health benefits than younger respondents (18-44 years old) (M-W U test, $P= 0.045$ for pleasantness and $P = 0.016$ for health benefits), and respondents aged between 45 and 54 years perceived more health benefit than respondents aged between 18 and 24 years ($P = 0.006$). Age was negatively correlated with the perceived **aesthetics service** ($r = -0.150$, $P = 0.034$) in HNWP; young respondents (18-24 years old) rated significantly higher in scenic beauty than respondents aged 45-54 years (K-W H test, $P =0.047$). And age was negatively correlated with the perceived **wildlife habitat service** ($r = -0.160$, $P = 0.024$) in HNWP; the junior respondents (18-44 years old) perceived a significantly higher wildlife habitat service than senior respondents (≥45 years old) (M-W U test, P = 0.025). Further, age was positively correlated with the perceived **comparative air quality** (r = 0.256, P <0.001) in HNWP; young respondents perceived a significantly lower margin of superior air quality compared to the neighbouring urban road than older respondents (18-24 years versus ≥65 years, P =0.017; 18-34 years versus ≥55 years, P =0.004; K-W H test,).

Highest education level was discovered to be negatively correlated with the perception of **pleasantness** (r = -0.253, P = 0.005), **health benefit** (r = -0.270, P = 0.003), **aesthetic value** (r = -0.267, P = 0.003), **recreation** (r = -0.298, P <0.001), **air purification** (r = -0.280, P =0.002), and **wildlife habitat** (r = -0.188, P =0.039) services in TDWP. Less educated respondents (those with a high school equivalent diploma or lower) reported greater health benefits (P = 0.030) and better air purification service (P = 0.019) (M-W U test). Specifically, those with a middle school or lower diploma reported more pleasant (P=0.010), greater health benefits (P = 0.014), aesthetic value (P = 0.004), and recreation service (P = 0.009), compared to those with a bachelor's degree (P = 0.006) (K-W H test). However, no such association was found in HNWP.

Monthly discretionary income was found to be related with perception of aesthetic value in both WPs, and negatively correlated with perception of **pleasantness** (r =-0.192, P = 0.049) and **recreation** (r = -0.219, P = 0.025) in TDWP. Besides, in TDWP, less wealthy respondents (with monthly discretionary income lower than 6000CNY) rated higher not only in perception of pleasantness (P = 0.050) and recreation (P = 0.018), but also in aesthetic value (P = 0.020) (M-W U test). In HNWP, respondents with income 6000-8999 CNY per month perceived better scenic beauty than respondents with income more than 15000 CNY per month (K-W H test, P =0.024).

The study found that **visiting habit factors** such as time spent on site, cost for a visit, and visiting frequency were related with certain PESs in TDWP. However, no significant difference was observed between these factors and PESs in HNWP (K-W test and/or M-W U test, P>0.05).

Time spent on site was related with the perceived pleasantness, health benefit, air purification services (general), and education services in TDWP. Respondents who spent more than 3 hours on site perceived higher pleasantness (P = 0.007), health benefit (P = 0.021), air purification service (general) (P = 0.033), and educational values (P = 0.002) than those spent less than one hour on site (K-W H test). Respondents who spent more than 3 hours on site also perceived higher pleasantness (P = 0.042) and environmental education (P = 0.014) than those spent one to three hours on site (K-W H test). In TDWP, time spent on site was positively correlated with perception of **pleasantness** (r = 0.270, P = 0.003) and **health benefit** (r =0.249, P = 0.006), **air purification** services (r =0.232, P =0.011), and **educational values** (r = 0.307, P<0.001).

Cost for a visit was associated with the perceived pleasantness, aesthetic value and wildlife habitat service in TDWP. Respondents who paid less than 20 CNY for a visit felt more pleasant (M-W U test, P= 0.040) and rated higher in wildlife habitat services (M-W U test, P=0.016) than those paid more than 20 CNY for a visit to TDWP. Besides, in TDWP, cost for a visit was negatively correlated with perceived **pleasantness** (r = -0.236, P = 0.011), **aesthetic value** (r = -0.224, P = 0.015). and wildlife habitat services (r = -0.209, P = 0.024).

Visiting frequency was found to be related with PESs except environmental education in TDWP. In TDWP, it shows significant difference in PESs except environmental education between less frequent users and more frequent users: respondents who visited TDWP more than once a month had higher ratings in ESs, excluding environmental education (Appendix A - 9). Moreover, it was found that in both WPs, visiting frequency is positively correlated with perceived **health benefit** (r = 0.258, P = 0.004, in TDWP; r =0.142, P = 0.045, in HNWP) and perceived **air purification service** (r = 0.338, P < 0.001, in TDWP; r = 0.208, P = 0.003, in HNWP). Besides, in TDWP, visiting frequency was positively correlated with the perception of **pleasantness** (r = 0.287, P = 0.002), **health benefits** (r = 0.258, P = 0.004), **aesthetics services** (r =0.332, P < 0.001), **recreation services** (r =0.305, P < 0.001), compared **air purification services** (r =0.338, P < 0.001), and **wildlife habitat services** (r=0.301, P < 0.001).

There was no difference found between groups of **travel time** (M-W U test and K-W H test, P >0.05) in PESs, except for the comparative air quality (the 5-point Likert scale question) in HNWP. Respondents in HNWP who travelled for less than 30 minutes perceived better comparative air quality than others (M-W U test, P = 0.060). In TDWP, travel time was negatively correlated with perceived **aesthetics services** (r = -0.200, P = 0.028).

Table 7-6 Likert Scale questions relating to perceived ES

Likert Scale questions	PES/well-being	TDWP Mean (±Std.Deviation)			HNWP Mean (±Std.Deviation)		
		Winter (N=70)	On-site (N=104)	Generally (N=120)	On-site (N=104)	Online (N=96)	Generally (N=200)
7-point Likert Scale questions: 1: strongly disagree; 2: disagree; 3: somewhat disagree; 4: neutral; 5: somewhat agree; 6: agree; 7: strongly agree							
I feel pleasant when I visit this WP.	well-being	5.50(±1.13)	5.96(±0.88)	5.69(±1.05)	5.90(±1.03)	6.02(±1.33)	5.96(±1.18)
Visiting this WP makes me healthier.		5.70(±0.98)	6.20(±0.83)	5.91(±0.95)	6.28(±0.73)	6.11(±1.26)	6.20(±1.02)
The scenery of this WP is beautiful.	aesthetics service	5.31(±1.21)	6.02(±0.82)	5.61(±1.12)	6.13(±0.76)	6.11(±1.26)	6.13(±1.03)
There are sufficient recreational space and facilities in this WP.	recreation service	4.91(±1.44)	5.68(±0.79)	5.23(±1.27)	5.53(±1.25)	5.55(±1.46)	5.54(±1.36)
The air is clean in this WP.	air purification service (general)	5.57(±1.25)	6.20(±0.78)	5.83(±1.12)	6.37(±0.67)	6.27(±1.19)	6.32(±0.96)
There are abundant and diverse animal and plants in this WP.	habitat service	4.96(±1.40)	5.52(±1.00)	5.19(±1.27)	5.85(±1.06)	5.90(±1.49)	5.87(±1.29)
I learn more about nature / environment when visiting this WP.	educational service	5.04(±1.22)	5.26(±1.18)	5.13(±1.20)	5.58(±1.17)	5.40(±1.55)	5.49(±1.37)
5-point Likert Scale questions: 1: much worse; 2: worse; 3: similar; 4: better; 5: much better							
Compared with North Daguan Road / Xinjiao Zhong Road, the air quality of where you currently stand/sit is	air purification service (compared)	4.04(±0.81)	4.22(±0.73)	4.12(±0.78)	4.54(±0.64) (N = 103)	4.24(±0.74) (N=95)	4.40(±0.70) (N = 198)
Light blue highlighted cells show the highest average score, followed by light green and light orange highlighted cells. Purple highlighted cells show the lowest average score.							

7.4.2 Motivations

As illustrated in Table 7-7, the motivations for visiting these two WPs were categorized in accordance with Maslow's Hierarchy of Needs (Maslow, 1954). This investigation did not uncover an expression of the need for self-actualization and the desires to know and the understand. Additionally, a small percentage of interviewees frequently use these two WPs for work-related reasons or no apparent motivation. It is worth noting that some respondents visited this WP for various motivations.

There were similarities and differences in the motivations for visiting these two WPs. Physiological needs, safety needs, love and belonging needs, and cognitive needs were essential motivations for visiting both WPs. However, belongingness and love need and aesthetic needs played a more significant role in TDWP, while physiological needs played a more prominent role in HNWP. The following paragraphs illustrates the motivations fitting in Maslow's Hierarchy of Needs and explore the relationship between the needs and the desired ESs for WP users.

(1) Physiological needs

The majority of respondents who visit these WPs for physiological purposes were either employees of neighbouring business buildings or nearby residents. For many respondents, the primary motivation is to take a walk, especially in HNWP.

(2) Safety needs

Getting relaxed was another essential motivation for users in both WPs. Particularly, a break in WPs was thought to help release stress from school and work. Lily, who was interviewed during the winter in TDWP, expressed her intention to relax and enjoy the sun following her university exams. Similarly, Rayan mentioned that he visited HNWP as a means to unwind from the stress of job hunting. Additionally, sunbathing, fresh air, and exercise are considered to be beneficial to one's physical health in both WPs. For example:

> *Since October, I've been coming every day. I had a bad illness last year, and the doctor advised me to walk more. I used to be a slacker who would rather drive than walk. After I became ill, I realized I couldn't be lazy any longer and needed to exercise, so I came here every day to walk. I was quite fatigued at first, but now I can walk two loops as far without tiring, and I feel healthier.*

(Brian, male, age of 55-64 years, high school equivalent degree, spent 1-3 hours on site, HNWP)

Table 7-7 Coding results about motivations

Primary nodes	Explanation (Maslow, 1954)	Secondary nodes	TDWP (N=67)		HNWP (N=93)	
			n	sum-up	n	sum-up
physiological needs	'Homeostasis and appetites'	take a walk	6	12 (17.9%)	23(24.7%)	29(31.2%)
		sunbathing	2		4	
		exercise	4		4	
		Fresh air	0		3	
safety needs	'Security; stability; dependency, protection; freedom from fear, from anxiety and chaos; need for structure, order, law, limits; strength in the protector.'	rest	10(14.9%)	15(22.4%)	10(10.8%)	16(17.2%)
		health	5		6	
Belongingness and love need	'Hunger for affectionate relations with people in general, namely, for a place in one's group or family.'	with families or friends	7	35(52.2%)	15(16.1%)	18(19.4%)
		Walk pets	5		0	
		Visit place that friends recommend	5		2	
		Video making for uploading	1		0	
		visit internet-famous place	17(25.4%)		1	
Esteem needs	'Desire for a stable, firmly based, usually high evaluation of themselves, for self-respect, or self-esteem, and for the esteem of others.'	Sing	2	2(1.7%)	0	0(0.0%)
The need for self-actualization	'The desire to become more and more what one idiosyncratically is, to become everything that one is capable of becoming.'		0	0	0	0
The desires to know and the understand	'To satisfy curiosity, to know, to explain, and to understand.'		0	0	0	0
Aesthetic needs	'Be satisfied by beauty.'	Aesthetics needs	23(34.3%)	23(34.3%)	14(15.1%)	14(15.1%)
work task	Work related reasons	-	2	2(1.7%)	1	1(1.1%)
no particular motivation		Pass by and then visit	3	7(10.4%)	0	27(29.0%)
		Easy access (near from accommodation)	3		16(17.1%)	
		Visit a new place or a different place just in time for its turn	0		12(12.9%)	
		unknown	1		0	

(3) Belongingness and love need

Most respondents' primary motivation is to meet their needs for love and belonging. Incentives for loving and belonging needs include spending time with family, friends, and pets. In TDWP, 22 respondents came to see the internet-famous *Taxodium distichum* location in TDWP. The majority of these respondents were making their first visit. They were drawn in by photographs or videos of autumn scenery they saw on social media or from friends or family. While in HNWP, the majority of respondents visit for belongingness and love needs came with families (especially kids) or friends; only a small percentage of respondents visit because of a suggestion from a friend or the internet.

(4) Esteem needs

A respondent, in instance, came with a peer to sing. Their visit is motivated by other visitors as the possible audience. Given that they sing not for money but for the audience's appreciation, this could be interpreted as esteem requirements.

> *I went to this WP for the first time a few weeks ago and discovered that there are a lot of people there and that the atmosphere is pleasant. We would not take into account the content mentioned in the questionnaire. Singers usually hope that their efforts will be appreciated by an audience! We came here to sing since there were so many people.*

(Reece, male, age of 18-24 years, high school equivalent degree, spent more than 3 hours on site, winter, TDWP)

(5) Aesthetic needs

Respondents who visited TDWP in winter to see the internet famous *Taxodium distichum* not only due to the love and belonging needs, but also aesthetics needs. Although most respondents take photos in TDWP in summer, photograph was not the primary motivation, except one respondent who visited this WP only to take photos for aesthetics needs:

> *I've been going here frequently since I moved in last year, photographing everything I see. Sometimes I bring a telephoto lens to photograph portraits and birds, while other times I bring a macro lens to photograph flora. It's not so much that the park is gorgeous as it is that you have an eye for beauty. Every time I visit, I discover something new, such as dew on the fir leaves in the morning or spiders in the grass. Even if you don't take any pictures, just going around can make you feel wonderful.*

(Elliot, male, age of 55-64, high school equivalent degree, spent 1-3 hours on site, interviews in the summer, TDWP)

Many respondents had travelled to HNWP specifically to appreciate the blooms. And one respondent was visiting to shot the *Taxodium distichum* in the mist in early morning.

> *Today I came to photograph the red-leaved cypress the fog, which adds an incredible refinement. Now that the fog is clearing, it's not so beautiful, but it's especially lovely in*

> *the morning. When there are flowers and red-leaved trees, I typically come to photograph them, but I would not visit this WP when there is no scenery.*

(Aya, female, age of 55-64 years, college degree, spent 1-3 hours on site, HNWP)

(6) Work task

A few respondents visited the two WPs for work-related purposes. A respondent in TDWP was a member of a photography team for a local singer who came to the WP to shoot a music video. Besides, since TDWP is nearby a geo-information company called South Survey, whose services covered the survey equipment, satellite navigation and so on, staffs from this company can be seen almost every work day in this WP testing equipment including drones and tacheometry. One respondent was one of these staffs, stated that

> *We typically fly drones over the basketball court because it is safer without people. We also have other fields for testing, but this WP is closer, therefore we are usually here. We sometimes test camera lenses here, because the trees and colours in this WP are ideal.*

(Bill, male, college degree, spent more less than hours on site, summer, TDWP)

One respondent visited HNWP to a distribute questionnaires on cultural ESs as an assistant of a PhD student from a local university.

(7) No particular motivation

Three interviewees who visited TDWP for the first time came for no particular reason; two of them walked in after passing TDWP while doing business nearby. For example:

> *I came to the official building nearby for business. It is lunch time, so I take a walk here and waiting for the working hours.*

(Lauren, female, age of 18-24 years, bachelor's degree, spent less than 1 hour on site, interviewed in the winter)

Surprisingly, many people used HNWP for no apparent reason or purpose. 16 respondents indicated that they frequently visit this WP only because it is close to their home or that public transportation is convenient to this WP. 10 respondents stated that they either wanted to visit a new location or preferred to take turns visiting various public spaces in Guangzhou.

7.4.3 Comparison with the settings before the creation of the WPs

Before the formation of TDWP, only two respondents had visited the location. They concurred that it was an overgrown wasteland, and the WP makes the area more conducive to leisure. One respondent also stated that the construction of the WP has reduced mosquito populations.

> *I initially visited here about a year before the wetland park was established (2015). It was a wasteland at the time. I passed by this WP on occasion because my company was nearby. There were a lot of mosquitoes flying about in the sky. And there was only the reservoir to wander around at that moment. I've been watching this WP's*

> *development since then. It has maintained its quality over time, and even gotten better as the trees have grown taller. I understand that some people may believe it's not as beautiful as it was when it first opened in 2016, perhaps because the plants were just placed in and look neat, but it's only natural for a wetland park to have dead branches and leaves, so I actually think it's rather good now.*

(Jesse, male, age of 35-44 years, bachelor's degree, spent 1-3 hours on site, interviewed in TDWP)

Prior to the founding of HNWP, nine HNWP respondents had visited the place. According to them, Prior to the establishment of HNWP, the area was predominantly used for agricultural purposes, including cultivation of crops and orchards. Before the 1980s, rivers were clean. However, due to industrialization in the Haizhu District, rivers have become polluted and stinky black bodies of water. Since the establishment of the WP, the water quality has improved, and inhabitants have a place for recreation, albeit at the expense of crops and orchards. For example:

> *I've been around since I was a kid. I used to swim and paddle in the neighbouring rivers as a kid. We lacked food in my childhood, so I would swim and paddle over to the orchard to pick up lychees that had fallen to the ground and eat them, and I also fished for fish and shrimp in the river. Many outsiders moved in after the Reform and Opening Up, and the water quality deteriorated; the river was black and foul. Thanks to the water quality improvement projects of the rivers in Haizhu District and the creation of the wetland park since a decade ago, the water quality improved. I did not notice any flood prevention. There has never been any flooding in the past, and flood gates were already installed in these rivers when I was young, so I only noticed that the river used to flow faster and now flow very slowly. Overall, here becomes much more beautiful.*

(Melinda, female, age of 55-64 years, college degree, spent 1-3 hours on site, interviewed in HNWP)

> *I lived in the Longtan Village[33]. It used to be longan and lychee orchards; currently, some of the older trees have been preserved, and many other plants have been added, making it a more beautiful place with a better environment. Although our land has been turned into a park and the compensation is not much, it is still a good thing that more people can enjoy this environment. It would be nicer if there were no entrance fee (although I don't have to pay it), so a lot more people would be able to enjoy this wonderful place.*

(Hugh, male, age of 35-44 years, college degree, spent 1-3 hours on site, HNWP)

> *This area used to be orchards, with lychees, longans and carambola (star fruit). There was no road to get in and no good view. It is much better to have this WP, as you can see the city landmarks such as the Canton Tower, and the view is open, which makes me delighted.*

(Francis, male, elder than 65 years old, master's degree and above, spent 1-3 hours on site, HNWP)

[33] Longtan Village was in the area before the construction of the wetland park

7.4.4 Differentiation value

In the interview, some respondents mentioned other parks or WPs in Guangzhou or adjacent cities as a comparison. Some were spontaneously referred to other parks or WPs for comparison; others were asked and then compared. Several respondents compared the two case study sites. Competitors including Nansha Wetland Park, Lu Lake Park, Liwan Lake Park, Liuhua Lake Park, Dongshan Lake Park, Baiyun Mountain, Tianhe Park, Yuexiu Park, Shumu (Tree) Park, Ertong (Children's) Park, South China Botanical Garden, and Yuntai Garden in Guangzhou, and Qiandeng Lake Wetland Park in Foshan were mentioned. HNWP was typically preferred than TDWP and other parks mentioned, while TDWP was occasionally less preferred.

Comparing the two WPs examined in this study by respondents who visited both, it was discovered that HNWP performed better than TDWP in delivering various ESs. For example:

> *I think the ecology of the Haizhu National Wetland Park is better. Generally speaking, it may be better than here. This WP is too long and narrow, too close to the road, with exhaust and noise. But the advantage is that it feels unmanaged here, and children can go fishing here and release their nature. Although I didn't bring my children to fish today, but I saw many children are fishing. I might get him to play again in the future. Besides, it feels more like the countryside here. The Haizhu National Wetland Park is too delicate and is not so comfortable. It's nice to have such a natural place in the city; you know, many people drive long distances to Zengcheng District to get close to nature. Moreover, the water quality here is cleaner than that of the ponds in the countryside……Although I think Haizhu National Wetland Park is not bad, I still change places to play instead of going all the time. I haven't visited there this year.*

(Kyle, male, age of 35-44 years, bachelor's degree, spent 1-3 hours on site, interviewed in TDWP)

TDWP had a disadvantage in comparison to Nansha Wetland Park and Qiandeng Lake Wetland Park (in Foshan[34]) due to the absence of Yijing[35]:

> *Have you been to Nansha Wetland Park? I highly recommend it. The sky, lakes, migratory birds there makes me feel a sense of returning to my innocence. In Nansha Wetland Park, there is no cars or human sounds, but the sound of boat sirens can be heard, which is in harmony with its coastal environment. The experience is very good…… Haizhu National Wetland Park and Qiandeng Lake Wetland Park are also better than this WP. Qiandeng Lake Wetland Park gives me a feeling of when a wanderer is returning to their hometown. While this WP is 'a fulcrum for a long journey, instead of a point of leverage'. Moreover, the cultural heritage contained in Cantonese*

[34] Foshan is the neighbouring metropolis to Guangzhou. The distance between the two megacities is only 20 kilometres.

[35] Yijing （意境）is closely related to empathy (移情作用), the phenomenon of emotional projection with presupposes personal experience and is the interflowing of human beings and the object. More details are presented in Section 7.6.2.

opera and ancient buildings also helps to express the mood. The Haizhu National Wetland Park have more cultural deposits than this WP, like the traditional Lingnan architecture and orchard.

(Harry, male, age of 35-44 years, high school equivalent degree, spent 1-3 hours on site, interviewed in TDWP)

Some fewer respondents think TDWP has an advantage over similar places. These advantages involved the scenery, the cost, and the activities. For example:

I feel pretty good. There have some elements that other parks don't have, such as these creeks. Also, it doesn't charge tickets.

(Mia, female, age of 25-34 years, college degree, spent 1-3 hours on site, TDWP)

I saw someone on the Internet saying that dog walking is allowed here, so I brought my dog here. Tianhe Park, which is near my home, prohibits dog walking, so I haven't taken him out for a long time. Thus, after getting the information, I drove here with my dog to have a walk……I guess my dog is pleasant with this visit!

(Bethany, female, age of 25-34 years, bachelor's degree, spent less than 1 hours on site, TDWP)

Some respondents believed that various parks have their own advantages.

I usually go to Haizhu National Wetland Park and Dafu Mountain. All the three places are very comfortable. I won't deliberately compare these parks.

(Ella, female, age of 18-24 years, college degree, spent 1-3 hours on site, interviewed in TDWP)

7.5 Wildlife habitat service in wetland parks

Providing habitat to wildlife is one of the motivations for creating wetland parks (WPs), and this service had been perceived to be vital by WP visitors. Species abundance and richness have been shown to benefit various ecosystem services (ESs), such as pest regulation, pollination, timber production, freshwater fishing, and recreation (Harrison *et al.*, 2014). Hence, the necessity of conducting research on habitat services is evident. Various expressions have been used to describe the service relevant to wildlife habitat, for example refugia, biodiversity, lifecycle maintenance, and so on. Wildlife habitat service is defined as 'refugia that provide habitat for resident and transient populations, for example nurseries, habitat for migratory species, regional habitats for locally harvested species, or over wintering grounds' (Costanza *et al.*, 1997). TEEB (2010) defined it as 'habitats provide everything that an individual plant or animal needs to survive; migratory species need habitats along their migrating routes', and emphasise the significance of ecosystems in providing habitat for migratory species, relating it to the maintenance of genetic diversity. A comparable description of wildlife habitat service by CICES 5.1 (Haines-Young and Potschin, 2018) is 'lifecycle maintenance, habitat and gene pool conservation', although which is categorised as a regulatory and maintenance service. In this thesis, wildlife habitat service refers to the provision of habitat for wildlife resident and transient populations. And this thesis adopted the definition of 'habitat' as an area with a combination of resources (such as food, cover, and water) and environmental conditions (such as temperature, precipitation, and the presence or absence of predators and competitors) that encourages individuals of a given species (or population) to occupy it and allows them to survive and reproduce (Morrison, Marcot and Mannan, 2006, p. 10).

High-quality habitats could provide the conditions required for relatively successful survival and reproduction over relatively long periods of time when compared to other environments, therefore support biodiversity, species richness and healthy community structure (Morrison, Marcot and Mannan, 2006, p. 10). People get benefits from wildlife habitat as well. Biodiversity benefits human health by reducing harm (e.g., providing medicines, reducing exposure to air and noise pollution), and restoring and building capacities (e.g., restoring attention, relieving stress, encouraging physical activity) (Marselle *et al.*, 2021). Both plant and bird richness are positively related to human psychological well-being: plant richness promotes reflection and distinct identity, whereas bird richness enhances continuity with the past and attachment (Fuller *et al.*, 2007). Sites were judged to be more restorative if they were perceived to be rich in species, have natural sounds like birdsong, be natural rather than manufactured, and safe (X. Zhu *et al.*, 2020; Fisher *et al.*, 2021). It was also found that biodiversity improves the attractiveness of landscape. For example, Finnish national parks with high biodiversity values are more appealing to tourists than those with lower biodiversity values (Siikamäki *et al.*, 2015). Settings with several bird species singing were more highly appreciated than settings alone (Hedblom *et al.*, 2014). In addition, a choice experiment revealed that as the number of bird species increased, so did the inclination of tourists to visit a protected region (Naidoo and Adamowicz, 2005), and a wetland nature reserve as well.(L. Xu *et al.*, 2020).

7.5.1 Wildlife habitat service in the ecosystem service cascade

As an ES, wildlife habitat service (WHS) is not exempt from the discrepancy between the capacity of ecosystems to provide an ES and the benefits that individuals receive, namely an ES cascade or ES flow. Some studies have shown the consistency between actual and perception of plant richness in greenspaces or forests. For example, depending on the taxonomic category in question, greenspace users can perceive species richness with varying degrees of accuracy (Fuller *et al.*, 2007). Besides, in a study of greenspaces in Sheffield, UK, a correlation between perceived and sampled plant richness was discovered (Fuller *et al.*, 2007). Moreover, it was found that actual and perception of biodiversity of biotopes (high diversity, intermediate diversity, and low diversity) of deciduous broad-leaf forest is correlated; and the biotope with intermediate biodiversity produced the greatest favourable emotional response and was rated highest in terms of preference and conservation importance (Johansson *et al.*, 2014). However, spatially, it was found that the intensity of participatory-mapped locations of perceived biodiversity decreases as species richness (including six taxonomic groups) and terrestrial vegetation cover increase (van Riper *et al.*, 2017). And it is interesting that it is perceived species richness rather than actual species richness (including birds, butterflies and plants) associated with psychological well-being of urban greenspace visitors as a result of a study of urban riparian areas (Dallimer *et al.*, 2012, p. 47). **More evidence is needed for understanding the relationship between the actual and perception of species richness, as well as the relationship between wildlife habitat, the perception, and human well-being.**

7.5.2 To technically understand wildlife habitat service

It is widely acknowledge that habitat quality can be evaluated in two ways: by directly measuring attributes of a habitat for a single species (e.g., critical resources, ecological constraints that limit the use of those resources), or by indirectly measuring variables for individual wildlife and populations in different habitats (Morrison, Marcot and Mannan, 2006). When measuring indirectly, most studies measure indicator species to reveal habitat quality; that includes demographic measures (e.g., density or abundance, reproduction, and survival of birds), distribution measures (e.g., habitat selection, occupancy), and individual condition measures (e.g., morphological variables, physiological variables) (Johnson, 2007). This research evaluates the wildlife habitat service in WPs using indirect methods, as the majority of WPs do not prioritise the conservation of a specific species, but rather protect as many as feasible.

7.5.2.1 Using vascular plants and birds as indicators

Historic definitions of ‘wildlife habitat’ centred on three factors including cover, food, and water; it was widely acknowledged that animals depend on vegetation cover for survival, and that alterations to this cover might have a significant impact on wildlife populations (Morrison, Marcot and Mannan, 2006, p. 46). For example, the diversity of birds increases as the vertical complexity of vegetation increases (MacArthur and MacArthur, 1961). And it was discovered that vegetation structure and habitat configuration (e.g., size, shape, and distribution of vegetation in an area) as well as plant species taxonomy are closely associated with the distribution and abundance of bird species (Rotenberry, 1985). For example. it is known that as a result of its diversity and richness in flora (i.e. trees, shrubs, weeds, and grass), riverine forest has provided a desirable and productive home for avian species, which are consistently scattered throughout the forest (Rajpar, Rajpar and Zakaria, 2021). Therefore, vascular plants were used as the indicator of wildlife habitat service in this thesis.

Scientifically and practically, birds are frequently recognised as excellent indicators of wildlife. Compared to insects, amphibians, and mammals, they are easy to detect, identify, and count. The habitat range of birds is extensive, their abundance, body size, and life spans are moderate; hence, their responses to environmental change occur at moderate spatial and temporal scales. Due to their position at or near the top of the food chain, birds are sensitive to signals that accumulate through the food chain (Gregory *et al.*, 2005). Specifically, birds play crucial roles in forest ecosystems, partially via top-down processes, such as insect herbivore predation, and also via the widespread plant–animal mutualisms that sustain pollination and seed dispersal (Bregman, Sekercioglu and Tobias, 2014). For these reasons, many studies have used birds as an indicator of assessing biodiversity and habitat quality (e.g., (Vandewalle *et al.*, 2010; Reis, López-Iborra and Pinheiro, 2012). Further, other wetland-dwelling wildlife, such as amphibians, reptiles, fish, and insects, are more difficult to count and monitor, necessitating additional equipment, personnel, and time. Hence, birds were utilised as the additional indicator of wildlife habitat service in this thesis.

This thesis employs plants as indicators in Tianhe Daguan Wetland Park (TDWP) and birds as indicators in Haizhu National Wetland Park (HNWP). The plant survey was not conducted in HNWP because it would have required more than 500, 10×10 quadrats to cover 1.5% of HNWP's total area, and the author was unable to access many areas due to the water barrier. Instead, surveys of birds, which is more practicable on large sites, was conducted.

7.5.2.2 Vegetation baseline survey methods in the Tianhe Daguan Wetland Park

10×10 metres quadrats were used for survey of shrub and trees in TDWP. Location of quadrats were determined using ArcGIS Pro. 10×10 metres fishnet was created, and quadrates were selected randomly and evenly (see Figure 7-26). Using two-stage sampling (Sutherland, 2006, p. 40), four small quadrats were selected randomly within each 10×10 metres quadrats; 0.5×0.5 metres quadrats for herbaceous and 1×1 metre quadrats for aquatic plants (Figure 7-20). Since species richness and diversity usually increase with area, the number of samples taken was proportional to the total area of the WPs (Hermy and Cornelis, 2000).

The total area of 58 quadrats (10×10 metres) consist 1.5% of the WP's area. Name of species, numbers of shrubs and trees or cover of herbaceous and aquatic plants were recorded. The field survey was undertaken between 2020-09-28 and 2020-10-23, during the growing season when the majority of plant species were likely to be present and when precipitation was lower, making the study safer and quicker to conduct. The species, families, genera, and numbers of shrubs and trees or coverage of herbaceous and aquatic plants were recorded.

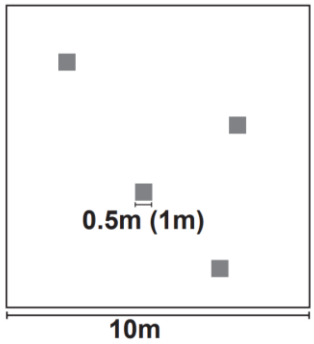


Figure 7-20 Two-stage sampling

7.5.2.3 Bird baseline survey methods in the Haizhu National Wetland Park

It has been reported that there are 187 species of birds inhabit in Haizhu National Wetland Park (HNWP) (Haizhu Wetlands, 2022). However, the number is a composite of data for ten years and the involved geographical area is uncertain. The list may include species that have only been observed once in the past decade, for example stragglers. Although it would be unscientific to say that a species no longer inhabits the WP simply because it has not been seen for years, it is still doubted that a mere tally of numbers over a number of years provides an adequate representation of the bird diversity of the WP. Therefore, this thesis intends to assess the recent bird habitat service of HNWP. Citizen science (CS) and field surveys were utilised to complement one another. CS requires less time and less human resources to collect a huge volume of data, but the data may be biased because the context behind each record is unknown. It is possible to effectively control the bias of field surveys (i.e., counts), but field surveys are typically time-consuming. Consequently, this thesis uses field survey data to evaluate citizen science data over a longer period of time, and by combining data from the two sources, a more complete picture of the bird habitat service provided by HNWP was generated.

7.5.2.4 Citizen science approach

Data collected through CS is becoming increasingly important to applied ecological research and conservation planning. Traditional citizen research or volunteer efforts have generated long ecological temporal records, particularly in ornithology. In 1749, amateurs in Finland began collecting data on the first arrival dates of spring migrant, marking the beginning of the first large-scale collaborative ornithological study in Europe (Greenwood, 2007, p. 79). Initiated in 1900 by the Audubon Society (in the United States and Canada), the Christmas Bird Count provides long-term data trends for several species; and the British Trust for Ornithology, founded in 1932, makes extensive contributions to the National Biodiversity Network using data gathered by amateur birdwatchers. Data from these projects have assisted environmental groups in targeting their conservation efforts to specific regions (Catlin-Groves, 2012, p. 2). This widespread participation of volunteers in scientific endeavours during the past two decades has come to be known as 'citizen science.' Data can be gathered and transmitted instantly thanks to mobile phone technology and the proliferation of high-speed Web-capable smart phones equipped with GPS and data uploading capabilities (Catlin-Groves, 2012).

CS approach allows professionals access to large volume of species record data from large spatial extent, while some bias need to be taken into account when using the data. It has been shown that contributors from the United States and Canada on eBird tended to be more specialised in groups with a higher rate of participation, but not all bird experts actively contributed; achievement (e.g., keeping a life list) is the primary motivation for active participants (Rosenblatt *et al.*, 2022). Therefore, although most contributors are specialized, the absence of minimum effort requirements in certain programmes can result in biased samples. This bias can manifest as an over-reporting of uncommon species, an under-reporting of common species, and a failure to report repeated sightings that are deemed uninteresting by the observer. In addition, if no organisms of interest are seen, individuals may simply cease sampling. This can typically result in studies and findings that reflect variation in effort rather than actual biological patterns and processes (Dickinson, Zuckerberg and Bonter, 2010, p. 163). Over time, analysts establish methods for filtering large data sets based on principles for reducing mistake and bias, such as excluding data from (a) first-year participants, (b) those who submit inconsistently, and (c) participants who have submitted incorrect reports (Dickinson, Zuckerberg and Bonter, 2010, p. 165).

This research uses the CS data from the BirdReport (中国观鸟记录中心 [China Bird Watching Record Centre], http://www.birdreport.cn/), the Chinese version of eBird. In 2021, there were 21796 active users using the BirdReport (increased by 50% compared to 2020); these citizen scientists (CSs) recorded 1353 species inhabit in China and location of their record overlap 85.62% of county administrative units (Kunming Vermilion Bird Research Institute, 2022). Data of HNWP from 2019-10-01 to 2022-09-31 were downloaded. Total number of bird species that have been observed by each observer (namely the uploader), number of bird species and quantity of each species recorded in each report, and the date of observation, were organized into an Excel table manually. To reduce the potential for bias caused by a lack of observational expertise, this research did not include reports uploaded by observers who had observed less than 60 species and reports include less than five species.

7.5.2.5 Field surveys of birds

In addition to the CS method, bird surveys were carried out in October and December 2022 in HNWP, to validate the CS data, and use bird data as indicator for biodiversity hotspots. Although count of birds will always be less than the actual number of birds present, the result may still be proportional to the actual number (Bibby, Burgess and Hill, 1992, p. 27). In order to maximise precision, the counts were repeated eight to ten times per month, so that the fluctuation of the results was closely clustered around the true value.

The surveys were conducted eleven times at the Haizhu Lake (HL) and eight times at the Wetlands Phase 1 and 2 (P1&2) in October 2022, and nine times at the Lake and eight times at the P1&2 in January 2023 (Appendix A - 12). The author walked slowly (1.5-2 km/h) through a route (Figure 7-21) that traversed all key locations of the site, including those that most respondents highlighted by HL, thus making this survey more typical of the whole HNWP. This method is similar to the line transects sampling technique, which is widely used collect data on birds in open environments and is particularly beneficial when bird populations occur at low density (Sutherland, 2006) and when the transects are limited by the availability of trails and roads (He *et al*., 2019). To eliminate bias due to time of day and weather, all surveys were completed within four hours after sunrise or before sunset, when birds are most active. And surveys were suspended when there was strong rain or wind. Because the P1&2 open after 9 am, survey in that part of HNWP was only carried out in the afternoon. Birds observed or heard within the park were recorded, with attention paid to avoid double counting the same individual. The initial location of birds observed was recorded, regardless of where they flush to. BoGuan binoculars (8 ×42) were used for observation, and a SONY RX10M4 camera equipped with a 24-600mm ultra-zoom lens was used to take photographs for later identification. The *Checklist on the Classification and Distribution of the Birds of China* (Zheng, 2011) was used to determine the taxonomic system, residence type, and zonation of birds, and the *Field Handbook of the Birds in South China (including Hong Kong)* (Yin, Fei and Lin, 2017) was used for field identification. Notes were taken using the BirdReport App[36]; name, quantity, and behaviour of birds, their location and time of occurrence were recorded. DongNiao (懂鸟, KnowBird) App[37] which provides Artificial Intelligent detection of bird pictures and sounds, was utilized to help with identification.

[36] Function of the BirdReport app is similar to the well-known E-bird app. It is more user-friendly with Chinese and have a more comprehensive local database.

[37] Function of the Dongniao app is similar to the Merlin Bird ID app which is created by the Cornell Lab of Ornithology. It has a more comprehensive local database.

7.5.2.6 Data analysis of baseline surveys

Since a comprehensive list of plant and bird inhabitants in WPs are not relevant to this article's focus, surveys and statistics were limited to determining the observable wildlife habitat service supply of the two WPs.

(1) Describe species indices

To test the consistency in the observation and visitors' perception, potential indices including species richness, relative abundance, density (temporal and spatial frequency of occurrence of each species), number of individuals, and visibility[38] of individuals, which were assumed to influence the perception of birds' diversity, were analysed to test the impact factors of the perception.

(a) Richness

The aspect of biodiversity most often discussed is species richness. Number of species that encountered showed the observed value of species richness. For the plant survey in TDWP, species richness was computed as the total number of species documented during the survey. For the bird survey in HNWP, as shown below, four indices (S_d, S_z, S_t, and Margalef's richness index) were used to measure the species richness in various temporal and spatial section.

S_d – average number of species encountered each visit;

S_z – average number of species encountered in each plot;

S_t – total number of species encountered during the surveys.

Margalef's richness index formula was used to assess the bird species richness, as shown below:

$$D_{mg} = \frac{S - 1}{\ln N}$$

Where, D_{mg} designates Margalef's index, S indicates the number of species, N is the total number of individuals in the samples, and ln is the natural logarithm.

(b) Relative abundance

A species relative abundance is defined as number of individuals per species that observed (following (McGill *et al.*, 2007)). This thesis did not calculate relative abundance of plants. For birds, the average

[38] "Visibility" represents the easiness of seeing or hearing a bird.

number and range of bird species encountered per visit (a), as well as the total number of individuals per species (A), were calculated.

(c) Relative density

The density of vegetation in TDWP was not calculated. To help determine the density of birds in HNWP, the surveyed regions were divided into 45 plots; each plot was the land/waterbody around a 250 meter-length segment of the survey route (Plots A, Figure 7-21). The number of birds per 250 meter-length segment shows relative density of birds throughout the route.

Figure 7-21 Plots A and survey route

(d) Shannon-Wiener diversity index

Shannon-Wiener diversity index is one of the most popular metrics used in ecology. It is an indicator that takes into account both the variety of species (i.e., richness) and their relative abundance (i.e., evenness). Shannon's diversity index formula was used to calculate the plant species diversity of TDWP and the bird species diversity of HNWP, as shown below:

$$H = -\sum_{i=1}^{S}\left(P_i(\ln P_i)\right) = -\sum_{i=1}^{S}\left(\frac{n_i}{N}\left(\ln\frac{n_i}{N}\right)\right)$$

Where, H designates diversity (the greater the value of H, the greater the species diversity), S indicates the number of species, P_i is the proportion of the i^{th} species, n_i is the number of the i^{th} species, N is the total number of individuals in the sample, and ln is the natural logarithm.

(e) Frequency

The frequency of a plant species was determined by the percentage of quadrats that included it (Sutherland, 2006). For birds, temporal and spatial frequency were calculated. The temporal frequency of occurrence of each bird species (FT) (Zhao, 2001) and spatial frequency of occurrence of each species (FS) (Linsdale, 1928) was calculated following formulas shown below:

$$FT = \frac{d}{D} \times 100\%$$

Where, FT is the frequency of encountering a particular bird species during the survey, d represents the number of days that encounter this bird species, and D is the total days of surveys.

$$FS = \frac{m}{M} \times 100\%$$

Where, FS is the frequency of encountering a particular bird species among the plots, m is the number of plots on which the species occurs, and M is the total number of plots sampled.

To explore the connection between the observed and perceived bird habitat service, the Lake area of HNWP was divided into 11 zones according to landscape features (Plots B, Figure 7-22); eight zones were established based on the significance of areas to wildlife habitat as identified by respondents (Plots C, Figure 7-23). The spatial frequency of species presence among these plots was then statistically determined.

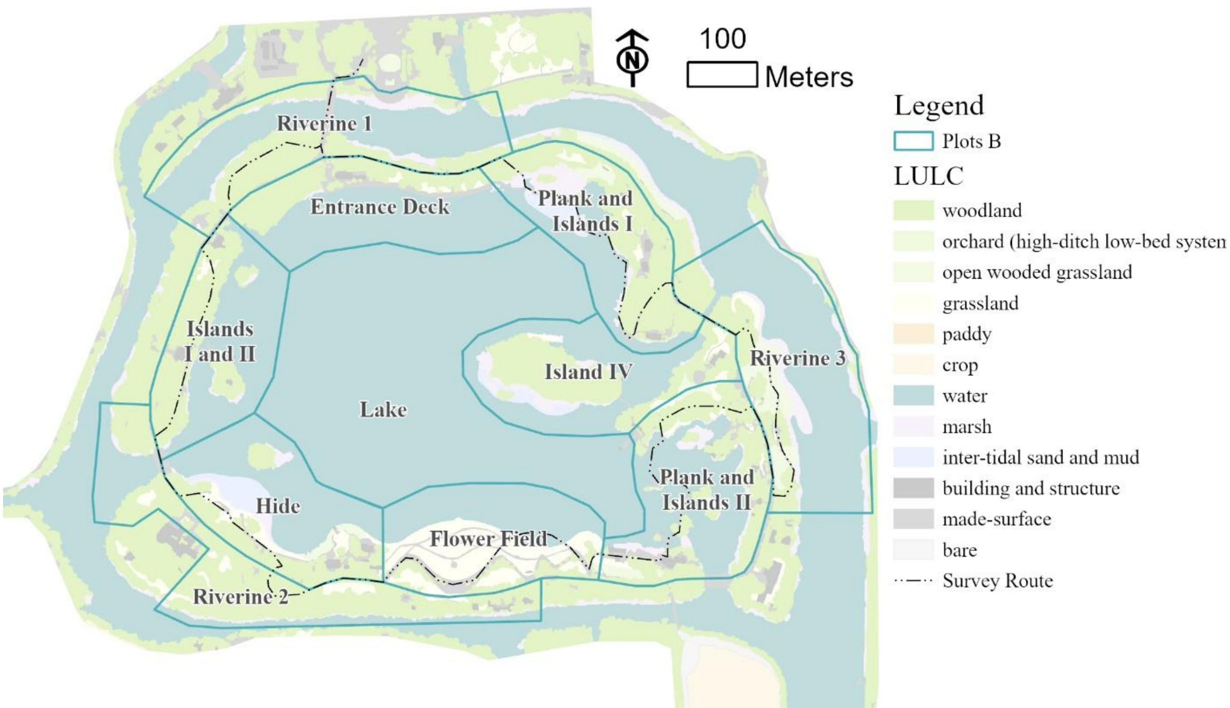


Figure 7-22 Plots B

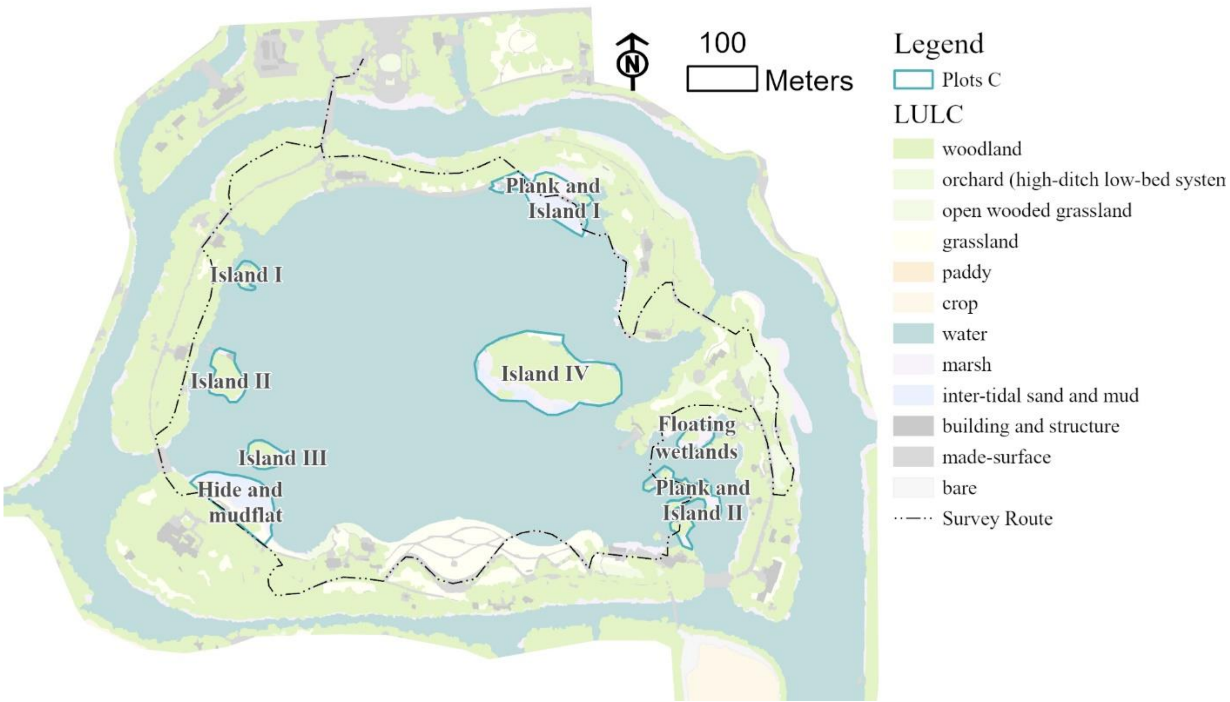


Figure 7-23 Plots C

(f) Visibility

Based on the size, colour, and flowers of plants, the species were divided into five categories according to their visibility (Table 7-8). Plants such as trees and bushes are the easiest to observe, whilst tiny herbaceous plants are the most difficult.

Table 7-8 Classification criteria for plants based on visibility

Classification	Description
very easy	Plants that can be seen and identified without effort
easy	Plants that can be seen and identified with little effort
more challenging	Plants that can be seen and identified with effort
difficult	Plants require much effort to be seen and identified, often necessitating close proximity to the plants for observation.
very difficult	Plants require significant effort to be seen and identified, often necessitating extremely close proximity for observation or the use of a magnifying glass.

Table 7-9 Classification criteria for birds based on visibility

Classification	Description
very easy	Birds that can be seen and identified with the naked eyes without effort
easy	Birds that can be seen and identified with the naked eyes with little effort
more challenging	birds that can be seen and identified with the naked eyes with effort
difficult	birds that can be seen and identified with the naked eyes with much effort, or when they get close to human
very difficult	shy birds that can be seen and identified with the naked eyes with much effort, or birds that can be seen and identified with binoculars.

Similarly, according to the size, colour, and behaviours, bird species were classified into five categories according to the ease of being seen. Large white birds were the easiest to identify, whereas little brown birds were the most difficult. Moreover, noisy and active birds are easier to find than those that are quiet or skulking (Bibby, Burgess and Hill, 1992, p. 29). Therefore, classification was according to the difficulty of being seen in actual observations (Table 7-9). Some birds that are large but shy and skulking were classified into the [difficult] category.

(2) Identify essential species

The IUCN Red List, List of Wild Animals/Plants under National Key Protection (National Forestry and Grassland Administrition, 2021; National Forestry and Grassland Administrition and Ministry of Agriculture and Rural Affairs of the People’s Republic of China, 2021), and under Guangdong Province Protection (Guangdong Provincial Forestry Bureau, 2021), were used to determine the conservation status of detected vegetation and bird species.

(3) Identify most/least ideal place for plants

The Shannon-Wiener diversity index, plant cover, and proportion of invasive and native plants were used to determine the most or least ideal habitat for plants. Hence, locations with high, medium, and poor-quality vegetative habitat might be identified, allowing for the establishment of a link between the quality of the habitat and the habitat service perceived by humans. Each quadrat was assigned a score between one and five. According to the range of Shannon-Wiener diversity index and other indices of quadrats, scores were assigned as shown in Table 7-10. Total score for each quadrat was calculated by adding up the indices’ scores. The total scores were then classified into three categories using Natural Breaks method and illustrated in ArcGIS.

Table 7-10 Criteria for plant index rating

Score	Shannon-Wiener diversity index	Proportion of native species	Proportion of invasive species	Coverage
1	$x \leq 0.3$	$x \leq 0.2$	$x > 0.8$	$x \leq 20$
2	$0.3 < x \leq 0.6$	$0.2 < x \leq 0.4$	$0.6 < x \leq 0.8$	$20 < x \leq 40$
3	$0.6 < x \leq 0.9$	$0.4 < x \leq 0.6$	$0.4 < x \leq 0.6$	$40 < x \leq 60$
4	$0.9 < x \leq 1.2$	$0.6 < x \leq 0.8$	$0.2 < x \leq 0.4$	$60 < x \leq 80$
5	$x > 1.2$	$x > 0.8$	$x \leq 0.2$	$x > 80$

7.5.3 To measure the perception of wildlife habitat service

Self-completion questionnaires and face-to-face semi-structured interviews were designed to assess public perceived wildlife habitat service (PWH). Ratings on PWH (7-point Likert scale questions) were included in the questionnaire. For surveys in both wetland parks (WPs), a 7-point Likert scale question on agreement was asked: ‘There are abundant and diverse animal and plants in this WP’. Based on findings from Tianhe Daguan Wetland Park (TDWP), three detailed 7-point Likert scale questions on agreement were asked additionally in Haizhu National Wetland Park (HNWP): (1) There are rich and diverse plants in this WP; (2) There are rich and diverse fish, shrimp and crabs in this WP; (3) There are rich and diverse birds in this WP.

During the interviews, questions about the perceived species richness were asked: ‘How many different kinds of plants/birds do you think live in this wetland park?’, and ‘How do you come up with this number?’

In TDWP, additionally, according to findings of vegetation baseline survey, three panoramas showing places with high biodiversity, intermediate biodiversity, and low biodiversity respectively were used for photo ranking. Respondents were asked ‘which of the three locations do you think have the most rich and diverse plants? And which do you think have the least plant diversity?’ And a follow-up question ‘How do you come up with this ranking?’ were asked.

While in the Haizhu Lake in HNWP, additionally, participatory mapping tasks were included. The following instruction was given to respondents before drawing the polygons, ‘in your experience in Haizhu Lake, are there any places you think the most ideal places for wildlife inhabit?’ And a follow-up question ‘Why do you think those places are good for wildlife?’ were asked.

To analyse survey data, SPSS was used for descriptive and inferential statistics. NVivo was used to conduct a thematic analysis on interview data. And ArcGIS Pro was used to digitise and analyse the participatory mapping data.

7.5.4 Technical understanding of vegetation habitat in Tianhe Daguan Wetland Park

7.5.4.1 Plant species richness and composition

In total, 114 vascular plant species belonging to 38 orders, 57 families, and 102 genera were detected in quadrats in Tianhe Daguan Wetland Park (TDWP). They were mostly herbaceous (78.9%), with only 13 tree species (8 evergreen and 5 deciduous) (Figure 7-24). None of them were listed as endangered or threatened. There were 74 native species, 29 exotic species (23 from outside of the country and 6 from within China), and 11 invasive species. Two invasive species (*Sphagneticola trilobata* and *Eichhornia crassipes*) may be intentionally introduced in TDWP for ornamental reasons or water purification purpose. Specific to the northern part where the perception related surveys were conducted, there were 89 vascular plant species belonging to 34 orders, 48 families, and 83 genera. The list of vascular plant species is shown in Appendix A - 11.

Compared to the results of a plant survey undertaken in 2017 using 25, 5-by-5-metre quadrats, more families and genus of species were discovered. According to their survey, there were 66 vascular plant species belonging to 32 families and 54 genera (Wang L. *et al.*, 2019). In comparison to the design that planted 62 species (Wang L. *et al.*, 2019), the number of plant species has risen significantly over the past few years.

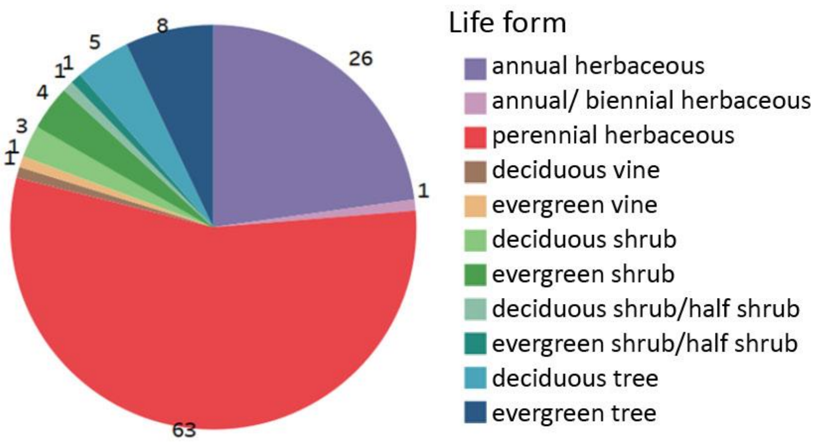


Figure 7-24 Vascular plant species composition (life form)

7.5.4.2 Shannon-Wiener diversity index for plants

Shannon-Wiener diversity analysis indicated a low plant diversity in TDWP, especially for trees and shrubs. It was found that in average, diversity of tree and shrubs in quadrats were low (Shannon-Wiener diversity index = 0.553 ± 0.320; standard deviation is shown), and diversity of ground cover plants were moderate (Shannon-Wiener diversity index = 0.649 ± 0.332; standard deviation is shown). Highest Shannon-Wiener diversity index for trees and shrubs layer and the ground cover layer were 1.061 and 1.362, respectively.

7.5.4.3 Most frequently occurred plants

25 species were detected in at least six quadrats (> 10% of all quadrats) (Figure 7-25). Six of these 25 species were so small that they were difficult to observe. *Bidens alba* and *Sphagneticola trilobata*, two invasive herbaceous species, were among the top 3 most common plant, occurring in approximately half of the quadrats. Another widespread species was the native *Cyclosorus interruptus*. The swamp cypress (*Taxodium distichum*) was the most frequently occurring tree, appearing in 19 quadrats (32.76% of all quadrats).

Syzygium samarangense and *Bauhinia* were two additional common trees (appeared in seven quadrats, respectively).

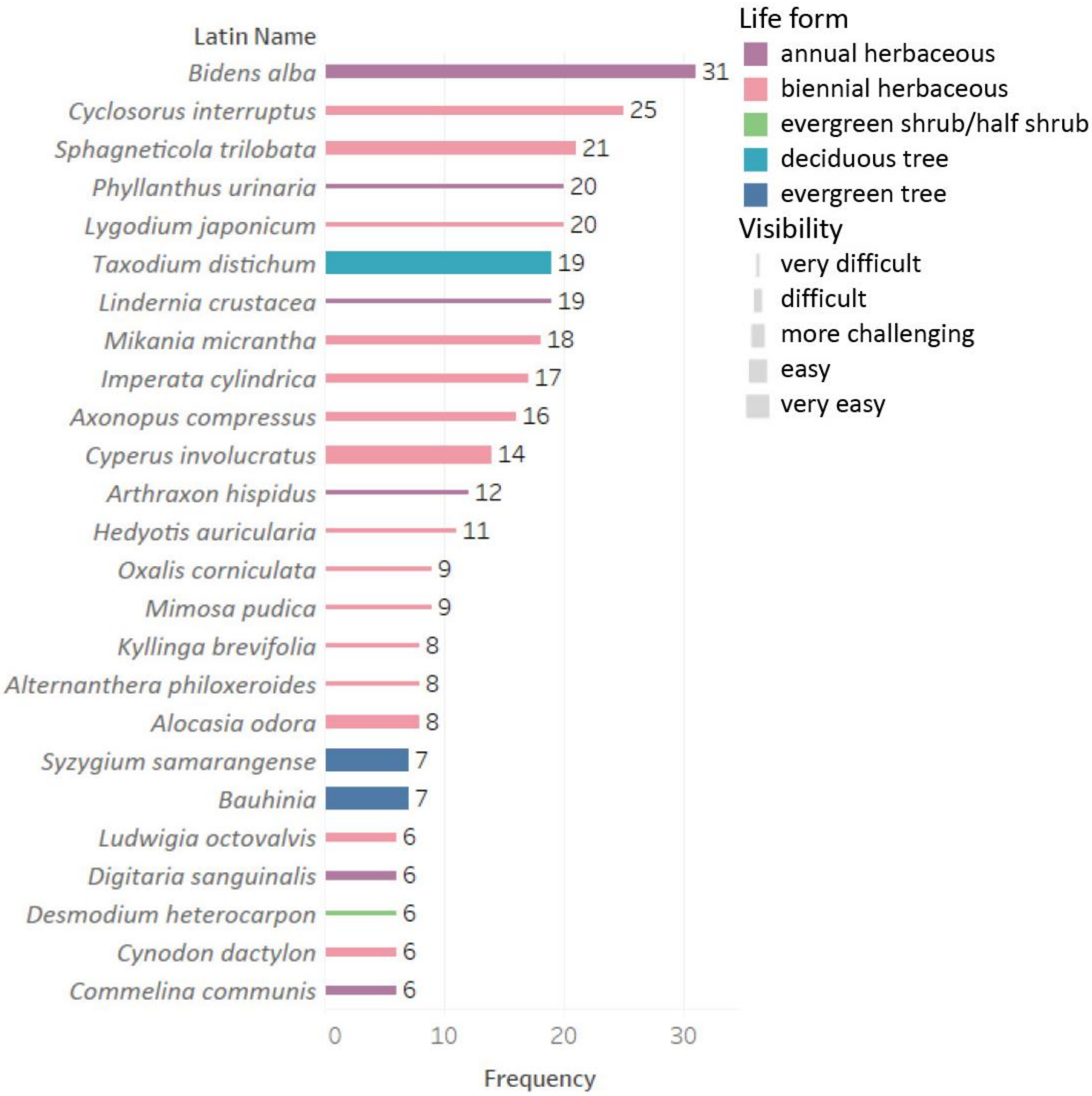


Figure 7-25 Most frequently occurred plants

7.5.4.4 Visibility of plants

Most plants were difficult to see; 31 species were tiny and very difficult to see, and 42 species were difficult to see. Only 13 species were very easy to see (e.g., trees and large shrubs). And 15 species were easy to see, including shrubs and large aquatic such as reeds. Others were moderately easy to see.

7.5.4.5 The most/least ideal place for plants

In each of the three parts of the park, the highest, lowest, and intermediate scores can be found (Figure 7-26). It was discovered that the quadrat with the highest scores were located in the marsh or wetland edges, except Quadrat NO.52 which located near the entrance. Quadrats with the lowest score were located in conifer woodland, open-wooded grassland, and shrubs near city roads.

Areas surrounding the three quadrats with high, medium, and low scores were selected and photographed for perception surveys specific to the more visited northern portion of TDWP (Figure 7-27). These quadrats were not all accessible to visitors. Considering that the majority of visitors will encounter quadrats NO.0 (low score), NO.24 (high score), and NO.40 (middle score), as well as Quadrat NO.0, which illustrated the most common landscape in TDWP – the swamp cypress forest, the areas surrounding these quadrats were selected and photographed (Figure 7-29, Figure 7-28, Figure 7-30).

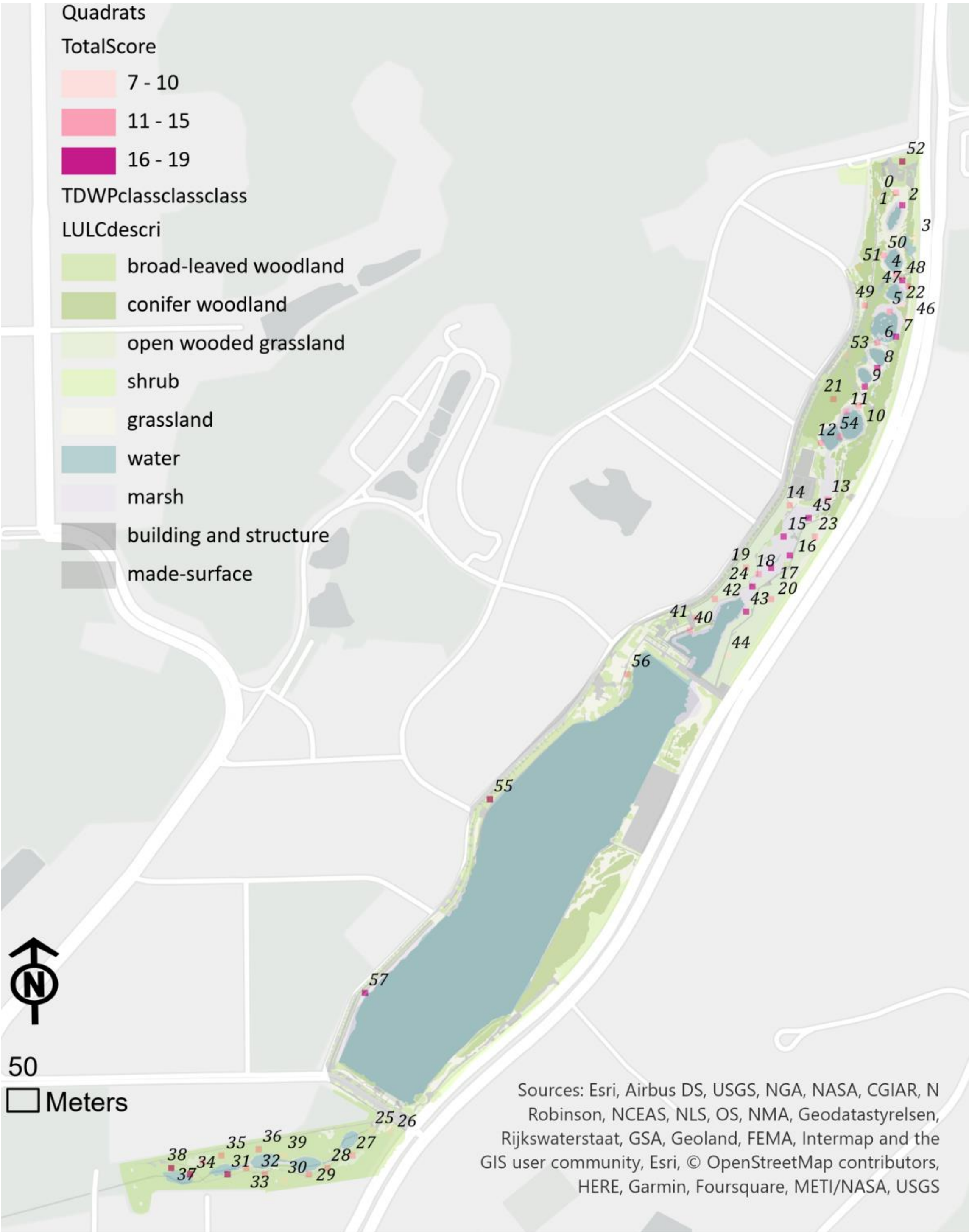


Figure 7-26 Scores of quadrats

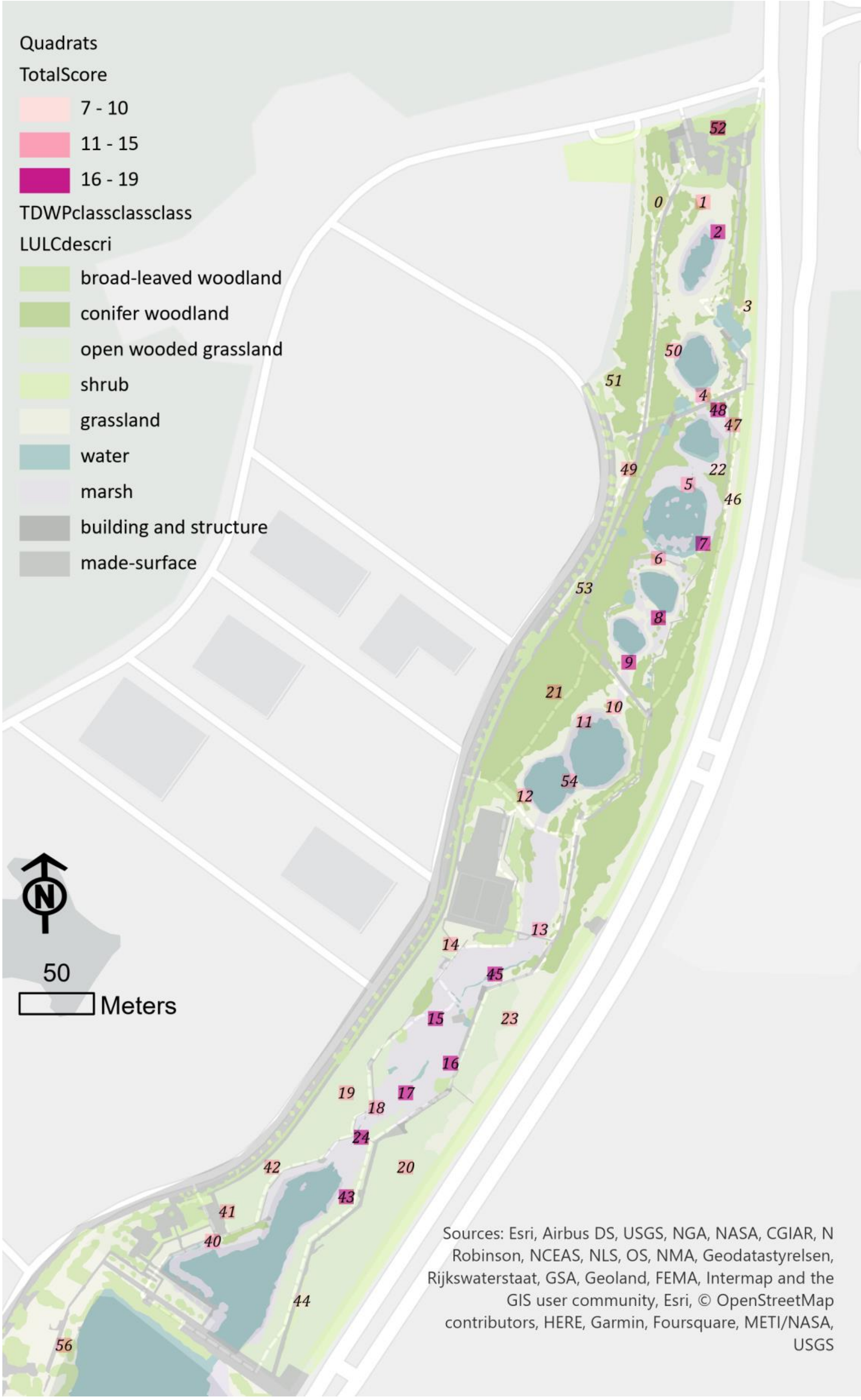


Figure 7-27 Scores of quadrats in the northern part

Figure 7-28 Quadrat NO.0 (low score)

Figure 7-29 Quadrat NO.24 (high score)

Figure 7-30 Quadrat NO.40 (medium score)

7.5.5 Technical understanding of avian habitat in Haizhu National Wetland Park

7.5.5.1 Overall indices

7.5.5.2 Bird species richness

In total, 167 bird species belonging to 17 orders and 48 families were recorded in Haizhu National Wetland Park (HNWP) by 414 reports created by citizen scientists (CSs) during 2019-10-01 to 2022-09-31[39]. Some

[39] Number of valid records range from 0 to 93 per month: there was no record in February 2020 due to the Covid-19 outbreak, and

species were only recorded once. These species may be vagrant visitors or misidentified. After deducting species that were recorded only once, the number of species recorded was 113, with 67, 72, and 95 species in each year. Two on-site surveys recorded 67 bird species from 13 orders and 30 families. In October 2022, 58 bird species from 11 orders and 27 families were encountered, and in January 2023, 55 from 12 orders and 27 families. With 21 species appeared only in one month's survey, the Jaccard similarity[40] of the species encountered in the two months was 68.66%. List of species is shown in Appendix A - 14.

CSs recorded a larger number of species between October and January than the field surveys. 129 bird species belonging to 16 orders and 42 families were recorded by CSs during October to January; among them, 86 species belonging to 13 orders and 34 families were recorded at least twice. For October, Jaccard similarity between species observed in the field and those recorded by CSs was 42.60% with 4-years records and 52.46 percent with 2022 recordings. For January, there was a 56.90% Jaccard similarity between species observed in field surveys and those detected by CS in 4- year records, and an 82.09% similarity with 2022 records.

However, field surveys documented a slightly higher average number of species per visit (25 in October and 27 in January) than CS (in average 21 species). Moreover, it was found that number of species encountered each visit in January was larger than that in October, for CSs' travels and the field surveys (Figure 7-31).

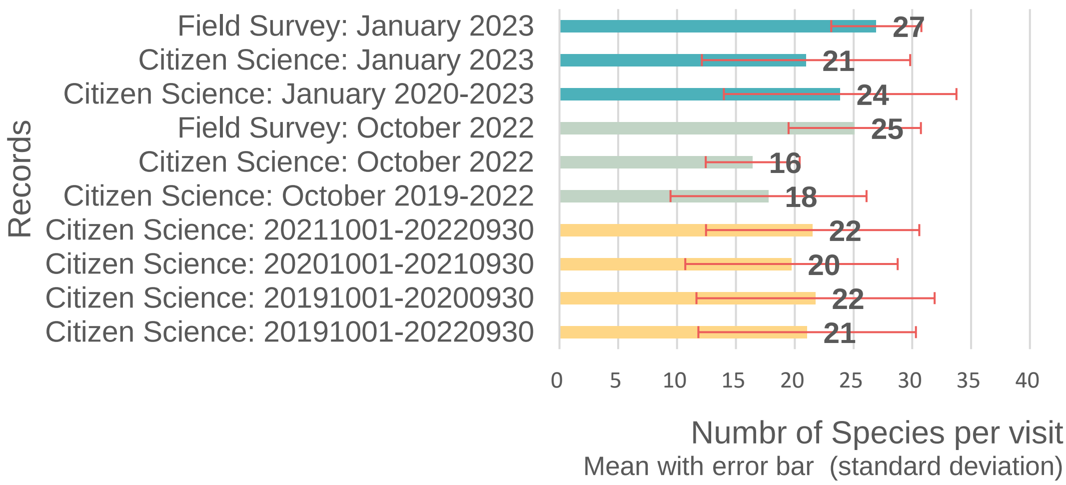


Figure 7-31 Number of bird species per visit

there were 93 records in January 2022 due to the event "Bird Watching Competition in Guangdong, Hong Kong and Macau". There were more reports between September and April than between May and August (Appendix A - 10).

[40] Jaccard Similarity is the degree of similarity between two sets. It is defined as the proportion of common elements in two sets to the total number of elements in their union. The formula is as follows: $J(A,B) = \frac{|A \cap B|}{|A \cup B|}$

CS data shows that monthly average number of species from October to April are higher than that from May to September (Figure 7-32). This is similar to results of a bird survey during 2013 and 2015 in HNWP (Tang *et al.*, 2018). The fact that there are more winter migrants than summer migrants in Guangzhou (Liu, Zhang and Hu, 2008) may explain why a greater number of species were detected from October to April by CSs. Besides, during the windy and wet months of May through September, there might be fewer birds are active (Bibby, Burgess and Hill, 1992, p. 31), and there might be more difficulties in travelling for observers. Due to this seasonal variance, it is acceptable that both field surveys for this study were undertaken between October and April, when more birds were present.

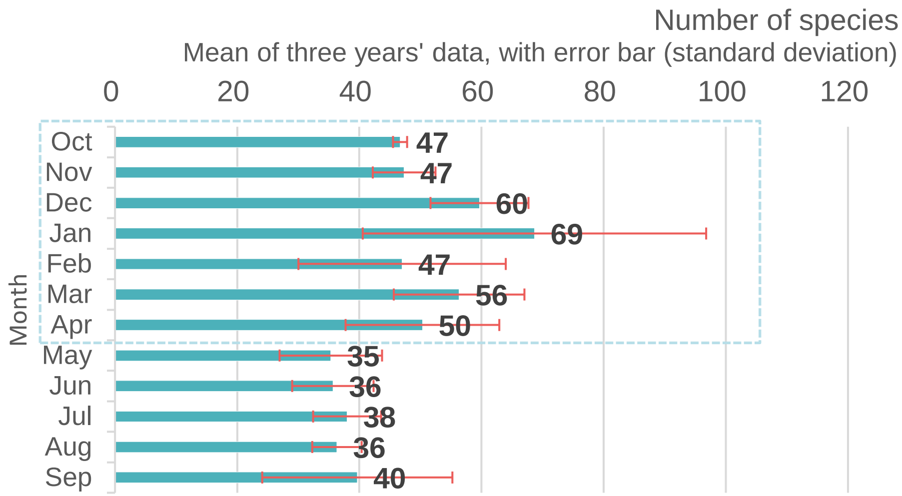


Figure 7-32 Monthly bird species richness variation

Among the 157 species documented by CS, there were 32 species occurred in each month, 41 species occurred in more than three quarters of the year, 59 species occurred in more than half a year, 77 species occurred in more than a quarter of a year, 107 occurred in at least two month, and 50 species occurred in only one month. In average, 47 species was recorded per month during the three years. Generally, among the three-year CS reports, six species were recorded by more than 80% of the reports, eight species were recorded by 60%-80% of the reports.

7.5.5.3 Relative abundance of bird species

Chinese Spot-billed Duck, Grey Heron, Light-vented Bulbul, Sooty-headed Bulbul, Swinhoe's White-eye, Chinese Blackbird, Crested Myna were among the top 10 species that most abundant in citizen science data and in both month's surveys. Black-crowned Night Heron and Little Egret were among the top 10 most abundant species in citizen science data and in the January's survey. Scaly-breasted Munia was among the top 10 most abundant species in citizen science data and in the October's survey. Black-collared Starling and Red-billed Starling were among the top 10 most abundant species in October's survey, respectively. (Figure 7-33)

7.5.5.4 Most frequently occurred species

Generally, among the three-year citizen science reports, six species were recorded by more than 80% of the reports, including Black-crowned Night Heron, Grey Heron, Little Egret, Light-vented Bulbul, Swinhoe's White-eye, and Chinese Blackbird. Eight species were recorded by 60%-80% of the reports, including Chinese Spot-billed Duck, Common Moorhen, Spotted Dove, Long-tailed Shrike, Sooty-headed Bulbul, Common Tailor Bird, Oriental Magpie Robin, and White Wagtail.

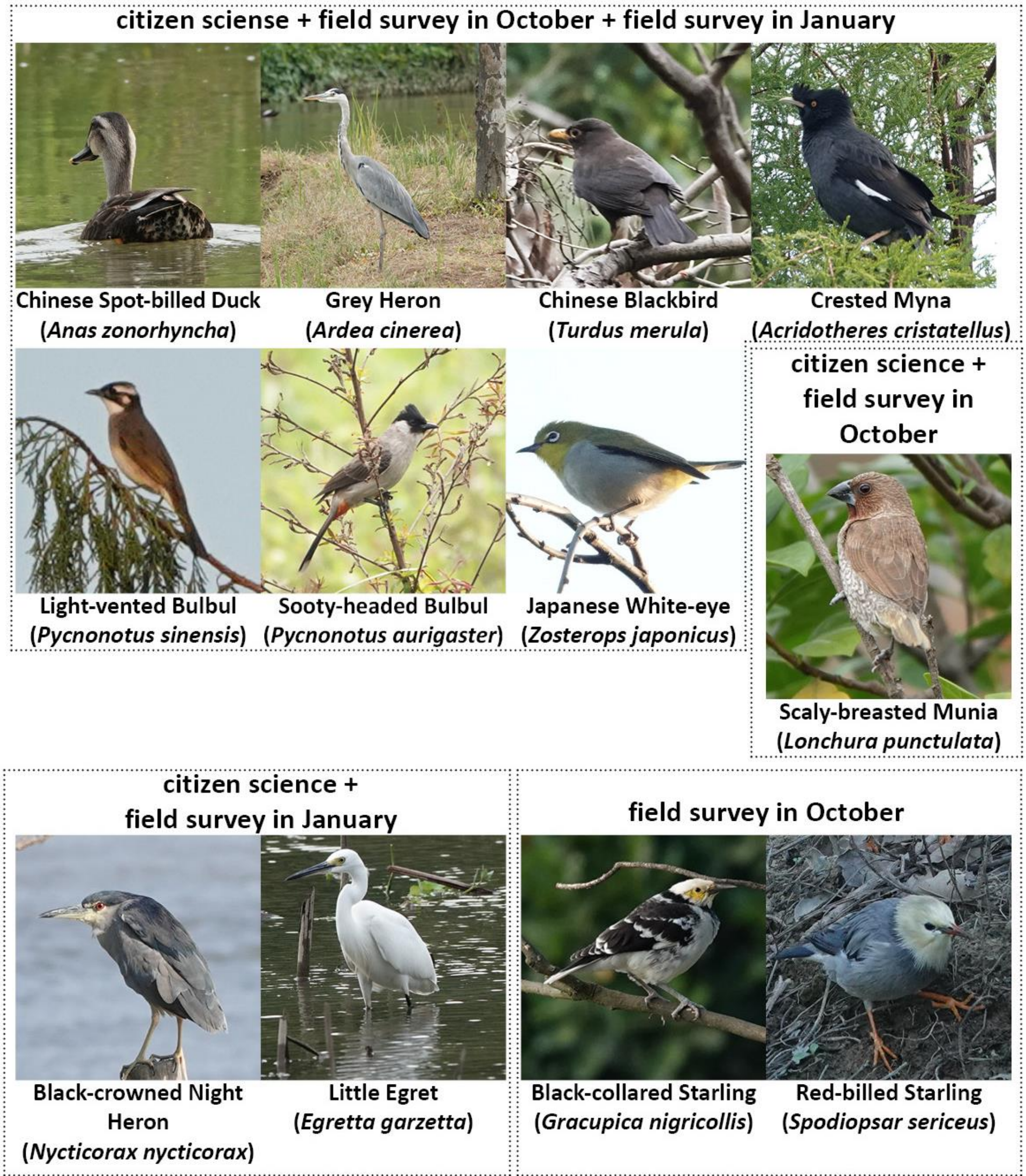


Figure 7-33 Top 10 most abundant species in citizen science data and field surveys

7.5.5.5 Essential bird species

According to the IUCN Red List Categories and Criteria, a total of four species of threatened birds were recorded by CSs in HNWP, including one vulnerable species (the free-range Swan Goose (*Anser cygnoides*) which is not naturally distributed in Guangzhou), and two near threatened species (the Black-tailed Godwit

(*Limosa limosa*) which was only recorded once, and the Alexandrine Parakeet (*Psittacula eupatria*) which is not naturally distributed in Guangzhou), and one critical endangered species (Yellow-breasted Bunting (*Emberiza aureola*)). Three vulnerable species except the Black-tailed Godwit were also recorded in the field survey. While there were 6 vulnerable, 13 near threatened, 4 endangered, and one critically endangered species recorded in Guangzhou. Besides, citizen scientist recorded 23 National second-class protective species (including the free-range Swan Goose and Alexandrine Parakeet which are not naturally distributed in Guangzhou) and one National first-class protective species (*Emberiza aureola*) in List of Wild Animals under National Key Protection, and 21, during the three years. While field surveys recorded eight National second-class protective species (7 in October and 5 in January) and one National first-class protective species (*Emberiza aureola*) (in October). Besides, in field surveys, 11 species under key protection in Guangdong Province were recorded; 7 of these species were encountered in both months.

7.5.5.6 Visibility of birds

In HNWP, the largest bird species recorded in field surveys was Great Egret whose body length is about 94-104cm, and the smallest bird species recorded was Pallas's Leaf Warbler whose body length is about 9-10 cm. The mean size of individuals that encountered during the survey was 26-35 cm. Approximately half of the bird species were brown, others were black, grey, black and white, white, green, blue, and orange. 5 species were very easy to spot, 9 were easy, 13 were difficult, and 24 were extremely difficult. The remaining species were neither difficult nor easy to see.

7.5.5.7 Spatial variation

Bird diversity indices varies in different parts of HNWP. **Some indices in Haizhu Lake (HL) were higher than that in Wetlands Phase 1 and 2 (P1&2)**, including (1) average number of species observed per 250-metre walk during each month (15 and 16 species in HL, 14 and 13 species in P1&2); (2) average number of species observed on more than 80% of 250-metre sections per visit (3 and 4 species in HL, 3 and 2 species in P1&2). **Some indices in P1&2 were higher**, including (1) total number of species (50 and 46 species in P1&2, 43 and 45 species in HL); (2) average number of species per visit (30 in P1&2 in both months, 22 and 24 species in HL); (3)species that encountered more than 80% of visits in the two months (19 in P1&2, 12-14 in HL), (4) Shannon-Wiener Index in both months (2.76 and 3.17 in P1&2, 2.61 and 2.48 in HL); (5) Margalef Index in both months (6.03 and 6.05 in P1&2, 5.55 and 5.59 in HL). Number of species that could be encountered on more than 80% of 250 meter-length segments of the route for a single visit in both parts was similar (3 in HL in both months, 4 and 2 in P1&2). Relative abundance (i.e., average number of birds that encountered per visit) in P1&2 was higher in October (425 versus 176), while lower in January (212 versus 290). Specifically, P1 ranked the lowest in the three parts in total number of species, Margalef index, and relative abundance in both months. (Figure 7-34, Appendix A - 23, Appendix A - 24)

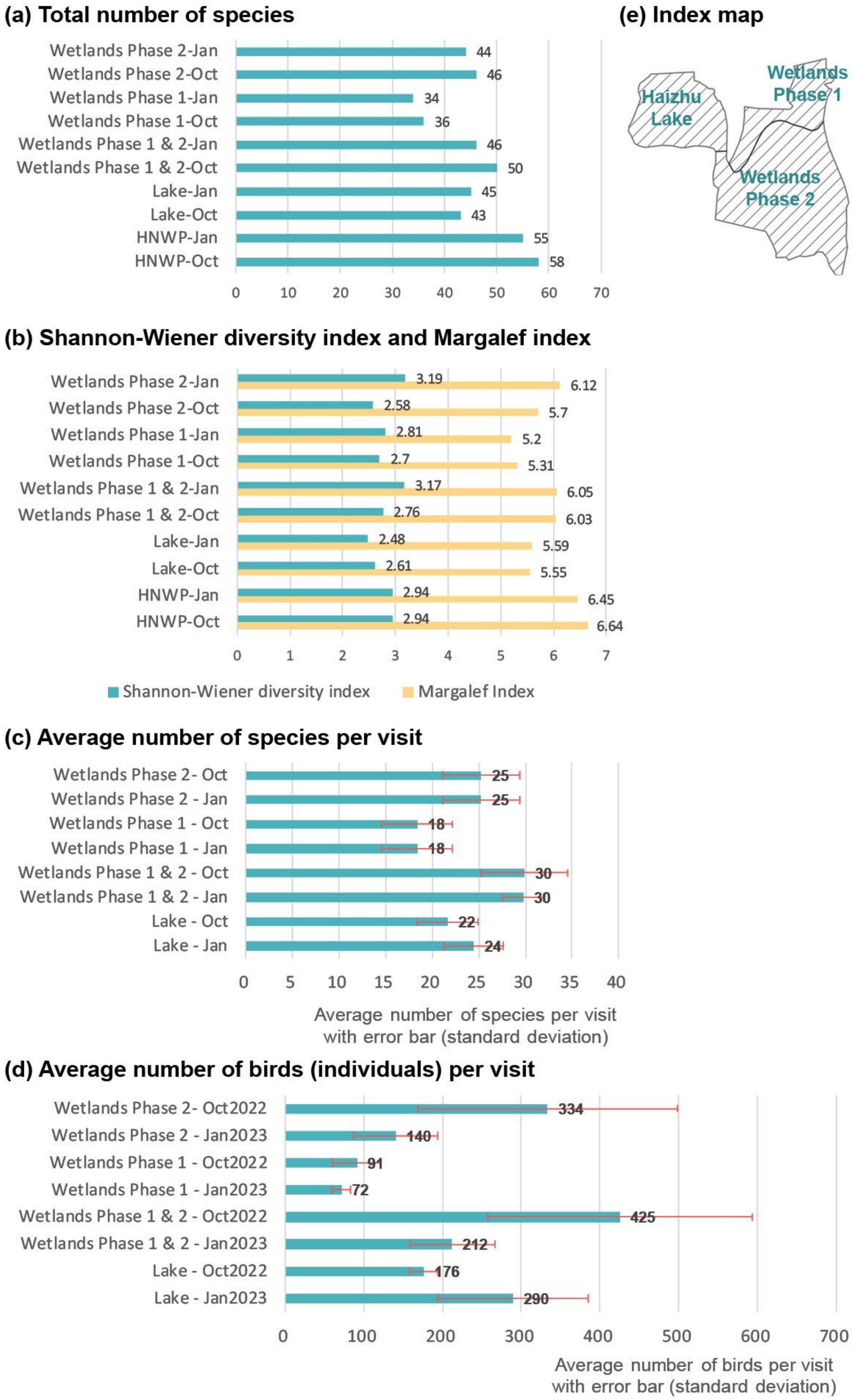


Figure 7-34 Indices of birds in various parts of HNWP

In both months, scaly-breasted Munia was only abundant in P1&2, while Swan Goose was only abundant in HL. Chinese Spot-billed Duck was the only species that in average more than 20 individuals could be encountered per visit in both parts in both months. More than 50 individuals of Scaly-breasted Munia and Red-billed Starling could be encountered per visit in P1&2 in October. Luckily, one can even encounter 320 individuals of Red-billed Starling or 128 individuals of Scaly-breasted Munia for one visit in P1&2. More than 50 individuals of Chinese Spot-billed Duck can be encountered per visit in HL in both months; additionally, more than 50 individuals of Grey Heron can be seen per visit in HL in January.

In the field surveys in October and January, 19 species can be encountered in the P1&2 more than 80% of visits, and 12-14 species can be encountered in HL in more than 80% of visits (Appendix A - 17 and Appendix A - 18). Among them, four species (Chinese Blackbird, Swinhoe's White eye, Chinese Spot-billed Duck and Grey Heron) can be encountered every visit in both months in all zones of HNWP.

In October's survey, three species (including Lighted-vented Bulbul, Swinhoe's White-eye, Chinese Blackbird) and four species (including Sooty-headed Bulbul, Lighted-vented Bulbul, Chinese Blackbird and Swinhoe's White-eye) can be encountered on more than 80% of 250 meter-length segments of the route in HL and in P1&2, respectively. In January, three species (including Chinese Blackbird, Swinhoe's White-eye, and Japanese Tit) and two species (including Chinese Blackbird and Sooty-headed Bulbul) can be encountered on more than 80% of 250 meter-length segments of the route in HL and in P1&2, respectively. (Appendix A - 17 and Appendix A - 18)

Specific to HL, for Plots B (Figure 7-35), Plank and Islands I and Plank and Islands II had the highest species richness in both months. They also had the highest abundance in October, and the second/fourth highest abundance in January. The Hide had the highest abundance in January, and had the third highest abundance in October; it ranked the third in species richness. Flower Field has a moderate species richness but low abundance in October and high abundance in January. Least birds occurred on the Lake where was not close to any islands.

Specific to Plots C (Figure 7-36), Plank and Islands I and II had the highest species richness in both months. Plank and Islands I also had the highest abundance in October, and had the third highest abundance in January. Island III and IV had the highest abundance in January. The Hide and mudflat had a moderate richness but low abundance in both months.

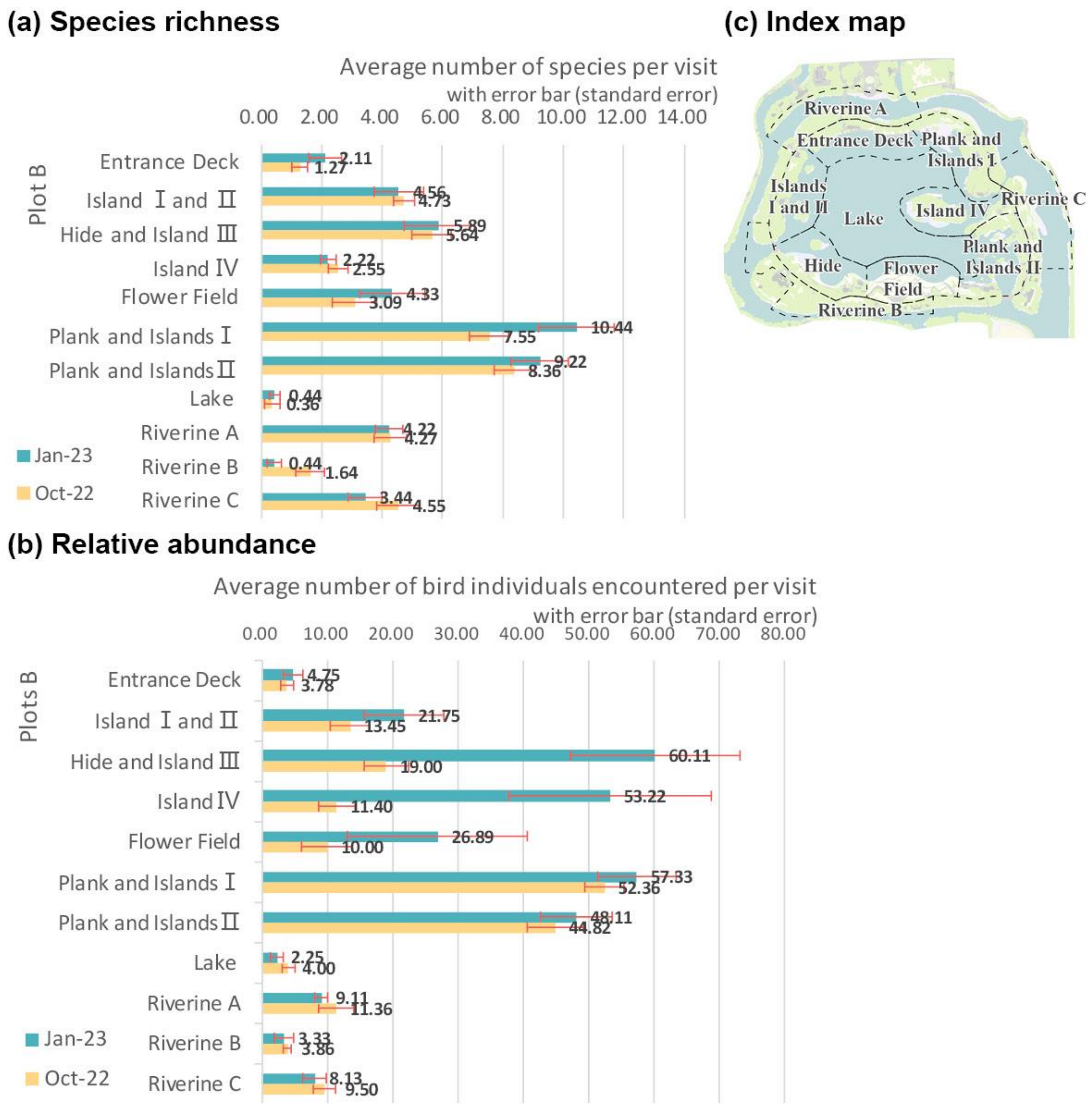


Figure 7-35 Species richness and relative abundance of Plots B

It was discovered that Plots B differ in the composition of bird individuals in relation to their visibility (Appendix A - 19 and Appendix A - 20). In October, a much greater proportion of very easily observable individuals was recorded around Island IV compared to Island I and II, Plank and Islands II, and Riverine A and C. In January, a much greater proportion of very easily seen individuals was observed around Island IV compared to other plots except areas of the lake where are not close to any islands. Besides, in October, around the Hide, Plank and Island I and II, Riverine A and Riverine C, a significantly greater proportion of birds that are very easily seen can be discovered. And in January, the proportion of very easily observed individuals was also high around the Hide. Island I and II include greater proportion of birds that are easily observed than Flower Field in both months. The difference between plots regarding birds that were difficult to see was insignificant in October, but there were larger proportion of very difficultly seen birds around Flower Field than Island IV.

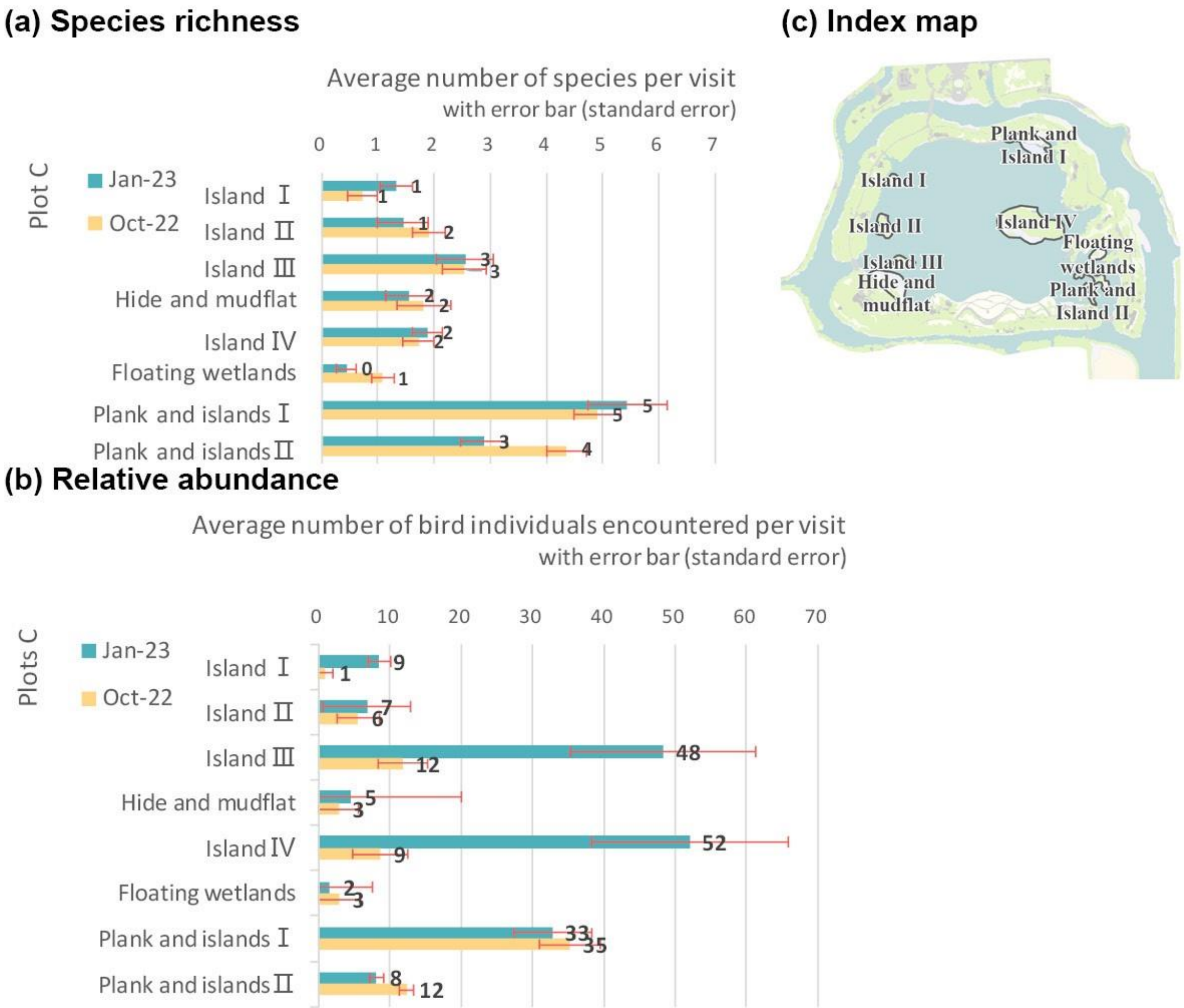


Figure 7-36 Species richness and relative abundance of Plots C

When looking only at Plots C where perceived to be ideal places for wildlife inhabit (Appendix A - 21 and Appendix A - 22), the areas around Plank and Islands II had a much higher number of very difficultly observable individuals compared to Island III and Island IV in both months. In October, around Island I and Island II, a substantially higher proportion of easily observable birds can be found. While in January, the significantly higher proportion of birds can only be found around Island I. Moreover, Island III and Island IV have a significantly higher proportion of very easily observable birds in both months.

7.5.6 Visitors' perception of wildlife habitat service

7.5.6.1 Overall perception (ratings) and influencing factors

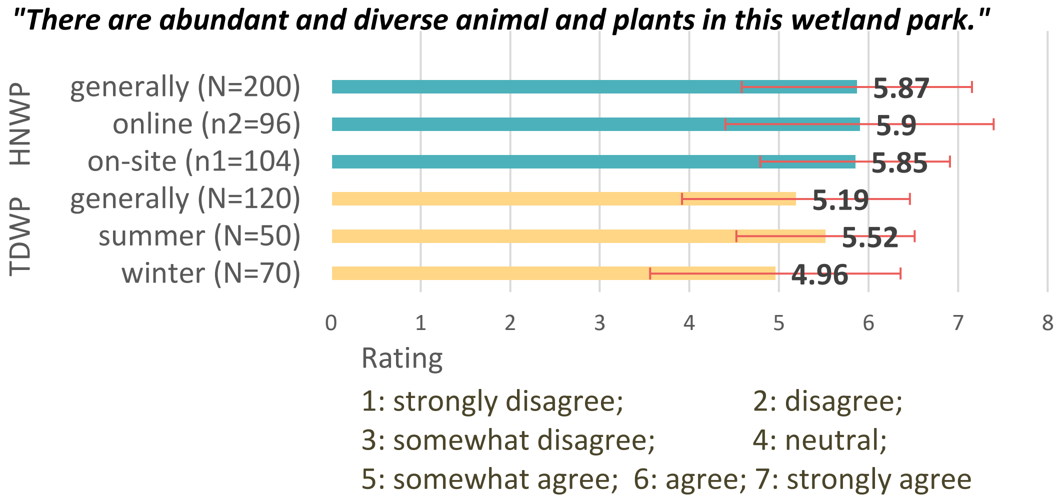


Figure 7-37 Rating of perceived wildlife habitat service (HNWP = Haizhu National Wetland Park and TDWP = Tianhe Daguan Wetland Park).

Overall, the perception of wildlife habitat service (PWH) in both case study sites was moderately positive. Ratings for HNWP was slightly higher than that for TDWP. Based on qualitative findings from TDWP, more habitat-related Likert scale questions were included in HNWP. The set of PWH questions passed both the reliability (Cronbach's alpha = 0.834) and validity tests (KMO sampling was satisfactory (=0.762), and Bartlett's test of sphericity was significant (P<0.001). In general, the majority of respondents agreed with these Likert scale items. The level of agreement on the indicators is lower than on the PWH item (Table 7-11). The perceived plant biodiversity item earned highest average score, while the perceived aquatic animals' biodiversity item earned the lowest average score.

Table 7-11 Descriptive results of Likert Scale questions relevant to perceived wildlife habitat services (Haizhu National Wetland Park)

7-point Likert Scale questions	PES	Mean (N = 172)
There are abundant and diverse animal and plants in this WP.	habitat services	5.87(±1.29)
There are rich and diverse plants in this WP.	Indicator -habitat services (plants)	5.63(±1.14)
There are rich and diverse fish, shrimp and crabs in this WP.	Indicator -habitat services (aquatic animals)	4.78(±1.30)
There are rich and diverse birds in this WP.	Indicator -habitat services (birds)	5.30(±1.32)
(1: strongly disagree, 2: disagree, 3: somewhat disagree, 4: neutral, 5: somewhat agree, 6: agree, 7: strongly agree)		

There was no significant association found between PWH items and gender in both WPs. However, a significant association was observed between PWH items and age, highest education level, monthly discretional income, cost for a visit, visiting frequency, and regions that visitors have been to.

Age was found to be associated with PWH in HNWP, but not in TDWP. In HNWP, age was negatively correlated with the PWH (r = -0.160, P = 0.024); younger respondents (18-44 years old) perceived a significantly higher PWH than senior respondents (≥45 years old) (K-W H test, P = 0.025), while senior respondents (≥45 years old, especially ≥55 years old) perceived a better habitat for aquatic animals than younger respondents (18-44 years old, especially 18-34 years old) (K-W H test, P = 0.003).

The general PWH was negatively correlated with education level in TDWP (r = -0.209, P = 0.024). Although no difference was discovered between groups of **highest education level** in the general PWH in HNWP, it was found that highest education level influence perceptions on habitat for plants, birds and aquatic animals. Respondents who had bachelor's degree rated higher in plant biodiversity than respondents who graduated from specialised college (K-W H test, P=0.017). Besides, less-educated respondents (high school equivalent diploma and lower) perceived higher avian (M-W U test, P = 0.016) and aquatic animals (M-W U test, P=0.002) biodiversity than well-educated respondents. Specifically, respondents who graduated from high school/specialised school rated the aquatic animal biodiversity higher than respondents who graduated from specialised college.

A relationship between **monthly discretional income** and PWH was found in that related to aquatic animals in HNWP: less-wealthy respondents (with a monthly discretional income lower than 6000 CNY) rated aquatic animals' biodiversity higher than more-wealthy respondents (M-W U test, P = 0.009).

Cost for a visit influences the general PWH only in TDWP: respondents who paid less than 20 CNY for a visit rated the higher in PWH than those who paid more than 20 CNY (M-W U test, P=0.016), and cost was negatively correlated with the general PWH (r = -0.209, P = 0.024). In HNWP, respondents who spent less than 20 CNY for a visit rated aquatic animals' biodiversity higher than those spent more than 20 CNY for a visit (M-W U test, P = 0.012).

Visiting frequency was positively correlated with the PWH (r =0.301, P < 0.001) in TDWP, and respondents who visit TDWP less frequently than once a month rated a lower PWH than those visit more frequently (M-W U test, P < 0.033). Furthermore, respondents who visited HNWP less frequently than once a month rated higher in biodiversity of aquatic animals than those visited more frequently (M-W U test, P= 0.005). Specifically, respondents who visited HNWP less frequently than once every half a year and respondents who visited this WP once every 2-3 months perceived significantly lower aquatic animals' biodiversity than respondents who visited multiple times a week.

There were other factors that influence the PWH for aquatic animals in HNWP. On-site respondents rated the aquatic animal biodiversity higher than online respondents (M-W U test, P=0.031). Additionally, the regions that were visited influenced people's perceptions of birds' diversity. Respondents who had only visited Haizhu Lake rated higher bird biodiversity than those respondents who had only been to Wetlands Phase 1 and 2 (K-W H test, P = 0.011).

In summary, age, highest education level, cost for a visit, and visiting frequency could influence PWH (but not always). Additionally, age, income, and the regions that were visited could influence PWH for certain groups of wildlife. Especially, age, highest education level, income, cost for a visit, and visiting frequency influence the PWH for aquatic animals. Highest education level may positively influence the perception of plant habitat service, while highest education level may negatively influence the perception of bird habitat service. It was interesting to find that regions that respondents visited affect the perception of bird habitat service. (Figure 7-38)

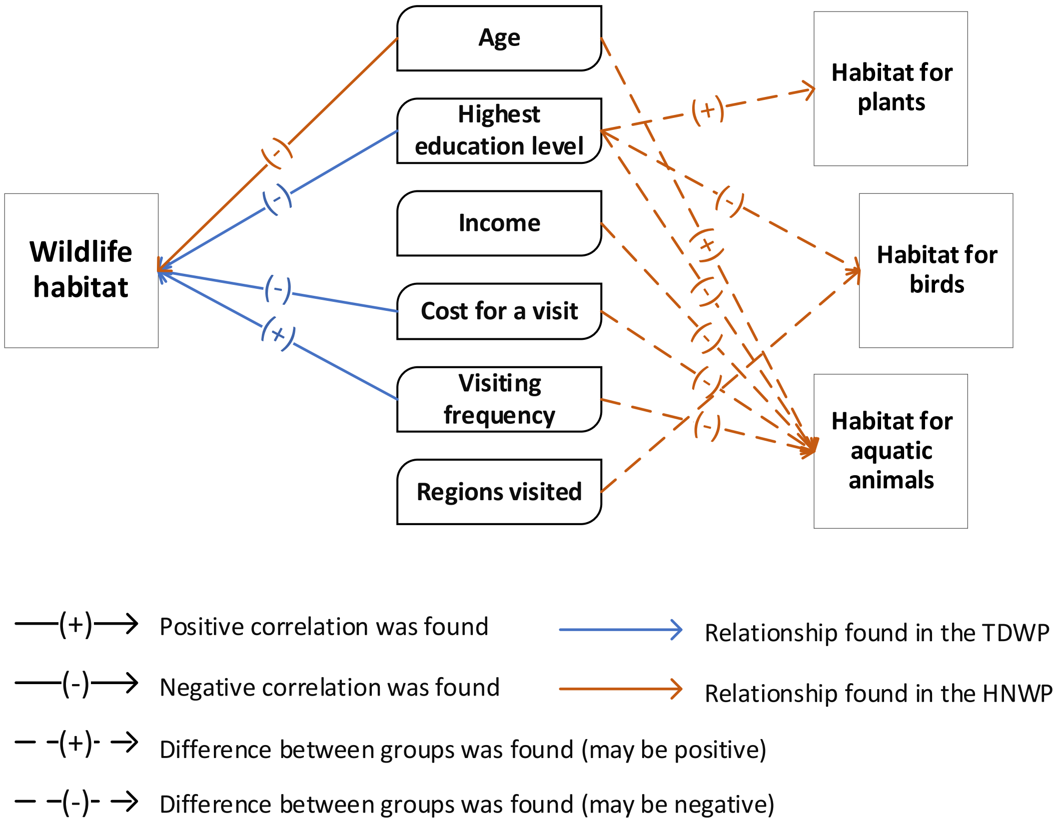


Figure 7-38 Influencing factors of perception (rating) of wildlife habitat service

7.5.6.2 Perceived plant diversity in the Tianhe Daguan Wetland Park

Table 7-12 Photo ranking regarding perceived plant diversity

Panorama	Score	Mean
 Lake	109	2.53
 Marsh	96	2.23
 Swamp Cypress Forest	53	1.23
Note: Score 3: ranked as the 1st; Score 2: ranked as the 2nd; Score 1: ranked as the 3rd		

This section is specific to TDWP; 43 respondents provided input on this section. As shown in Table 7-17, when ranking photos, most respondents thought the lake possesses the highest plant diversity, while the Swamp Cypress Forest has the least. Nearly all respondents made their selections intuitively. The primary consideration is whether or not the species can be counted. The majority of respondents picked the Swamp Cypress Forest as the least diverse because ‘there is only one species of tree.’ Two respondents believe that the Marsh has the greatest plant diversity because ‘it is messy and I cannot count the number of species.’

7.5.6.3 Perceived species richness and influencing factors

Data of this section was collected in both WPs on-site. As shown in Table 7-13 and Table 7-14, 17.5% of respondents in TDWP, and 18.0% and 19.0% respondents in HNWP could not assess the plant and bird species richness, respectively, because they ‘did not pay attention to it’.

Due to a lack of relevant knowledge, around 13% of respondents in both WP were unable to estimate the range of plant and bird species richness; these respondents can only say whether it is a lot or a few or compare it to the South China Botanical Garden (SCBG). Most people who mentioned the diversity of plant species believed there were less than 50 plant species and less than 20 bird species in TDWP, and 50-500 plant species and 11-50 bird species in HNWP. That is, the perceived species richness was higher in HNWP than TDWP.

Table 7-13 Perceived plant species richness

	TDWP(N=77)		HNWP(N=101)	
Perceived Plant Species Richness	Frequency	Percent	Frequency	Percent
I didn't paid attention to it	13	16.88	36	35.64
[1-20]	15	19.48	5	4.95
[21-50]	9	11.69	1	0.99
[51-100]	7	9.09	8	7.92
[101-200]	7	9.09	10	9.90
[201-500]	1	1.30	10	9.90
[501-1000]	2	2.60	3	2.97
[>1000]	4	5.19	1	0.99
I don't know, but there must be a lot	15	19.48	19	18.81
I don't know, but there must be a few	1	1.30	5	4.95
I don't know, but not as much as the Botanical Garden	3	3.90	3	2.97

Table 7-14 Perceived bird species richness

	TDWP(N=77)		HNWP(N=101)	
Perceived Bird Species Richness	Frequency	Percent	Frequency	Percent
I didn't paid attention to it	21	27.27	38	37.62
[1-10]	26	33.77	7	6.93
[11-20]	10	12.99	9	8.91
[21-50]	3	3.90	15	14.85
[51-100]	0	0.00	2	1.98
[>100]	2	2.60	3	2.97
I don't know, but there must be a lot	2	2.60	12	11.88
I don't know, but there must be a few	13	16.88	13	12.87
I don't know, but it's similar to the Botanical Garden	0	0.00	1	0.99
I don't know, but not as much as the Botanical Garden	0	0.00	1	0.99

Some respondents estimate the species richness totally based on observations. Here the observation includes both seeing and hearing. For example, Zachary in HNWP said 'I reckon there are one hundred or more species, as I have roughly counted.' And Lee in HNWP said 'I have seen and heard ten to twenty bird species, and there are eight or nine species on the signage boards near the telescopes, so I'm guessing there are twenty to thirty.'

Some respondents simply multiply the observed value by the appropriate multiplier to obtain an estimate of the species richness. For example, Hudson in TDWP said 'I met birds two or three times today, and there might be a bit more. Maybe five or six species?' And Cassie in TDWP remarked, 'I can count out at least five or six species of plants in this small area around us, therefore there are likely more than a dozen plant types in this wetland park.'

Comparison with other familiar places aids the estimation. For example, Dilan in HNWP said 'There might be 30 species of birds here. I saw maybe 10 species in my residential area, and there must be more in the wetland park. May be three times?' And Bruce in TDWP remarked, 'There should be more than a hundred distinct species of plants, with the exception of a handful that I've never seen before in Guangzhou's parks.'

Signage boards with information on the plants and birds are essential elements that help with perception of species richness. For example, Toby in HNWP mentioned ‘There might be around 30 or 40 species. I remember I’ve seen that many kinds of birds on signage boards. If there were more, they would appear on the signage boards.’ Other forms of publicity, such as articles and news, also have an impact on perception of species richness:

> *Denny: I believe there are 500-1000 plant and 100-200 bird species.*
>
> *Interviewer: Woah, your estimation is very close to the official numbers. How do you do it?*
>
> *Denny: Because I am extremely familiar with this wetland park. I’ve been coming here since the park opened. It has been almost ten years. And I always keep an eye out for any publications mentioning it.*

(Denny, female, age of 35-44 years, high school equivalent degree, spent 1-3 hours on site, interviewed in HNWP)

Besides, certain wildlife-related events may also influence perception. Anthony in HNWP complained, ‘I heard there is a bird-watching competition this weekend. I thought there would be lots of birds here, so I don’t understand why I haven’t seen any.’

According to Melinda, Anthony’s confusion may have been caused by a lack of equipment that hampered his awareness of the abundance of bird species: ‘Although I know some of the birds, I didn’t have a telephoto lens or binoculars with me when I visited the park to see them, so I have no idea.’

Some respondents based their estimates on their understanding of the link between animals and habitat. ‘There should just be a few birds’, Victoria in TDWP noted, ‘because the woodlands are sparse and the leaves are thin, there should be few places for birds to hide’. Similarly, Paul in TDWP said, ‘the quantity of trees is limited, and most of them are of a single species; it is difficult for birds to hide in these trees’, Additionally, the influence of the size of habitat was mentioned by one respondent in HNWP, ‘I have no idea how to estimate the number; all I know is that there are many plants and a few birds. Bird islands and wetlands of this size are still too small to have a meaningful effect on biodiversity’. Further, disturbance from human was taken into consideration: ‘birds are rarely seen flying’, Alva said, ‘Daguan Road is quite busy and noisy, there must be some impact’.

In summary, direct observation (i.e., counts), a coefficient multiplied by the direct counts, comparison with other familiar places, number of species shown on publications (including those displayed on signage boards on site), wildlife-related events, equipment (e.g., binoculars), and knowledge on the relationship between habitat and wildlife are factors that influence the perception and estimation of species richness (Figure 7-39).

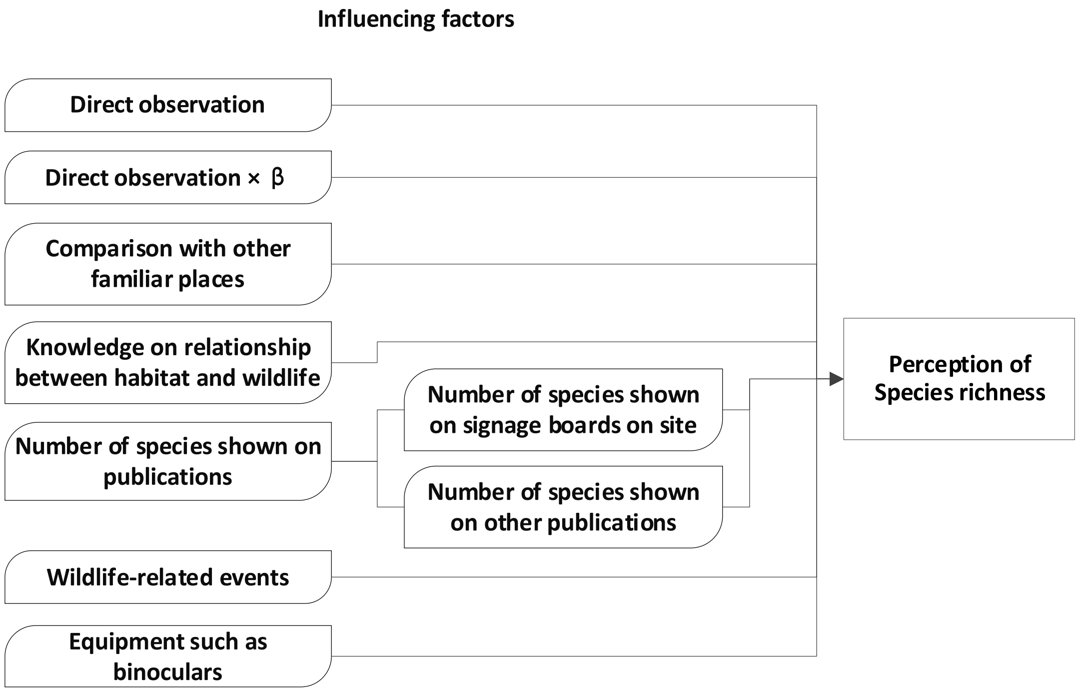


Figure 7-39 influencing factors of species richness perception, evidence from interviews

7.5.6.4 Areas in Haizhu Lake that are thought to be ideal for wildlife habitat

The participatory mapping was only conducted in Haizhu Lake (HL) of the Haizhu National Wetland Park (HNWP). As a result of the participatory mapping of ideal places for wildlife to inhabit, there were 99 polygons that related to hotspots of perceived wildlife habitat service (PWH) identified by 46 respondents (Table 7-15). The area of polygons ranged from 238 m^2 to 301,137 m^2, and in average 15,268.30 m^2. The polygons cover 423,700 m^2, and consist 54% of the study area[41]. The hotspots of PWH concentrated on the islands in the lake, particularly the island adjacent to the Hide (Figure 7-40) with binoculars (Island III, Table 7-16, Figure 7-41, Figure 7-42). The predominant land cover in these hotspots consisted of woodland, water, marsh, inter-tidal sand and mud, with only a small amount of grassland and man-made surfaces (Table 7-17).

[41] The study area was about 78.3 hectares.

Figure 7-40 The Hide with binoculars in Haizhu National Wetland Park

Table 7-15 Number of polygons that each respondent mapped (wildlife habitat)

Number of polygons	Number of respondents (N = 46)
1 polygon	25
2 polygons	7
3 polygons	4
4 polygons	6
5 polygons	2
6 polygons	0
7 polygons	2

Table 7-16 Overlapping counts of the perceived hotspots (wildlife habitat)

	Max overlapping polygons	Rank
Island Ⅰ	11	5
Island Ⅱ	12	4
Island Ⅲ	32	1
Island Ⅳ	15	3
Hide and mudflat	19	2
Plank and islands Ⅰ	7	6
Floating wetlands	12	4
Plank and islands Ⅱ	12	4

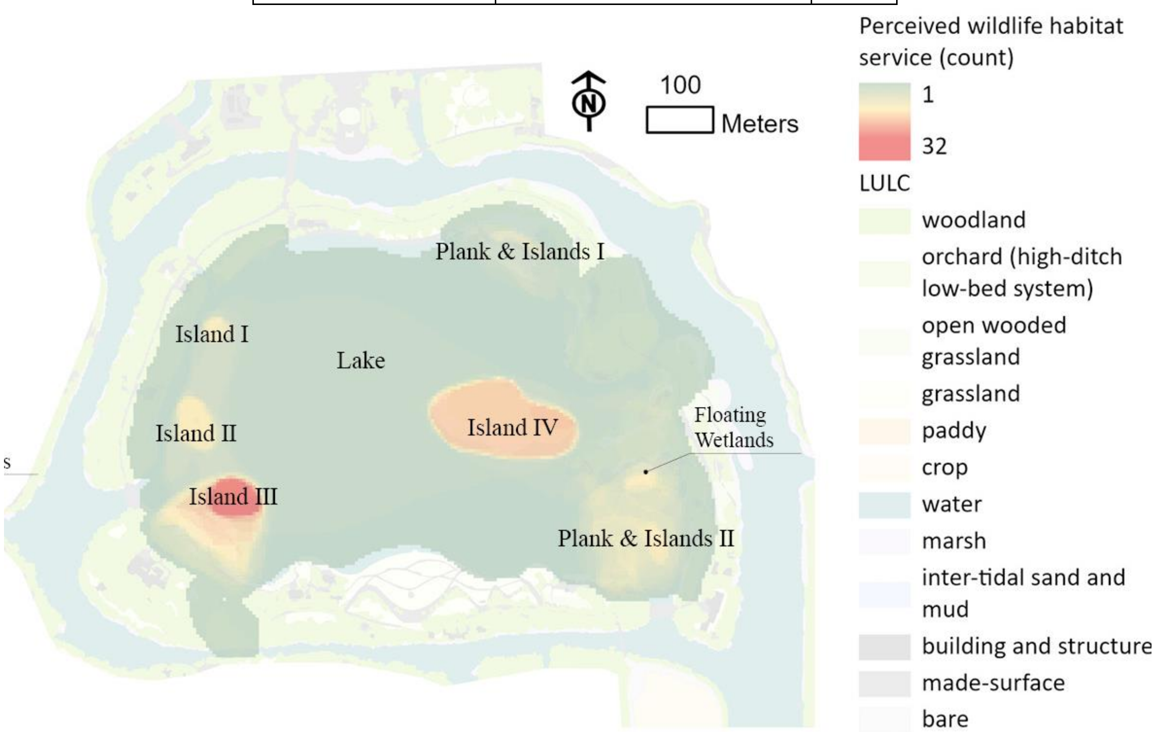


Figure 7-41 Hotspots of perceived wildlife habitat service

Table 7-17 Landscape cover composition of perceived wildlife habitat service core area

Land Cover	Perceived wildlife habitat service core areas (m^2)							
	floating wetland	Islands near Plank I	Islands near Plank II	Island IV	Hide & Island III	Island II	Island I	SUM
woodland	297.0 (29.7%)	1901.2 (46.7%)	676.5 (39.2%)	12216.9 (61.6%)	1270.6 (9.6%)	2083.6 (60.8%)	429.2 (57.2%)	16974.1 (42.5%)
grassland				296.9 (1.5%)	9.8 (0.1%)			306.8 (0.8%)
water	81.5 (8.2%)	1019.7 (25.1%)	678.3 (39.3%)	3303.3 (16.7%)	8128.3 (61.5%)	824.0 (24.1%)	182.8 (24.4%)	13198.3 (33.0%)
marsh	619.9 (62.0%)	654.6 (18.4%)	370.2 (21.5%)	2477.1 (12.5%)	840.1 (6.4%)	325.4 (9.5%)	138.0 (18.4%)	4770.7 (11.9%)
inter-tidal sand and mud				1510.6 (7.6%)	2976.1 (22.5%)			4486.7 (11.2%)
building and structure						166.9 (4.9%)		166.9 (0.4%)
made-surface	1.5 (0.2%)	493.4 (12.1%)		20.2 (0.1%)		24.8 (0.7%)		46.6 (0.1%)
SUM	1000.0	4069.0	1725.0	19825.0	13225.0	3425.0	750.0	39950.0

Figure 7-42 Arial view of core areas of wildlife habitat service

Similar to findings of the previous section, reasons behind the mapping of habitat services hotspots including direct observation, degree of human disturbance, and information from videos or signage boards about species (mainly birds). For example, one respondent mapped the east part of the park around the sluice gate, and another two respondents who mapped the southern woodland near the office buildings, indicated that they had seen many song birds in those areas. Most respondents who mapped the Island I and Island IV thought that 'more animals inhabit those areas where there are fewer people'. Many respondents who mapped the Islands III said that 'there were many birds on that island when see from the Hide with binoculars', and one respondent further explained that 'although I don't know the birds and can't see them well enough to distinguish the species, there is a large quantity of birds.' One respondent thought the Island IV provided the best habitat for wildlife because 'I have watched a video introducing the species on the island, and I have seen some birds on the island'. In summary, birds' diversity and habitat disturbance by humans were the dominant evidence for most respondents to judge the wildlife habitat suitability. Additionally, during the survey, it was interesting to note that many respondents mentioned 'the place with binoculars' when they were looking for the location of Hide and Island III on the map. Therefore, the availability of binoculars could facilitate the perception.

7.5.6.5 Benefits and expectations for wildlife habitat service

By discussing perceived species richness and identifying PWH hotspots, the benefits and expectations of these sites were revealed. The PWH helps satisfy some curiosity and inquisitiveness. In TDWP, Evan shared, 'I was passing by when I spotted this bird (at the same time showed a video of a white-breasted waterhen he took), so I sat down to see it up close. I'm curious as to what this is. This is the first time I saw it; I thought it is very attractive.' And he further stated that 'there will be more things to look at and learn about if there is more variety wildlife.'

It seems that the opportunity to see the creatures is likely more important to visitors than whether they are wild. Also, respondents emphasised the importance of prioritising the enjoyment of a wildlife-rich environment over the counting of species. Notwithstanding the fact that some species may not be wild, Elijah stated his acceptance of bird collecting and feeding in the WP.

> *I counted more than ten bird species on the signage boards, but I didn't see many of them in person. Some of the water birds in the park are most likely captive-bred, as they been here as soon as the park was constructed. They can't be wild. Even though they were human-bred, to have these birds in such a park in the city centre is extremely good.*

(Elijah, male, age of 45-54 years, high school equivalent degree, spent 1-3 hours on site, HNWP)

Besides, Jenifer in TDWP stated, 'I doubt there would be any birds. Birds will not come here since the plants are not diversified and are unhealthy (withered). It would be preferable if the managers could bring in and feed some birds in this wetland park.'

> *There are many plants, at least two hundred species. There are probably forty or fifty species of birds. But it doesn't really matter to me, it's something you experts are concerned about. Having such a comfortable place to sit and relax in the breeze is fine enough for me.*

(Grey, male, age of 45-54 years, bachelor's degree, spent 3-5 hours on site, interviewed in HNWP)

In addition to merely being in a natural setting with wildlife, interaction with the animals was also expected:

> *There are many plants, but there are too few birds (I've seen less than ten). Before the epidemic, I travelled to Europe and New Zealand, where I saw ducks and swans on the lakes. Birds and squirrels will come and eat breadcrumbs if I sit and feed them. Interacting with the animals was fantastic. Although ducks and herons can be seen at Haizhu Lake, they are too far away from humans to interact with them, and there aren't quite enough of them in terms of number and variety.*

(Francis, male, elder than 65 years old, master's degree and above, spent 1-3 hours on site, interviewed in HNWP)

Throughout the interviews, it was discovered that respondents preferred to talk about birds over flora. There was consensus that plants are favourable if they are abundant. Yet, Anthony reckoned that 'the plants here are abundant but sparse; if they could recur on a larger scale, they would be more attractive.'

7.5.7 Does the perception match measured habitat wildlife service?

7.5.7.1 Overall perception

The overall PWH was slightly higher in Haizhu National Wetland Park (HNWP) than in Tianhe Daguan Wetland Park (TDWP), which was consistent with the technical understandings of the wildlife habitat quality at the two sites, given that HNWP is larger in size, contains a greater variety of wetland types, and has a greater plant and bird species richness (Table 7-18, and Table 7-19).

7.5.7.2 Species richness

When asked to estimate species richness, only a small number of respondents came anywhere close to the actual number based on a comparison to scientific data. Of the 67 people who provided responses about the richness of plant species in TDWP (Table 7-18), 5.8% had an estimation that was close to the actual count (114 species). The largest group of people who estimate a range of species richness (15 responses) came close to the number of species that are very easy to see (i.e., trees). Another 7.5% of respondents perceived the species richness was a little bit higher, and was almost on level with the number of species that are most commonly occurring or easy to observe (i.e., trees and shrubs). 5.8% respondents overestimated the plant species richness. Due to the paucity of data on the richness of plant species in HNWP, no conclusions can be drawn.

The percentage of respondents who accurately estimated the number of bird species was even less (Table 7-19). In TDWP, just 2.5% of respondents estimated a level near to the one-year record by CSs, and none estimated a value close to the total richness over multiple years. The largest group of individuals (10 responses) who estimated a range of species diversity came close to the average number of species recorded per visit. Similar conditions prevailed in HNWP. Just 1.5% of respondents estimated a number comparable to the multi-year total species richness. Another 1.0% of respondents predicted a number close to that recorded within one to six months. The largest group of individuals (15 responses) who estimated a range of species richness was close to the average number of species documented per visit. 4.5% and 3.5% of respondents guessed perceived a number close to the number of species that can be observed on over 80% of fieldworks or that are easily observed, and in over 80% of citizen science reports or that are very easily observed, respectively. The two respondents in HNWP who compared the species diversity to the South China Botanical Garden (SCBG) perceived a species richness that was similar to the technical understanding.

Table 7-18 Comparison of technical understandings and perceptions of perceived plant species richness

Perceived Plant Species Richness	Technical understandings (TDWP)	TDWP (N=77)		Technical understandings (HNWP)	HNWP (N=101)	
		F	%		F	%
I didn't paid attention to it		13	16.88		36	35.64
[1-20]	13 (very easy to see) 13 (trees)	15	19.48		5	4.95
[21-50]	22 (trees and shrubs) 25 (most frequently occurring) 28 (easy or very easy to see)	9	11.69		1	0.99
[51-100]	89 (in the northern part)	7	9.09		8	7.92
[101-200]	114 (in total)	7	9.09		10	9.90
[201-500]		1	1.30		10	9.90
[501-1000]		2	2.60	625 (Huang et al., 2018) (include all regions in Haizhu Wetlands)	3	2.97
[>1000]		4	5.19		1	0.99
I don't know, but there must be a lot		15	19.48		19	18.81
I don't know, but there must be a few		1	1.30		5	4.95
I don't know, but not as much as the Botanical Garden		3	3.90		3	2.97

Table 7-19 Comparison of technical understandings *and perceptions of perceived bird species richness*

Perceived Bird Species Richness	Technical understandings (TDWP)[42]	TDWP (N=77)		Technical understandings (HNWP)	HNWP (N=101)	
		F	%		F	%
I didn't paid attention to it		21	27.27		38	37.62
[1-10]		26	33.77	6 (recorded by more than 80% of citizen science reports) 5 (very easy to see)	7	6.93
[11-20]	18 (average, per visit)	10	12.99	12-14 (in the Haizhu Lake more than 80% of visits) 13 (easy to see) 18 (average, per visit, Wetlands Phase 1) 19 (in the Wetlands Phase 1 and 2 more than 80% of visits)	9	8.91
[21-50]	24 (annual CS records, 2019-10-01 – 2020-09-30) 48 (annual CS records, 2020-10-01 – 2021-09-30)	3	3.90	21 (average, per visit by CSs) 25 (average, per visit in October) 27 (average, per visit in January) 32 - 41 (each month or >3/4 year) 47 (average, per month by CSs)	15	14.85
[51-100]	51 (species recorded at least twice) 54 (annual CS records, 2021-10-01 – 2022-09-30) 64 (all years' citizen science records)	0	0.00	58 (October) 55 (January) 67 (two months' records) 59 - 77 (>1/4 year or >1/2 years)	2	1.98
[>100]		2	2.60	167 (three years' citizen science records) 107 (at least two months in citizen science records)	3	2.97
I don't know, but there must be a lot		2	2.60		12	11.88
I don't know, but there must be a few		13	16.88		13	12.87
I don't know, but it's similar to the SCBG		0	0.00	180 (three years' citizen science records)	1	0.99
I don't know, but not as much as the		0	0.00		1	0.99

[42] The TDWP's technical understandings were obtained from BirdReport by conducting a simple search and utilising the numbers provided. There have been 64 total reports from the platform's establishment through 2023-03-03. When calculating the average number of species per visit, only reports containing more than five species were included.

SCBG						

7.5.7.3 Spatial variation

In TDWP, when ranking images by perceived plant diversity, nearly all respondents correctly identified the location with the lowest reported plant diversity. Yet, a community of larger, regularly aligned plants may be perceived as having greater plant diversity than a community of tiny herbaceous plants randomly dispersed, which was inverse to the technical understandings.

In HNWP, the perception findings show that respondents who had only been to Haizhu Lake (HL) rated higher PWH than those only been to Wetlands Phase 1 and 2 (P1&2), was converse to most indices indicating that there were higher richness and abundance of birds in the Wetlands Phase 1 (P1). A possible factor that determines the perception may be the relative density of birds, as there were more species observed per 250-metre walk in HL than that in P1&2. Another possible reason behind this phenomenon could be that a substantial proportion of those who only visited P1&2 only visited P1 which is closer to the entrance that more accessible, and the species richness and relative abundance of P1 were actually lower than those of HL. If the latter is the case, then perception and reality roughly correspond.

Specific to places in HL, hotspots of PWH broadly corresponded with relevant technical understandings. All hotspots of PWH were examined to performed better as bird habitat as a result of field surveys.

Areas around Plank and Islands I and II had the highest species richness in both months, and had a high species abundance among Plots B and Plots C. However, they ranked lower among the perceived hotspots. A relative smaller proportion of easily or very easily observable birds may explain this phenomenon.

The Plank and Island II was perceived to provide better habitat for wildlife than the Plank and Island I, despite the fact that their biodiversity is comparable. This can be explained by the placement of signage boards with species information, as there were signage boards with 10 species positioned along the path through the Plank and Island II, but none near the Plank and Island I.

However, the wildlife habitat service of the Flower Field was underestimated, as none of the respondents emphasised the Flower Field as an ideal habitat, despite its medium bird species diversity and abundance. The underestimation of the WHS of the Flower Field may be due to a lack of knowledge of visitors that the nectar and seeds of flowering plants can serve as food sources for birds; it may also be due to the fact that there were usually fewer visitors present when more birds were spotted in the Flower Field, thereby limiting the number of people who can observe a large number of birds in the Flower Field. Besides, Flower Field has the largest proportion of very difficultly observable individuals. This may explain why the wildlife habitat service of the Flower Field was underestimated, although it has a moderate species richness in both months and a high abundance in January. Besides, seasonal replacement of flowering plants and high visitor volume during peak blooming may make the flower field unsuitable for bird nesting, limiting its use to foraging. Therefore, visitors with relevant knowledge may not consider the flower field a suitable bird habitat.

In summary, **it is possible to perceive and estimate wildlife habitat service on a spatial level**, though achieving a considerable amount of accuracy with regards to the number of species is challenging. A greater degree of accuracy was found in the estimation of plant species richness compared to that of birds.

7.5.8 Factors influencing perception of wildlife habitat service

7.5.8.1 What indices could be used to predict perception of wildlife habitat service

(1) Plants

After matching technical understandings and perceived plant species richness, it was discovered that **potential indices influence the perceived plant species richness ratings from extremely likely to less likely with the following: (1) number of species that are very easy to see (e.g., trees); (2) number of species that are easy to see (e.g., trees and shrubs); (3) number of species that occurred most frequently.** This finding aligns with prior research indicating that less common species are less likely to be detected, thus impacting the overall perception of species richness (Southon *et al.*, 2018). This thesis suggests that additional quantitative research be conducted to evaluate and substantiate the influence of these indices on perceived plant species diversity.

(2) Birds

After connecting technical understandings and perceived bird species richness (Table 7-19), it was found that **the potential indices influence the perceived bird species richness rated from extremely likely to less likely to be the following: (1) number of species encountered per visit or per month on average; (2) number of the most common species or number of species that are easy to see; (3) number of species that are very easy to see;** (4) number of species that occurred in at least two months of the year or throughout multiple years; (5) number of species that occurred in a month to six months. Follow-up quantitative research is suggested for evaluating and confirming the influence of these indices on perceived bird species richness more precisely.

It should be noted that it is possible that these indices found by connecting technical understandings and perceptions were due to coincidence. Hence, these indicators should not be taken as absolute truths, but as hypotheses to be tested.

7.5.8.2 What other factors influence perception of wildlife habitat service?

Factors that influence ratings of PWH and perceived species richness were summarized and illustrated in Figure 7-43.

Environmentally, in addition to the measured species richness (as summarised in Section 7.5.8.1), the perceived species richness also influenced by settings of WPs including number of species shown on publications or signage boards on site, availability of equipment such as binoculars, and wildlife-related events such as bird-watching competition. Because visitors' psychological well-being is associated with their perception of species diversity (Dallimer *et al.*, 2012, p. 47), enhancing these aspects will assist in increasing the public's satisfaction with the wildlife habitat service and their well-being.

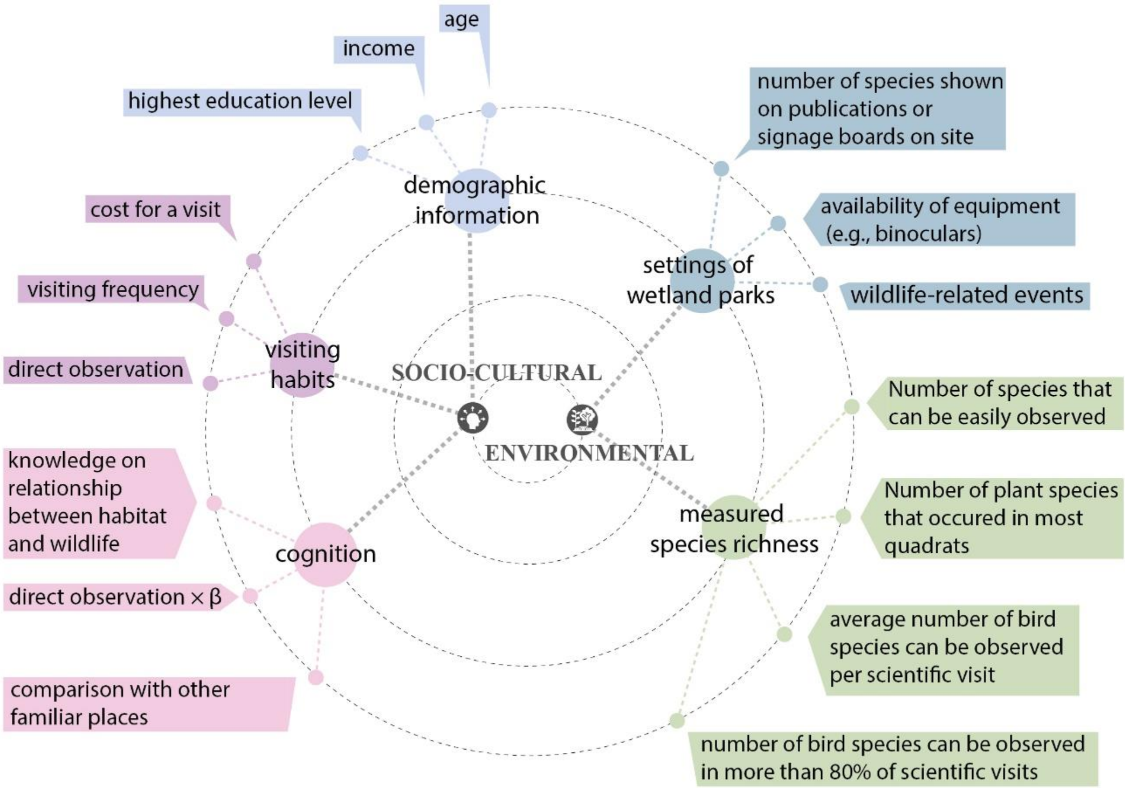


Figure 7-43 Dimensions of visitors' perception on wildlife habitat

Socio-culturally, visitors' demographic information, visiting habits, and cognition, influence the ratings of PWH and perceived species richness.

Age (in TDWP) and highest education level (in HNWP) was negatively correlated with the rating of PWH. In HNWP, the influence of age and income was only found in perception on habitat for aquatic animals, and the influence of highest education level was found in perception on habitat for aquatic animals and birds.

Given that China's urbanisation has primarily taken place within the past four decades, it is likely that most seniors spent their youth in rural areas and thus have more familiarity with fishing, leading to a greater awareness of aquatic animals. Meanwhile, China has undergone significant environmental degradation and subsequent ecological restoration over the past four decades. The quality of wildlife habitat of WPs may not have reached the same standard as those experienced by older respondents in their youth, while it might be better than what younger respondents have experienced in their youth. Considering that older adults generally derive more benefits from wildlife compared to young adults (McGinlay *et al.*, 2018), increasing the perceived diversity of plants and birds among older adults is important for enhancing their perceived benefits from wildlife habitat.

Although less-educated respondents rated higher in wildlife habitat service in TDWP, well-educated respondents rated aquatic animal and avian diversity higher in HNWP, with no difference in overall rating between education groups. Well-educated visitors may be aware of the negative factors in wildlife habitat found in TDWP, such as its small size and proximity to roads. In comparison, HNWP offers a larger area and a greater diversity of habitat types, making it considered to be more suitable for birds and aquatic plants.

In TDWP, the rating of PWH was negatively correlated with cost for a visit while positively correlated with visiting frequency. Higher visiting frequency may allow visitors observe more species, and perceiving higher biodiversity may motivated visitors to visit the WP more frequently. Furthermore, species richness can be determined through direct observation when visitors using the WPs. Even when conducting surveys, observers could see more birds if they exerted more effort: if observers rush around a plot, they will miss species that are quiet or skulking (Bibby, Burgess and Hill, 1992, p. 28); not to mention laypeople would missed most species during their visits. Moreover, several species are alike in appearance (e.g., little egret and great egret, *Phragmites australis* and *Arundo donax*), making it difficult for laypeople to identify between them, even if they have seen them. This may result in a lower perception of species richness than there actually is.

Cognitively, coefficient assignment based on direct observation, comparison with other familiar places, and knowledge on relationship between habitat and wildlife, were factors that influence the perception of species richness. People’s basic knowledge of habitats (e.g., the negative impacts of human disturbance on habitats) and the park’s urban surroundings and proximity to metropolitan highways may have led many respondents to the underestimation. One possible explanation of the gap between the perception and scientific measurement could due to some species such as egrets and herons may have adapted to repetitive roadway noise (Morrison, Marcot and Mannan, 2006, p. 137), resulting in more birds than expected being observed in surveys. Interestingly, whereas prior research has indicated that individuals tend to favour environments featuring birdsongs due to their restorative effects (Hedblom *et al.*, 2014; X. Zhu *et al.*, 2020), the present study did not see any influence of birdsong exposure on the perception of bird species richness and on ratings of wildlife habitat service.

7.5.9 Limitations and outlooks

Like other research, this study is subject to certain limitations. First, field surveys of birds were conducted only in two months and all in autumn to winter. However, CS data and another survey during 2013 and 2015 in HNWP (Tang *et al.*, 2018) both suggest that October through April averaged more species than May through September. Therefore, it is considered to be acceptable that both field surveys for this study were undertaken between October and April, when more birds were present. Further studies involving long-term monitoring of wildlife would significantly strengthen the findings.

The Quality Improvement Project conducted during 2019 to 2021 may influence the validity of the CS data. During these years, some birds may have relocated within HNWP, while others may have left HNWP due to the construction's effects. However, most WPs in China are undergoing frequent renovation and renewal to improve their ecological and social qualities, making it difficult to conduct a study during a period with no renovations. Nonetheless, findings of this research can offer insights for the ongoing renovations of WPs and other natural parks, thereby increasing their capacity to promote publics' satisfaction and well-being.

Density, reproductive success, and survival rate are all part of the habitat quality metric; density do not always indicate a healthy environment (Horne, 1983). However, data collection for examining offspring production and survival was time-consuming and labour-intensive, and offspring production and survival rate were difficult for laypersons to comprehend. Density, richness, and other indices are deemed acceptable for providing scientific evidence for comparison with public perception. Walking along the trail may not provide an accurate estimate of overall bird indices because it may be far from the home range of some species; however, because the trails chosen for the survey were those most frequently used by visitors, the bird count data would be comparable to those perceived/observed by visitors.

Birds may migrate or change home range; because of these movements, species abundance, diversity and composition that can be observed in a certain place fluctuates, and not all patches may be permanently occupied. In addition, throughout their home range, animals devote different amounts of time to each activity and place each day (Morrison, Marcot and Mannan, 2006). Therefore, indirectly measurement of habitat quality using birds as indicators may not reveal the whole picture of the habitat. However, the presence of a high number of birds in a particular location may indicate that the habitat quality of said location is relatively favourable.

Additionally, a much higher proportion of easily observable individuals were found around the Islands III and IV; this may due to they are distant from the route and tiny birds were hard to spot and record. The lack of access to the islands for observation lead to a limitation of this study. However, since visitors are also prohibited from setting foot on the islands, the data collected and used for this study is a reasonable proxy for comparison with visitors' perception data.

Respondents of this study were park visitors, with more female and well-educated individuals engaged, thus the sample may not represent the population in its entirety. Nevertheless, because it is a random sample, it is expected to be representative of the majority of WP visitors. For a more precise evaluation and confirmation of the impact of the factors identified in this study on PWH, future research could be quantitatively conducted with a larger sample size and include non-users of the WPs.

7.6 Aesthetic value

Ecosystems offer locations and opportunity for aesthetic appreciation, which could promote mental health, enhance a subjective sense of culture or place, and deepen objective understanding of natural and social science (Millennium Ecosystem Assessment, 2005). Aesthetics of the landscape is a vital link between humans and ecological processes. The sensory system and emotional life of humans are tightly interwoven, and among these emotions, pleasure exerts an especially strong influence on how we respond to environmental stimuli. Moreover, aesthetic experience can drive landscape change and influence landscape management and policy. For example, aesthetic landscape planning, such as that utilised in the Lower Wisconsin State Riverway, could be a politically viable strategy for conserving biodiversity (Hale et al., 2005). Furthermore, individual aesthetic preferences that result in decisions and actions can have enormous effects on landscapes and ecosystems when combined across larger social and societal levels (Gobster et al., 2007, p. 964). Although auditory and olfactory stimuli can evoke aesthetic appreciation, visual experience still predominates. Visual landscape assessment is mainly used to evaluate the aesthetics of a landscape. Hence, this study focus on visual aesthetic value of the landscape, and all subsequent discussions of aesthetics will refer to visual aesthetics.

7.6.1 Aesthetic value in the ecosystem service cascade

As an ES, aesthetic value is subject to the ES cascade or ES flow (Potschin and Haines-Young, 2011; Tallis *et al.*, 2012; Bagstad *et al.*, 2014). Studies have examined the aesthetic value flow at the landscape scale or regional scale to identify the spatial relationships between service-providing areas and service-receiving areas in order to eliminate the spatial disparity between them (Egarter Vigl *et al.*, 2017; Langemeyer, Calcagni and Baró, 2018). Nonetheless, in addition to spatial disparity, there are also disparities in the cascade of ESs within the same space, i.e., the utilisation of capacity becomes benefits when humans perceive it; this is what this study seeks to examine.

Aesthetic value in the most widespread ES frameworks emphasises landscape aesthetics, particularly scenic beauty (Daniel *et al.*, 2012). Therefore, theories on landscape aesthetics or scenic beauty could be used in AES studies. Since the advent of landscape aesthetics, various philosophical schools have taken an objective or subjective position on what constitutes beauty. The objectivist paradigm views that landscape quality is an inherent feature of the physical landscape; while the subjectivist paradigm is founded on the interpretation of what is observed via memories, associations, imagination, and any symbolism it elicits (Lothian, 1999, p. 178). **The objectivist paradigm corresponds to the supply capacity of aesthetic value in the ES cascade, whereas the subjectivist paradigm corresponds to the perceived benefits by individuals.**

Studies assess the supply capacity (i.e., objectivist paradigm) usually conducted based on pre-selected criteria or evaluation indices derived from previous research; each study employed a unique set of criteria or indices, with various weighs (e.g., (Luo *et al.*, 2022; Zhang, 2022)). ES estimating tools utilise a range of indicators to assess aesthetic value as well. These indicators differ across tools, as there is no standardised system in place. Viewshed, the area that can be visible a specific vantage point, which is similar to the concept of the visual scale (Tveit, Ode and Fry, 2006), is the indicator that used by most computer-based tools for aesthetic value (such as InVEST, ARIES, and ESII (Villa *et al.*, 2014; Guertin *et al.*, 2019; Natural Capital Project, 2022). Other indicators such as flower abundance and diversity, tree size, landscape diversity or habitat mosaic, water body naturalness, nature designations, number of houses bordering natural areas, were used by other tools (Value of Nature to Canadians Study, 2017; Smith *et al.*, 2021; Hölzinger *et al.*, 2022).

For perception of aesthetic value, Scenic Beauty Estimation method (Daniel and Boster, 1976) and the Law of Comparative Judgement (Buhyoff, 1978) are two approaches in common use (Hull, 1986); they used image as stimuli for participants view and rating the scenic beauty of landscape. In addition to ratings, ranking tasks with photographs as stimuli have been used to evaluate the visual quality of landscapes (Arriaza et al., 2004). Recently, more evidence of landscape perception was found by examine psychological and physiological response of landscape scenes stimuli recorded by electroencephalogram (e.g.,(Chiang, Li and Jane, 2017)), electromyography, electro-cephalography, and blood volume pulse measurements (Chang *et al.*, 2008).

7.6.2 Attributes that influence aesthetic perception: literature review

Gestalt principles in visual perception result in distinct regions within the visual field, where elements are perceived as grouped or as a whole; this leads to an object stand out from its environment (Wagemans *et al.*, 2012). Thus, the perception of a landscape as a whole may be influenced by the perception of a single object. Numerous factors have been identified as indicators for assessing the aesthetics of a landscape. Indicators commonly used in landscape aesthetic assessment including the framework consist of nine visual concepts[43] proposed by Tveit, Ode and Fry (2006), the four informational factors in an environmental preferences matrix[44] proposed by Kaplan and Kaplan (1989), the landscape properties within the paradigms proposed by Zube, Sell and Taylor (1982), and mixed of picked indicators from those frameworks (e.g.,(Herzog, 1985,

[43] The visual concepts include: stewardship, coherence, disturbance, historicity, visual scale, imageability, complexity, naturalness, and ephemera.

[44] The environmental preferences matrix based on the two basic informational needs – understanding and exploration – and with four informational factors including coherence, legibility, complexity, and mystery.

1989; Tenerelli, Püffel and Luque, 2017)). Based on the studies mentioned above, more and more detailed influencing factors have been identified from studies at various scales (e.g., from a tree to landscape) and various landscapes (e.g., forests, wetlands, green roofs, and gardens). **These identified criteria were classified into five categories in two camps (Table 7-20)**. The majority of these factors are familiar to scholars in Western countries, with the exception of 'Yijing(意境),' a term that has a significant impact on aesthetics within the framework of Chinese culture.

Specific to wetlands, It has been demonstrated that the presence of trees, quantity of water, and perceived wetland health (i.e., water quality) can predict the public aesthetic preference of wetlands in Melbourne, Australia (Dobbie, 2013). When taking a close look at photographs of wetlands[45], water transparency and colour, the presence and appearance of aquatic vegetation, the presence of sediments, and trophic status, were criteria that strongly influence people's perception of aesthetical values of wetlands in France (Cottet, Piégay and Bornette, 2013). Nonetheless, factors that influence the real-world perception are not limited to a particular scale or perspective. Thus, it is necessary to explore which factors have a greater impact on real-world perception of wetlands.

In summary, a better understanding on aesthetic value of urban wetlands is needed, while current evaluation of aesthetic value of wetlands lacks a standardised index system that provides empirical guidance on the selection and weighting of indicators. Further, most current index system overlooks the contextual factors such as culture and scale that may have an impact on the assessment. In addition, current aesthetics assessment tools are difficult to provide an implementable basis for enhancing the aesthetics services of the landscape due to the lack of connection to the real landscape. This study adopts a subjectivist perspective while acknowledging the importance of objectivist assessment. **The objectives of this study are to determine the degree to which visitors' perceptions of aesthetic value of WPs align with the supply capacity (i.e., an objective assessment) and to identify the key factors that influence perceptions. Therefore, to contribute to the development of the index system for expert-based aesthetic value evaluation, which can be applied either manually or through computer-based tools.**

[45] Photos used in this study showed partial views wetlands, including the water surface, and/or aquatic plants, substrate.

Table 7-20 Factors that influence aesthetics preference (checklist from literature review)

Factors that influence visual preference	Description	References
1. Overall Landscape		
Stewardship/Orderliness (cues to care)	A reflection of human management that shows how carefully the land was managed.	(Nassauer, 1995; Sheppard, 2001; Tveit, Ode and Fry, 2006; Dobbie, 2013; Kirillova et al., 2014)
Coherence/harmony/balance	A reflection of the cohesion of a scene and the correspondence between land use and natural conditions in a region.	(Smardon, 1975; Kaplan and Kaplan, 1989; Sheppard, 2001; Tveit, Ode and Fry, 2006; Kirillova et al., 2014)
Disturbance Lack of visually disturbing detractors	A reflection of inconsistency or misalignment with the surrounding context.	(Laurie, 1975; Tveit, Ode and Fry, 2006)
Historicity	Include the visual presence of various time layers as well as the condition and diversity of cultural elements.	(Tveit, Ode and Fry, 2006; Kirillova et al., 2014)
Visual scale (e.g., landscape room, visibility, openness, enclosure, spaciousness)	The perceptual units that encompass the experience of landscape room, visibility, and openness.	(Tveit, Ode and Fry, 2006; Dobbie, 2013; Kirillova et al., 2014)
Imageability[46] / Sense of place /Uniqueness/novelty	A quality of a landscape that is present in its entirety or through elements that make it distinct and memorable.	(Tveit, Ode and Fry, 2006; Kirillova et al., 2014)
Complexity/Diversity/richness	The number of elements that can be perceived independently within a scene.	(Laurie, 1975; Smardon, 1975; Zube, Sell and Taylor, 1982; Kaplan and Kaplan, 1989; Tveit, Ode and Fry, 2006; Kirillova *et al.*, 2014)
Naturalness/ wilderness	How closely a landscape resembles its perceived natural condition.	(Sheppard, 2001; Arriaza et al., 2004; Tveit, Ode and Fry, 2006; Dobbie, 2013)
Ephemera (e.g., seasonal/weather changes, atmospheric haze)	Contains elements that change with season and weather.	(Tveit, Ode and Fry, 2006)
Layers/depth	The scene could be divided into distinct planes, such as foreground, middle ground, and background, thus creating a sense of depth.	(Ulrich, 1983; Yu, 1999)
Evidence of design	Signs indicate that the entire or a portion of the landscape was designed by humans.	(Laurie, 1975)

[46] The Imageability was defined as "qualities of a landscape present in totality or through elements; landmarks and special features, both natural and cultural, making the landscape create a strong visual image in the observer, and making landscapes distinguishable and memorable" by Tveit, Ode and Fry (2006)

2. Landscape elements		
[Water/wetlands] - Water quality, transparency and colour	-	(Laurie, 1975; Gregory and Davis, 1993; Yu, 1999; Cottet, Piégay and Bornette, 2013; Dobbie, 2013)
[Water/wetlands] - The presence of aquatic vegetation	-	(Cottet, Piégay and Bornette, 2013; Dobbie, 2013)
[Water/wetlands] - The presence of sediment	-	(Cottet, Piégay and Bornette, 2013)
[Water/wetlands] - Amount of water visible	-	(Smardon, 1975; Gregory and Davis, 1993; Arriaza *et al.*, 2004; Howley, 2011; Dobbie, 2013)
[Water/wetlands] - Wetland-type diversity	The variety of different wetland types, e.g., swamps, marshes, lakes.	(Smardon, 1975)
[Water/wetlands] - Quite – wavy waterbody, flow level	In relation to water flow volume.	(Yu, 1999; Pflüger, Rackham and Larned, 2010)
[Water/wetlands] - Reflecting water	-	(Cottet, Piégay and Bornette, 2013)
[Water/wetlands] - Wood in water	-	(Piégay et al., 2005)
[Vegetation] - Health of vegetation (lush-arid)	-	(Laurie, 1975; Dobbie, 2013)
[Vegetation] -Vegetation characteristics (e.g., leaves, height, colour, flowers, canopies)	Characteristics that contribute to the attractiveness of vegetation.	(Hoyle, Hitchmough and Jorgensen, 2017; Zhao, Xu and Li, 2017)
[Vegetation] -Vegetation species	Preference for particular plant species (e.g., *Eucalyptus*).	(Williams and Cary, 2002)
[Vegetation] -Vegetation coverage	The proportion of land covered by vegetation.	(Arriaza et al., 2004)
[Vegetation] -Species richness/diversity	-	(Yu, 1999; de Lacy and Shackleton, 2017)
Presence of mountains/hills, and their shapes		(Yu, 1999; Arriaza et al., 2004)
[Man-made elements] - Positive man-made elements	e.g., roads, industries, power lines	(Arriaza et al., 2004)
[Man-made elements] - Negative man-made elements	e.g., sights and typical houses	(Arriaza et al., 2004)
[Dominating elements] - Man-made elements dominated	-	(Lange, Hehl-Lange and Brewer, 2008)
[Dominating elements] - Vegetation-dominated	-	(Dobbie, 2013)
[Dominating elements] - Water-dominated	-	(Howley, 2011; Dobbie, 2013)
[Colour] - Colour contrast	Contrasting colours in a manner that highlights their differences and creates visual interest.	(Laurie, 1975; Arriaza et al., 2004)
[Colour] - Colour diversity	The variety of colours visible.	(Graves, Pearson and Turner, 2017)

Shape	e.g., round-angular, symmetric-asymmetric, and sophisticated-simplistic.	(Kirillova et al., 2014)
Distinctive elements / adornments (e.g., vegetation distinguished by age or rarity, waterfalls, turbulent rapids)	A distinctive elements or focal point that captures the observer's attention. (e.g., vegetation distinguished by age or rarity, waterfalls, turbulent rapids).	(Lee, 1979; Yu, 1999)
Edge complexity/irregularity	The irregularity of the physical boundary of a wetland where it meets a landform or vegetated edge.	(Smardon, 1975; Lee, 1979)
Wildlife and domestic animals	Presence of animals.	(Laurie, 1975)
3. Cognition		
Mystery	The degree to which a scene suggests additional information that could be discovered by further exploration.	(Lee, 1979; Zube, Sell and Taylor, 1982; Kaplan and Kaplan, 1989)
Prospect-refuge	Seeing without being seen.	(Appleton, 1975; Zube, Sell and Taylor, 1982)
Legibility	This pertains to an individual's capacity to comprehend and identify connections between various components. The viewer could identify connections and distinguish between elements.	(Lee, 1979; Zube, Sell and Taylor, 1982; Kaplan and Kaplan, 1989)
Identifiability	The degree of recognizability, distinguishability, and memorability of specific features, elements, or characteristics within a landscape to an observer.	(Zube, Sell and Taylor, 1982)
Hazard	Anything that can potentially cause harm, damage, or negative consequences to individuals.	(Zube, Sell and Taylor, 1982)
Yijing 意境	Also translated as ‘artistic conception’, literally translates to ‘the realm (boundaries, situation, state) of ideas(concepts)’. The phenomenon of emotional projection with presupposes personal experience and is the interflowing of human beings and the object.	(Zhu, 1983; Zong and De Meyer, 2017)
4. Social-cultural factors		
Familiarity	The extent to which individuals are familiar with, and have a sense of belonging or comfort within the environment.	(Zube, Sell and Taylor, 1982; Dearden, 1984; Kaplan and Kaplan, 1989)
Residential environment	Physical and psychological aspects of a person's living environment.	(Kaplan and Kaplan, 1989)
Locals / tourists	-	(Kaplan and Kaplan, 1989)
Ethnicity	-	(Kaplan and Kaplan, 1989)
Regional culture / Nationality	-	(Masuda et al., 2008; van Zanten et al., 2016)
Subculture (relevant to age)		(Kaplan and Kaplan, 1989)
Specialization (Professionals – lay people)	-	(Kaplan and Kaplan, 1989; Zheng, Zhang and Chen, 2011)

Education level	-	(van Zanten et al., 2016)
5. Synaesthesia		
Sound	The aesthetic experience that certain sounds elicit.	(Kirillova et al., 2014)
Thermal comfort	The aesthetic experience that thermal comfort elicit.	(Febriana and Kaswanto, 2015)

7.6.3 To measure the perception of aesthetic value

7.6.3.1 Questionnaire and semi-structured interview

Self-completion questionnaires and face-to-face semi-structured interviews were designed to assess public perceived aesthetic value. Ratings on aesthetic value (7-point Likert scale questions) were included in the questionnaire. For surveys in both wetland parks (WPs), a 7-point Likert scale question on agreement was asked: ‘The scenery of this WP is beautiful.’ There are as many different conceptions of ‘what is beauty’ as there are philosophers who have attempted to define it. Ordinary individuals may also have varying conceptions of ‘beauty’. This study contends that providing a clear definition of beauty to participants may impact their evaluations. The research question does not go deeper into the participants’ own definitions of beauty, and therefore, no definition of beauty was included in the survey questions. That is, respondents’ perception of aesthetic value, rather than their definition of it, is what matters.

Based on findings from Tianhe Daguan Wetland Park (TDWP), six detailed 7-point Likert scale questions on agreement were asked additionally in Haizhu National Wetland Park (HNWP): (1) landscapes are diverse in this WP; (2) landscape is unique in this WP (compared to other parks/WPs in Guangzhou); (3) this WP has layering landscape; (4) the plants in this WP are exquisite and beautiful; (5) the plants in this wetland park are growing vigorously; (6) the water in this wetland park is clean and clear.

During the semi-structured interviews, photo-ranking tasks were conducted, followed by photo elicitation interviews; method of preparing photos is presented in the following section. Additionally, in Haizhu Lake of HNWP, participatory mapping tasks were conducted. The following instruction was given to respondents before drawing the polygons, ‘in your experience in Haizhu Lake, are there any places you think has the most beautiful scenery?’ And a follow-up question ‘why do you think they are beautiful?’ were asked.

7.6.3.2 Preparing photos

Two groups of 180° panoramas were used for the photo ranking task in the Tianhe Daguan Wetland Park (TDWP). Panoramas were taken by a DJI OSMO POCKET (a 3-axis stabilized handheld camera). The weather and season were as consistent as possible throughout all images. Panoramas for exploring preference of wetland types were taken on the path or pedestrian bridge with the same handrails at three different spaces in TDWP, showing different types of wetlands in this WP (Figure 7-44). Panoramas for exploring preference of vegetation diversity were taken on three sites with high, medium, and low plant diversity in this WP (Figure 7-45, as discovered in Section 7.5.4). The very left and right part of the three panoramas in the second group were cut out to reduce the impact of the paths. The panoramas were printed on professional photo paper at 254×305mm. Panoramas for the winter survey were taken on 20th December 2020, and those for the summer survey were taken on 14th April 2021.

In HNWP, eight photos show eight typical wetland sceneries in the WP were took (Figure 7-46). The photos have been manipulated so that the horizon line is in the same position in each image. Additionally, two groups of photos (Figure 7-47) of the same location took from the same point of view were used, to explore people's preference of different scenarios. Scenario 1 shows the sceneries before the Quality Improvement Project (QIP), while Scenario 2 shows sceneries after the QIP. Because the colour of flowers varies in seasons, to control the influence of colour (Zhang, Dempsey and Cameron, 2023), the colour of flowers in the Flower Field – Scenario 2 was modified in Photoshop. The results of individual's selection were used in the discrete choice experiment task. The weather and season were as consistent as possible throughout all images, and the photos were printed on professional photo paper at 152× 114mm.

7.6.3.3 Data analysis

Description of pictures were coded into themes, and all expressions relevant to aesthetics were then projected on the list of factors that influence aesthetic appreciation obtained from the aforementioned literature review. Some expressions were simple to match with the checklist's elements, while others were rather specific: for example, the term 'messy' was viewed as the opponent of stewardship or orderliness. 'Bald ground' and 'exposed soil' were linked with 'vegetation coverage' because they were believed to be the result of poor vegetation coverage. 'Calm' was related to Yijing (意境). 'full' was connected to visual scale. The expression about 'pattern planting' was associated with orderliness.

Additionally, to determine the extent to which the data support the themes (Nassaji, 2021), the frequency manifest effect sizes were calculated using the prevalence rate of each theme (Onwuegbuzie and Teddie, 2003). The frequency of occurrence of a theme divided by the total number of individuals constitutes the frequency manifest effect size. The greater the frequency manifest effect size, the stronger the evidence for that theme.

7.6.4 To technically understand aesthetic value of sceneries: content analysis

Studies have evaluated the visual quality of landscapes objectively, but based on pre-selected criteria or evaluation indices derived from previous research; each study employed a unique set of criteria or indices, with various weighs (e.g., (Luo *et al.*, 2022)). Instead of evaluating the visual quality of WPs based on selecting indicators whose applicability to the context is uncertain, this thesis measured the visual quality by presenting the content of scenes and scores that scenes could gain on all reviewed indicators except a few inapplicable ones. For example, the factor of 'dominating elements' was deemed inapplicable due to the presence of a unifying theme and shared characteristics among the various groups of photographs. The contents of sceneries illustrated in photographs used for ranking tasks and interviews were analysed and scored using the scale of measurement shown in Table 7-21. The scale of measurement only includes indicators that can be objectively measured; indicators involving human preference or cognition were omitted.

Semantic-based image segmentation, which groups pixels with the same theme into multiple segments (e.g., sky, road, trees), was performed to prepare data for calculating the proportion of elements over the entire image. The open-source deep learning tool OneFormer (Jain *et al.*, 2022) was used for the segmentation. Images were further corrected manually in Adobe Photoshop if any details were misidentified. The ratio of each segment's pixels to the total image's pixels was then determined.

Table 7-21 Measurement scale for landscape attributes and elements

Variable		**Scoring**	
Overall Landscape			
Stewardship/Orderliness		1	Low level (e.g., presence of waste or weed)
		2	Middle level
		3	High level (e.g., freshly pruned plants, tidy fences, very clear water)
Coherence/harmony/balance		1	Low level (e.g., no repeating colours and patterns, land use does not in correspondence with natural conditions)
		2	Middle level (e.g., some repeating colours and patterns, land use in correspondence with natural conditions)
		3	High level (e.g., large proportion of repeating colours and patterns, large proportion of land use in correspondence with natural conditions)
Disturbance Lack of visually disturbing detractors		Proportion of disturbing elements (e.g., motorway, urban elements, temporary construction) in the scene 0 = 0; 1-10% = 1; 11-20% = 2; ≥21% = 3	
Historicity		Proportion of historical/cultural elements: 0 = 0; 1-25% = 1; 26-50% = 2; ≥51% = 3	
Visual scale		Proportion of open land/water (i.e., land/water devoid of trees and bushes), except sky 0 = 0; 1-30% = 1; 31-60% = 2; ≥61% = 3	
Imageability / Sense of place /Uniqueness/novelty		Proportion of landmarks and special features that are rare in Guangzhou: 0 = 0; 1-25% = 1; 26-50% = 2; ≥51% = 3	
Complexity/Diversity/richness		Number of types of objects (e.g., sky, tree, shrub, herbaceous plants, water, rock) 1-5 types = 1; 6-10 types = 2; ≥11 types = 3	
Naturalness/ wilderness		1	Low level (e.g., vegetation and water with clear boundary)
		2	Middle level
		3	High level (e.g., vegetation and water with fuzzy boundary, wild vegetation or unintended natural elements appears)
Ephemera (e.g., seasonal change, weather changes, Atmospheric haze)		Proportion of elements with seasonal change (e.g., red leaves, water level) or shows good weather: 0 = 0; 1-25% = 1; 26-50% = 2; ≥51% = 3	
Layers		Number of layers (i.e., presence of elements in foreground, middle ground, and background): 1 = 1; 2 = 2; 3 = 3;	
Evidence of design		Proportion of man-made elements (i.e., bridge, footpath; except city buildings on the background) and ornamental elements: 0 = 0; 1-25% = 1; 26-50% = 2; ≥51% = 3	
Landscape elements			
Water/ wetlands	Water quality, Water transparency and colour	1	Muddy water
		2	Neither muddy nor clear, there is no visible substrate
		3	Transparent water with visible substrate
	The presence of aquatic vegetation	Proportion of aquatic vegetation: 0 = 0; 1-25% = 1; 26-50% = 2, ≥ 51% = 3	
	The presence of sediment	Proportion of sediment: 0 = 0; 1-25% = 1; 26-50% = 2, ≥ 51% = 3	
	Amount of water	Proportion of water: 0 = 0; 1-25% = 1; 26-50% = 2, ≥ 51% = 3	
	Wetland-type diversity	The number of different wetland types: 1 = 1; 2=2; ≥3 = 3	
	Quite – wavy waterbody; flow level	1	Quite water
		2	Water with shallow waves
		3	Wavy water
	Reflecting water	0	Not reflecting water
		3	reflecting water
	Wood in water	0	With wood in water
		3	Without wood in water

vegetation	Health of vegetation (Lush-arid)	Proportion of brown/withered/dry vegetation among all vegetation: 0 = 3; 1-25% = 2; 26-50% = 1, ≥ 51% = 0
	Vegetation characteristics (e.g., leaves, height, colour, flowers, canopies)	Proportion of vegetation with attractive characteristics (e.g., spreading canopies, flowers) among all vegetation: 0 = 0; 1-25% = 1; 26-50% = 2, ≥ 51% = 3
	Vegetation coverage	Proportion of land that is devoid of vegetation (bare land): ≥ 51% = 0; 26-50% = 1, 11-25%= 2; 0-10% = 3;
	Species richness/diversity	Number of vegetation species that is easily to be distinguished: 1-5 = 1; 6-10 = 2; ≥11 = 3
Presence of mountains/hills, and their shapes		0 No mountain 1 Common shapes 2 Uncommon shapes 3 Very unique shapes
Man-made elements	Positive man-made elements	Proportion of positive man-made elements: 0 = 0; 1-25% = 1; 26-50% = 2, ≥ 51% = 3
	Negative man-made elements	Proportion of negative man-made elements: 0 = 3; 1-25% = 2; 26-50% = 1, ≥ 51% = 0
Colour	Colour contrast	Not included= 0; included = 3
	Colour diversity	One colour = 1; two colours = 2; three or more colours = 3
Shape		Presence of any geometric shapes (e.g., round-angular) Not included= 0; included = 3
Distinctive elements / adornments		Not included= 0; included = 3
Edge complexity/irregularity		Smooth edge = 0; Irregular shaped edge = 3
Wildlife and domestic animals		Not included= 0; included = 3

Note:
Unless otherwise specified, all proportions have the entire scene as their denominator.

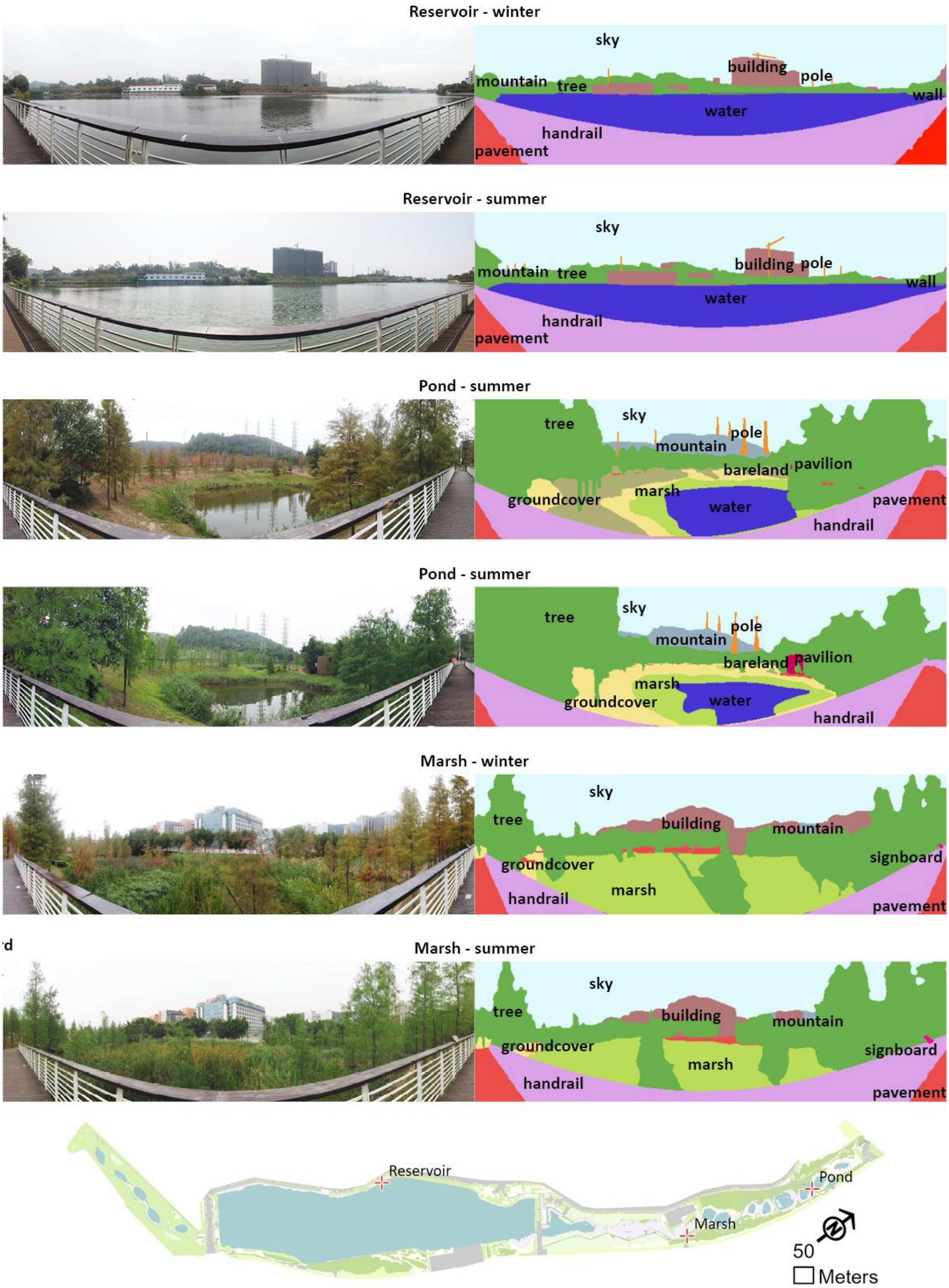


Figure 7-44 Content analysis of panoramas used for photo ranking (Tianhe Daguan Wetland Park; wetland types – Reservoir, Pond and Marsh; the map shows where the panoramas were shot)

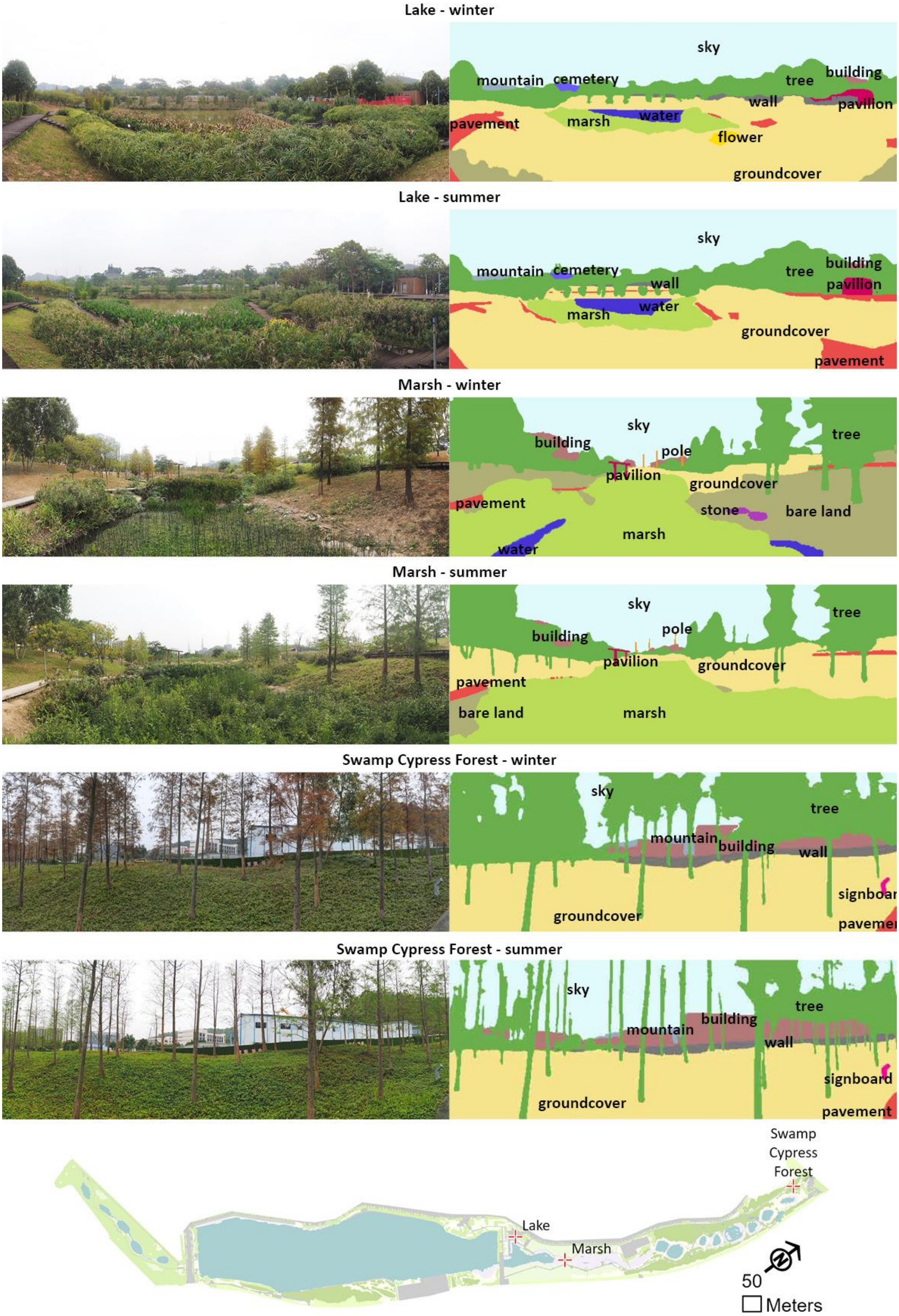


Figure 7-45 Content analysis of panoramas used for photo ranking (Tianhe Daguan Wetland Park; plant diversity; the map shows where the panoramas were shot)

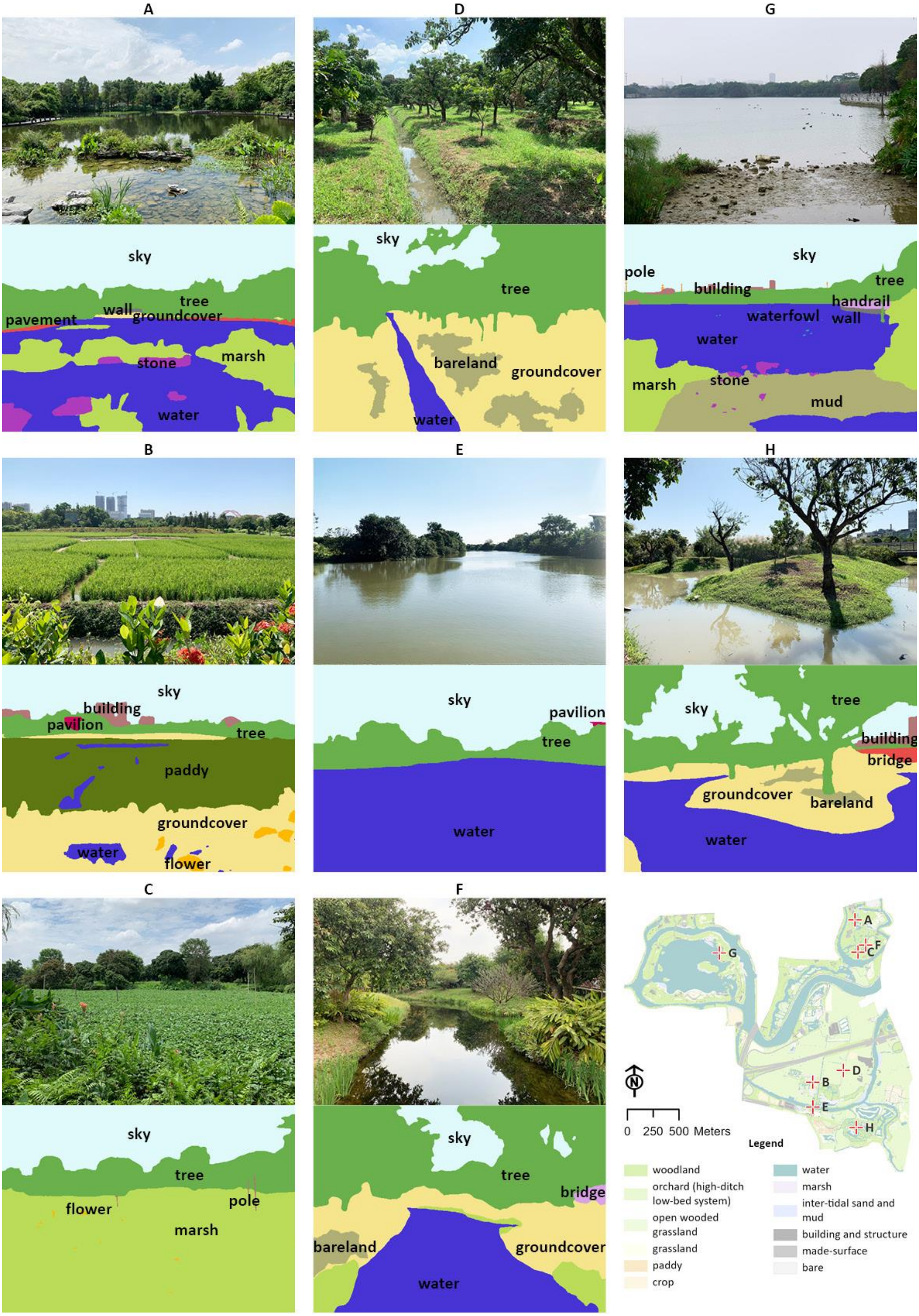


Figure 7-46 Content analysis of photos used for photo ranking (Haizhu National Wetland Park; wetland types; the map shows where the photos were shot)

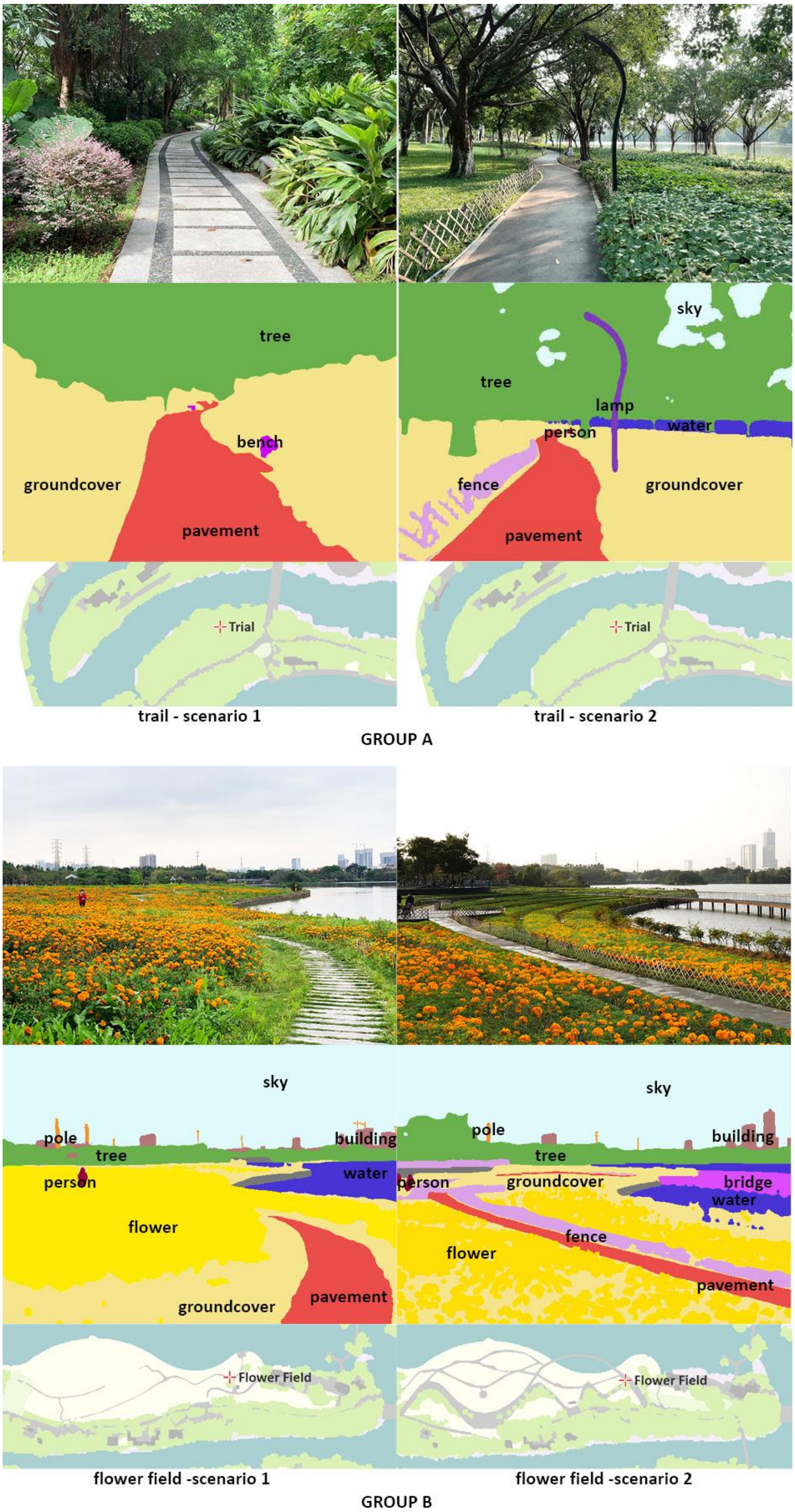


Figure 7-47 Content analysis of two groups of photos of various scenarios (Haizhu National Wetland Park; the maps show where the photos were shot)

7.6.5 Technical understanding of the aesthetic value of examined sceneries

The scoring analysis showed that twelve panoramas of TDWP (Figure 7-44 and Figure 7-45) do not exhibit signs of historicity, ephemeral characteristics, sediment, wood in water, and animals. The six panoramas varying in **wetland types** do not exhibit distinctive elements, edge complexity. All these six panoramas were rated equally based on their layers, diversity of vegetation, presence of mountains, and man-made elements. While the six panoramas depicting varying levels of **plant diversity** in TDWP are devoid of reflecting water, distinctive element, and received the same score on stewardship, disruption, evidence of design, and negative man-made elements. In both groups of panoramas, winter scene scores were higher than summer scene scores. As for **wetland types**, the general landscape scores were similar, but slightly lower for the Marsh in summer and the Pond in winter. The scores for landscape elements vary, with the Pond receiving the highest score in both seasons, followed by the Reservoir. The Marsh was ranked the lowest. Regarding the other group, the Marsh scored highest for overall landscape, followed by the Lake. However, the Marsh and Lake received similar scores for landscape elements. The Swamp Cypress Forest received the lowest scores in terms of overall landscape and landscape elements.

Among the eight photos illustrating **wetland types** in HNWP (Figure 7-46), the traditional high-bed low-ditch orchard system with longan and lychee were considered as a sign of historicity. All the photos lack signs of wood in water, mountain, obvious colour contrast, obvious positive man-made elements, and distinctive elements. All photos show the same level of health of vegetation. Photos A and B score higher for overall landscape, and Photos A, B, and F score higher for landscape elements. The scores for the eight photographs are ranked in descending order as follows: A, B, F, G, E, H, and C. (Table 7-24)

The two scenarios of the Trial (Figure 7-47) vary in the coherence, disturbance, visual scale, complexity, ephemera, layers, as well as attractive vegetation, vegetation species richness, colour contrast, and edge complexity. Scenario 2 received higher scores in both camps of measurement scales. The two Flower Field scenarios (Figure 7-47) vary in terms of disturbance, naturalness, layers, shape, and edge complexity. Scenario 2 received a slightly higher landscape score overall, while both scenarios received the same score for landscape elements. No signs of wood in water were included in any of the examined scenes. (Table 7-25)

Table 7-22 Content analysis results and whether they were mentioned by respondents (wetland types – open Lake, Marsh and Swamp Cypress Forest) (Tianhe Daguan Wetland Park)

Variable		 Marsh-winter	 Marsh-summer	 Pond-winter	 Pond-summer	 Reservoir-winter	 Reservoir-summer	mentioned by respondents
Overall Landscape								
Stewardship/Orderliness (cues to care)		1	1	2	3	3	3	√
Coherence/harmony/balance		2	2	3	3	3	3	√
Disturbance Lack of visually disturbing detractors		1	1	0	1	1	1	√
Historicity		0	0	0	0	0	0	
Visual scale		2	2	2	2	3	3	√
Imageability / Sense of place /Uniqueness/novelty		2	0	2	0	0	0	√
Complexity/Diversity/richness		2	2	3	3	2	2	√
Naturalness/ wilderness		3	3	2	2	1	1	
Ephemera (e.g., weather changes, sunlight, Atmospheric haze)		3	0	3	0	0	0	
Layers		2	2	2	2	2	2	
Evidence of design		1	1	0	1	1	1	
SUM (overall landscape)		19	14	19	17	19	16	
Landscape elements								
Water/ wetlands	Water quality, Water transparency and colour	0	0	2	2	2	2	√
	The presence and appearance of aquatic vegetation	1	1	1	1	0	0	
	The presence of sediment	0	0	0	0	0	0	
	Amount of water	0	0	1	1	2	2	√
	Wetland-type diversity	1	1	2	2	1	1	
	Quite – wavy waterbody; flow level	0	0	1	1	2	2	
	Reflecting water	0	0	3	3	3	3	√
	Wood in rivers	0	0	0	0	0	0	
vegetation	Health of vegetation (Lush-arid)	1	2	1	3	3	3	√
	Vegetation characteristics (e.g., leaves, height, colour, flowers, canopies)	2	0	2	0	0	0	√
	Vegetation coverage	3	3	2	2	3	3	√
	Species richness/diversity	2	2	2	2	2	2	√

Presence of mountains/hills, and their shapes		1	1	1	1	1	1	√
Man-made elements	positive man-made elements	0	0	0	0	0	0	
	negative man-made elements	2	2	3	3	2	2	√
Colour	Colour contrast	3	0	3	0	3	0	√
	Colour diversity	3	3	3	2	2	2	√
Shape (e.g., round-angular, symmetric-asymmetric, sophisticated-simplistic)		0	0	3	3	0	0	
Distinctive elements / adornments		0	0	0	0	0	0	
Edge complexity/irregularity		0	0	0	0	0	0	
Wildlife and domestic animals		0	0	0	0	0	0	√
SUM (landscape elements)		19	15	30	26	26	23	
SUM (total)		38	29	49	43	45	39	

Table 7-23 Content analysis results and whether they were mentioned by respondents (plant diversity, Tianhe Daguan Wetland Park)

Variable		 Lake-winter	 Lake-summer	 Marsh-winter	 Marsh-summer	 Swamp Cypress Forest-winter	 Swamp Cypress Forest-summer	mentioned by respondents
Overall Landscape								
Stewardship/Orderliness (cues to care)		2	2	2	2	2	2	√
Coherence/harmony/balance		2	2	3	3	1	1	√
Disturbance Lack of visually disturbing detractors		1	1	1	1	1	1	√
Historicity		0	0	0	0	0	0	
Visual scale		3	3	3	3	1	1	√
Imageability / Sense of place /Uniqueness/novelty		0	0	0	0	2	0	√
Complexity/Diversity/richness		3	2	2	2	2	2	√
Naturalness/ wilderness		1	1	3	3	1	1	√
Ephemera (e.g., weather changes, sunlight, Atmospheric haze)		3	0	3	0	3	0	
Layers		3	3	2	2	1	1	√
Evidence of design		1	1	1	1	1	1	
SUM (overall landscape)		19	15	20	17	15	10	
Landscape elements								
Water/wetlands	Water quality, Water transparency and colour	1	1	1	0	0	0	√
	The presence and appearance of aquatic vegetation	1	1	2	2	0	0	√
	The presence of sediment	0	0	0	0	0	0	
	Amount of water	1	1	1	0	0	0	
	Wetland-type diversity	2	2	2	1	0	0	
	Quite – wavy waterbody; flow level	1	1	1	0	0	0	
	Reflecting water	0	0	0	0	0	0	
	Wood in water	0	0	0	0	0	0	
vegetation	Health of vegetation (Lush-arid)	2	2	2	3	1	2	√
	Vegetation characteristics (e.g., leaves, height, colour, flowers, canopies)	1	1	1	1	2	0	√

	Vegetation coverage	3	3	1	3	3	3	√
	Species richness/diversity	2	2	2	2	1	1	
Presence of mountains/hills, and their shapes		1	1	0	0	1	1	
Man-made elements	positive man-made elements	1	1	0	1	0	1	√
	negative man-made elements	3	3	3	3	3	3	√
Colour	Colour contrast	0	0	3	0	3	0	√
	Colour diversity	2	3	3	2	3	2	√
Shape (e.g., round-angular, symmetric-asymmetric, sophisticated-simplistic)		3	3	0	0	0	0	√
Distinctive elements / adornments		0	0	0	0	0	0	
Edge complexity/irregularity		0	0	3	3	0	0	
Wildlife and domestic animals		0	0	0	0	0	0	√
SUM (landscape elements)		24	25	25	21	17	13	
SUM (total)		43	40	45	38	32	23	

Table 7-24 Content analysis results and whether they were mentioned by respondents (wetland types, Haizhu National Wetland Park)

Variable		 A	 B	 C	 D	 E	 F	 G	 H	mentioned by respondents
Overall Landscape										
Stewardship/Orderliness (cues to care)		3	3	3	2	3	3	3	3	√
Coherence/harmony/balance		3	2	3	3	3	3	1	2	
Disturbance Lack of visually disturbing detractors		1	1	0	0	0	0	1	1	√
Historicity		0	0	0	3	0	0	0	1	
Visual scale		3	3	3	2	3	2	3	3	√
Imageability / Sense of place /Uniqueness/novelty		2	2	0	3	0	0	0	0	√
Complexity/Diversity/richness		2	2	1	1	1	1	2	2	√
Naturalness/ wilderness		1	1	2	1	2	1	2	1	√
Ephemera (e.g., seasonal change, weather changes, Atmospheric haze)		2	2	2	1	2	1	1	1	√
Layers		3	3	3	2	2	3	3	2	√
Evidence of design		1	1	0	0	0	0	1	1	√
SUM (overall landscape)		21	20	17	18	16	14	17	17	
Landscape elements										
Water/wetlands	Water quality, Water transparency and colour	3	1	0	1	2	3	2	1	√
	The presence and appearance of aquatic vegetation	1	2	3	0	0	1	1	0	√
	The presence of sediment	0	0	0	0	0	0	1	0	√
	Amount of water	2	1	0	1	3	2	2	2	√
	Wetland-type diversity	3	2	1	1	1	2	3	1	
	Quite – wavy waterbody; flow level	1	1	0	1	2	1	2	1	√
	Reflecting water	3	0	0	3	3	3	0	3	√
	Wood in water	0	0	0	0	0	0	0	0	
0vegetation	Health of vegetation (Lush-arid)	3	3	3	3	3	3	3	3	
	Vegetation characteristics (e.g., leaves, height, colour, flowers, canopies)	0	2	0	0	0	1	0	0	√
	Vegetation coverage	3	3	3	2	3	3	3	3	
	Species richness/diversity	2	2	1	1	1	1	1	1	

Presence of mountains/hills, and their shapes		0	0	0	0	0	0	0	0	
Man-made elements	positive man-made elements	1	0	0	0	0	0	0	0	
	negative man-made elements	0	1	0	0	0	0	0	1	√
colour	Colour contrast	0	0	0	0	0	0	0	0	
	Colour diversity	2	3	2	2	2	3	3	3	
Shape (e.g., round-angular, symmetric-asymmetric, sophisticated-simplistic)		0	3	0	3	0	3	0	0	
Distinctive elements / adornments		0	0	0	0	0	0	0	0	
Edge complexity/irregularity		3	0	3	0	3	0	0	0	
Wildlife and domestic animals		0	0	0	0	0	0	3	0	√
SUM (landscape elements)		27	24	16	18	23	25	24	19	
SUM (total)		48	44	33	36	39	39	41	36	

Table 7-25 Content analysis results and whether they were mentioned by respondents (scenarios of the same place, Haizhu National Wetland Park)

Variable		 Trail-Scenario 1	 Trail-Scenario 2	mentioned by respondents	 Flower Field-Scenario 1	 Flower Field-Scenario 2	mentioned by respondents
Overall Landscape							
Stewardship/Orderliness (cues to care)		3	3	√	3	3	√
Coherence/harmony/balance		2	3		3	3	
Disturbance Lack of visually disturbing detractors		2	1		1	2	
Historicity		0	0		0	0	
Visual scale		1	2	√	2	2	
Imageability / Sense of place /Uniqueness/novelty		0	0		0	0	
Complexity/Diversity/richness		1	2	√	2	2	√
Naturalness/ wilderness		1	1	√	2	1	√
Ephemera (e.g., seasonal change, weather changes, Atmospheric haze)		0	1	√	0	0	
Layers		1	2	√	2	3	√
Evidence of design		1	1		1	1	
SUM (overall landscape)		12	16		16	17	
Landscape elements							
Water/ wetlands	Water quality, Water transparency and colour	0	2		2	2	
	The presence and appearance of aquatic vegetation	0	0		0	0	
	The presence of sediment	0	0		0	0	
	Amount of water	0	1	√	1	1	
	Wetland-type diversity	0	1		1	1	
	Quite – wavy waterbody; flow level	0	2		2	2	
	Reflecting water	0	0		0	0	
	Wood in water	0	0		0	0	
vegetation	Health of vegetation (Lush-arid)	3	3	√	3	3	
	Vegetation characteristics (e.g., leaves, height, colour, flowers, canopies)	1	0	√	2	2	
	Vegetation coverage	3	3		3	3	
	Species richness/diversity	2	1	√	1	1	
Presence of mountains/hills, and their shapes		0	0		0	0	
Man-made elements	positive man-made elements	1	1	√	1	1	√
	negative man-made elements	0	0		1	1	
Colour	Colour contrast	3	0		3	3	√

	Colour diversity	3	3		3	3	
Shape (e.g., round-angular, symmetric-asymmetric, sophisticated-simplistic)		0	0	√	0	3	√
Distinctive elements / adornments		0	0		0	0	
Edge complexity/irregularity		3	0		3	0	
Wildlife and domestic animals		0	0		0	0	
SUM (landscape elements)		19	17		26	26	
SUM (total)		31	33		42	43	

7.6.6 Visitors' perception of aesthetic value

7.6.6.1 Overall perception (ratings) and influencing factors

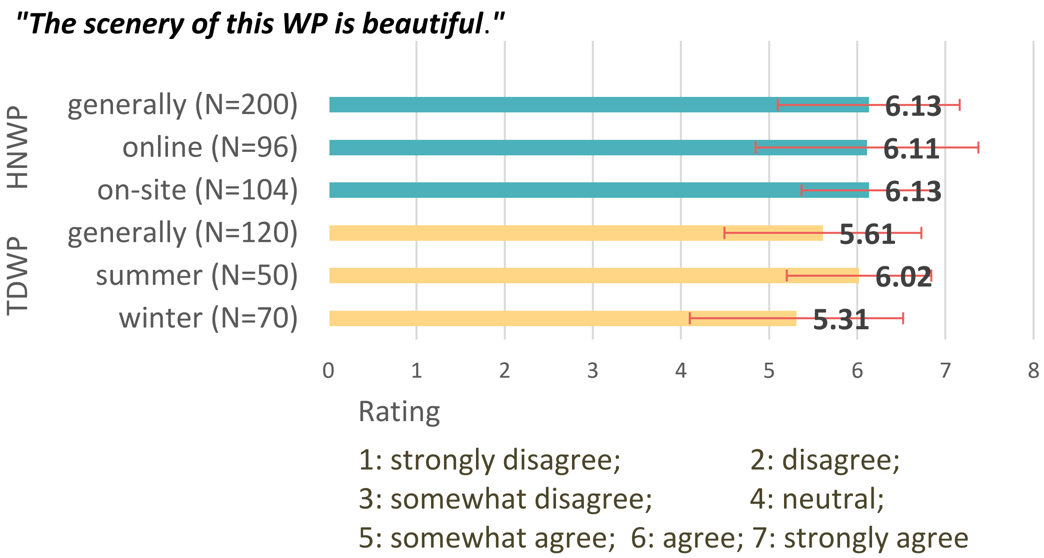


Figure 7-48 Rating of perceived aesthetic value

Generally, the perception of aesthetic value (PAV) in both case study sites was positive. Ratings for Haizhu National Wetland Park (HNWP) was slightly higher than that for Tianhe Daguan Wetland Park (TDWP); the difference was more obvious when compared to surveys collected in winter in TDWP. Based on qualitative findings from TDWP, more aesthetics-related Likert scale questions were included in HNWP. The set of perceived aesthetic value questions passed both the reliability (Cronbach's alpha = 0.894) and validity tests (KMO sampling was satisfactory (= 0.890), and Bartlett's test of sphericity was significant ($P < 0.001$). In general, the majority of respondents agreed with these Likert scale items (Table 7-26). The level of agreement on the indicators is lower than on the perceived aesthetics services item. The indicator item with the greatest average score was 'plants are thriving', while the one with the lowest average score was 'landscape uniqueness'. All tests of non-normality for Likert scale items were significant (Shapiro-Wilk, all $P < 0.05$), hence the Mann-Whitney U and Kruskal-Wallis tests were used to determine differences between groups of independent variables. As a result, the source only influences the perception of water cleanness (M-W U test, $P = 0.021$). On-site respondents (mean rank = 108.78) perceived cleaner and clearer water than online respondents (mean rank = 90.58).

Table 7-26 Descriptive results of Likert Scale questions relevant to perceived aesthetic value (Haizhu National Wetland Park)

7-point Likert Scale questions	PES	Mean (N = 199)
The scenery of this WP is beautiful.	aesthetics services (AES)	6.13 (±1.032)
Landscapes is diverse in this WP.	Indicator -AES	5.48 (±1.180)
Landscape is unique in this WP (compared to other parks/WPs in Guangzhou)	Indicator -AES	5.20(±1.218)
This WP has layering landscape	Indicator -AES	5.27(±1.270)
The plants in this WP are exquisite and beautiful	Indicator -AES	5.34(±1.190)
The plants in this WP are thriving	Indicator -AES	5.85(±1.080)
The water in this WP is clean and clear	Indicator -AES	5.36(±1.310)
(1: strongly disagree, 2: disagree, 3: somewhat disagree, 4: neutral, 5: somewhat agree, 6: agree, 7: strongly agree)		

Age was negatively correlated with the PAV (r = -0.150, P = 0.034) in HNWP; young respondents rated significantly higher (K-W test, 18-24 years old versus 45-54 years old, P =0.047). Specifically, young respondents rated significantly higher in **landscape layers** (K-W H test, P = 0.025, 18-24 years old versus 55-64 years old; M-W U test, P = 0.017, 18-44 years old versus elder than 45 years old), **thriving plants** (K-W H test, P = 0.006, 18-34 years old versus 35-54 years old) and **exquisite plants** (K-W H test, P = 0.010,18-34 years old versus 35-54 years old).

The influence of **highest education level** to the general PAV was found in TDWP: a negatively correlation was found (r = -0.267, P = 0.003), and those with a high school equivalent or lower diploma (especially middle school or lower) perceived higher aesthetic value than those with higher degrees (M-W U test, P = 0.020; K-W H test, P = 0.005). In HNWP, however, it was found that the highest education level influences the perception of **landscape diversity** and **water cleanness**. Respondents with university/bachelor's degrees perceived higher **landscape diversity** than respondents who graduated from specialised colleges (K-W H test, P = 0.025). A significant difference between less-educated (i.e., high school equivalent or lower) and well-educated respondents were observed in the perception of **water cleanness** (M-W test, P = 0.023). Specifically, respondents with high school equivalent diplomas perceived **cleaner water** than those with specialised college diplomas (K-W H test, P = 0.011).

Monthly discretionary income was found to have an impact on the general PAV, but this relationship was observed only in HNWP: respondents with income 6000-8999 CNY per month perceived better scenic beauty than respondents with income more than 15000 CNY per month (K-W test, P =0.024). Only when the monthly discretionary income was reclassified into two categories does it affect the perception of **landscape layers**. Respondents with lower income scored higher on the 'landscape layers' item (M-W U test, P =0.049). However, the finding may not be stable because the significance value is approaching 0.05.

In addition, **cost for a visit** and **travel time** was negatively correlated with the perceived aesthetic value (r = -0.224 and -0.200 respectively, P = 0.015 and 0.028 respectively) in TDWP. Respondents who spent less than 30 minutes for travelling to TDWP rated aesthetics higher than those travelled for longer time (M-W U test, P = 0.060). **Visiting frequency** was positively correlated with the PAV (r = 0.332, P < 0.001). Respondents who visited TDWP less frequently than once a month rated the general PAV lower than those visit more frequently (M-W U test, P < 0.001). Further, respondents recruited in summer perceived higher aesthetic services (M-W U test, P = 0.001).

In summary, age, highest education level, monthly discretionary income, cost for a visit, travel time, and visiting frequency could, but not always, influence PAV (Figure 7-49). Additionally, age, highest education level, and monthly discretionary income, influence the perception of the diverse landscape, layering landscape, exquisite plants, thriving plants, and clean water, which were considered to be features that contribute to aesthetic perception. The PAV was unaffected by gender.

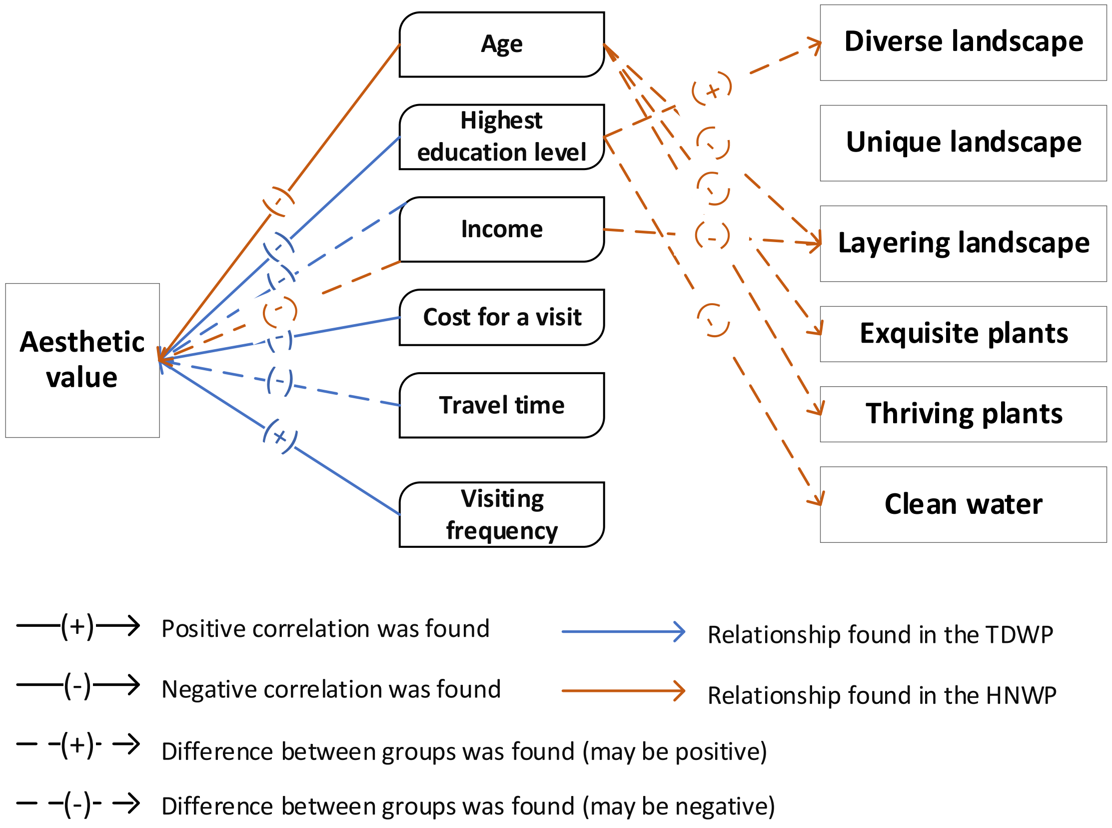


Figure 7-49 Influencing factors of perception (rating) of aesthetic value

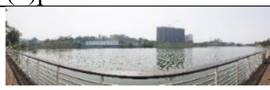
7.6.6.2 Aesthetic preference of wetland types

In TDWP, based on the photo ranking results of 73 respondents (with 41 in the winter survey and 32 in the summer survey), it was found that generally, the Reservoir (score = 151, mean = 2.07) and the Pond (score = 156, mean = 2.14) were preferred over the Marsh (score = 131, mean = 1.79) (Figure 7-44). In the winter survey, the Pond earned the highest score and was the most aesthetically preferred scenery, while the

Reservoir was the least preferred scenery. However, in the summer survey, the Reservoir was the most preferred and the Marsh was the least preferred (Table 7-27).

As a result of contingency table with Chi-square analysis and pairwise z-test, there was no significant difference found in the selection of this group of photos between seasons, age, monthly discretionary income, cost, travel time, time spent on site. On the contrary, there were significant differences between gender, highest education level, and visiting frequency (Appendix A - 25). The Reservoir was ranked as the least preferred by a larger proportion of female, well-educated people and less-frequent visitors. The Pond was ranked as the most preferred by a larger proportion of female and well-educated people. The Reservoir was ranked as the most preferred by a greater percentage of less-educated respondents.

Table 7-27 Photo ranking result, wetland types in Tianhe Daguan Wetland Park

Panorama (Winter)	S	M	R	Panorama (Summer)	S	M	R
 (a)marsh	80	1.95	2	 (a)marsh	51	1.59	3
 (b)pond	89	2.17	1	 (b)pond	67	2.09	2
 (c)reservoir	77	1.88	3	 (c)reservoir	74	2.31	1
S: sum; M: mean; R: rank							

For the survey in HNWP, it was found that photo A has the most attractive scenery, which was followed by the photo E and F. Photo C and D show the least preferred sites (Figure 7-46). According to the results of cross-tabulation with comparison of column proportions (Appendix A - 27), there were significant differences between source, gender, age, highest education level and visiting frequency in the preference of the photos. These results were summarised and shown in Table 7-29.

Table 7-28 Photo ranking result, Haizhu National Wetland Park

	F	S	R		F	S	R
 A	162 81.8%	399	1	 E	119 60.1%	242	2
 B	66 33.3%	139	4	 F	86 43.4%	155	3
 C	42 21.2%	64	6	 G	47 23.7%	83	5
 D	31 15.7%	47	8	 H	41 20.7%	58	7
F: frequency of selected; S: score; R: overall ranking							

Table 7-29 Summarized cross-tabulation results of demographic information or visiting frequency with photo ranking (Haizhu National Wetland Park)

	Selected by a larger proportion of			
Photo	Selection of the top 3 photos	Ranked as the third preferred	Ranked as the second preferred	Ranked as the most preferred
 A	Female Well-educated			Online Female Less frequently
 B	Less-educated	On-site Seniors (≥45) Less-educated More frequently		Male
 C			Seniors (≥45)	
 D				
 E	On-site More frequently	More frequently	Seniors (≥45)	On-site Seniors (≥45) More frequently
 F	On-site			On-site
 G	Online	Less frequently		
 H	Online Less-educated	Online	Male	

7.6.6.3 Aesthetic preference of plant diversity

Based on the photo ranking results of 73 respondents (with 42 in the winter survey and 31 in the summer survey), it was found that generally, the Lake (score = 178, mean = 2.44) were preferred than the Swamp Cypress Forest (score = 134, mean = 1.84) and the Marsh (score = 126, mean = 1.73). In both seasons, the Lake with medium plants diversity was the most preferred scenery. In the winter survey, the Marsh with highest plants diversity was the least preferred scenery, while in the summer survey, the Swamp Cypress Forest with the lowest plants diversity was the least preferred (Table 7-30). **The aesthetic preference ranking of photos was found to be inconsistent with the ranking based on the measured plant richness and diversity.**

As a result of contingency table with Chi-square analysis and pairwise z-test, there was no significant difference found in the selection of this group of photos between highest education level, monthly discretionary income, cost, and time spent on site. On the contrary, **there were significant differences between season, gender, age, travel time and visiting frequency** (Appendix A - 26). The Lake was ranked as the least preferred by respondents who spent longer than 30 minutes on the way to the WP; it was ranked as the second preferred by a larger proportion of winter respondents; it was ranked as the most preferred by a larger proportion of summer respondents, less-educated respondents, those who spent less than 30 minutes for traveling, and those who visited this WP more frequently than once a month. The Marsh was ranked as the least preferred by a larger proportion of winter respondents and senior respondents (≥45 years old); it was ranked as the second preferred by a greater percentage of summer respondents and less-educated respondents with high school equivalent and lower diploma. The Swamp Cypress Forest was ranked as the least preferred by a greater percentage of summer respondents and those who spent less than 30 minutes for traveling; it was ranked as the most preferred by a larger proportion of winter respondents, females, and respondents who spent more than 30 minutes on the way.

Table 7-30 Photo ranking result, vegetation diversity, in Tianhe Daguan Wetland Park

Panorama (Winter)	S	M	R	Panorama (Summer)	S	M	R
 Lake	99	2.36	1	 Lake	79	2.55	1
 Marsh	66	1.57	3	 Marsh	60	1.94	2
 Swamp Cypress forest	87	2.07	2	 Swamp Cypress forest	47	1.52	3
S: sum; M: mean; R: rank							

7.6.6.4 Aesthetic preference of same sites of different scenarios

Respondents generally preferred the Scenario 2 of the Trail and Flower fields in the Haizhu Lake, namely the scenes after the Quality Improvement Project (Table 7-31). The total response in this section was less than 172 because three respondents considered both scenes excellent, and it was difficult to determine which was superior.

Table 7-31 Aesthetics preference, before and after the Quality Improvement Project, in Haizhu National Wetland Park

	Frequency		Frequency	Total N
 Trail – Scenario 1	66 (33.5%)	 Trail - Scenario 2	131 (66.5%)	197
 Flower Field- Scenario 1	83 (42.3%)	 Flower Field- Scenario 2	113 (57.7%)	196

As a result of the contingency table with Chi-square and Cramer’s V test, the source did not affect the two scenarios’ perceived aesthetics for the Trail but influenced the preference of the two scenarios for the Flower Field (P=0.003). The majority of on-site respondents (68.0%) preferred the Scenario 2 of the Flower Field, while the majority of online respondents (53.1%) prefer the Scenario 1.

The regions respondents had visited did not affect the perceived aesthetics of the two scenarios of the Flower Field but influenced the preference of the two scenarios of the Trail. A larger proportion of respondents who prefer the Scenario 2 had visited both regions, while a larger proportion of respondents who prefer the Scenario 1 had only visited Wetlands Phase 1 and 2. Because the Trial is located in the Haizhu Lake, this finding indicated that respondents who had used the trial tend to prefer the Scenario 2; in addition to visual factors, there may be other factors that influence visual preference.

Age influences the preference for both photos (Appendix A - 28 and Appendix A - 29). A larger proportion of older respondents (≥45 years, especially ≥55 years) preferred Scenario 2 of the Flower Field, while a larger proportion of young respondents (18-34 years, especially 18-24 years) preferred Scenario 1 of the Flower Field. And a larger proportion of older respondents (≥45 years) preferred Scenario 2 of the Trail, while a larger proportion of young respondents (18-34 years) preferred Scenario 1 of the Trail.

Besides, it was found that a larger proportion of **less-educated** respondents preferred Scenario 2, while a larger proportion of **well-educated** respondents preferred Scenario 1 (Appendix A - 30).

A difference was found between the two categories of **visiting frequency** (reclassified) in preference of the two scenarios for the Flower Field: a larger proportion of respondents who visited less frequently than once a month (52.2%) preferred the Scenario 1 of the Flower Field, while a larger proportion of respondents visited more frequently (69.4%) prefer the Scenario 2 (P = 0.024). **Travel time** only found to be related to the preference of the two scenarios for Flower Field. Most respondents who **spent less than 30 minutes on the way** (67.7%) preferred the Scenario 2, while most respondents who spent more than 30 minutes on the way (51.1%) prefer the Scenario 1 (P = 0.018). Gender, monthly discretional income, time spent on site, and cost for a visit did not affect the preference of both photos.

7.6.6.5 Core areas of perceived aesthetic value

The participatory mapping was only conducted in Haizhu Lake of HNWP. As a result of the participatory mapping of aesthetics hotspots, there were 108 polygons that pertinent to aesthetic value generated by 49 respondents (Table 7-32). The area of polygons ranged from 382 to 70,604 m², with an average of 19,435.41 m². The polygons encompass 415,125 m² and constitute 53% of the research area. The hotspots of perceived aesthetic value concentrated on the Flower Field, the Hide and Island III, and Planks and Islands I and II (Figure 7-50). The predominate land cover type in the core areas (highlighted by at least ten respondents) of perceived aesthetic value were waterbody and grassland (especially flower field) (Table 7-33, Figure 7-51).

Table 7-32 number of polygons that each respondent mapped (aesthetics)

Number of polygons	Number of respondents (N = 49)
1 polygon	18
2 polygons	11
3 polygons	12
4 polygons	5
5 polygons	1
6 polygons	0
7 polygons	1

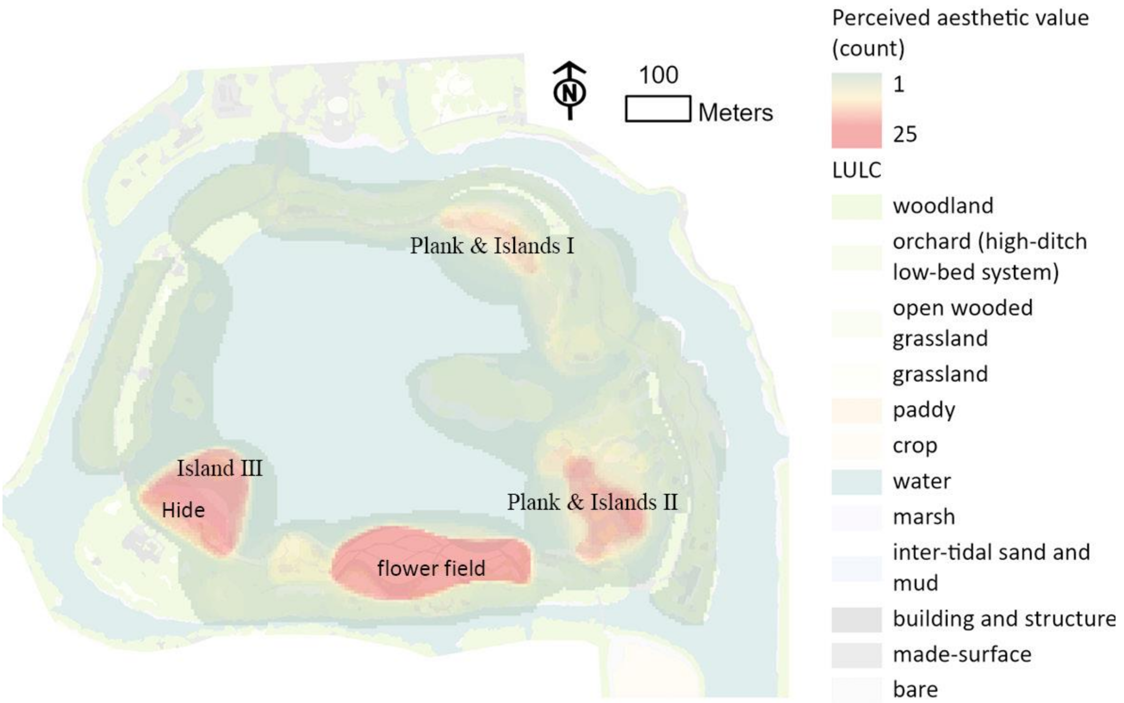


Figure 7-50 Heatmap of perceived aesthetic value

Table 7-33 Landscape cover composition of perceived aesthetic value core areas

Land Cover	Perceived aesthetic value core areas (m^2)				
	Hide & Island Ⅲ	Flower field	Plank and Islands Ⅱ	Plank and Islands Ⅰ	SUM
woodland	2510.9 (18.0%)	3348.7 (12.5%)	3433.0 (17.6%)	676.5 (12.4%)	9969.0 (15.2%)
open wooded grassland		158.6 (0.6%)		7.0 (0.1%)	165.6 (0.3%)
grassland		14540.6 (54.3%)	1631.4 (18.4%)		16172.0 (24.6%)
water	9632.3 (69.0%)	4030.2 (15.1%)	9152.6 (46.9%)	2001.5 (36.7%)	24816.6 (37.8%)
marsh	687.0 (4.9%)		1434.1 (7.4%)	1888.6 (34.7%)	4009.6 (6.1%)
inter-tidal sand and mud			3403.0 (17.5%)	344.2 (6.3%)	3747.1 (5.7%)
building and structure	35.8 (0.3%)	29.2 (0.1%)		106.0 (1.9%)	170.9 (0.3%)
made-surface	1084.1 (7.8%)	4667.6 (17.4%)	446.0 (2.3%)	426.2 (7.8%)	6623.9 (10.1%)
SUM	13950.0	26774.8	19500.0	5450.0	65674.8

As indicated by respondents, reasons behind the mapping of aesthetics services hotspots including vegetation characteristics (especially flowers), animals (especially ducks), diverse landscape, open view, positive artificial elements such as the Canton Tower. A few respondents failed to map the aesthetics hotspots because ‘the scenery is relatively even across the Haizhu Lake. I don’t think there is anywhere particularly beautiful or ugly, it’s all pretty much the same level’.

Figure 7-51 Arial view of core areas of aesthetic value

7.6.6.6 Other factors influencing aesthetic perception in wetland parks

In total, 43 factors were revealed to influence the perception of aesthetics value of WPs from photo elicitation interviews. Landscape elements including waterbody and vegetation were common criteria for respondents in TDWP (Appendix A - 31), while overall landscape such as visual scale and diversity were the primary influencing factors for most respondents in HNWP (Appendix A - 32). The strength of evidence for a particular factor varies across different WPs (Figure 7-52).

The findings provided strongest evidence indicating that the aesthetic perception was influence by complexity and visual scale of overall landscape, and the amount of water (including whether water can be seen or not). Strong evidence was found to support the influence of water quality, presence of positive man-made elements, and layers of the overall landscape, waterbody/wetland size, presence of negative man-made elements, and disturbance. The influence of vegetation characteristics (e.g., colour, flowers), quantity of the vegetation (e.g., woodland, field of flowers), stewardship or orderliness of the overall landscape, naturalness, health of vegetation, colour diversity, and vegetation coverage, were supported by moderate evidence. Weaker evidence was found to support other attributes. This thesis will not extensively discuss indicators that are already widely known and do not contribute new knowledge. The subsequent paragraphs present visitors' interpretations of factors that supported by strongest evidence, as well as those pertaining to wetlands and Chinese culture (i.e., context-specific influencing factors).

(1) Influencing factors with strongest evidence

(a) Amount of water

Amount of water comprises the presence of water and the extent of the waterbody. It is the most significant factor influencing aesthetic perception in wetland environments. The presence of water that is visible was the most noteworthy factor in TDWP. 24 respondents used the expression 'because there is water' as an explanation of their preference for the Pond, Reservoir and Lake (Figure 7-44). In HNWP, nine respondents who prefer the Scenario 2 of the Trail (Figure 7-47) because of the visibility of water (river). With water present was preferred to no water, and the larger the water body, the more preferable it may be. According to 14 respondents in TDWP and 17 respondents in HNWP, a broad expanse of water enhances visual perception. Two respondents disliked the Pond in TDWP (Figure 7-44) because 'the pond is too small.' The little body of water may evoke the notion that 'pools with stagnant water are usually dirty.' Besides, according to the TDWP interview, in the summer, large bodies of water may be accompanied by a breeze, which provides thermal comfort; this is why three respondents like the Reservoir.

Figure 7-52 Frequency manifest effect sizes of attributes

(b) Complexity/diversity/richness of overall landscape

The complexity of landscape elements affected aesthetic perception. The complexity is usually a positive description as the opposite of ‘monotonous’, but occasionally a negative descriptor as the opposite of ‘pure’. Pond and Marsh in Figure 7-44, Marsh in Figure 7-45, and Photo A in Figure 7-46 were preferred because there were more diverse elements. Elements that were mentioned to contribute to the complexity include waterbody, trees, hills, stones, grass and trails; the more elements (except trails), the better. However, complexity and diversity were sometimes considered to be messy and some respondents prefer purer scenes such as the Swamp Cypress Forest in TDWP and the Scenario 2 scenes in HNWP.

(c) Visual scale of overall landscape

Scenes that were perceived to be ‘spacious and unobscured’ that relevant to the visual scale include the Reservoir in TDWP (Figure 7-44), Scenario 2 on the Trail and Photo E in HNWP (Figure 7-47),

In both WPs, it was believed that the open and spacious scenery could lift people’s spirits and make them feel broad minded, especially when they were upset. A respondent in TDWP explained that ‘the open and spacious scenery can make my mood better, especially when I’m upset.’ Additionally, when the view was unobstructed with more sunlight poured down, the feeling of delighted intensified (for example the Scenario 2 on the Trail). The open and spacious scene with open wooded grassland also was regarded as a ‘blank space’ which is a common technique used in the creation of traditional Chinese artworks that leave room for imagination:

> *I appreciate this scene (i.e., the Trail-Scenario 2) because it’s open and spacious; on the contrary, the other shot contains too much foliage that fills the landscape without any blank space.*

(Debbie, female, age of 35-44 years, high school equivalent degree, HNWP)

(2) Context-specific influencing factors

(a) Familiarity

Some respondents favoured a certain landscape because it reminded them of their hometown. For instance, in TDWP, the **ponds** reminded Iris of her rural hometown, thus she felt them to be the most attractive. Daisy, a native of northern China, was captivated by the **red swamp cypress forest** because it reminded her of the autumn in her hometown. In HNWP, the feeling of familiarity relevant to the **paddy field**, and five of seven of respondents who mentioned the familiarity of paddy field also highlighted that there are paddy field around the house in their childhood. However, sometimes familiarity can be detrimental to one’s perception. One respondent to TDWP selected the Lake (Figure 7-44) as the second most favoured and stated, ‘It’s not that bad. Only because I’m too familiar with it to be attracted by it.’

(b) Yijing 意境

Yijing emerged when the scenery evokes an emotional response that corresponds to the soul of respondents. For example, Harriet in HNWP preferred the paddy field (Photo B in Figure 7-46) because of the paddy evoke the sense of prospect, the prospect of harvest. Photo A, D, and F (Figure 7-46) were cited as ‘peacefulness’ that calm them down. Specifically, Vivian commented the photo F (Figure 7-46) which was her favourite as 'a peaceful place that is extremely beautiful and like an isolated heaven that is far away from modern life.[47]

The combination of the attractive plants also make the Yijing emerge, for example Alva in TDWP stated that 'the presence of waterlilies in the foreground and the sunlight permeating through the cypress forest evoke a sense of Yijing'. Additionally, Grey in HNWP ranked the photos according to Yijing:

> *The photo E make me feel very comfortable and I cannot tell any drawbacks of it so it's my favourite. Then it comes to the photo H which I think is full of Yijing, with beautiful trees and reflections. I would rank photo E as my third preferred although it's well-layered, because it lacks the Yijing.*
>
> *(Grey, male, age of 45-54 years, bachelor's degree, HNWP)*

However, both Alva and Grey are unable to describe their understanding of Yijing.

(c) Thermal comfort

In TDWP, in summer, four respondents ranked the photos considering the thermal comfort. For example, Adam ranked the Marsh (Figure 7-44(b)) as the second aesthetically preferred because 'the vegetations here are short, and here must be very uncomfortable when it hot. If there were more trees surrounds, it would make me feel better.' In contrast, he liked the Pond because it appears to be cooler. Breeze from the reservoir (Figure 7-44) makes it more attractive to Alex, Andy, and Jerry. In HNWP, three respondents prefer the Scenario 1 of the Trail because 'the tree is flourishing and would make the place cool and comfort to walk or sit in'.

(d) Birds, fish and shrimps

Water fowls are animals that promote visual perception in both WPs. In HNWP, three respondents mentioned ducks in photo G (Figure 7-46), and thought it appears to be a habitat for fish, shrimp, and other birds; and one respondent emphasized the consideration of good fish habitat in Photographs E and F (Figure 7-46) which contributes to the photos' visual beauty. Similarly, in TDWP, two respondents mentioned their appreciation of fish and birds, for example, 'I like watching fish and watching kingfisher fishing around there'.

(e) Association of pests

Association about annoying or troublesome animals had a detrimental impact on the perception of aesthetics. It is linked to vegetation coverage. In TDWP, Kate expressed her dislike for the Swamp Cypress Forest

[47] Literally the respondent used the phrase "世外桃源" which comes from the well-known fable "A Tale of the Fountain of the Peach Blossom Spring" written by TAO Yuanming (A.D. 421) that described a chance to discover an ethereal utopia where the people lead an ideal existence in harmony with nature and unaware of the outside world for centuries.

(Figure 7-45) because 'snakes, mosquitoes, rats, and mosquitos are frequently hidden in this type of ground cover.'

(f) Participatory

Whether or not a scene is participatory influences aesthetic perception from a utilitarian standpoint. Despite the fact that only one interviewee in each WP brought it up, it may be worthy of note.

> *The most beautiful places in this WP are the small ponds. Because it is easy to go down to the waterfront, it is possible to participate……It's the same reason why I prefer this scene (Pond in Figure 7-44). In the place shown in the Lake in Figure 7-44, the water is not clear, and it can only be seen instead of getting down to the waterfront.*

(Kyle, male, age of 35-44 years, bachelor's degree, TDWP)

> *I like these photos[48] because it appears that I can go into the scenery and enjoy it rather than standing out of it and only looking at it (for example photo E).*

(Angus, male, age of 55-64 years, master's degree or higher, HNWP)

7.6.7 Does the perception correspond to the measured aesthetic value?

Overall, the perception exhibited a partial alignment with the measure of aesthetic value. Regarding wetland types, the study found that participants in TDWP generally preferred the Pond and the Reservoir over the Marsh, which aligns with the objective measurement results. However, the Pond was the most preferred scene while the Reservoir was the least preferred in winter, and the Reservoir was the most preferred and the Marsh was the least preferred in summer. In HNWP, Photo A shows the most appealing scenery, while Photos H and D shows the least appealing scenery, as measured and perceived. Regarding places varied in plant diversity in TDWP, it was found that generally, the Lake were preferred than the Swamp Cypress Forest and the Marsh; this was not wholly consistent with the technical understanding. Although respondents generally preferred the Scenario 2 of the Trail and Flower Fields in the Haizhu Lake, which was align with objective measurement, ranking results of other groups of photos contradict objective measurement, indicating that some factors exert a greater influence than others.

Attributes that drawn from previous literature and measured objectively were not always influence visitors' aesthetic preference. Some attributes that measured to be varied across stimulates were not mentioned by any respondent. For example, for the group of eight photos from HNWP, attributes including coherence, historicity, wetland-type diversity, vegetation coverage, vegetation species richness, colour diversity, shape, and edge complexity, received various scores in objective measurement but were not mentioned by respondents.

[48] the photo F and H, which this respondent ranked as second and third preferred

Although some attributes were measured to be at the same level of quality, they still influence the preference. For example, in spite of the six panoramas regarding various wetland types in TDWP share the same score on complexity of the overall landscape, vegetation species richness, and presence of mountains/hills and their shapes, respondents ranked the panoramas using these criteria. Although the six panoramas regarding places with different level of plant diversity share the same score on stewardship, disturbance, and negative man-made elements, and no sign of animal was found in the photos, expressions relevant to these attributes were put forward by respondents. There is a potential for tiny differences to exert an impact on aesthetic perception and preference.

However, on the other hand, not all factors that influenced the preference have been included in the objective measurement framework. For example, respondents proposed unexpected factors such as thermal comfort, participatory, and familiarity, when commenting on wetland types in TDWP photos, and prompt out factors including participatory, familiarity and Yijing when commenting on wetland types in HNWP photos.

7.6.8 Factors influencing perception of aesthetic value

It was found that not all indicators stated in literatures were mentioned by respondents. Factors in the category of ‘overall landscape’ were all mentioned; however, some in the ‘landscape elements’ and most in the category of ‘cognition’ were not mentioned, including several factors that did not exist in both WPs (i.e., wood in rivers, shoreline). The lack of sufficient visual stimuli (i.e., photographs) and a small sample size may contribute to this observation. However, it is evident that these factors have limited significance. Besides, diversity of associated water bodies, wetland-type diversity, wood in rivers, outline/edge of water areas, native/non-native species, contrast of vegetation types, shape of mountain/hill, shoreline, element that dominates the landscape, distinctive elements or adornments, and edge complexity, prospect-refuge (seeing without being seen), and hazard, were not considered as determinants by all respondents. And there was no evidence found in this study that sound influence visual aesthetic preference. Nevertheless, some factors that have not been cited in the literature were stated by respondents, including quantity of vegetation (e.g., woodland, field of flowers), negative association about snakes and insects, specific colour (e.g., green, red), and participatory landscape. Dimensions of visitors’ aesthetic judgement was summarized and presented in Figure 7-53.

Visual scale and amount of water are the most important factors in influencing aesthetic experiences. This might be attributed to that WPs are typically flat and water-themed; visitors to WPs may be motivated by the enjoyment of open landscapes and proximity to water. People tend to see what they want to see; that is, the influence of motivation on information processing extends into the preconscious processing of stimuli, thereby influencing what the visual system presents to conscious awareness (Balcetis and Dunning, 2006).

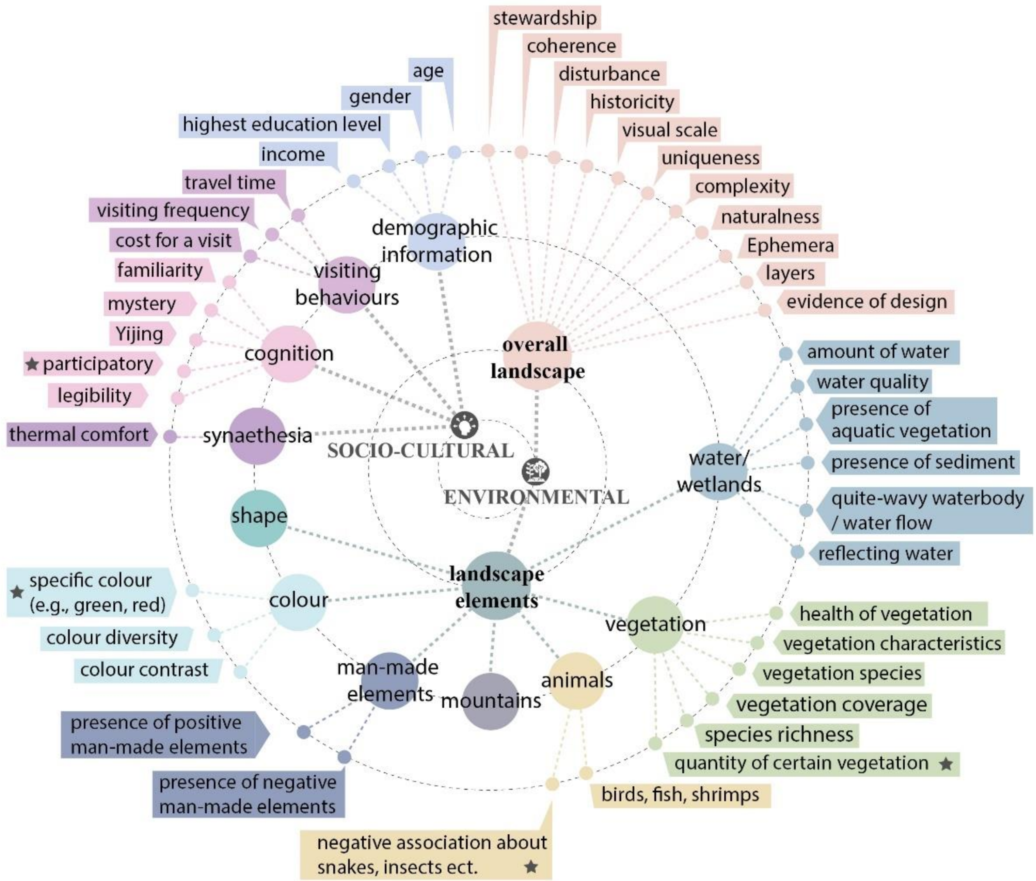


Figure 7-53 Dimensions of visitors' aesthetic judgement

(The study identified new attributes that influence the perception, as indicated by a star symbol.)

Besides, the preference for water as an aesthetic criterion may be rooted in its role as a source of life and its influence on the topography of a place (Burmil, Daniel and Hetherington, 1999). Research using simulations have indicated that small water bodies can lower the air temperatures in their surroundings by approximately 0.2-0.6 °C during the afternoon (Jacobs *et al.*, 2020). The presence of water and the synaesthesia of thermal comfort may contribute to people's preference for water.

The discovery that the visual scale exerted the greatest influence on aesthetic perception in WPs lends support to the validity of utilising computer-based tools such as InVEST and ARIES (Villa *et al.*, 2009; Natural Capital Project, 2022) that using visual scale as a primary indicator for measuring AES in WPs and similar settings. Nevertheless, **this study suggests that relying solely on the visual scale as a criterion for evaluating the aesthetics of WPs is inadequate. Instead, a better strategy would be to <u>combine the visual scale, complexity and amount of water</u>.**

The findings of the importance of water quality, overall landscape complexity, and stewardship are consistent with the findings that wetland health, complexity, order, and naturalness were found to be predictors of preference for freshwater wetlands in Victoria, Australia (Dobbie, 2013), although naturalness was found to be less important than the other three factors, and additional factors are essential in aesthetic experiences.

Surprisingly, the cognition of whether a scene can be participated influence the aesthetic perception. This cognition may be relevant to the demand of intimate human-nature interactions. Another unanticipated finding was that thermal comfort through synaesthesia plays a notable role in aesthetic perception in WPs. This unexpected result could potentially be elucidated by prior research findings. Research has shown that in a subtropical urban environment like Shanghai, which is similar to Guangzhou, a waterbody can greatly improve human comfort in the littoral zone during high summer temperatures; thermal comfort is most significant at a distance of 10-20 metres from the water's edge (Xu *et al.*, 2010). Microclimate service (e.g., release of cooler air, shading) is identified as the most significant ES in an urban park in Chengdu, China, which experiences a similar hot and humid summer with Guangzhou (Swapan, Iftekhar and Li, 2017). In subtropical cities with high summer temperatures, landscape features that could induce thermal comfort synaesthesia need to be considered in aesthetic assessments. This study found that even an association with animals such as snakes and insects can result in an unfavourable aesthetic perception, consistent with the findings of a previous study that snakes, bats, and spiders were less preferred by participants. In that study, it was hypothesised that this was a result of 'irrational' fears related to animal phobias, culture, and affective responses to images (Knight, 2008). Also, Guangzhou's subtropical climate may be conducive to the proliferation of mosquitoes and unfavourable animals, thereby heightening the negative aesthetic perceptions associated with them among visitors. Hence, in summary, it is recommended that the index system utilised for aesthetic evaluation be tailored to suit the specific local cultural and climate conditions.

Further, this study confirms that various elements contribute differently in aesthetic perception, but not necessarily as discovered by Li *et al.* (2023) that the whole class of elements (e.g., spatial elements) have a greater impact than another class of elements (e.g., natural elements). Moreover, the findings demonstrate that in actual perception, indicators from different camps (e.g., overall landscape, landscape elements, cognitions) can act concurrently to determine preferences; therefore, it is not reasonable enough to use only indicators from a single camp for aesthetic evaluation.

It is notable that the same scene might be perceived differently depending on the same factor; for example, complexity can be perceived to be positively or negatively to the aesthetic perception. And social-demographic factors influence differently in different groups of sceneries of the two case study sites; this is consistent with previous findings that there is significant heterogeneity in landscape preference (Howley, 2011). Therefore, careful consideration must be given to these characteristics when evaluating the aesthetic quality using these indicators and designing spaces for the use of specific populations.

In addition, age, education level, and income were found to influence the rating of aesthetic value. Different demographic groups, such as those based on gender, age, education level, and income, exhibit diverse aesthetic preferences. Having diverse landscapes in WPs is crucial for providing equal aesthetic benefits to different demographic groups, as it caters to their distinct aesthetic preferences.

Further, the rating was negatively correlated with cost for a visit to TDWP, and visitors spent longer than 30 minutes on the way to TDWP rated lower than those travelled for shorter time. The low perception of aesthetic value may be attributed to their high expectations and substantial costs associated with travelling. The rating showed a positive correlation with the frequency of visits; there may be a potential mutually reinforcing relationship between the two attributes.

7.6.9 Limitations and outlooks

This study has only examined the aesthetic preferences of users of the two WPs. Although these users are members of the general public, caution must be taken when using the factors and their relative importance discovered in this study as indicators for determining which scenes are preferred by the general public.

This study used real-life photographs as stimuli to recall respondents' memories of particular places. However, contents in photographs may influence the findings, as certain factors were omitted from the photographs, or the degree of influence of certain factors was comparable, thereby precluding a comprehensive analysis of their impact. Besides, the utilisation of fixed-size 2D photographs may result in the loss or overabundance of details. In order to enhance the robustness of findings, it is recommended that forthcoming research employ more immersive stimuli, such as Virtual Reality. Despite efforts to control variables during the capture and selection of photographs for ranking and interviews, some variables still showed variability compared to controlled trials. The photo-ranking or selection method utilises real landscape images, making it challenging to control the elements depicted in the pictures. Consequently, determining the extent to which a feature influences aesthetic preference becomes difficult. However, due to the nature of landscape, in reality it is impossible to isolate and alter a single factor that is driving the shift. Besides, the objective of this study is to have participants' perceptions be as close to reality as possible, hence a bottom-up approach that allows for minor undesirable variations of variables was accepted. It would be valuable to conduct additional research that quantitatively examines the impact of each factor in controlled trails.

Ranking questions aid in evaluating the relative significance of items, but cannot reflect the degree of preference or satisfaction for the top-ranked items. That is, the preference for a particular scene among respondents does not necessarily indicate its high quality. Some advanced scales could be used to resolve this issue, although they may be time-consuming and require respondents to exert greater effort (e.g.,(Sung and Wu, 2018)).

7.7 Recreation service

'Recreation' can be understood as the activities that people engage in during their spare time, as well as the experiences that emerge from those activities (Moore and Driver, 2005). It is a participant-designed and -enjoyed product, comprising of leisure activities and emotions such as satisfaction, enjoyment, and pleasure, and so relates to aspects of life's quality (Hansen, 2021, p. 129). CICES (Haines-Young and Potschin, 2018) classifies recreational service as one of the cultural ESs, which are the characteristics of living systems that enable activities that promote health, recovery, or enjoyment through active or immersive interactions. Generally or specific to blue space, recreation provides physical exercise, aesthetic pleasures, intellectual stimulation, inspiration, and other contributions to physical and mental health (Gascon et al., 2017). Hansen (2021, p. 134) summarized that recreational landscapes consist of recreational content, a physical setting, and the resulting experience.

7.7.1 To technically understand recreation service

Recreation potential and opportunity are important components of the recreation service that determine the supply of recreation service (Weyland and Laterra, 2014). On the one hand, the **recreation potential** of ecosystems, landscapes, or regions indicates their ability to provide recreational services to humans. Biophysical and geographical characteristics of ecosystems or landscapes (e.g., land-use, net primary production, mountainous terrain, adjacency to landscape and nature protection zones, landscape diversity, scenic beauty) are considered to determine the recreation potential of ecosystems (Haines-Young, Potschin and Kienast, 2012; Peña, Casado-Arzuaga and Onaindia, 2015, p. 109; Hou et al., 2018, p. 281). Green space per capita was used as an indicator for assessing recreation potential on a regional scale (Haase et al., 2012). It was also discovered that recreation potential was negatively correlated with temperature (Dobbs, Nitschke and Kendal, 2014). The recreation potential of places in a Turkish national park was calculated by adding up the park's ratings in five categories: landscape value, climate value, accessibility, recreational facility, and negative factors (e.g., air pollution, insecurity, noise) (Cetin and Sevik, 2016). On the other hand, **recreation opportunity** accounted for the infrastructure that was in place to host or guide the visitors (Casado-Arzuaga et al., 2014, p. 1397). On the premise that a recreational setting comprises biophysical, social, and management attributes, the Recreation Opportunity Spectrum (ROS) framework was developed. It generates maps of six opportunity zones, ranging from low use-primitive to high use-urban, as to model and manage the diverse recreation opportunities available in forests. (McCool, Clark and Stankey, 2007; Paracchini et al., 2014). To determine the recreation service, the ROS model was applied, with the recreation potential index and the remoteness/accessibility index serving as indications. The recreation potential index is comprised of the degree of naturalness, natural protection, and water component; the accessibility index is comprised of the distance from human-made structures and roads (Mohammadyari et al., 2023).

Furthermore, the assessment of recreation services indicators varies depending on whether they are measured extrinsically or intrinsically. When measuring extrinsically, indicators including accessibility (e.g., regional communication via highway, access to public transport), scenic spots, and hotel facilities could be used (Hou *et al.*, 2022). Cost and duration of travel can also be used as indicators of accessibility (H. Wang *et al.*, 2019). When measuring intrinsically, it was found that park characteristics and neighbourhood socio-demographic factors affect park use and physical activity (McCormack et al., 2014). Facilities, including playgrounds, sport courts, and paths, encourage more physical activities in park settings (Shores and West, 2008). It was discovered that developed infrastructure (e.g., roads, retail, parking, walkways, lookouts, day-use, camping, amenities, and accommodation) in the right setting has a positive influence on recreation demand in south-eastern Australia's protected regions (Heagney *et al.*, 2018). Besides, topography including elevation, slope, aspect and surface condition (e.g., plain, bumpy, or rough) influence the recreation uses (Cetin and Sevik, 2016; Caglayan *et al.*, 2020).

Additionally, some factors that influence aesthetic perception are also considered to affect recreation potentials. Ten attributes, including landform contrast, landform diversity, wetland-edge complexity, associated water-body size, diversity of associated water bodies, surrounding land-use contrast, surrounding land-use diversity, wetland-type diversity, internal wetland contrast[49], and wetland size, were considered to be indicators to evaluate opportunity for recreational and educational diversity in wetlands (Smardon, 1975). Seven indicators (wilderness; feeling of the forest; panoramic views, water, and scenery; biodiversity and land form; cultural history; activity and challenge; service and gathering) were used to mapping the recreation values of the green structure in greater Copenhagen (Caspersen and Olafsson, 2010). Natural components including grass, flower, water and trees/bushes are significant attributes that people consider when trying to find a place to sit down and rest when walking across a large town and feeling mentally exhausted (Nordh and Østby, 2013).

Sometimes, factors relevant to biodiversity are also considered to influence recreation potentials. Potential for recreational purposes in urban forest have been evaluated using criteria including types of forest habitats, ages of dominant species, stand composition, stocking index, the share of undergrowth, soil cover, canopy closure, and surface water (Wajchman-Świtalska *et al.*, 2022).

Similar to the assessment of aesthetics, the assessment of recreational quality of landscape has been conducted using expert-based techniques or perception-based techniques. Mapping and assessing recreation service using expert-based methodologies has proven effective, while visitor-based approaches better

[49] The "internal wetland contrast" is defined as the degree of contrast generated within a wetland by variances in the height and texture of vegetation and water.

capture the spatially-specific nature of recreation services (Hermes *et al.*, 2018). The Delphi survey is the most frequently employed expert-based method for determining the factors and weights that influence recreational value, and the expert-defined criteria could subsequently be used to evaluate the recreational value (e.g.,(Nahuelhual et al., 2013; Wajchman-Świtalska et al., 2022)). Based on a Delphi survey, it was discovered that in Europe, the size of trees within a stand and the size of clear-cuts are the most important key contributors to the recreational value of forests (Edwards et al., 2012).

7.7.1.1 Measuring supply of recreation service in wetland parks

Recreation service provision could vary between wetland parks (WPs) in terms of recreation potential and opportunity. The overall recreational potential of the two WPs was determined by their accessibility to other locations in Guangzhou, the number and density of scenic spots in each WP, and aesthetics and biodiversity. Both WPs are adjacent to residential areas and business campus, with similar walking accessibility levels (Ma, Brindley and Lange, 2023). Therefore, in this study, measurement of accessibility focusses on the public transporting accessibility; it was determined by counting number of public transportations stops within 200 metres', 500 metres', and 1 kilometres' buffer. ArcGIS Pro based on data gathered from Amap.com. Number of scenic spots were counted according to signage boards on site and official publications. Based on results of ratings of ESs in questionnaire, the recreation potential influenced by biodiversity and aesthetics was slightly greater in Haizhu National Wetland Park (HNWP) than in Tianhe Daguan Wetland Park (TDWP), as the average rating scores for the two ESs were higher in HNWP. This section only assesses the accessibility and number of scenic spots of both WPs.

Evaluation of the recreation opportunity within WPs was limited to Haizhu Lake because recreation facilities were limited in TDWP and the majority of recreational activities were spontaneous and not dependent on facilities. The author assumed that the landscape quality (e.g., aesthetics and biodiversity) within WPs is similar. Thus, it was assumed that all places in the case study sites had equivalent recreation potential in terms of scenery quality, air quality, temperature, etc. The variance of recreation service within WPs would be dictated by the supply of recreational opportunities. Hence, infrastructure and facilities that support activities of visitors were mapped for the purpose of measuring recreation opportunity. To comprehend the spatial patterns of recreation opportunity, kernel density was computed, enabling a comparison with the spatial patterns of perceived recreation service.

7.7.2 To measure the use and perception of recreation service

The benefit and perception of recreation service may be viewed as the landscape use level for recreation (i.e., tourists flow) (Weyland and Laterra, 2014). The actual use, including utilisation frequency and intensity, can be measured to evaluate recreation services (Daniel *et al.*, 2012, p. 8815). The number of visitor days, the average distance travelled from home residences and the cost of travel influence the consumer surplus[50] of recreation (Mayer and Woltering, 2018, p. 382). Additionally, a foundational model is the outdoor recreation experience model (Moore and Driver, 2005; Morse, 2020), in which people participate in outdoor recreation due to specific recreation-related motives, preferences, or desires. Based on these motivations, users engage in specific outdoor recreation activities by selecting settings and their fellow participants. Hence, they attain their desired outcome, which is typically a combination of outdoor recreation experiences.

The perception and benefit of recreation service can be evaluated using a monetary approach, or using perception-based approach, or combining the two approaches. Using a monetary approach, which includes use value or non-use value, is the most prevalent method for evaluating recreation value. Travel Cost Method and Contingent Valuation Method are two most widely used monetary approach to estimate recreation service/value. For example, recreational value of mangrove forest in Wet Lombok Indonesia was evaluated using these two methods (Diswandi and Saptutyningsih, 2019). Besides, integrated use value and non-use value of a coastal wetland park in Guangzhou has been evaluated using choice experiment method and travel cost interval analysis (Xu and He, 2022). Travel cost modelling and Willingness To Pay (WTP) for access were analysed to assess the monetary value of recreation in 115 man-made wetland ecosystems based on geotagged photo metadata in South Florida, USA (Ghermandi, 2018).

Methods for gathering information about outdoor recreation perception and preference can be classified into two camps: direct engagement, and indirect engagement, and the two camps of methods could identify comparable landscape preferences in general (Komossa et al., 2020). Direct engagement approaches include participatory mapping (e.g., (Rice et al., 2020)), free listing (e.g., (Komossa et al., 2020)), quantitative photo ranking, discrete choice experiment, and so on. Indirect engagement approaches using user-generated content such as social media location, user tags, and photo content (e.g., (Keeler et al., 2015; Komossa et al., 2020)), direct observation (e.g., (McCormack et al., 2014)), GPS visitor tracking which based on the spatial distribution and density of recreational movement (e.g.,(Korpilo, Virtanen and Lehvävirta, 2017; Long, Chen and Che, 2020)), and visitor employed photography (e.g., (Heyman, 2012)). Specifically, the System for Observing Play and Recreation in Communities (SOPARC) tool have been widely used to observe and summarize park usage (by demographics and physical activity level) across a variety of geographic settings (Evenson *et al.*, 2016).

[50] Consumer surplus is the difference between the price that buyers are willing to pay for a good and the actual price they pay. It quantifies the perceived benefit that buyers derive from a good.(Mankiw, 2016)

7.7.2.1 Measuring perception and use of recreation service in wetland parks

Self-completion questionnaires and face-to-face semi-structured interviews were designed to assess public perception and usage of recreation service. Ratings on recreation service (7-point Likert scale questions) were included in the questionnaire. For surveys in both wetland parks (WPs), a 7-point Likert scale question on agreement was asked: ‘there are sufficient recreational space and facilities in this WP.’

For the entire WP, the frequency of visits, length of time spent on-site, and number of activities that could be carried out indicate the use and perception of recreation service. These three indicators were measured by asking the following questions or interviews in both WPs. In the beginning of the survey, ‘how often do you use this WP?’ was asked orally (on-site) or in the questionnaire (online). In the questionnaire, ‘how long do you usually spend in this WP? (For the first time: How long do you plan to spend in this WP?)’ were asked to measure the length of time spent on-site. Options include ‘less than 1 hour’, ‘1 to 3 hours’, ‘longer than 3 hours’ (only in TDWP), and ‘3 to 5 hours’ and ‘longer than 5 hours’ (only in HNWP). Since HNWP was large in size and would take longer time to walk around the park (especially in Phase 1 and 2), an additional category was included.

In addition, a multiple-choice question titled ‘What activities have you conducted or do you plan to conduct in this WP today?’ was presented in order to investigate the activities conducted by respondents on-site. The query included an ‘others’ option with a blank where respondents could list activities that were not included in the list of options. Follow-up questions were asked to understanding the motivations, considerations, and preference of choosing a place to conduct an activity.

Within WPs, visitors are free to engage in a wide range of activities on the provided landscape at their preferred timing, based on their individual preferences for recreation services. In Haizhu Lake of HNWP, participatory mapping tasks were further conducted. The following instruction was given to respondents before drawing the polygons, ‘in your experience in Haizhu Lake, are there any places you like to have a rest or do activities the most? For example, some place you often visit and do activities when you visit Haizhu Lake?’ And a follow-up question ‘why do you like to have a rest or do activities in these places?’ was asked.

7.7.3 Technical understanding of recreation service

7.7.3.1 Recreation potential

Accessibility, quantity and density of scenic spots, and types of facilities, were used to measure supply of recreation service of the two WPs. It was found that both WPs has good public transportation accessibility. There were two subway stations near the entrances of HNWP, one within the 250-meter buffer from the North Gate of HL and the other within the 500-meter buffer from the North Gate of P1&2. However, there was only one subway station near the North Gate of TDWP, within the 1-kilometre buffer. There were more bus routes connected within the 1-kilometer buffer from HNWP gates (53) than TDWP gates (29), while there were twice as many bus routes connected within the 250-meter buffer from TDWP gates (22) than HNWP gates (11).

When considering scenic spots, it can be observed that HNWP encompasses a greater number of scenic spots compared to TDWP. There were 72 scenic spots in HNWP, with 30 in Haizhu Lake, 25 in Wetland Phase 1, and 17 in Wetland Phase 2. While there were 18 scenic spots in TDWP. Regarding the density of scenic spots, when divided by the size of the respective wildlife parks, HNWP exhibited a density of 0.2 scenic spots per hectare, while TDWP had a density of 0.38 scenic spots per hectare.

In summary, accessibility of the two WPs that were analysed may be comparable. And it is challenging to determine which WP has a higher potential for recreation in terms of scenic spots, as TDWP has a higher density, and HNWP has a higher quantity.

7.7.3.2 Recreation opportunity

Regarding infrastructures that host the visitors (i.e., recreation opportunity), both WPs offer benches and pavilions for resting, trails for walking on, jogging tracks for exercising, and vending machines for purchasing beverages. Additionally, HNWP contains several bird-watching hides, numerous cafes, restaurants, and retailers, and offers paid boating excursions in HL and paid shuttle bus tours in P1&2. Although a sports ground exists in TDWP, visitors were not granted access to it.

Since TDWP's recreation facilities were limited and most people's recreational activities were spontaneous and not dependent on facilities, and mapping of facilities in the large area of P1&2 were challenging, the evaluation of recreation opportunities in WPs was restricted to Haizhu Lake. Figure 7-54 depicts the distribution and density of paths and benches, including those in pavilions. The areas with the greatest recreational potential are paved areas with integrated benches located near the entrance in the northern part and facing the flower field and lake in the southern part. Two smaller paved areas with built-in benches and three water-front pavilions constituted additional areas with high recreation opportunities.

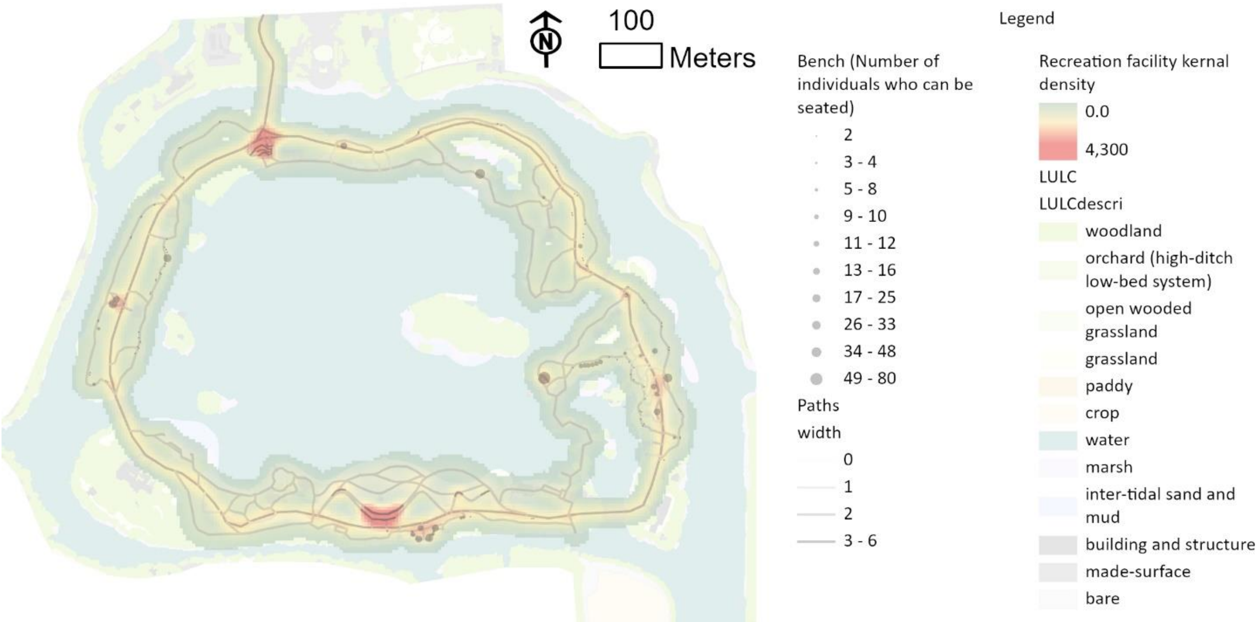


Figure 7-54 Recreation opportunity of Haizhu Lake

7.7.4 Visitors' use and perception of recreation service

7.7.4.1 Overall perception (ratings) and influencing factors

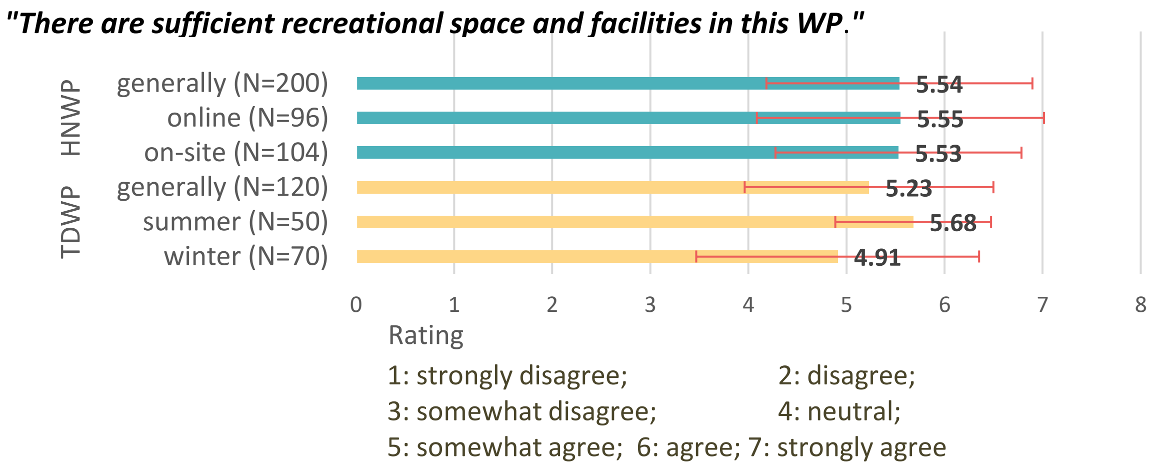


Figure 7-55 Rating of perceived recreation service

Generally, visitors agreed that there were sufficient recreational space and facilities in the two WPs. HNWP had a slightly higher average rating for recreation opportunities compared to TDWP (M-W U test, $P = 0.011$). Additionally, TDWP had a higher average rating for recreation opportunities in the summer compared to winter.

In TDWP, highest education level, monthly discretionary income, season, influences the perception of recreation opportunity. A negative correlation was found between the **highest education level** and ratings on recreation opportunity ($r = -0.298$, $P < 0.001$). Specifically, respondents with middle school diplomas or less and those with a specialised college diploma rated recreation service higher than those with a bachelor's degree ($P < 0.001$). Besides, **less-wealthy** respondents (earned less than 6000 CNY per month, M-W U test, $P = 0.018$) and respondents recruited in **summer** (M-W U test, $P=0.003$) rated higher. Moreover, **visiting frequency** was positively correlated with the rating ($r = 0.305$, $P < 0.001$). Causality between the two variables is difficult to determine. However, no significant differences or correlation were found in the ratings of recreational opportunities among demographic groups in HNWP. Regions where respondents had been to, frequency of visits, times spent on sit, and cost did not affect the rating as well. In summary, it is possible that the perception of recreational opportunities may be influenced by or have an influence on factors such as the highest education level, monthly discretionary income, and frequency of visits. However, these relationships were not always the case.

7.7.4.2 Travelling time

Majority respondents reported a travel time of less than 30 minutes to both WPs. A larger proportion of respondents spent more than one hour on the way to TDWP (21% compared with 12%), while larger proportion of respondents spent 30 to 60 minutes to HNWP (37% compared with 18%) ($P = 0.003$). There was no statistically significant difference observed in the proportion of respondents who reported travelling less than or more than 30 minutes between the two sites ($P = 0.104$). Additionally, a larger proportion of respondents who have only been to Haizhu Lake spent less than 30 minutes on the way, while a larger proportion of respondents who have only been to P1&2 spent more than 30 minutes.

7.7.4.3 Frequency of visits

In general, there was a significantly greater percentage of participants were new to TDWP (52.5% were first-time visitors), compared to HNWP where 25.5% were new ($P<0.001$). The proportion of respondents visiting TDWP for the first time in winter (70%) was 2.5 times that of respondents visiting in summer (28%). About 20% of respondents visited the WPs at least once a week (20.8% in TDWP and 19.5% in HNWP). The proportion of visitors that use TDWP at least once per week in summer (30%) was approximately seven times that of respondents visiting in winter (4.3%).

Significant difference between gender, age, and highest education level, were found in the visiting frequency. Male respondent visited both WPs more frequently. **Seniors** visited more frequently than juniors (M-W U test, $P<0.001$ in HNWP and $P = 0.004$ in TDWP); and a larger proportion of senior (≥45 years old) respondent visit both WPs more frequently than once a month. A greater proportion of respondents with **lower levels of education** visited both WPs more frequently than once per month. And most well-educated respondents visited less frequently than once a month in HNWP. Respondents who **spent less than 30 minutes for travelling** used both WPs more frequently ($P<0.001$). Specifically, a larger proportion of respondents who spent more than 30 minutes on the way to HNWP visit it for the first time, while the majority of respondents who spent less than 15 minutes on the way visit HNWP more frequently than once a month. Monthly disposable income and cost for a visit did not aways differentiate regarding visiting frequency in TDWP. However, a larger proportion of more-wealthy respondents (monthly income ≥6000CNY) used HNWP less frequently than once per month, and a larger proportion of **less-wealthy respondents** use it more frequently. A larger proportion of respondents who spent more than 20 CNY on a visit use HNWP less frequently than once per month, and a larger proportion of respondents who **spent less than 20 CNY for a visit** use HNWP more frequently. Additionally, majority of **online respondents** visited HNWP less frequently than once a month, while most onsite respondents visited HNWP more frequently than once a month.

7.7.4.4 Time spent on site

Most visitors of both WPs spent one to three hours per visit (74.2% in TDWP and 69.0% in HNWP). Significantly more TDWP respondents (15%) spent less than one hour on site than HNWP respondents (3.5%), while more HNWP respondents (27.5%) spent more than three hours on site than TDWP respondents (10.8%). 2.0% respondents in HNWP spent more than five hours on site per visit. In both WPs, no significant difference was found in time spent on site between season, gender, age, highest education level, monthly discretionary income. **A significant difference was observed in the time spent on-site in HNWP between different cost groups**: the majority of respondents who spent less than 20 CNY for a visit spent less than 3 hours, while approximately half of the respondents who spent more than 20 CNY spent more than 3 hours on-site. The causal relationship between the two variables remains undetermined. There was no significant difference or correlation between frequency of visits and time spent on site. Additionally, respondents who spent less than one hour in TDWP were those visited during their lunch break or were disappointed about this WP; while most respondents who were willing to stay for more than three hours enjoyed the slow and comfortable time in TDWP.

7.7.4.5 Activities and preference

In average, respondents did three activities for the visit of the survey day in both WPs (in TDWP mean=2.97, in HNWP mean = 3.07). Participants engaged in at least one activity in both WPs, with a maximum of eight activities in TDWP and seven activities in HNWP. No significant difference was found in the number of activities that respondents performed for a visit between the two WPs. Taking a walk was the most popular activity as more than 80% of respondents did it in both WPs. More than half of respondents in both WPs took seats. Taking photos was another most popular activity; 49.2% and 61.0% of respondents took landscape photos in TDWP and HNWP respectively, and approximately 30% of respondents took figure photos in both WPs. It was found that a larger proportion of respondents in TDWP lied down and rest, or had a picnic, while a larger proportion of respondents in HNWP took landscape photos or did birdwatching and other natural observations (Table 7-34). Moreover, Fishing, walking dogs or cats, catching butterflies, and sing were activities that performed in TDWP but not in HNWP; feeding fish or birds, drinking or eating in cafes were activities that conducted in HNWP but not in TDWP.

Table 7-34 Comparison of activities performed in two case study sites

Activities	Case Study Site			
	TDWP		HNWP	
	C	%	C	%
Take a walk	96	80.0%	169	84.5%
Jogging	12	10.0%	19	9.5%
Other exercise	8	6.7%	6	3.0%
Take a seat	76	63.3%	111	55.5%
Lie down and rest	13	10.8%	7	3.5%
Have a picnic	17	14.2%	12	6.0%
Landscape photography	59	49.2%	122	61.0%
Figure photography	36	30.0%	62	31.0%
Make video or internet broadcast	6	5.0%	11	5.5%
Bird watching and other natural observations	11	9.2%	61	30.5%
Pick flowers and grasses for ornamental purpose	2	1.7%	12	6.0%
Environmental education activities	1	0.8%	9	4.5%
Fishing	6	5.0%	0	0.0%
Feed fish or birds	0	0.0%	1	0.5%
Scenery sketch	2	1.7%	11	5.5%
Walk cats/dogs	10	8.3%	0	0.0%
Catch butterflies	1	0.8%	0	0.0%
Sing	1	0.8%	0	0.0%
Drink/eat in cafes	0	0.0%	3	1.5%
	Chi-square = 84.951, P <0.001* a,b			

Notes:
(1) C: count; %: proportion of that groups of respondents (e.g., proportion of on-site respondents, proportion of male respondents)
(2) Cells highlighted with blue indicate that the proportion of that groups of respondents is higher than the proportion of the other group of respondents (highlighted with green) and that this difference in proportions is statistically significant at the 5% significance level.
(3) a. More than 20% of cells in this subtable have expected cell counts less than 5.
(4) b. The minimum expected cell count in this subtable is less than one. Chi-square results may be invalid
(5) Cells highlighted with yellow indicate that the activity only performed in one WP.

(1) Preferred places for conducting activities in Haizhu Lake in Haizhu National Wetland Park

Specific to Haizhu Lake (HL) in HNWP, the 132 polygons associated with recreation service hotspots were generated by 49 respondents. Participants mapped 1 to 10 polygons. 16 respondents mapped only one polygon, 14 respondents mapped two polygons, 9 respondents mapped three polygons, 2 respondents mapped four to six polygons respectively, 3 respondents mapped seven polygons, and 1 respondent mapped ten polygons. The area of polygons ranged from 34 to 79,107 square metres, with an average of 19,435.41 square metres. The polygons encompass 29.66 hectare and constitute 38% of the study area. Core areas of perceived recreation service (i.e., places where visitors preferred to undertake activities) mostly consist of building or structure (e.g., pavilions and the Hide) and grassland (i.e., flower field) (Figure 7-56).

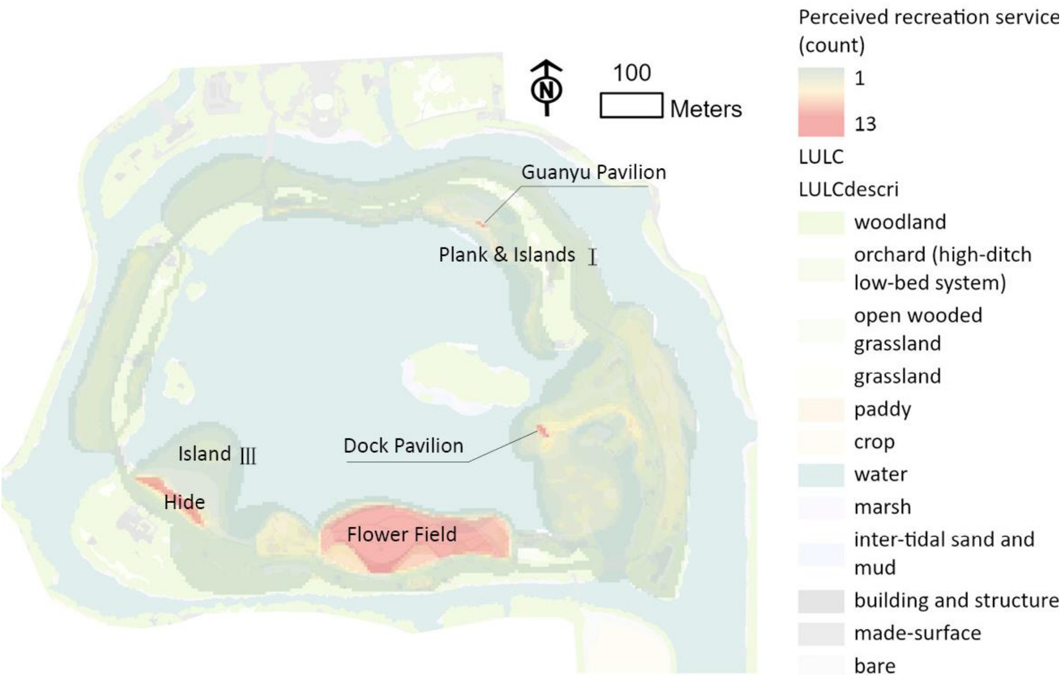


Figure 7-56 Heatmap of perceived recreation service

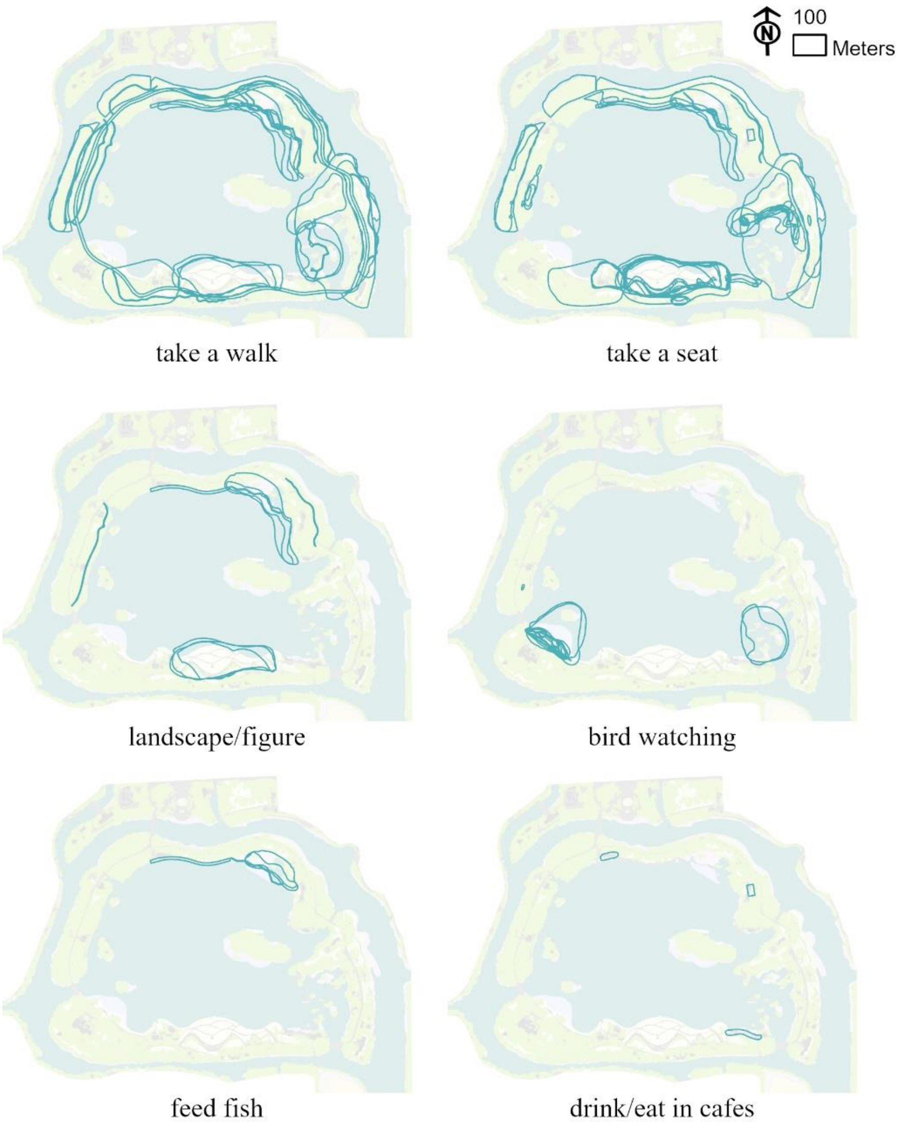


Figure 7-57 Preferred areas in Haizhu Lake for conducting activities

Throughout the park, polygons pertinent to activities were mapped (Figure 7-57). 32 polygons out of 132 were applicable to at least two activities. Most polygons were relevant for sitting and walking, evenly distributed throughout the park surrounding facilities. Bird-watching-related polygons appeared on the Hide, Island III, and Plank and Islands II. Photography relevant polygons were located on the trail near the lake in the west part of the park, the Flower Field, and the Plank and Islands. Respondents prefer to feed fish from the north observation deck and the Plank and Islands I, while to drink tea or have meals in cafes.

(2) Factors that influencing preference of conducting activities

In both WPs, number of activities differs significantly between gender, age, and highest education groups. Females conduct more types of activities than males (M-W U test, $P = 0.002$ in TDWP and $P = 0.001$ in HNWP). For example, in HNWP, on average, females performed 3.35 activities, while males performed 2.67 activities. And 18- to 44- year-old respondents performed more types of activities than the older respondents (M-W U test, $P<0.001$ in TDWP and $P = 0.041$ in HNWP). Additionally, well-educated respondents did more types of activities than less-educated respondents (M-W U test, $P= 0.021$ in TDWP and $P = 0.044$ in HNWP).

Gender, age, and cost for a visit were significantly relevant to some activities in both WPs. Landscape and figure photography were preferred by female respondents in both WPs. Figure photography was preferred by 18-to-45-year-old respondents in both WPs. A larger proportion of respondents who spent over 20 CNY engaged in picnicking and figure photograph in both WPs.

Relationships were found between other demographic information or visiting habits with certain activities in only one of the WPs (Figure 7-58). For example, taking a walk was undertaken by a greater proportion of respondents who spent one to three hours on-site, visited less frequently than once per month, and were surveyed in winter in TDWP, while by a larger proportion of on-site, senior (>45 years old), and less-educated respondents in HNWP. Taking a sit were undertaken by a larger proportion of respondents between the ages of 18 and 45, and those surveyed in the winter in TDWP, while by a larger proportion of on-site respondents, and those who spent less than 20 CNY on a visit in HNWP.

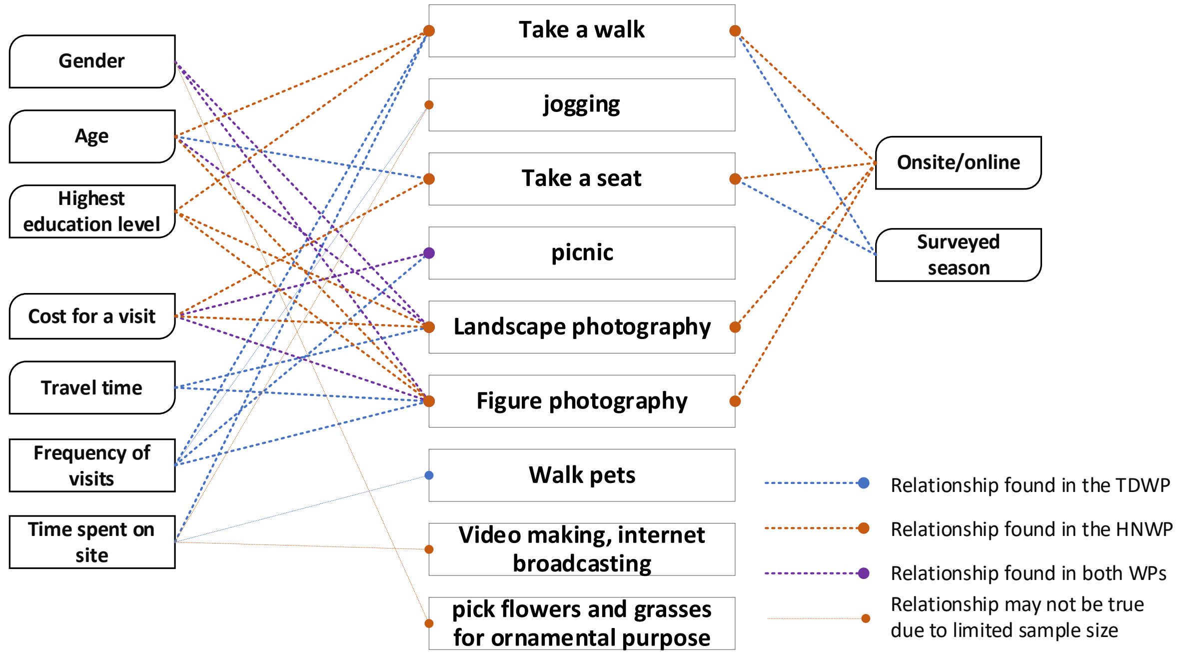


Figure 7-58 Relationships between preference of activities and socio-demographics or visiting habits

Landscape photography, figure photography, making video or internet broadcast, picking flowers and grasses for ornamental purpose, and scenery sketch, were highly relied on personal aesthetic taste, and highly relevant to aesthetic service. Engaging in activities such as bird watching, observing nature, feeding fish or birds, and catching butterflies is particularly meaningful in areas where there are opportunities for interaction with wild animals, depending on biological resources or biodiversity of the WP. The paragraphs below illustrate the factors that influence individuals' preference for participating in other activities.

When **taking a walk**, apart from the majority of respondents who just walked around randomly, some respondents had some preferences, that dictated where they walked. These preferences included beautiful scenery, good air quality, fewer people present, spacious, greenery, and clean areas. In both WPs, a few respondents favour plastic path trails because they are more comfortable to walk on. Moreover, the majority of respondents walked around Haizhu Lake once (approximately 2.68 kilometres) per round, while three respondents preferred to walk around twice for fitness purposes. The loop trail with appropriate length makes Haizhu Lake like a huge Track and Field, as indicated by Dilian and Elijah:

> *Haizhu Lake is a loop, from where you enter to where you leave. As a result, I don't take the time to discover the road. The scale is also ideal, with a circular of 2.65 km taking only around 45 minutes to walk. So, I won't get tired for walking around and enjoy the scenery.*

(Elijah, male, age of 45-54 years, high school equivalent degree, spent 1-3 hours on site, HNWP)

Additionally, it is noteworthy that two respondents expressed concerns regarding the safety of walking on the 1-metre-wide paths going through hilly grassland in TDWP, particularly for vulnerable groups such as children and the elderly, who could suffer serious injuries if they fell from the path.

The locations favoured for **jogging** were similar to those favoured for walking, with similar reasons. A respondent who just finished his 20 kilometre's jogging shared his preference and route of jogging in TDWP:

> *I just finished my 20km jogging…… I ran for three hours. I live nearby and have come to run frequently in the past three months, maybe every week……I ran around the wetland park. Each round was about 3km. I ran around a large circle, from the greenway, NO.78 bus station, to the North Daguan Road path......Although the air in the place where I live is better and more vegetation (I live in the Science City), this WP is relatively spacious, in a large area, with many small lakes. These make it more comfortable to walk and jog here.*

(Damian, male, age of 35-44 years, bachelor's degree, spent more than 3 hours on site, TDWP)

Majority of respondents choose places to **sit and rest** based on randomness without deep considerations, i.e., they sit wherever there is an available seat when they are exhausted. When consciously selecting places to sit, sensory experience plays a vital role. The attractive scenery and wildlife in both WPs draw visitors to sit down. In addition, olfactory pleasure enhances the seating experience. Melinda expressed her fondness for the Dock Pavilion at Haizhu Lake in HNWP due to the fragrance of the *Osmanthus fragrans* grown surrounding it. Thermal comfort also plays a role: some respondents preferred sitting in the shade when the sun is basking, and prefer to have sunbath when the weather is cold. According to a TDWP respondent, the physical instincts made the choice. Moreover, several respondents in TDWP mentioned that they prefer to sit where there are few people and quiet. Additionally, the comfort of the seat also affects people's preferences. For instance, a bench without a backrest was deemed uncomfortable, whereas Oliver, who visited TDWP almost daily during his lunch breaks, preferred to lean on the pavilion's vertical pillars and rest.

The choice of **picnic** place was mostly benches or flat lawns. It was observed that the occurrence of picnics on lawn in HNWP was limited to instances where security personnel and administrators were absent from nearby areas, because activities on lawn was not officially permitted.

> *When choosing a picnic place, we consider that here is relatively flat, and we can bask in the sun, and the grass is relatively dry. The grass in the woods over there is wet and not so flat. Moreover, here we can watch our children play in the wood.*

(Elizabeth, female, age of 25-34 years, college degree, spent 1-3 hours on site, TDWP)

Walking pets was the activity limited to TDWP, because pets were banned in HNWP. Interestingly, a small number of individuals were observed walking cats in the park. For safety consideration, respondents prefer to walk pets anywhere there are few people randomly. Appropriate size of the park and flexible route attract people to walk dogs in TDWP. For example:

When walking my dog, I just walk and stroll around. I think it's good here because I can walk freely. Unlike some parks, I have to get into the park in a particular way, like a wooden plank road or anything else. I can walk anywhere here, and it's not too big, which is good.

(Bethany, female, age of 25-34 years, bachelor's degree, spent less than 1 hours on site, TDWP)

Some respondents, whether adults visited alone or with children, **learned about nature and the environment** by viewing videos played on-site (only in HNWP) and reading informational signboards. Some parents in both WPs reckoned that exposing their children to nature in WPs constitutes environmental education, and indicated this was one of the motivations to bring the kid to the WPs.

Some birds in both WPs and lizards in TDWP were visible to the unaided eyes, and visitors observed them when they were encountered. Doris in TDWP delightfully shared a video of a white-breasted waterhen that he captured a few minutes ago, and stated that he was waiting and observing this bird that he had just seen for the first time. One Hide in HL of HNWP provide binoculars for visitors to watch birds on the islands, this facilitates the birdwatching activity. For example, stated by Baily, 'there are binoculars in the bird viewing deck, something I've never seen before; it's so lovely to see birds with binoculars.'

Because TDWP's management intensity was not high, **fishing for fish and catching butterflies** were allowed. However, these activities were banned in HNWP for ecological conservations. A respondent believed that fishing could release the children's nature, making children play happily. When choosing a fishing location, the primary consideration should be where it is easier to get close to the water and where there is much fish to catch.

7.7.5 Does the perceived recreation service match recreation potential and opportunity?

In both WPs, the perception (rating) of recreation service and the frequency of visits (more or less than once per month) were comparable. There was a consistency between the recreation use and the size as well as the number of scenic spots of the two WPs. Specifically, more respondents in HNWP spent more than 3 hours at the site, whereas more respondents in TDWP spent less than 1 hour ($P < 0.001$). Although types of activities happened in the two WPs were different, there was no statistically significant difference in the number of activities that respondents engaged in during their visits to the WPs. This suggests that the number of activities undertaken may not be related to scenic spots offered.

In TDWP, rating of recreation opportunity in summer was higher than that in winter, while facilities did not change between seasons. This inconsistency could potentially be attributed to a higher volume of visitors during winter, who come to appreciate the red leaves of *Taxodium distichum*. Therefore, the limited capacity of the facilities may not be sufficient to carrying the large number of visitors, resulting in inadequate access to the facilities for all visitors.

In Haizhu Lake of HNWP, recreation facility density and perceived recreation service were correlated (Pearson's correlation = 0.093, $P < 0.001$). There was a positive correlation between recreation facility density and perceived recreation service, with synergies being greatest at the Flower Field (Figure 7-59(a)). The study revealed positive correlations in the majority of lake-facing waterfront locations, as well as in the river-facing northern portion of the park. However, negative correlations were discovered along the primary circular road, in the eastern portion of the park facing the river, and on Plank and Island II. The negative correlations on the primary circular road and eastern river-front places indicate a large number of facilities with low use and perception, whereas the negative correlations on Plank and Island II indicate sparse facilities with high use and perception (Figure 7-54, Figure 7-56, Figure 7-59 (a)). The observed negative correlations between facility density and perceived recreation service on Plank and Island II may be attributed to the impact of scenic beauty and biodiversity, given the positive correlation between perceived recreation service and perceived aesthetic value and wildlife habitat service in that area (Figure 7-59). Positive correlations were identified between perceived recreation service and perceived aesthetic value as well as recreation facility density in other core areas of recreation service (Figure 7-56 and Figure 7-59(a)(c)). Overall, the density of recreational facilities and recreational services showed a positive correlation, while aesthetic services and recreational services exhibited a positive correlation across a broader area; this suggests that **aesthetics may have a greater influence on recreation service perception than recreational facilities.**

In summary, the perceived recreation service match recreation potential and opportunity to some extent. The two WPs offer different recreation potential, with HNWP performing better on total number of scenic spots, accessibility using subway, and TDWP performing better on density of scenic spots accessibility using bus, but the visitors' use of recreation service was similar. Within Haizhu Lake in HNWP, the spatial heterogeneity of perceived recreation service could be explained by the perceived recreation facility density, PWH, and perceived aesthetic value.

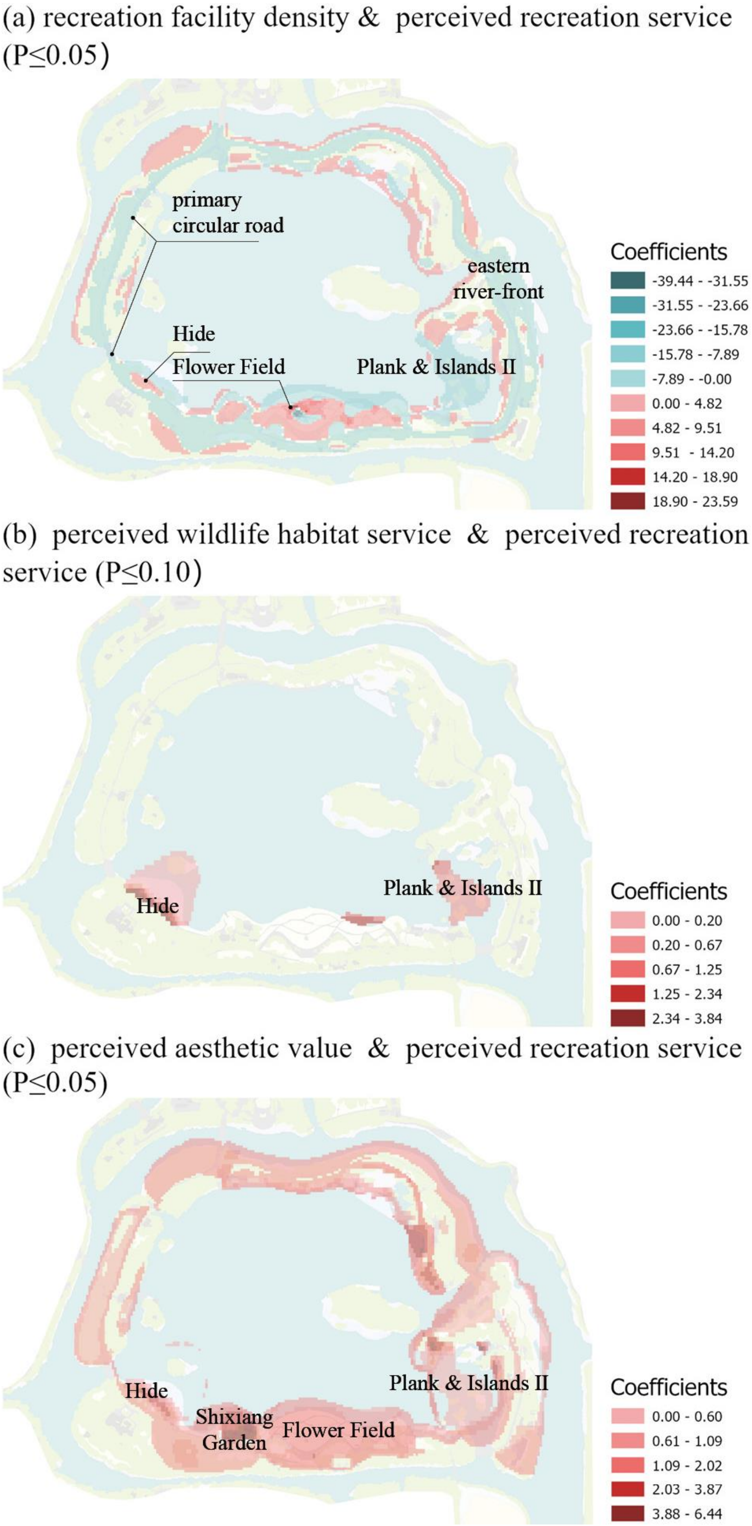


Figure 7-59 Perceived recreation service and recreation opportunity and potential (GWR results)

7.7.6 What factors influence the perception and use of recreation service?

Figure 7-60 summarises the factors that influence the perception and use of recreation service. These factors affect various dimensions, including general perception, visitation pattern, and activity preference, to influence the perception and utilisation of recreation services.

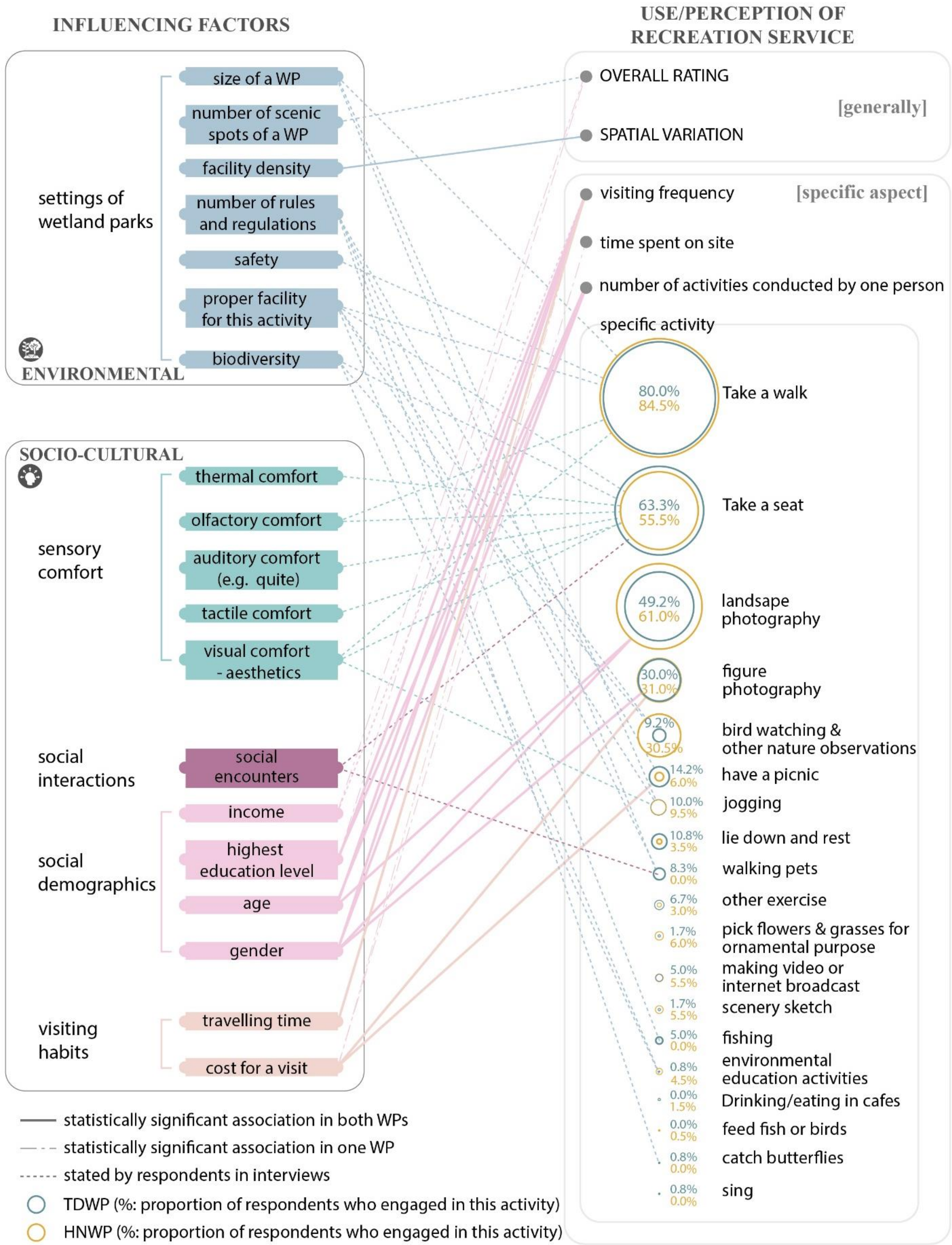


Figure 7-60 Factors that influence the usage and perception of recreation service

Settings of WPs such as the size and number of scenic locations may influence the perception, and the density of recreation facilities has been found to correlate with the perception of recreation service. There was a consistency between the recreation use and the size as well as the number of scenic spots of the two WPs. This may suggest that size of WPs could not only determine the total recreation service of sites (McLachlan *et al.*, 2013), but also influence individuals' perceptions of recreation service. However, considering the larger a WP is, more scenic spots could be contained, it is challenging to differ the influence of size and number of scenic spots. Density of scenic spots did not affect the perception in this study. Correlation between recreation facility density and perceived recreation service in Haizhu Lake of HNWP confirms that facilities support recreational activities as suggested by other scholars (e.g., (McCormack *et al.*, 2010)). Moreover, the current study observed that the frequency of picnicking on the lawn in HNWP was restricted to occasions when security personnel and administrators were not present in the area, as such activities were not officially permitted. Furthermore, it was observed that TDWP offered a wider range of unstructured activities such as lying down and rest, picnicking, fishing, and walking pets, which implies that a moderate reduction in rules and regulations could potentially promote the delivery of recreation service. These findings support the inclusion of the 'amount of rules and regulations' in the Recreation Opportunity Spectrum (McCool, Clark and Stankey, 2007). Additionally, it has been discovered that park characteristics associated with injury prevention are related to park use and physical activity (McCormack *et al.*, 2010). Therefore, concerns about the safety of walking on narrow paths must be addressed in order to guarantee the use and physical activities of parks by vulnerable visitor groups.

Sensory comfort, including thermal comfort, auditory comfort, tactile comfort, and visual comfort, influences the preference of places to conduct activities. The impact of thermal comfort on the selection of seating areas for rest is in line with prior research conducted in parks located in Guangzhou (Yang, 2019) and Mediterranean cities (Ferré, Guitart and Ferret, 2006). TDWP respondents preferred quiet places for auditory comfort, while HNWP respondents preferred fragrant places for olfactory comfort. The preference for plastic trails and benches with backrests that provide comfort suggests the influence of tactile comfort. Visually, perception of recreation service was relevant to perceived aesthetic value and perceived wildlife habitat. The observed spatial correlation between perceived aesthetic value and perceived recreation service aligns with the previously reported association between aesthetics and park utilisation and physical activity engagement (McCormack *et al.*, 2010).

Social interactions, such as social encounters with other visitors, influence the perception. TDWP showed a higher rating of recreation opportunity in summer compared to winter, with no change in facilities between seasons, and several TDWP respondents preferred quiet and less crowded locations to take seats and have rests. These findings provide support for the inclusion of social encounters as a determinant of the Recreation Opportunity Spectrum (McCool, Clark and Stankey, 2007). Besides, the findings indicate that individuals tend to prefer WPs with a moderate to low likelihood of frequent social interactions for recreation. In addition, a greater proportion of summer-recruited respondents visit TDWP more frequently than winter-recruited respondents; this may be due to the influence of weather, social interactions, or scenic attractiveness.

Socio-demographic features including gender, age, and highest education level played roles as well. **A larger proportion of males, senior (≥45 years old in TDWP, ≥35 years old in HNWP) respondents, or less educated respondents visit the two WPs more frequently.** This could be explained by the finding of other researchers that visitors older than 45, male visitors, or less educated respondents have greater recreation needs (Zhang *et al.*, 2013, p. 49). Juniors visits less frequently may also be owing to leisure constraints such as working hours and lacking in leisure time (Mao, Liu and Zhao, 2023). Findings from Chapter 5 indicating that the 45–54 age group perceived the greatest physical and mental health benefits from visiting WPs and that men perceived greater health benefits than women may also explain the effect of age and gender on frequency of visits.

In contrast to the impact of gender, age, and educational attainment on visitation frequency, it was observed that **female, young adults (younger than 45 years old), or well-educated respondents engaged in a greater variety of activities in both WPs.** These findings indicated that **various groups of visitors using recreation service through different ways**. The insignificant correlation between the frequency of visits and the number of activities among women, juniors or well-educated respondents, suggesting a low likelihood that the higher number of activities performed by them was attributed to their preference for engaging in more activities to make up for less frequent visits. A more likely explanation could be that there were fewer male-preferred activities available in WPs (e.g., fishing and playing chess (Yang, 2019)). Improving recreation facilities to accommodate a wider range of activities may enhance the benefits that males derive from engaging in recreation in WPs. And less-educated respondents may participate in fewer activities due to a decline in leisure-time physical activity as a result of their low perceived control over life (Droomers, 2001).

Further, in TDWP, a <u>negative correlation</u> was discovered between the **highest education level** and recreation service ratings. However, there was not always a correlation between education level and rating of recreation service (i.e., the correlation only found in TDWP); therefore, additional research is necessary to corroborate the existence of this correlation.

As for **visiting habits**, larger proportion of respondents who spent less than 20 CNY for a visit to HNWP, or spent less than 30 minutes on the way to both WPs, visiting the WPs more frequently. This suggests that the reduced expenses and travel time facilitate more frequent visits to WPs.

7.7.7 Limitations and outlooks

Several factors that have been identified in previous studies as influencing the utilisation and perception of recreation were not found to have an effect in the present study, for example having a companion (H. Wang et al., 2019), social clubs and neighbourhood associations (Strath, Isaacs and Greenwald, 2007). This may be due to the fact that WPs may not include all the types of activities that are possible in conventional parks due to their different settings, resulting in the variation of recreational habits. Future research on whether and how these factors affect the perception of recreation services in wilderness areas is necessary.

7.8 Relationships between the perception of wildlife habitat, aesthetic value, and recreation services

7.8.1 Existing knowledge regarding relationships of the three ecosystem services

Wildlife habitat service, aesthetic value and recreation service were discovered to be most frequently PESs when visiting WPs and were perceived to be important for promoting human health. However, tourism is the activity most likely to conflict with biodiversity conservation in WPs. And it has been discovered that even among individuals who are generally sympathetic to the conservation of biodiversity, when daily practises and actual environmental behaviours conflict with biodiversity conservation, the conflicting activities are prioritised (Scholte *et al.*, 2016). Understanding the trade-offs and synergies between wildlife habitat service, aesthetic value, and recreation service may aid in achieving a more sustainable future.

Trade-offs arise when prioritising one ES over another results in the loss of benefits from the unselected ES, whereas synergies are described as the opposite; they vary over place and time and have varying degrees of reversibility (Rodríguez *et al.*, 2006). Understanding the interconnections between ESs could therefore facilitate the synergy of ESs, encourage management practices that increase the benefits to people (Kong *et al.*, 2018; Plieninger *et al.*, 2019), and enable the forecast of crucial ES trade-offs and synergies on the landscape (Raudsepp-Hearne, Peterson and Bennett, 2010, p. 5245).

Regarding relationships between wildlife habitat and aesthetic values, it has been demonstrated that plant diversity is attractive to humans in itself (Lindemann-Matthies, Junge and Matthies, 2010). Besides, biodiversity and cultural services were discovered to be highly associated at regional scale in Iran (Karimi, Yazdandad and Fagerholm, 2020). However, to the best of our knowledge, the relationship between these two ESs remains ambiguous on a medium scale.

Relationship between wildlife habitat and recreation service is twofold. On the one hand, wildlife habitat service could be advantageous to the recreation service. It was found that tourists are more likely to visit a protected area, if there are more bird species there to see (Naidoo and Adamowicz, 2005). Large mammal biodiversity had context-specific effects on visitor spatial distribution in four South African national parks (Arbieu *et al.*, 2018). However, there is no evidence that ecological restoration with higher biodiversity significant effect on the recreational value of coastal wetlands; visitors who were attracted to the natural setting will visit coastal wetlands more frequently after the restoration, whereas visitors who use the wetland for recreational purposes will visit less frequently (Pueyo-Ros *et al.*, 2018). On the other hand, recreation activities could be harmful to wildlife. There is evidence that high levels of disturbance (at least 30 visitors per day) can affect the habitat usage of upland waders (Pearce-Higgins *et al.*, 2007). Recreational activities reduce resource availability for Iberian frogs; to reduce local disturbance to the species, buffer areas more than 2.5 metres from streams or less than 5 visits per hour are recommended (Rodríguez-Prieto and

Fernández-Juricic, 2005). Even for Blackbird accustomed to urban environments, human disturbance has a negative impact on their feeding strategies in urban parks, ultimately altering their density and abundance (Fernández-Juricic and Tellería, 2000). Yet, recreationists may not be aware of this detriment; it was found that in general, respondents of a survey about how recreationists perceive their effects on wildlife believed it was acceptable to approach wildlife closer than empirical data suggested wildlife would permit (Taylor and Knight, 2003).

Recreation services and aesthetic value are usually considered to be synergies. It was discovered that the association between aesthetics and park utilisation, as well as physical activity engagement, was summarized to be significant for individuals across various age groups, including adults, children, and adolescents (McCormack *et al.*, 2010). Indicators such as scenic beauty or criteria related to landscape aesthetics (e.g., landscape diversity) were considered when evaluating recreation services or recreation potential (Cetin and Sevik, 2016; Hou *et al.*, 2018), showing synergies between the two ESs. However, a weak spatial correlation between the two ESs was found in the Bilbao Metropolitan Greenbelt (northern Spain) (Casado-Arzuaga *et al.*, 2014). Further research is required to classify the relationships, particularly in wetlands.

On the basis of these limited information, it is still difficult to determine sustainable future pathways that benefit human well-being and the ecological environment; people's perceptions and opinions on the trade-offs and synergies between wildlife habitat service, aesthetics, and recreation need to be investigated. Therefore, **this study seeks to investigate the trade-offs and synergies between perceptions of the three ESs, in terms of values and spatial extent, to determine the optimal scenario for the future development of WPs from a human welfare stance.** Hence, this study could provide evidence to fill in the knowledge gap regarding potential trade-offs in wetland management and to compare alternative management actions (Xu *et al.*, 2018).

7.8.2 To investigate the perceived relationship between the three ecosystem services

To achieve the research objective, in Haizhu Lake of Haizhu National Wetland Park (HNWP), mix methods combining discrete choice experiment (DCE) (Section 7.2.4) and participatory mapping (Section 7.2.3.2) with follow-up interview were used. While in Tianhe Daguan Wetland Park (TDWP), only trade-offs were examined, through the final question in the questionnaire:

> *Assuming that there will be a quality improvement of this wetland park, and you were one of the decision-makers for the quality improvement project. All three of these features—beautiful landscape, sufficient recreational opportunities, and diverse and rich wildlife—cannot be enhanced at the same time. Is there one of these three that you think ought to be prioritized above the others? What about the least crucial of the three? To indicate importance, please rank them.*

7.8.3 Results of choices in questionnaire, Tianhe Daguan Wetland Park

In Tianhe Daguan Wetland Park (TDWP), 116 respondents gave answers to the question about trade-offs between ESs; other four respondents thought it was too difficult to answer. When aesthetics, recreation and wildlife habitat services trade-offs, nearly 36.2% of respondents thought aesthetics service was the most important ESs, then come recreation service, and last was the habitat service (Table 7-35). And 30.2% of respondents also agreed that aesthetics services were the most vital ES, but cares more about wildlife habitat service than recreation service. 20.8% of respondents believed that recreation service was the most essential ES in WP. And only 11.7% of respondents agreed that wildlife habitat service was the most important.

As results of contingency table with Fisher's exact or Chi-square analysis, there was no statistically significant relationship between the gender, age, income, cost, travelling time, visiting frequency, time spent on site, or surveyed season and the ranking of ESs was found. A larger proportion of well-educated respondents opted for the prioritisation of wildlife habitat rankings as the most significant factor (P = 0.027).

Table 7-35 Frequency of choices on trade-offs between ESs

	Frequency	Percentage (%)
aesthetics > recreation > wildlife habitat	42	36.2
aesthetics > wildlife habitat > recreation	35	30.2
recreation > aesthetics > wildlife habitat	12	10.3
recreation > wildlife habitat > aesthetics	13	11.2
wildlife habitat > aesthetics > recreation	11	9.5
wildlife habitat > recreation > aesthetics	3	2.6
SUM	116	100

7.8.4 Results of discrete choice experiment

7.8.4.1 Sample population

Because one respondent dropped out of the survey before participating in the choice experiment due to a rush, there were 199 valid responses for the DCE (Table 7-36). Among the 199 responses, 96 were from online.

Table 7-36 Demographic characteristics of respondents of choice experiment

	Total N=199			**Total N=199**	
	n	%		n	%
1. Gender			**3. Highest education level**		
Male	82	41.2	Middle school and below	17	8.5
Female	117	58.8	High School / Technical School	48	24.1
2. Age			College	33	16.6
18-24	47	23.6	University / Bachelor	78	39.2
25-34	63	31.7	Master and above	23	11.6
35-44	23	11.6	**4. Monthly discretionary income**		
45-54	25	12.6	0-2999	31	15.6
55-64	19	9.5	3000-5999	57	28.6
≥65	22	11.1	6000-8999	31	15.6
			9000-11999	19	9.5
			12000-14999	9	4.5
			≥15000	16	8.0
			Unwilling to tell	36	18.1

Answering the DCE was neither easy nor difficult for 30.3% of respondents; 16.9% of respondents found it difficult to choose from the choice sets. Among all 199 respondents, 5 respondents refused to pay (which means that in each choice set those respondents chose neither of the given scenarios), accounting for 2.5%. 138 respondents stated the reasons behind their choices: 40 respondents (29.0%) cared most on the aesthetic service, because the main driver for their visits is to see the beautiful scenery; 25 respondents (18.1%) highlighted the significance of wildlife habitat service; 5 respondents (3.6%) thought the recreation was the most important; while 68 respondents (49.3%) were firstly concerned about the price.

7.8.4.2 Valuation of ecosystem services

The parameter estimation outcomes of the MNL and RPL models are nearly identical (Table 7-37 and Table 7-38). Although the RPL model fits the data substantially slightly better, further estimations were conducted using MNL model because it is simpler.

Table 7-37 Estimation results of MNL and RPL model

	MNL model					**RPL model**				
Variable	Coeff.		S.E.	z	Sig.	Coeff.		S.E.	z	Sig.
ASC	1.841	**	0.127	14.52	0.000	1.841	**	0.127	14.51	0.000
Aesthetic Service	1.405	**	0.136	10.32	0.000	1.405	**	0.136	10.31	0.000
Recreation service	0.437	**	0.136	3.22	0.001	0.437	**	0.136	3.22	0.001
Wildlife habitat service	0.690	**	0.138	4.99	0.000	0.691	**	0.139	4.98	0.000
Cost	-0.013	**	0.001	-10.74	0.000	-0.013	**	0.001	-10.69	0.000
Log-likelihood	-1543.58					-1543.57				
Pseudo R2						0.12				

N = 1592; Coeff.: Coefficients; S.E: Standard Error; Sig.: Significance; **: significance at 1% level.

It shows that whether or not considering the influence of demographic characteristics, the improvement of all the three services positively influences the utility, while cost negatively impact the utility. Aesthetics service has the most significant influence, follows by the wildlife habitat service and recreation service.

As can be seen from Table 7-38, the parameter for age and gender is statistically significant at the 95 percent level, and the negative age and gender (male) parameter suggests that older respondents and female respondents are more likely to select the second alternative relative to the first, all else being equal, and hence be more subject to right to left response bias when answering the survey tasks. As a result of the MNL with interactions model that includes socio-demographic interactions with ESs attributes (Table 7-39), the interaction term between age and aesthetic, recreation and habitat service are significant and positive, suggesting that older respondents were less sensitive[51] to the services, all else being equal. The interaction term of education, location and satisfaction are not statistically significant.

[51] That is, holding ES attributes constant, older respondents have a greater disutility for improvement of ES attributes

Table 7-38 Estimation results of MNL and RPL model (with influence of demographic characteristics)

Variable	MNL model Coeff.		S.E.	z	Sig.	RPL model Coeff.		S.E.	z	Sig.
ASC	2.315	**	0.616	3.75	0.000	2.315	**	0.617	3.75	0.000
Aesthetic Service	1.636	**	0.336	4.88	0.000	1.637	**	0.336	4.87	0.000
Recreation service	0.408	**	0.150	2.71	0.007	0.408	**	0.151	2.71	0.007
Wildlife habitat service	0.605	**	0.153	3.97	0.000	0.606	**	0.153	3.96	0.000
Cost	-0.013	**	0.001	-9.81	0.000	-0.013	**	0.001	-9.73	0.000
Age	-0.106	*	0.043	-2.47	0.014	-0.106	*	0.428	-2.47	0.014
Gender (male)	-0.140	*	0.069	-2.03	0.042	-0.140	*	0.069	-2.03	0.042
Gender (female)	0.140	*	0.069	-2.03	0.042	0.140	*	0.069	-2.03	0.042
Highest education level	0.105		0.067	1.56	0.119	0.105		0.067	1.56	0.119
Income	-0.030		0.050	-0.60	0.551	-0.030		0.050	-0.60	0.551
Log-likelihood	-1246.80					-1246.79				
Pseudo R^2						0.13				

N = 1034; Coeff.: Coefficients; S.E: Standard Error; Sig.: Significance; **, *: significance at 1% and 5% level.

Table 7-39 MNL model with demographic characteristics and ESs attributes interaction effects

Variable	Age Coeff.		Gender Coeff.		Education Coeff.		Income Coeff.	
ASC	1.850	***	1.841	***	1.844	***	1.994	***
Aesthetic Service (AES)	0.949	***	1.417	***	1.884	***	1.704	***
Recreation service (RES)	-0.264		0.458	***	0.958	**	0.335	
Wildlife habitat service (Bio)	0.096		0.708	***	1.096	***	0.542	*
Cost	-0.011	***	-0.013	***	-0.015	***	-0.016	***
Age × AES	0.120	*	-		-		-	
Age × RES	0.182	**	-		-		-	
Age × Bio	0.154	*	-		-		-	
Age × Cost	-0.008		-		-		-	
Gender × AES	-		0.068		-		-	
Gender × RES	-		0.121		-		-	
Gender × Bio	-		0.100		-		-	
Gender × Cost	-		0.000		-		-	
Education × AES	-		-		-0.147		-	
Education × RES	-		-		-0.161		-	
Education × Bio	-		-		-0.125		-	
Education × Cost	-		-		0.000		-	
Income × AES	-		-		-		-0.079	
Income × RES	-		-		-		0.026	
Income × Bio	-		-		-		0.024	
Income × Cost	-		-		-		0.001	
Log-likelihood	-1537.18		-1542.93		-1541.07		-1250.29	

Coeff.: Coefficients; **, *: significance at 1% and 5% level.

7.8.4.3 Estimation of welfare

Table 7-40 reports the WTP values of the ESs calculated by using MNL model. The WTP for increasing the scenic beauty from less preferred to more preferred scenes (i.e., aesthetic service) were estimated at 107.04

CNY or 107.08 CNY per visit; 33.30 CNY per visit for a 20% increase in recreation facilities or activities (i.e., recreation service); 52.59 CNY per visit for a 20% improvement in wildlife biodiversity.

Table 7-40 Estimation results of marginal willingness to pay (WTP) (CNY)

	MNL model			
	WTP (CNY)	S.E.	z	Sig.
Aesthetic service	107.08	15.700	6.82	0.000
Recreation service	33.30	12.1	2.75	0.006
Wildlife habitat service	52.59	13.39	3.93	0.000

N = 1592; Coeff.: Coefficients; S.E: Standard Error; Sig.: Significance;
****: significance at 1% level; S.D.: Standard Deviation**

The estimated compensating variation (CV) for the five scenarios represents the amount money that need to be compensated to maintain welfare levels in the presence of a decrease in the defined suite of ESs (Table 7-41). Changing to the Ideal Scenario where all three ESs are improved is expected to increase the mean WTP to 201.06 CNY/visitor. The 'harmonious Co-existence between Human and Nature' Scenario increase the mean WTP to 168.60 CNY/visitor, making it an outstanding scenario for development of this wetland park. Single improvement of aesthetic service could result in an CS of 118.89 CNY/visitor, and it is a merit scenario. However, changing to the Rewilding Scenario 1 where there will be 20% improved biodiversity with a less preferred scenery and 20% decreased recreation facilities and activities could result in a decrease WTP of 37.96 CNY/visitor from the baseline and 48.41 CNY/visitor from the Inaction Scenario.

Table 7-41 Compensating Variation for each management scenarios (CNY/visitor)

	H	**A**	**R**	**Change from baseline**	**Change from Inaction Scenario**
Inaction Scenario[52]	0		0	10.44	0
Park-like Scenario	-	+	+	100.28	89.83
Rewilding Scenario 1	+	-	+	-37.96	-48.41
Rewilding Scenario 2	+	+	-	136.57	126.13
'Harmonious Co-existence between Human and Nature' Scenario	+	+	0	168.60	158.16
Ideal Scenario	+	+	+	201.06	190.62
Single Improvement Scenario (aesthetic service)	0	+	0	118.89	108.45
Single Improvement Scenario (recreation service)	0	0	+	37.72	27.28
Single Improvement Scenario (wildlife habitat service)	+	0	0	54.41	43.97

H: wildlife habitat service, A: aesthetic value, R: recreation service
[0]: maintain; [+]: high in Aes or 20% improved of Rec or Bio; [-]: Low in Aes or 20% deteriorate of Rec or Bio.

[52] The recreation facilities and activities and biodiversity remain the status quo, no matter how the quality of the scenery is, because the scenic beauty is subjective

7.8.4.4 Rationale behind the choices: qualitative results

In the choice experiment, half of respondents prefer to pay the minimum to enhance all ESs. Some respondents did not care what the scenarios would be, as long as the WP was free to use and no additional fees were required, they were satisfied.

The majority of respondents who prioritise aesthetic value stated that their primary motivation for going outdoors during leisure time was to appreciate the scenery. Wildlife habitat service was highlighted by approximately one fifth of respondents. One respondent mentioned his understanding that WPs differ from conventional parks in biodiversity and it is the responsibility of WPs to conserve biodiversity. Consequently, it was determined that biodiversity should take precedence over the other two ESs. Besides, the pursuit of 'Unity of Heaven and Humanity (天人合一)' motivated visitors to emphasise the significance of biodiversity. Moreover, beautiful environment was considered as the result of ecology and biodiversity. In addition, interestingly, good wildlife habitat was viewed as an indicator of a healthy environment for humans to inhabit, for example:

> *I believe that birds are cleverer than humans and possess a greater sensitivity towards the environment. When there are fewer birds, it indicates a degradation in the environment, which makes me less willing to visit. It's like the animals have already chosen this environment for us.*

(Zachary, male, elder than 65 years, high school equivalent diploma, spent 1-3 hours on site, HNWP)

However, uncertainty about the specific location and technique of biodiversity improvement can affect people's willingness to pay; for instance, Bjorn stated that he would be willing to pay if biodiversity improvement involved creating a peony garden. Also, individuals did not always appreciate biodiversity. For example, one online respondent noted that because she has a Zoophobia, perfect animal environment may not benefit her, despite the fact that biodiversity is beneficial theoretically.

As current recreational facilities in HNWP were comparatively fewer than those of conventional parks, some respondents believed that the number of facilities should be increased so that they can walk and rest without becoming too exhausted when visiting the WP. Nevertheless, some respondents stated that they did not mind sitting on the lawn and that no facilities were required if the scenery and biodiversity were appealing.

7.8.5 Results of participatory mapping

7.8.5.1 Numerical statistical results

There were 99, 108, and 132 polygons associated with wildlife habitat service, aesthetic value, and recreation service generated by 49 respondents, respectively. There were significant Spearman Correlations ($P<0.001$) observed between habitat and aesthetics ($r = 0.290$), habitat and recreation ($r = 0.060$), aesthetics and recreation (r = 0.780). The linear regression shows similar results (Figure 7-61, Appendix A - 33). Coefficient between wildlife habitat service and aesthetic value were the highest, while that between wildlife habitat service and recreation service were the lowest. Additionally, multiple linear regression was tested setting the recreation services as dependent variable and the other two services as independent variables. Aesthetics services and habitat services explain 74.7% of the variability of the recreation services (Adj.R^2 = 0.747), and the two independent variables statistically significantly predict the dependent variable (P=0.000). The multiple linear regression model for this case is: $\text{Recreation} = 0.269 + 0.319 \times \text{aesthetics} - 0.120 \times \text{habitat}$.

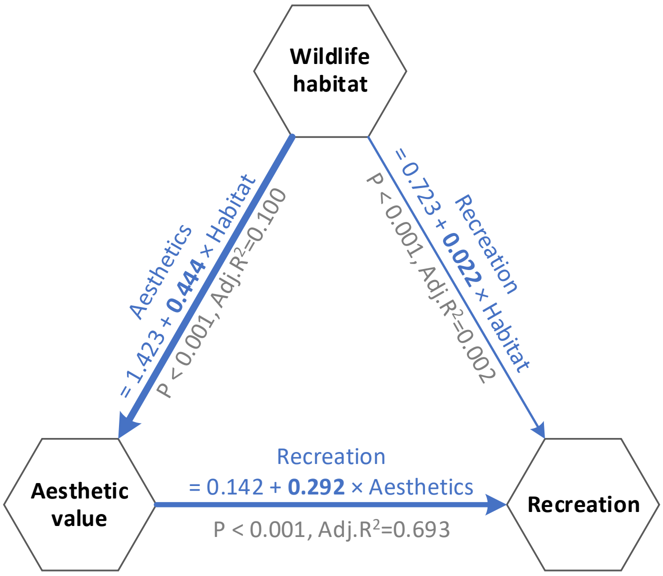


Figure 7-61 Relationship between the three ecosystem services (linear regression results)

7.8.5.2 Spatial statistical results across the ESs

The GWR analysis reveals the spatial variation of coefficients among ESs; only places that two ESs synergies were presented. The synergy between aesthetic value and recreation service occurs over a larger geographical area compared to the synergy between wildlife habitat and recreation service. As depicted in Figure 7-62 (a), the highest wildlife habitat service and aesthetic value synergy was found in the Island III, Plank and Islands I and II, areas around the Floating Wetlands, western and eastern open-wooded areas near the water, and the Viewing Platform near the northern entrance of the park. As shown in Figure 7-62 (b), synergy between wildlife habitat and recreation services is greatest in the Hide, Footbridge, and Plank and Islands II. As shown in Figure 7-62 (c), aesthetic value and recreation services synergize best in the Hide, Plank and Islands I, Shixiang Garden, and the Flower Field.

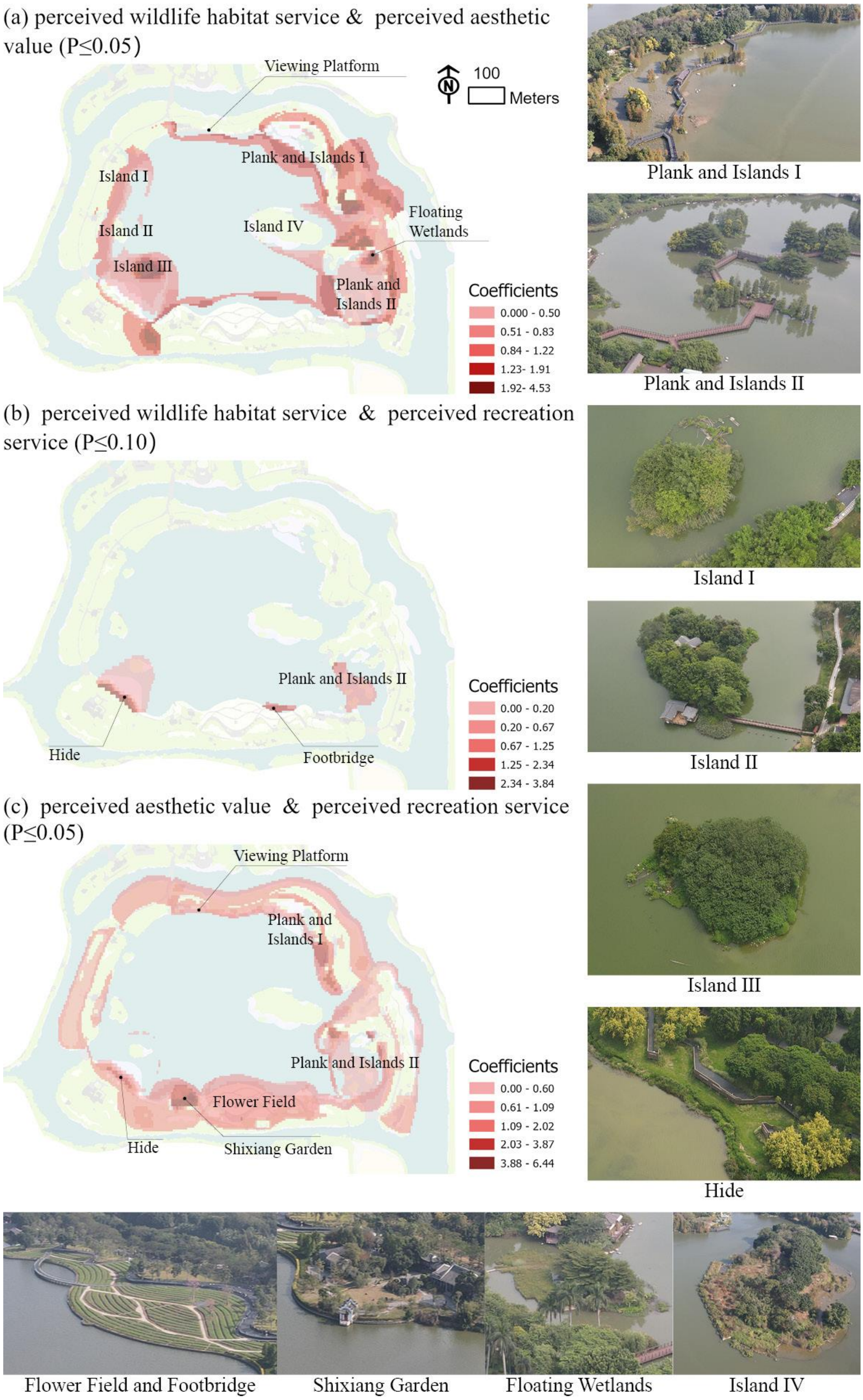


Figure 7-62 Spatial relationships among the three ecosystem services (GWR results)

7.8.6 Synergies and trade-offs between the perception of the three ecosystem services: discussion

This study found that biodiversity hotspots are associated with aesthetic and recreation services at the site scale, which is consistent with the findings of Karimi *et al.* (2020), who found that cultural and biodiversity hotspots were highly associated in protected areas and their surrounding regions at the local scale. Besides, the results of this study indicate that enhancing the provision of recreational services has a comparatively lower impact on overall welfare when compared to the enhancement of the other two ESs. However, 20% enhancement in recreational services coupled with a 20% decline in biodiversity, did not result in a reduction in welfare. This finding contradicts the results of a prior study conducted on national parks (Juutinen *et al.*, 2011). Further, qualitative findings regarding the relationship between PWH and aesthetic value support findings from earlier studies that there are aesthetic and non-aesthetic methods to benefit from interactions between humans and different species (McGinlay *et al.*, 2018). In addition, this study concurs with those studies that consider recreation services and aesthetic value to be synergies, despite a conflicting finding of a weak spatial correlation between the two ESs in one study (Casado-Arzuaga *et al.*, 2014). The disparity in findings between the current study and previous studies could be due to variations in the spatial scale of analysis used.

This study provide evidence for decision makings on the prospective path of WPs' development. Whilst the optimisation of all three focal ESs through the implementation of the 'Changing to the Ideal Scenario' approach is desirable, it may not always be feasible due to resource or budget constraints. The choice experiment analysis showed that the 'harmonious Co-existence between Human and Nature' scenario, which improve biodiversity and aesthetic quality while maintain the recreation opportunity, was the most favourable option for HNWP development. Making use of the synergies between the three ESs, it is possible to increase the aesthetic value by moderately enhancing the quality of wildlife habitat. In light of the findings from the follow-up interviews, it seems likely that sharing information about the present situation of ecological conservation, the biodiversity index, and the individual species that will be added to or protected, will increase visitors' value placed on wildlife habitat services. As a result, three ESs can be enhanced to varying degrees, thereby benefiting visitors the most.

Additionally, it is noteworthy for planning and design professionals to recognise that lay visitors of wildlife preserve place significant value on the provision of wildlife habitat services. Designs that prioritise aesthetic preferences of the public and offer additional facilities, but have negative ecological impacts, do not necessarily enhance the utility of visitors.

This study contributes to the limited literature on examination of ESs trade-offs and synergies on site or patch scale that people can actually experience, expanding the spatial scale of understanding ESs trade-offs and synergies, as the majority of existing ESs studies focus on local or larger scales. Moreover, this is a comprehensive study examining the interrelationship between PESs by valuation and spatial distribution, as well as the rationale for the valuation, on the same site with the same respondents. Additionally, this research is one of the few applications of the DCE methods and participatory methods to a case study on WPs. To the author's knowledge, the application of the DCE method to wetlands is limited to rural wetlands. For example, a study interviewed rural and urban population lived a continuum of distance from the studied wetland (from about 10 km to 500 km) (Birol, Karousakis and Koundouri, 2006), another study interviewed residents who live approximately 65 km from estuarine wetlands (Birol and Cox, 2007). Through an examination of the welfare that urban wetlands situated in **city centres** provide to visitors, and visitors' decision making on ESs when they cannot be improved at the same time, this study expand our understanding of the relationship between human well-being and wetlands (especially urban wetlands).

Similar to other research, this study is not exempt from limitations. These include that aesthetics perception is totally subjective and the comparison between pictures fails the indicate the difference between the actual level of aesthetic value. The 1-unit change of aesthetics value to different respondents may not be the same. Moreover, although several temporal characteristics of ESs were examined in this research, the temporal interaction between ESs was not. To develop spatiotemporal analysis of ES interactions, longer-term research should be conducted in the future.

This study assessed WTP per visit as opposed to WTP annually; as a result, frequent park visitors may have a lower WTP than infrequent visitors. However, those who visit the WP for the first time or less frequently than once a year may find it challenging to choose the choice sets if the annual payment option was used. Since the price attribute is calculated based on the total number of annual visits, testing the WTP per visit to the park is reasonable.

7.9 Chapter summary

In general, the evaluations of ESs in both study areas were favourable. In both WPs, the highest rating was given to air purification service, followed by aesthetic value. Both WPs are frequently visited for physiological, safety, affection and belonging, and cognitive reasons. The study found that in TDWP, there was a greater emphasis on the fulfilment of belongingness, love, and aesthetic needs, while in HNWP, physiological needs were more salient. Despite the perceived significance of air purification services, this chapter did not delve into the topic due to the limited accessibility of air quality data. This chapter did not delve into the educational value in depth because it received a low rating and was not emphasised in previous studies. In this chapter, the service of wildlife habitat, the aesthetic value, and the service of recreation were examined. The technical understanding of the three ESs was compared to the perception of the same ESs. The study revealed that visitors tended to underestimate the value of wildlife habitat services in WPs. Additionally, the current metrics used to measure aesthetic value in WPs were found to be incomplete, and weights were suggested to be assigned. Finally, the perceived level of recreation service was found to be somewhat aligned with the potential and opportunity for recreation in WPs. In addition, environmental and sociocultural factors influence perception. Furthermore, it was determined that the three ESs exhibited a correlation with one another, with the greatest synergy being observed between aesthetics and recreation. Additionally, it was found that wildlife habitat services contributed more to aesthetics than to recreation services. The prioritisation of aesthetic value was chosen by the majority of respondents among the three ESs when they conflict. The importance of wildlife habitats in providing environmental benefits, including visual quality, was emphasised.

Chapter 8. Discussion and conclusion

This chapter commences with a brief summary of the major findings that align with the objectives of the research. Based on these key findings, there is a discussion of the significance of the research and its contribution to existing knowledge. Recommendations are provided for policymakers, planning and design professionals, and the general public to enhance the supply and perception of ecosystem services (ESs) in wetland parks (WPs). The limitations of this study are then summarised and suggestions made for future research to overcome these limitations. This chapter only discusses the contributions and limitations of the entire thesis; contributions and limitations specific to each ES and semi-study were discussed in their respective chapters. Finally, the thesis is completed with the conclusion.

8.1 Interweaving findings and research objectives

8.1.1 RO 1: Identifying ESs that are more critical to WPs, especially those valued by the public

Chapter 4 to Chapter 6 confirm the hypothesis that WPs do not provide the entire set of ESs specified in the framework, that some ESs (e.g., recreation and wildlife habitat) are more important to WPs than others, and some ESs (e.g., air regulation) are more easily recognised and deemed more significant by the general public.

Previous studies or design statements on WPs in Guangzhou reveal the provision of ESs, including wildlife habitat, flood regulation, air regulation, water purification, recreation, aesthetics and environmental education. Other ESs outlined in ES frameworks were not mentioned as being delivered or intended to be delivered by Guangzhou WPs. WPs provide benefits to both citizens and visitors: they help with, for example, reducing flood risk and purifying the air for nearby communities, while offering additional benefits to visitors. Therefore, **visitors to WPs** were identified as the primary beneficiary group for this study and the subsequent study focused on the perceptions of ESs among visitors who were also laypeople and members of the general public.

The social media research gives an overview of perceptions of ESs in WPs in Guangzhou, indicating that the top ESs perceived by the general public and communicated by institutions were **recreation**, **aesthetics**, **social relations** and **wildlife habitat**. The study of the health benefits of WPs showed that **wildlife habitat** and **water purification** were considered to be the most important ESs that promote the perceived human physical and mental health benefits. The majority of respondents perceived **air regulation** in WPs and deemed it beneficial to physical health. Although flood regulation and noise reduction were considered to be beneficial to health, only half of the respondents noted this in relation to WPs. The fact that WP users perceived air regulating services more easily than flood regulating services may be due to people being more concerned about poor air quality than flooding events (Duan *et al.*, 2018). During heavy rainstorms, visitor access to WPs may also be limited due to transportation difficulties, and some WPs may temporarily close to ensure visitor safety. Therefore, recognising WPs as flood storage areas is problematic, potentially hindering the recognition of their importance in flood prevention.

This study also confirms that certain ESs have varying levels of significance for WPs, as indicated by the government, scholars and landscape architects, and perceived by the public. Landscape architects and government institutions have emphasised certain ESs, including flood regulation, cultural heritage value and environmental education. However, these ESs have been overlooked by the general public and there was limited evaluation of how well WPs actually performed. Certain ESs, such as air regulation, were more readily acknowledged and considered to be of greater importance by the general public. Yet, when formulating proposals for WPs, planners and designers have often neglected to take these ESs into account.

Based on the findings pertaining to other objectives of this research, it is possible to bridge these gaps. For example, this study found that the presence of on-site signs displaying bird species has raised awareness among respondents about the wildlife habitat service. Similarly, it would be possible to raise public awareness about the overlooked ESs such as flood regulation and cultural heritage value through increased scientific and educational outreach, thereby increasing the public's subjective well-being and their willingness to support WP projects. This study also suggests that landscape architects and researchers should devote more attention to overlooked ESs in future practice and research.

8.1.2 RO 2: Determining the extent to which public perceptions of ESs are consistent with technical understanding

This study found that public perception and technical understanding of the focal ESs (i.e., wildlife habitat service, aesthetic value and recreation) exhibit various degrees of consistency across different scales or aspects (Chapter 7).

The general perception (rating) of wildlife habitat service roughly corresponded with technical understanding at the site level and among locations within WPs concerning the relative relationship between high and low service, with the wildlife habitat service in a few locations being underestimated by the public. It is possible to perceive and estimate wildlife habitat service on a spatial scale, but it is difficult to achieve accuracy with respect to the number of species. A limited number of participants provided estimates that closely approximated the scientific data. Notably, the estimation of plant species richness demonstrated greater accuracy compared to the estimation of avian species.

To technically understand the aesthetic value of WPs, this study conducted unweighted scoring on stimuli by utilising semantic segmentation of images and a 3-point measurement scale developed based on aesthetic elements identified in existing literature. By comparing the measured score/ranking to the results of visitors' photo ranking, it was found that the measured ranks and perception ranks do not always exhibit similarities or differences. Seasons affect measuring scores and perceived evaluations for the same location viewed from the same place, indicating the need to incorporate temporal variation in aesthetic service evaluation. The disparities between measured scoring and perceived ranking also suggest that some indicators play a more significant role than others, necessitating the assignment of weighting.

To some extent, the perceived recreation service corresponds with recreation potential and opportunity. There was consistency between the recreation use and the size and number of scenic spots for the two WPs, while the number of activities undertaken may not be related to scenic spots offered. In Tianhe Daguan Wetland Park (TDWP), the surveyed season affected the assessment of recreational opportunities, indicating that not only the facilities themselves but also other visitors (competitors) who were using the facilities may influence perceptions. In Haizhu Lake in Haizhu National Wetland Park (HNWP), a spatial correlation was discovered between the perceived recreation service and recreation opportunity (i.e., recreation facility density) as well as recreation potential (i.e., perceived aesthetic value and wildlife service).

Despite the fact that the primary focus of this study was on ESs, ecosystem disservices were found to influence the perception of ESs. Although the creation of wetland protection areas may reduce mosquito populations compared to leaving the land unattended and overgrown, mosquitoes are still a significant ecosystem detriment that WPs provide, and this impacts the perception of ESs such as aesthetic value.

8.1.3 RO 3: Determining the factors that influence ESs perception in WPs

Common factors were observed to influence the perception of ESs, although the components and degrees of influence varied between the six WPs studied in the social media survey (Chapter 4). Recreation services varied across WPs; individuals highlighted diverse activities across WPs. The most important stimuli for the perception of aesthetic value in five WPs, excluding the Nansha Wetland Park, were coloured-leaf trees and floral species. Wildlife, including birds, mangroves and *Phragmites australis*, were the most important aesthetic stimuli for the Nansha Wetland Park. Birds were the most influential stimulus for the perception of wildlife habitat service in WPs, whilst Egrets (*Ardeidae*) were more influential in Huadu Lake Wetland Park than in Nansha Wetland Park. Butterflies, bees and flora were the primary stimuli for some WPs.

Through studies in HNWP and TDWP, factors that influence the perception of three focal ESs were further examined and explored (Chapter 7).

The rating of **wildlife habitat service** was influenced by socio-demographic characteristics in a disparate manner across the two WPs. The relationship between visiting habits and the rating of wildlife habitat service was also not consistently observed. The ratings of habitat for different groups of wildlife, namely plants, birds and aquatic animals, were influenced by socio-demographic characteristics in diverse ways within the context of HNWP. Before the association between socio-demographic characteristics, visiting habits and perception of wildlife habitat service can be better understood, additional research needs to be conducted on the topic.

Indices were identified that could be used to predict the perception of wildlife habitat service relating to plants and birds. The number of plant species that are very easy to see (e.g., trees) is most likely to influence the perception of vascular plant species richness, followed by the number of species that are easy to see (e.g., trees and shrubs). The number of bird species that could be encountered by experts per visit or per month on average is most likely to influence laypeople's perception of bird species richness, followed by the number of species that are easy to see (e.g., large and white birds such as *Ardeidae*). Further, as stated by respondents, the number of species shown on publications (including signage boards on site and other publications), wildlife-related events (e.g., bird watching competition) and availability of equipment such as binoculars, were discovered to be factors influencing the perception of species richness. Spatially, islands in the lake were perceived to be superior wildlife habitats due to their isolation from human disturbance. From a socio-cultural perspective, direct observation, comparison with other familiar places and knowledge about the relationship between habitat and wildlife, as well as visitors' demographic characteristics, were factors that influenced the perception of species richness.

The study revealed that a subset of the indicators of **perceived aesthetic value** documented in the literature were not reported by the participants. All factors pertaining to the 'overall landscape' category were mentioned, while some factors under 'landscape elements' and most under 'cognition' were not mentioned. This includes several factors that were not present in both WPs, such as wood in rivers and the shoreline. The interviewees did not mention any social-cultural factors identified in previous literature other than familiarity and there was no evidence to suggest that sound affected visual aesthetic preferences. Despite this, respondents highlighted four factors that were not addressed in the literature: specific colour (e.g., green, golden, red), quantity of certain vegetation (e.g., flower field), negative association with pests, and participatory landscape. It is noteworthy that the same scene may be perceived differently based on the same factor; for instance, complexity can be perceived positively or negatively in terms of aesthetic perception. Moreover, the two WPs reflect the differential influence of social-demographic factors on aesthetic appreciation. This study found that the aesthetic perception of WPs is primarily influenced by the visual scale of the overall landscape, followed by the presence of water, water body or wetland size, vegetation species richness or diversity, stewardship or orderliness of overall landscape, vegetation characteristics, complexity and diversity of overall landscape, and disturbance or the presence of negative man-made elements. It is noteworthy that the Chinese traditional culture of Yijing (意境), 'Unity of Heaven and Humanity (天人合一)', 'Shanshui (山水)' plays a role in the aesthetic perception; although they were not very often mentioned they cannot be ignored. Temporarily, seasons influence the aesthetic perception of the same location by altering the colours, vegetation coverage and vegetation health, as well as influencing thermal comfort-related synaesthesia. These temporal factors that influence the perception could be associated with Guangzhou's subtropical monsoon climate, which is hot and humid in summer and warm in winter.

Factors that influence the perception and use of **recreation service** include the setting of WPs, sensory comfort, social interactions, socio-demographic features and the visiting habits of individuals. Size, number of scenic spots, facility density, number of rules and regulations and safety were qualitatively identified to be potential influencing factors. The preference of places for conducting activities was influenced by individuals' sensory comfort, which encompasses thermal, auditory, tactile and visual comfort. The possibility of encountering other visitors may also influence the perception of recreation services. Gender, age and highest education level were confirmed to influence the perception. Men, the elderly and less-educated visitors visited more frequently, while women, young adults and well-educated visitors participated in more types of activities. It was also suggested that reduced expenses and travel time facilitate more frequent visits to WPs. Understanding the factors that influence the frequency of visits will aid in encouraging the public to visit WPs more frequently, thereby providing more benefits, such as higher self-assessed mental health (Southon *et al.*, 2018).

The demographic characteristics of visitors were found to impact their perceptions of all the three ESs. Therefore, the preferences of different visitor groups for ESs and the pathways through which they can benefit from WPs were summarised.

8.1.3.1 Benefit pathways for various visitor groups

This study found that certain demographic characteristics have a direct influence on the perception of ESs (PESs) through their association with ratings, or an indirect influence through their association with specific attributes of PESs. That is, various visitor groups get benefits from WPs through various pathways. For example, men, seniors and less-educated visitors visited WPs more frequently for recreation services, while the other groups participated in a greater variety of activities. Ways to improve ESs can be proposed by understanding how different groups benefit from ecosystems, which will increase the perceived benefits for various groups of visitors.

The previous chapters found that men perceived greater health benefits against the background of Covid-19, but this did not emerge in the two examined WPs, indicating that in the perception of health benefits from WPs **gender** differences may only become apparent when individuals are exposed to a health event. The insignificant difference between male and female ratings of PESs suggests that the use of WPs benefits both genders equally. Nevertheless, there were gender disparities in landscape preferences and recreational habits, leading to variations in the ways men and women derived benefits (Figure 8-1). Learning from the pathways identified, for example, providing more landscapes similar to those shown in Photo B (Figure 7-46) may improve the benefits men experience, while encouraging women to visit WPs more frequently may enhance the benefits they get.

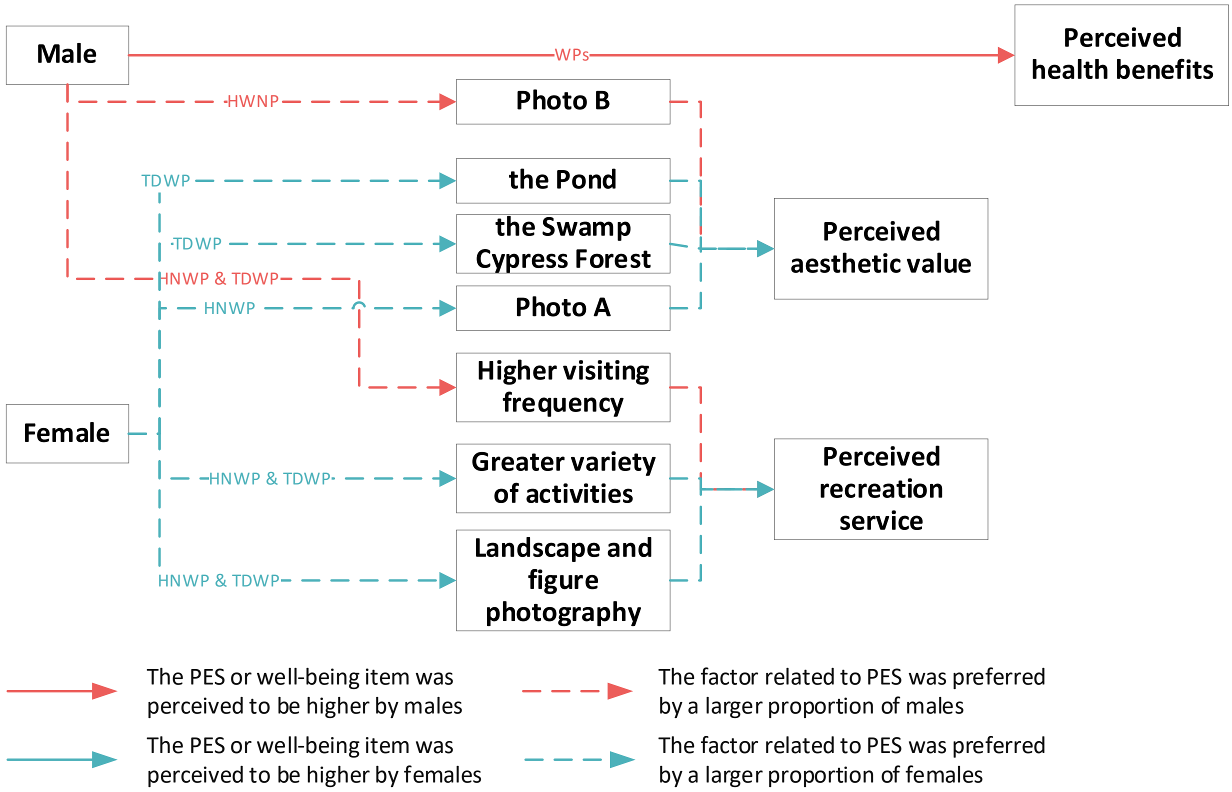


Figure 8-1 Different benefit pathways for males and females

The relationship between age and PESs differed across WPs, suggesting that it may depend on the specific context. Younger respondents tended to be more satisfied with less direct benefits (i.e., aesthetics, wildlife habitat) than senior respondents, who were more concerned about and satisfied by direct benefits (i.e., pleasantness, health benefits) (Figure 8-2). The higher ratings of perceived health benefits in WPs and air quality in HNWP by senior respondents may be attributed to their increased sensitivity to polluted air and concerns about health issues, which tend to increase with age and declining health status (especially declining lung function) (Sharma and Goodwin, 2006). Based on the pathways found, it is suggested that increasing the number of plants with robust air purifying capabilities could potentially enhance the advantages for senior visitors. Enhancing the visual quality and biodiversity may also have a positive impact on the benefits experienced by younger visitors.

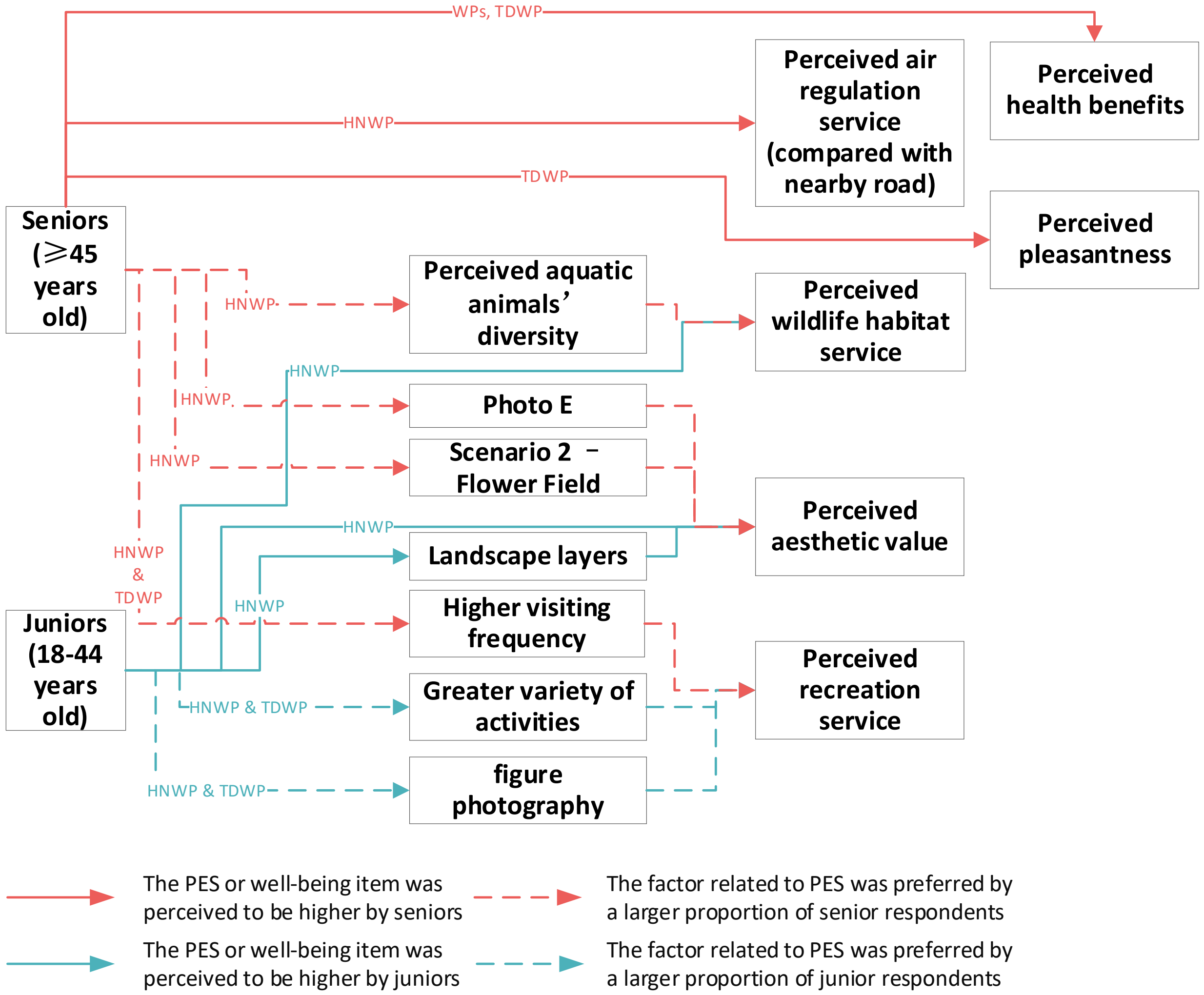


Figure 8-2 Different benefit pathways for senior and junior respondents

Less-educated visitors (high school equivalent or lower) perceived significantly more benefits in TDWP than well-educated visitors, but no such findings were found in HNWP. Nevertheless, pathways to benefits were found to be different between less-educated and well-educated respondents (Figure 8-3). It should be noted that in both WPs, there was a negative correlation between the highest education level and age. Some findings, such as that less-educated visitors visit more frequently and perceive higher health benefits and pleasantness, can be correlated with age. Drawing insights from the discovered paths, for instance, the provision of cleaner water and the creation of landscapes similar to the one depicted in Photo A (Figure 7-46) and the Pond (Figure 7-44) may have the potential to enhance the benefits perceived by well-educated visitors. Improving the perception of aquatic animal and bird habitats among people with lower levels of education may lead to enhanced benefits for them; using easily understandable content on signage boards may also aid in improving this perception.

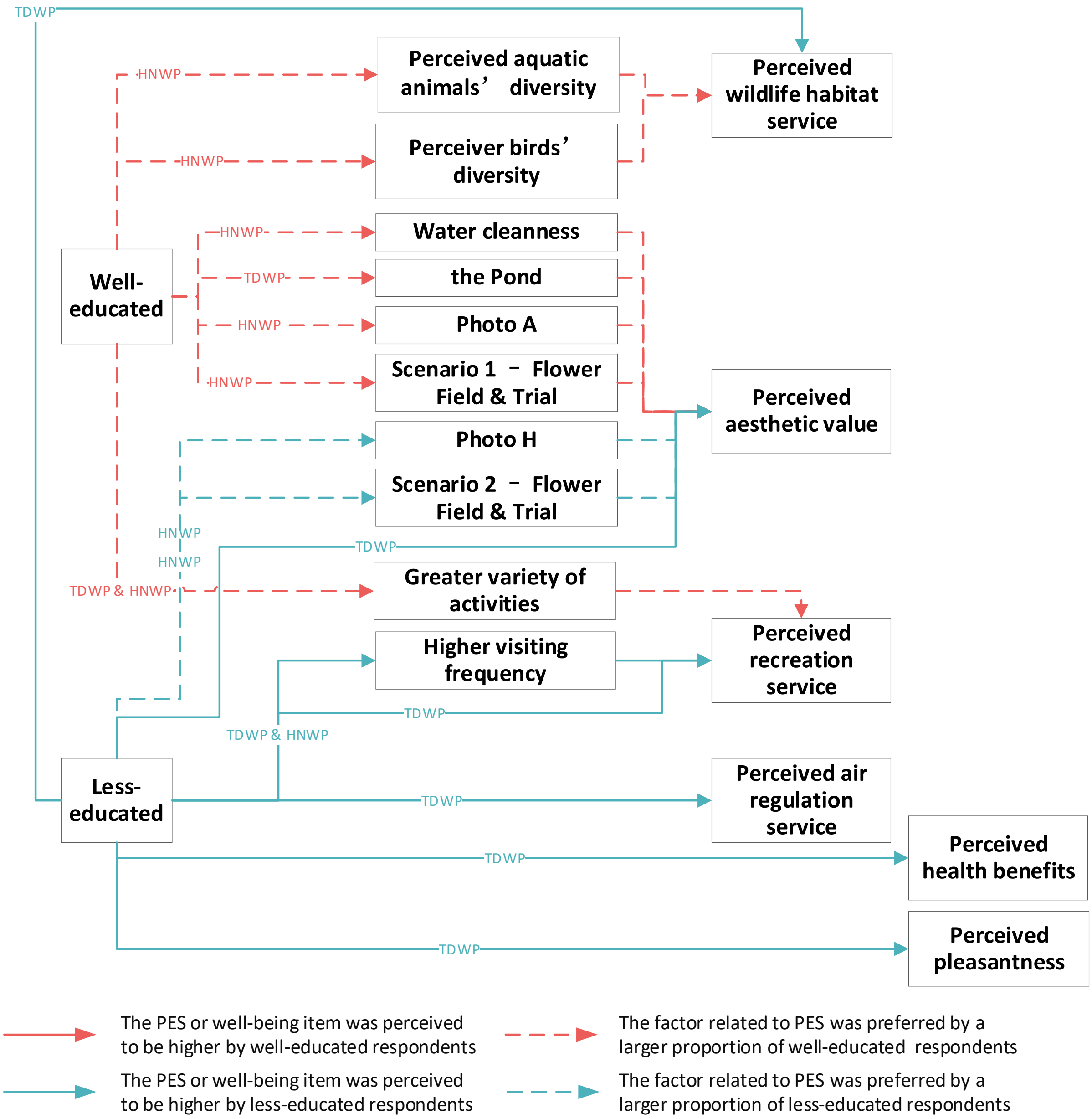


Figure 8-3 Different benefit pathways for well-educated and less-educated respondents

Monthly discretionary income was also found to be related to perception of pleasantness and aesthetic value in both WPs, and to perception of recreation service in TDWP. Less-wealthy visitors tended to perceive higher value; less-wealthy respondents also rated aquatic animal diversity and landscape layers of HNWP higher and visited HNWP more frequently (Figure 8-4). ESs provided by WPs were therefore more beneficial to vulnerable populations. In China, wealthier individuals often reside in commodity-housing estates that offer better public amenities within the estates, such as green spaces, in comparison to low-income neighbourhoods (Li, Zhu and Li, 2012). This may have contributed to a greater demand for high-quality public space, lower levels of satisfaction with ESs in current WPs, and lower visit frequency to WPs among higher-income groups compared to those with lower incomes. Nevertheless, higher-income groups have a greater capacity to financially support WP construction and wetland conservation; therefore, it is crucial to enhance their perception of the benefits from WPs and improve the quality of WPs to meet their needs.

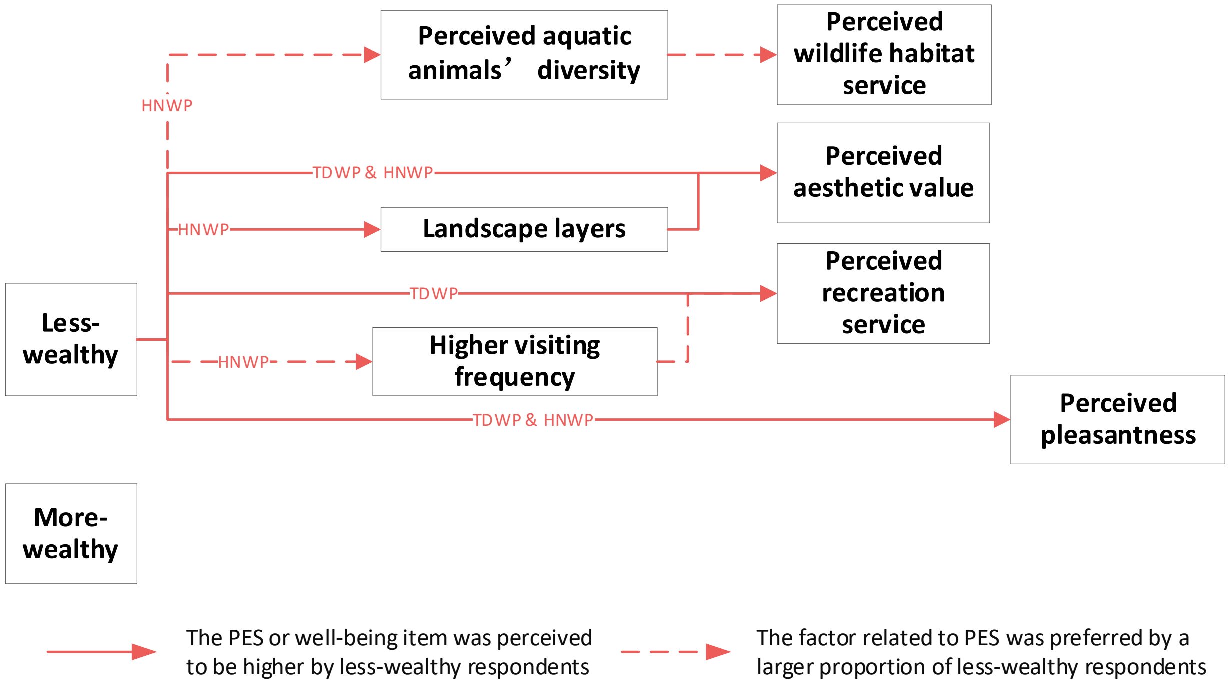


Figure 8-4 Different benefit pathways for respondents with different levels of wealth

Relationships between certain demographic characteristics and PESs were only discovered in one of the case study sites, indicating that such relationships may be context-dependent. Therefore, findings from studies conducted at a singular location may not always be applicable to other locations, even within the same city. Additional research is required to determine the factors influencing these context-dependent relationships.

8.1.4 RO 4: Exploring the relationships and interactions between perceptions of focal ESs.

The analysis of association rules using social media data (Chapter 4) reveals a strong relationship between aesthetic value and recreation service in five of the six WPs examined (with the exception of Nansha Wetland Park). Social relation service was occasionally associated with recreation service. In TDWP, recreation service, aesthetics service and social relation service were frequently mentioned simultaneously. In HNWP and Nansha Wetland Park, wildlife habitat services were frequently perceived alongside aesthetic services. Occasionally, the services of air quality regulation and recreation or aesthetics were perceived concurrently.

Participatory mapping at Haizhu Lake in HNWP (Chapter 7) indicates that significant correlations were observed between the perceptions of the three ESs when analysed pairwise. The pairwise linear regression model indicates that perception of aesthetic value influences recreation service more than wildlife habitat service. Multiple linear regression involving the three ESs revealed that perceived recreation service was synergised with perceived aesthetic value, while trade-offs occurred with perceived wildlife habitat service. Spatial synergies occurred at lake-facing waterfront locations. Around the Hide and Island III, the three ESs relate synergistically.

The choice experiment revealed that the improvement of all three services positively influence the utility that visitors get from HNWP, while cost per visit negatively impacts the utility. In HNWP, aesthetic value has the most significant influence, followed by the wildlife habitat service and recreation service. Similarly, in TDWP, aesthetic value was considered the most significant ES. However, recreation service was regarded as more important than wildlife habitat service in TDWP. The majority of respondents identified viewing beautiful scenery as their primary motivation for going outdoors in their leisure time, supporting the preference for aesthetic value. The differences in size and baseline conditions between the two WPs may have affected the choices visitors made regarding recreation service and wildlife habitat service. HNWP's larger size may make it more conducive to supporting wildlife habitats, whereas TDWP currently lacks sufficient recreational facilities. Examining the trade-offs that visitors make regarding the three ESs offers insights into resource allocation decision-making in the development of wetland parks.

8.2 Contribution to knowledge

This study provides a comprehensive investigation of ecosystem services (ESs) provided by wetland parks (WPs) and how they are perceived by WP users in Guangzhou. The findings augment existing theoretical knowledge towards the improvement of ESs research and urban wetlands management. The study:

- is the first to investigate **the actual use of ESs in WPs**, highlighting which ESs are valued by the public and which are not yet well-known to the public; it also analyses the reasons for this. The public perception of certain ESs can be enhanced purposefully to promote people's well-being.
- examines how biophysical environment and cultural factors influence the public perception of ESs (wildlife habitat, aesthetic value, and recreation) **at the site scale that people can actually experience.** Therefore, it embraces **a holistic perspective** on landscape (Antrop and Van Eetvelde, 2017) by integrating biophysical and social values.
- provides evidence for enhancing the **quality and capacity of delivery of ESs** in individual WPs within urban areas, thereby **allowing WPs of limited size within urban areas to deliver higher levels of ESs**. It highlights the importance of considering quality, in addition to quantity or area, when assessing the cultural ESs provided by wetlands. Further, due to unavoidable human disturbance, it is difficult to improve supporting, regulating and provisioning services (e.g., wildlife habitat) in WPs surrounded by urban areas, but there are measures that can be taken to increase the perception of the services and thus enhance human well-being in the short term.
- serves to augment the limited linkage established between biodiversity and human well-being by exploring the relationship between wildlife habitat service (Pires *et al.*, 2018), aesthetic value, and recreation service.
- may serve as supporting evidence for the application of machine learning techniques or other tools in aiding landscape architects and decision-makers in their selection of scenarios that are perceived to possess the greatest potential for wildlife habitat, aesthetic value, and recreation services, while also optimising the synergies between these three ESs.
- could inform the creation of an index (e.g., a visual quality index (VQI)), that could be used for assessing aesthetics and recreation services in urban wetland settings.
- enhances our understanding of the effect of demographic attributes on perceptions of ecosystem services: demographic attributes can indirectly influence perceptions not only by influencing other demographic attributes (Dou *et al.*, 2020), but also by influencing other landscape factors and green space use. These benefit pathways identified by various visitor groups may also serve as a useful tool when designing future research employing Structure Equation Modelling or similar models to quantitatively investigate the significance (i.e., weighting) of attributes to the perception of ESs.

The ‘wetland park’ is also somehow analogous to wetlands by other names in other countries, for example ‘stormwater wetlands’ (part of Water Sensitive Urban Design) (Sochacka, Bos and Dobbie, 2021), ‘multi-purpose green infrastructure’ (a series of constructed wetlands surrounded by a park) (Liquete *et al.*, 2016)), ‘wetland areas’ (Pedersen, Weisner and Johansson, 2019) , ‘wetland centres’ (Reeves *et al.*, 2021), urban wetlands, sustainable drainage systems (SuDS), nature reserves and so on. Hence, the findings of this thesis could also be applicable to wetland ecosystems with other names in comparable environments.

8.3 Implications of the research

This research's findings are used to generate a series of policy and practice recommendations for policymakers, planners and designers, from the level of legislation and planning, to design of individual WPs. This can thereby improve the public's benefits from wetland preservation and contribute to wetland conservation.

When formulating a territorial development or urban plan, policymakers and planners should consider incorporating a variety of WPs to cater to the preferences of various groups of citizens. It was found in this research that demographic composition of respondents from the two WPs varied, and this was also varied in respondents who had only been to one part of HNWP (Section 7.3.1.2 and 7.3.1.3). This indicates that, despite the fact that they are both wetland parks, there are differences in the WP users (i.e., on-site beneficiaries) due to varying internal attributes. The same visitor could also appreciate various ESs from various WPs (Section 7.4.4). Therefore, a greater variety of WPs could potentially benefit more citizens.

The present study on the wildlife habitat service in HNWP (Section 7.5.5.5) is consistent with prior research, indicating that protection of rare and endangered fauna is not effective in national WPs in China (Guo *et al.*, 2019). This statement is likely to capture the attention of policymakers. The process of restoring wetland habitats still requires significant progress.

It is noteworthy for planning and design professionals to recognise that lay visitors to wildlife conservation sites place significant value on the provision of wildlife habitat services. Designs that prioritise the aesthetic preferences of the public and offer additional facilities, but have negative ecological impacts, do not necessarily enhance the utility to visitors. In contrast, improving the quality of wildlife habitats could have a positive impact on scenic beauty, thereby increasing the utility for tourists. Strategically enhancing the richness and diversity of trees and shrubs, and making moderate attempts to attract avian species that are easy to see, can potentially enhance the public’s perception of biodiversity, thereby promoting a sense of well-being and the desire to conserve the environment. However, it should be noted that ESs are not all that is required. Ignoring the contribution of inconspicuous organisms, such as benthic organisms, to ecological processes may have a negative effect on the overall provision of ESs (Ingram, Redford and Watson, 2012). When applying the findings of this study to conservation, specific tools beyond ESs need to be developed to address the conservation of these particular issues.

Location decisions for WPs, as well as urban planning and design, should consider how to make WPs more accessible to as many people as possible. Although the study revealed that both the examined WPs (HNWP and TDWP) had adequate accessibility (Section 7.7.3 and 7.7.4.2) , it also demonstrated that inadequate accessibility to WPs was a major deterrent for Chinese citizens to use WPs (Section 6.3.2). When WPs are more accessible, more citizens can get more benefits from them.

This study also provides insights on how resource allocation decisions could be made during the development of WPs. Although it is desirable to optimise all three focal ecosystem services using the ‘Changing to the Ideal Scenario’ approach, limited resources and budget constraints may hinder the achievement of this ideal scenario. The choice experiment analysis showed that the ‘harmonious Co-existence between Human and Nature’ scenario, which improve biodiversity and aesthetic quality while maintaining the recreation opportunity, was the most favourable option for HNWP development. This scenario may also be favourable for other national wetland parks and large WPs that are already well-equipped. Nonetheless, for small WPs with weaker ecosystems and insufficient existing recreational facilities, the public would favour a moderate increase in recreational facilities.

Simply relying on signage within the park premises is insufficient in terms of effectively educating visitors about the environment. To sufficiently inform park visitors, particularly adults, and foster an increased understanding of ecosystem services that are presently undervalued, other media platforms should be employed. For instance, this could comprise the online promotion of the significance of biodiversity and flood regulation provided by wetlands, along with the provision of on-site educational courses for adults focusing on the observation of plants and birds. Environmental education can further enhance public comprehension of ecosystems, thereby mitigating fear of animals like snakes resulting from insufficient knowledge.

To address the limitations of this thesis in evaluating vital ecosystem services such as flood and air regulation, government departments and scientific institutions need to improve coordination, cooperation, and data accessibility. This will support future research on the effectiveness of these ESs. It will enable the accumulation of knowledge and the implementation of improvements to maximise the delivery of these ESs and benefit citizens the most.

Specific to individual WPs, this thesis proposes some design strategies to enhance aesthetics, recreation and biodiversity.

- Based on the demographics of the local community, the design can be adapted to the perceived ecosystem service patterns of the targeted population. For instance, creating a safer walking environment for the aging community.
- It is possible to increase the amount of time visitors spend in WPs by optimising the facilities and conditions for certain activities that are relevant to the amount of time spent on-site, thereby enhancing visitors’ well-being.

- The case studies on recreation services in WPs have revealed that a moderate approach to managing WPs is welcomed. Excessive regulations and managerial oversight may impede the delivery of recreational services, while inadequate management practises may negatively impact the perception of aesthetic services.

- Some activities related to provisioning ESs and recreation service may not be willingly offered by park managers (e.g., visitors picking flowers for ornamental use, fishing) (see Section 5.3.3 and 7.7.4.5); design strategies that suggest appropriate methods for the public to interact with these ESs may be needed. For instance, fishing was prohibited in HNWP, but a small fishing area has recently been established in Wetlands Phase 2 for those who would like to do so[53] (Figure 8-5). With proper management and guidance, it is possible to undertake these activities in an organised manner, resulting in mutual benefits for tourists and the ecosystem's long-term health.

Figure 8-5 Fishing ground in Haizhu National Wetland Park

- Although the post-QIP scenes in Haizhu Lake have a higher aesthetic value than the pre-QIP scenes (Section 7.6.6.4), this does not suggest that the post-QIP scenes are superior to the pre-QIP scenes. Enhanced stewardship of simple, organised vegetation may increase the aesthetic value, but at the expense of wildlife habitat. When performing this type of regeneration, caution is required.

- With the increase in global temperatures, the significance of thermal comfort is expected to escalate. As well as including additional vegetation with favourable cooling properties and an increase of canopy shadow, the visual design may also consider the synaesthesia of thermal comfort. That is, ensuring that WPs not only provide a sensation of thermal comfort, but also visually convey a sense of thermal

[53] The fishing ground was established after this thesis' survey period.

comfort.

- Due to the lack of environmental and ecological knowledge, some visitors are unable to comprehend the significance of wildlife habitat service and pay no attention to wildlife. Therefore, it is essential to increase their environmental awareness through effective education. A more diverse approach to on-site environmental education is recommended; the facilities should also be situated in highly visible locations and the content should be presented in an accessible manner.
- To mitigate the presence of pests, which are typically disliked by visitors, it is important to establish improved ecosystems with robust food webs. This will minimise ecosystem disservices

Last but not least, the factors influencing perception of ESs identified in this study can be used as indicators to assess the ESs that WPs or other similar public spaces could deliver before and after the landscape planning and design.

8.4 Limitations and outlook

To enhance the research design and methodology of forthcoming studies in relevant fields, it is essential to consider the limitations of this study.

- This thesis was unable to technically evaluate some of the ESs highlighted by respondents due to the lack of access to vital data such as detailed topographic, hydrologic and air quality monitoring data for the two WPs. The feasibility of gathering certain sensitive data may be impeded by transnational research, and so it is necessary to encourage local research institutions to utilise accessible resources to examine these unexplored ESs. Obtaining support from the local government and establishing the researchers' own monitoring apparatus may help to overcome constraints on data. This issue may also be addressed by augmenting basic databases on air purification, cooling effects and rainwater retention by plants with various characteristics and feeding these basic data into ESs modelling tools.
- This research involved wetland park users only from the general public, but off-site beneficiaries' perceptions of WPs are crucial to comprehending the perceptions of ESs. It is suggested that further studies involving off-site beneficiaries and, especially, those who are not interested in wetland parks should be conducted. For example, future surveys could be conducted in the high street, community, campus, etc.
- The majority of respondents in this thesis were young visitors, possibly due to their higher level of engagement with tourism information sharing (Lin, Gao and Tian, 2022). Older people's perceptions may therefore be oversimplified to some extent. Children's perceptions were also not investigated due to ethics considerations. The research findings may not be generalisable to the entire population.
- It is conceivable that only visitors unconcerned with covid would have been inclined to engage in discussions with the author and participate in this research, given that on-site surveys were carried out subsequent to the pandemic. With the exception of the comparative air purification service, there was no significant difference between on-site and online responses regarding perceived ESs, as stated in Section 7.4.1. While it is likely that individuals who are concerned about the COVID-19 pandemic might discontinue their usage of wetland parks, research presented in Section 6.3.2 reveals that a mere 16.5% of those who visited WPs prior to the outbreak would reduce their frequency of visits subsequent to the pandemic. Furthermore, concerns regarding infection did not emerge as the primary barriers from visiting WPs. Conversely, it was believed that WPs exhibited a minimal risk of infection due to their sparse population (Page 59). The potential impact of COVID-19 on individuals' utilisation of WPs and their perception of ES is unlikely to significantly alter the results of this study.
- The main reasons for not visiting WPs were poor accessibility (52.3%). After the Peak, 28.2% of the respondents would increase their visiting frequency, while 55.3% of respondents would keep their visiting frequency (Figure 6-3).

- Understanding of respondents' knowledge of ESs may be incomplete and variable, but this thesis did not conduct any comparison between perceptions of laypeople and experts in case studies like some other studies (e.g., (Cottet, Piégay and Bornette, 2013)). However, it was discovered that the perceived health benefits from WPs varies between laypeople and health experts (Chapter 6). Conducting a comparative analysis of the perception of ESs between lay people and those possessing expertise in diverse fields would yield significant insights. To further investigate if the changes in knowledge of ESs impact attitudes and opinions, it may also be useful to compare non-informed populations with those given particular information about ESs in the WPs.

- Some statistical findings exhibit significance, albeit with limited robustness, due to the restricted sample size. Increasing the sample size is deemed necessary when the available resources, such as manpower and study time, permit such an expansion.

- This study did not include interactions on demographic attributes, such as the relationship between men over the age of 45 and PESs. The inability to analyse causation between variables related to visiting habits was due to limitations in the research design and questionnaire. Further research is needed to thoroughly investigate these issues.

- Due to constraints on the research timeline and the length of the thesis, a comprehensive investigation and analysis of alterations in ESs pre- and post-establishment of the WPs, and pre- and post-renovation of the WPs were not undertaken. Future studies should seek to continue this work with the aim of comprehending the alterations in the supply of ESs and the public's perception thereof in WPs, as influenced by land use and land cover changes, over an extended temporal scope.

- Due to constraints on the length of the thesis, the analysis and presentation of factors influencing the delivery of environmental education were omitted, despite the fact that part of the data had been collected. This part of the research will be included in an upcoming manuscript for publication.

- The majority of this thesis is devoted to a single region of China, namely Guangzhou. However, the study was aware of the broader international literature, as well as domestic Chinese literature, in order to offer opportunities for comparison and contrast.

- As case studies, only two WPs were analysed, and the scope and level of government management of the two WPs varied. It is possible that the findings of this thesis cannot be generalised. The findings of this thesis would be more robust and generalizable with the incorporation of additional WPs into future research, such as expansive and reframed surveys.

8.5 Conclusion

This thesis is one of the first studies to investigate the actual use of ecosystem services (ESs) at the site scale that people can actually experience, bridging technical understanding of biophysical environment and beneficiaries' perceptions. Air regulation, disturbance regulation (i.e., flood regulation), water purification, wildlife habitat, recreation and aesthetics were found to be the most valuable ESs in WPs. Due to data availability, this thesis focusses on wildlife habitat, recreation and aesthetics.

In contrast to the common knowledge that wildlife habitat benefits human well-being indirectly, this work reveals that visitors to WPs perceive and value this supporting service. The wildlife habitat service was considered by lay visitors not only to contribute to aesthetic value, but also to promote physical and mental health. Furthermore, the perceived significance of wildlife habitat services in WPs was found to be greater than that of recreational amenities in one of the case study sites, although this may be due to the fact that this WP already has sufficient recreational amenities. Nonetheless, visitors underestimate or fail to understand the richness of plant and bird species in WPs. Unsurprisingly, aesthetic value was the most popular ES that visitors wished to share with others and the one that contributed the most to human welfare, despite the fact that it was deemed to have less relevance to health benefits than wildlife habitat and recreation service. Synergies between perceived aesthetic value and perceived recreation service were discovered when visitors were talking about the WPs and when they mapped the core areas of the two ESs. Although recreation was the primary motivation for visitors to use WPs, recreation opportunities relating to recreational facilities were the least important for most visitors compared with biodiversity and scenic beauty. The perceived recreation service matches the measured recreation potential and opportunity to some extent.

Further, attributes that influence the perception of the three ESs were discovered, so that the perceived benefits could be targeted for improvement. Having identified the benefit pathways, it is possible that more benefits could be perceived equally by various groups of visitors.

This thesis also found that if it is not possible to improve all three ESs in WPs simultaneously, the scenario of 'Harmonious Co-existence between Human and Nature' would be most beneficial for visitors. This scenario focuses on enhancing biodiversity and visual quality while maintaining recreation opportunities. This scenario could benefit the ecosystem as well.

This thesis did not address certain important ESs and ecosystem disservices and did not involve other beneficiaries due to limitations in data availability, study duration and thesis scope. Further research is required to investigate the supply and perception of ESs and ecosystem disservices, and to involve non-users of WPs, so the development pathways for WPs that benefit human well-being can be further optimised.

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Appendix - A Additional figures and tables

Appendix A - 1 Official documents, policy and legislation about wetland parks

Law/regulation/standard/official document	Highlighted contents
Notice on Strengthening Wetland Protection and Management (GOSC [2004] No. 50) 《关于加强湿地保护管理工作的通知》 （国办发[2004]50 号）	(1) Raise awareness of wetland protection (2) Take effective measures to stop the arbitrary encroachment and destruction of wetlands (3) Strengthen the planning of wetland protection (4) Take various measures to speed up the salvage protection of natural wetlands
Notice on Doing a Good Job in the Development and Construction of Wetland Parks (NFGA [2005] No. 118) 《国家林业局关于做好湿地公园发展建设工作的通知》（林护发[2005]118 号）	(1) Specify the basic conditions for the planning and construction of wetland parks (2) The establishment of a wetland park declaration and approval procedures (3) Specify that activities that have a negative impact on the ecological, landscape, cultural and recreational values and functions of WPs should be prohibited or limited 4) Stated the importance of the role that WPs plays in scientific research and in the protection and rational use of wetlands
Construction Regulation of National Wetland Park LY/T 1755-2008 (NFGA, 2008) 《国家湿地公园建设规范》	Wetland Parks: Wetland areas with a certain scale and scope, with wetland landscape as the main body, wetland ecosystem protection as the core objective, taking into account the demonstration of wetland ESs, science education and demonstration of rational use of wetlands, containing a certain cultural or aesthetic value, can be used for scientific research and ecotourism, special protection and management of wetland areas.
Regulations on Wetland Protection and Management (NFGA [2013] No. 32) 《湿地保护管理规定》(国家林业局令 32 号，2013)	Clarify the conditions for establishing wetland nature reserves and national wetland parks
Wetland Conservation and Restoration System Programme (GOSC [2016] No.89) 《湿地保护修复制度方案（国发办（2016）89 号)》	(1) To ensure that the total wetland area in China will not be reduced anymore (2) To ensure that abundance of wild flora and fauna inhabit in wetlands will not be reduced anymore
Administrative Measures on National Wetland Parks (NFGA [2017] No. 150) 《国家湿地公园管理办法》(林湿发[2017]150 号) (2018-2022)	(1) Area of wetlands in a national wetland park should be no less than 100 hectares, and with wetland rate larger than 30%. (2) National wetland parks should be designated conservation areas. The sum of the area of the conservation area, the restoration and reconstruction area and the sum of its wetland area should be greater than the total area of the wetland park and 60% of the total wetland area of the wetland park, respectively.
Urban Wetland Park Design Guidelines (MHURD [2017] NO.63) 《城市湿地公园设计导则》(建城[2017] 63 号)	(1) clarify the range of the proportion of various types of land in urban wetland parks, of which the wetland rate should be no less than 50% (2) Provide guidance on the design of water depth, shoreline, barge, plant configuration, and installation of artificial habitat facilities (such as artificial bird nests and feeding areas)
Administrative Measures on Urban Wetland Parks (MHURD [2017] NO.222) 《城市湿地公园管理办法》(建城[2017] 222 号)	Urban wetland park is within the scope of urban planning areas, to protect urban wetland resources for the purpose of both science education, scientific research, leisure tour and other functions of the parks.
Wetlands Conservation Law of the People's Republic of China (2022)	Wetlands that protected by the law include the natural or artificial, perennial or seasonal water areas and low tide water (<6m) that with significant ecological functions. Paddy fields, artificial waters and mudflats for aquaculture

《中华人民共和国湿地保护法》	were not protected by the law.
Guangdong Province Wetland Protection Regulations (2006) 《广东省湿地保护条例》	(1) specify the responsibilities among departments/government for wetland protection (2) Clarify the conditions for establishing wetland nature reserves (3) For wetlands that not established as wetland nature reserves but with beautiful ecological landscape, rich biodiversity, concentrated humanistic landscape, and obvious science and education value, wetland parks could be established with approvement by the people's government. (4) Specify the activities prohibited within the wetlands (5) Highlight the protection of mangroves
Guangzhou Wetland Protection Regulations (2018) 《广州市湿地保护规定》	(1) specify the responsibilities among departments/government for wetland protection (2) Identify important wetlands through regular wetland resource surveys. Protect important wetlands by establishing national parks, wetland nature reserves, wetland parks, aquatic germplasm resource reserves, marine special reserves, drinking water source reserves, wetland protection zones, etc. (3) Wetland parks are divided into national wetland parks, provincial wetland parks, municipal wetland parks (wetland area ≥ 15ha) and district-level wetland parks (wetland area ≥ 8ha). (4) A chapter on the protection of Haizhu Wetlands
Organs that issue the document: GOSC: General Office of the State Council of the People's Republic of China NFGA: National Forestry and Grassland Administration MHURD: Ministry of Housing and Urban-Rural Development of the People's Republic of China	

Appendix A - 2 ESs that the computer-based tools could assess

ESs		[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]	[13]	[14]	[15]	[16]	[17]
	Food	X	X			X	X					X		X		X		X
	Water supply	X	X		X	X	X	X								X		X
P	Raw materials					X						X		X		X		X
	Genetic resources					X												
	Ornamental resources					X												
	Biochemicals and natural medicines					X												
	Air quality regulation	X				X		X	X			X			X	X	X	X
	Climate regulation	X	X			X	X	X	X	X	X	X		X	X	X	X	X
	Flood regulation	X	X	X	X	X	X		X	X	X	X				X		X
	Water regulation			X		X	X					X						
	Water purification			X	X	X	X	X			X				X	X		X
R	Erosion regulation	X	X			X	X	X								X		X
	Soil formation					X	X											
	Pollination	X	X			X									X	X		X
	Pest and disease control					X										X		X
	Noise attenuation					X		X			X				X	X		
	Fire protection					X												
	Nutrient cycling	X				X											X	
S	Habitat (for species)	X				X	X			X	X	X	X	X			X	
	Maintenance of genetic diversity					X												
	Recreation & ecotourism	X	X		X	X	X			X	X	X	X	X		X		X
	Aesthetics	X	X			X	X	X				X	X			X		X
C	Cultural diversity					X	X											
	Knowledge systems					X												
	Educational values					X						X				X		X
	Spiritual experience and sense of place					X	X									X		X

Notes: (1) P: provisioning, R: regulating, S: supporting, C: cultural. (2) [X]: the tool is able to estimate the ES

[1] InVEST (Natural Capital Project, 2022)
[2] ARIES (Villa *et al.*, 2009)
[3] WaterWorld (https://www.policysupport.org/waterworld)
[4] Co$ting Nature (https://www.policysupport.org/costingnature)
[5] MIMES (Boumans *et al.*, 2015)
[6] EcoMetrix (Parametrix, 2010)
[7] ESII (Guertin et al., 2019)
[8] i-Tree Eco (https://www.itreetools.org/tools/i-tree-eco
[9] GI-Val (https://www.merseyforest.org.uk/services/gi-val/)
[10] B£ST (https://www.ciria.org/)
[11] LPES (Liu, Ou and Zheng, 2020)
[12] SolVES (Sherrouse and Semmens, 2020)
[13] NEVO (https://www.exeter.ac.uk/research/leep/research/nevo/)
[14] EcoservR (https://ecoservr.github.io/EcoservR/)
[15] EBN (Smith et al., 2021)
[16] InFOREST (https://inforest.frec.vt.edu/)
[17] NATURE tool (Hölzinger et al., 2022)

Appendix A - 3 Fruits planted in the Haizhu National Wetland Park

Appendix A - 4 Annual expenditures of HNWP (2015-2021)

Year	**Number of Visits**	**Total expenditures (CNY)**	**Cost for Quality Improvement (CNY)**	**General expenditure (CNY)**	**Cost for general operation per visit (CNY)**
2013	3,750,000	39,870,700		39,870,700	10.63
2014		60,146,600		60,146,600	
2015	6,249,549	76,606,500		76,606,500	12.26
2016	NA	110,919,500		110,919,500	-
2017	6,750,000	93,220,600		93,220,600	13.81
2018		112,628,600		112,628,600	
2019	8,216,000	126,202,000	16,252,200	109,949,800	13.38
2020		303,306,400	161,422,300	141,884,100	
2021	NA	103,761,900		103,761,900	-
Average	6,241,387	114,073,644		114,073,644	12.52
Sum			177,674,500		

Data source:
Annual departmental accounts of Haizhu Wetland Management Office (2013-2021) www.haizhu.gov.cn
Haizhu Yearbook (2018, 2020) www.haizhu.gov.cn
(Lin, 2020)

Appendix A - 5 Profile of the respondents, affected by season (with pairwise z-test) (TDWP)

Attributes	Difference	Winter		Summer		Total N=120	
		n1	% col.	n2	% col.	n	%
Cost for the visit**							
0	P =0.005, χ^2 = 15.097, Cramer's V = 0.361 3 cells (30.0%) have expected count less than 5. The minimum expected count is 2.96	16	23.9	28	57.1	44	36.7
1-20		30	44.8	10	20.4	40	33.3
20-50		12	17.9	4	8.2	16	13.3
51-100		5	7.5	4	8.2	9	7.5
>100		4	6.0	3	6.1	7	5.8
Unwilling to tell		3	-	1	-	4	3.3
Time spent on the way							
<15 minutes	P =0.003, χ^2 =14.209, Cramer's V = 0.344	7	10.0	16	32.0	23	19.2
15-30 minutes		27	38.6	23	46.0	50	41.7
31-60 minutes		17	24.3	5	10.0	22	18.3
>60 minutes		19	27.1	6	12.0	25	20.8
Time spent on the way (reclassified)**							
<30 minutes	P = 0.001, χ^2 = 10.601, Cramer's V = 0.297	34	48.6	39	78.0	73	60.8
>30 minutes		36	51.4	11	22.0	47	39.2
Frequency of visits**							
For the first time	P<0.001, χ^2 =33.063, Cramer's V = 0.525 10 cells (62.5%) have expected count less than 5. The minimum expected count is 0.83	49	70.0	14	28.0	63	52.5
Once every half a year		7	10.0	3	6.0	10	8.3
Once every 4-6 months		2	4.3	2	4.0	5	4.2
Once every 2-3 months		1 a	0.0	2 b	4.0	2	1.7
Once a month		0	0.0	4	8.0	4	3.3
Twice to three times a month		5	7.1	6	12.0	11	9.2
Once a week		3	4.3	4	8.0	7	5.8
Many times, per week		3	4.3	15	30.0	18	15.0
Frequency of visits (reclassifies)**							
Less frequently than once a month	P <0.001, χ^2 = 23.469, Cramer's V = 0.442	59	84.3	21	42.0	80	66.7
More frequently than once a month		11	15.7	29	58.0	40	33.3

% col.: percent within column, not include the missing data
A subset of source categories whose column proportions differ significantly from one another at the 0.05 level are indicated by a letter next to the number. Compared to light green highlighted cells, light blue highlighted cells have a larger proportion.

Appendix A - 6 Profile of the respondents, affected by source (with pairwise z-test) (HNWP)

Attributes	Difference	onsite		online		Total N=200	
		n_1	% col.	n_2	% col.	n	%
Gender							
Male	P = 0.005, χ^2 =7.989, Cramer's V = 0.200	53	51.0	30	31.3	83	41.5
Female		51	49.0	66	68.8	117	58.5
Age							
18-24	P<0.001, χ^2 = 50.563, Cramer's V = 0.503	13	12.5	34	35.4	47	23.5
25-34		22	21.2	42	43.8	64	32.0
35-44		13	12.5	10	10.4	23	11.5
45-54		18	17.3	7	7.3	25	12.5
55-64		18	17.3	1	1.0	19	9.5
≥65		20	19.2	2	2.1	22	11.0
Age (reclassified)							
18-34	P<0.001, χ^2 =45.788, Cramer's V = 0.478	35	33.7	76	79.2	111	55.5
35-54		31	29.8	15	15.6	46	23.0
≥55		38	36.5	5	5.2	43	21.5
Age (reclassified)							
18-44	P<0.001, χ^2 = 42.585, Cramer's V = 0.461	48	46.2	86	89.6	134	67.0
≥45		56	53.8	10	10.4	66	33.0
Highest Level of Education							
Middle school and below	P<0.001, χ^2 = 62.919, Cramer's V = 0.561	15	14.4	2	2.1	17	8.5
High School/Technical School		42	41.3	5	5.2	48	24.0
College		19	18.3	15	15.6	34	17.0
University / Bachelor		19	18.3	59	61.5	78	39.0
Master and above		8	7.7	15	15.6	23	11.5
Highest Level of Education (reclassified)							
Less-educated (high school equivalent and below)	P<0.001, χ^2 =53.477, Cramer's V = 0.517	58	55.8	7	7.3	65	32.5
Well-educated (college and above)		46	44.2	89	92.7	135	67.5
Cost for the visit							
0	P <0.001, χ^2 = 36.689, Cramer's V = 0.437	45	44.6	9	9.9	54	27.0
1-20		33	32.7	31	34.1	64	32.0
20-50		15	14.9	30	33.0	45	22.5
51-100		5	5.0	16	17.6	21	10.5
101-200		2	2.0	5	5.5	7	3.5
>200		1	1.0	0	0.0	1	0.5
Unwilling to tell		3	-	5	-	8	4.0
Cost for the visit (reclassified)							
0-20	P < 0.001, χ^2 = 22.372, Cramer's V = 0.341	78	77.2	40	44.0	118	59.0
≥21		23	22.8	51	56.0	74	37.0
Unwilling to tell		3	-	5	-	8	4.0
Time spent on the way							
<15 minutes	P < 0.001, χ^2 = 17.701, Cramer's V = 0.297	18	17.3	9	9.4	27	13.5
15-30 minutes		50	47.1	26	27.1	76	38.0
31-60 minutes		25	24.0	48	50.0	73	36.5
>60 minutes		11	10.6	13	13.5	24	12.0
Time spent on the way (reclassified)							

<30 minutes	P < 0.001, χ^2 = 16.723, Cramer's V = 0.289	68	65.4	35	36.5	103	51.5
>30 minutes		36	34.6	61	63.5	97	48.5
Frequency of visits							
For the first time	P<0.001, χ^2 = 54.884, Cramer's V = 0.524	18	17.3	33	34.4	51	25.5
Once every half a year		19	18.3	35	36.5	54	27.0
Once every 4-6 months		6	5.8	7	7.3	13	6.5
Once every 2-3 months		3	2.9	12	12.5	15	7.5
Once a month		8	7.7	4	4.2	12	6.0
Twice to three times a month		12	11.5	4	4.2	16	8.0
Once a week		13	12.5	0	0.0	13	6.5
Many times, per week		25	24.0	1	1.0	26	13.0
Frequency of visits (reclassified)							
Less frequently than once a month	P <0.001, χ^2 =53.477, Cramer's V = 0.517	46	44.2	89	92.7	135	67.5
More frequently than once a month		58	55.8	7	7.3	65	32.5

% col.: percent within column, not include the missing data
A subset of source categories whose column proportions differ significantly from one another at the 0.05 level are indicated by a letter next to the number. Compared to light green highlighted cells, light blue highlighted cells have a larger proportion.

Appendix A - 7 Profile of the respondents, affected by regions visited (with pairwise z-test) (HNWP)

Attributes	Difference	HL (N_1=57)		P 1&2 (N_2=43)		Both (N_3=100)		Total N=200	
		n_1	% col.	n_2	% col.	n_3	% col.	n	%
Gender									
Male	P = 0.023, χ^2= 7.539, Cramer's V = 0.194	26	45.6	10	23.3	47	47.0	83	41.5
Female		31	54.4	33	76.7	53	53.0	117	58.5
Age									
18-24	P < 0.001, χ^2 = 30.581, Cramer's V = 0.277	16	28.1	17	39.5	14	14.0	47	23.5
25-34		21	36.8	18	41.9	25	25.0	64	32.0
35-44		6	10.5	2	4.7	15	15.0	23	11.5
45-54		3	5.3	3	7.0	19	19.0	25	12.5
55-64		7	12.3	2	4.7	10	10.0	19	9.5
≥65		4	7.0	1	2.3	17	17.0	22	11.0
Age (reclassified)									
18-34	P < 0.001, χ^2 = 25.202, Cramer's V = 0.251	37	64.9	35	81.4	39	39.0	111	55.5
35-54		9	15.8	5	11.6	32	32.0	46	23.0
≥55		11	19.3	3	7.0	29	29.0	43	21.5
Age (reclassified)									
18-44	P < 0.001, χ^2= 16.535, Cramer's V = 0.288	43	75.4	37	86.0	54	54.0	134	67.0
≥45		14	24.6	6	14.0	46	46.0	66	33.0
Highest education level									
Middle school and below	P = 0.009, χ^2= 20.406, Cramer's V = 0.226	5	8.8	2	4.7	10	10.0	17	8.5
High School / Technical School		17	29.8	5	11.6	26	26.0	48	24.0
College		12	21.1	4	9.3	18	18.0	34	17.0

University / Bachelor		18	31.6	29	67.4	31	31.0	78	39.0
Master and above		5	8.8	3	7.0	15	15.0	23	11.5
Highest education level (reclassified)									
Less-educated (high school equivalent and below)	P = 0.035, χ^2 = 6.682, Cramer's V = 0.183	22	38.6	7	16.3	36	36.0	65	32.5
well-educated (college and above)		35	61.4	36 b	83.7	64	64.0	135	67.5
Time spent on the way (reclassified)									
<30 minutes	P = 0.003, χ^2= 11.982, Cramer's V = 0.245	37	64.9	13	30.2	53	53.0	103	51.5
>30 minutes		20	35.1	30	69.8	47	47.0	97	48.5
Frequency of visits									
For the first time	P < 0.001, χ^2 = 68.902, Cramer's V = 0.415	18	31.6	28	65.1	5	5.0	51	25.5
Once every half a year		11	19.3	10	23.3	33	33.0	54	27.0
Once every 4-6 months		2	3.5	1	2.3	10	10.0	13	6.5
Once every 2-3 months		2	3.5	2	4.7	11	11.0	15	7.5
Once a month		3	5.3	1	2.3	8	8.0	12	6.0
Twice to three times a month		5	8.8	1	2.3	10	10.0	16	8.0
Once a week		5	8.8	0	0.0	8	8.0	13	6.5
Many times, per week		11	19.3	0	0.0	15	15.0	26	13.0
Frequency of visits (reclassifies)									
Less frequently than once a month	P < 0.001, χ^2= 19.525, Cramer's V = 0.312	33	57.9	41	95.3	61	61.0	135	67.5
More frequently than once a month		24	42.1	2	4.7	39	39.0	65	32.5

% col.: percent within column, not include the missing data
A subset of source categories whose column proportions differ significantly from one another at the 0.05 level are indicated by a letter next to the number. Compared to light green highlighted cells, light blue highlighted cells have a larger proportion. Compared to light orange highlighted cells, light green highlighted cells have a larger proportion.

Appendix A - 8 Profile of the respondents for questionnaire survey (crosstabulation by case study sites)

Attributes	Difference	TDWP		HNWP		Total N=320	
		n_1	% col.	n_2	% col.	n	%
Age (reclassified)							
18-34	P=0.040, χ^2 = 6.428, Cramer's V = 0.142	82	69.3	111	55.5	193	60.3
35-54		24	20.0	46	23.0	70	21.9
≥55		14	11.7	43	21.5	57	17.8
Age (reclassified)							
18-44	P=0.030, χ^2 = 4.703, Cramer's V = 0.121	94	78.3	134	67.0	228	71.3
≥45		26	21.7	66	33.0	92	28.7
Highest Level of Education							
Middle school and below	P=0.009, χ^2 = 13.546, Cramer's V = 0.206	7	5.8	17	8.5	24	7.5
High School / Technical School		31	25.8	48	24.0	79	24.7
College		35	29.2	34	17.0	69	21.6
University / Bachelor		44	36.7	78	39.0	122	38.1

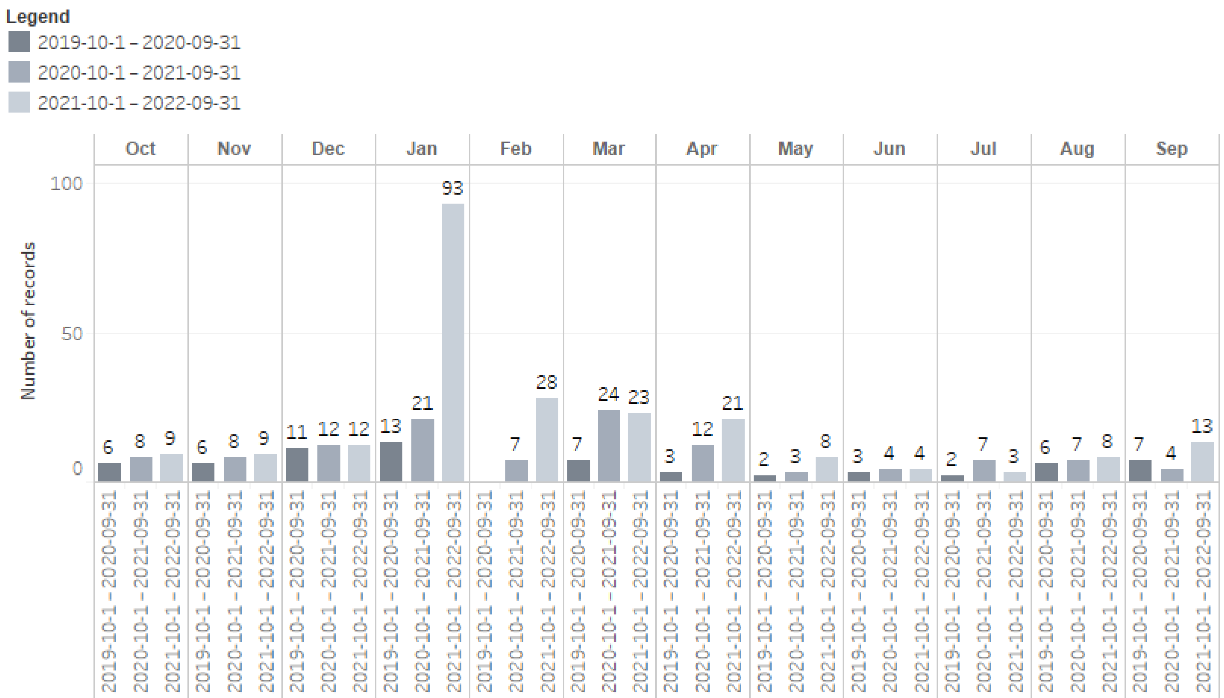
Master and above		3	2.5	23	11.5	26	8.1
Cost for the visit (reclassified)							
0-20	P =0.050, χ^2 = 3.845, Cramer's V = 0.112	84	72.4	118	61.5	202	65.6
⩾21		32	27.6	74	38.5	106	34.4
Unwilling to tell							
Travel time							
<15 minutes	P = 0.003, χ^2= 13.957, Cramer's V = 0.209	23	19.2	27	13.5	50	15.6
15-30 minutes		50	41.7	76	38.0	126	39.4
31-60 minutes		22	18.3	73	36.5	95	29.7
>60 minutes		25	20.8	24	12.0	49	15.3
Time spent on site							
<1 hour	P <0.001, χ^2 =22.782, Cramer's V = 0.267	18	15.0	7	3.5	25	7.8
1-3 hours		89	74.2	138	69.0	227	70.9
>3 hours		13	10.8	55 b	27.5	68	21.3
Frequency of visits							
For the first time	P<0.001, χ^2= 35.403, Cramer's V = 0.333	63	52.5	51	25.5	114	35.6
Once every half a year		10	8.3	54	27.0	64	20.0
Once every 4-6 months		5	4.2	13	6.5	18	5.6
Once every 2-3 months		2	1.7	15 b	7.5	17	5.3
Once a month		4	3.3	12	6.0	16	5.0
Twice to three times a month		11	9.2	16	8.0	27	8.4
Once a week		7	5.8	13	6.5	20	6.3
Many times, per week		18	15.0	26	13.0	44	13.8

% col.: percent within column, not include the missing data
A subset of source categories whose column proportions differ significantly from one another at the 0.05 level are indicated by a letter next to the number. Compared to light green highlighted cells, light blue highlighted cells have a larger proportion.

Appendix A - 9 K-W test result of perceived ecosystem services by visiting frequency (reclassified) (TDWP)

Perceived ecosystem services	**P**	**Mean rank**	
		Less frequently than once a month	More frequently than once a month
I feel pleasant when I visit this WP.	0.020	55.61	70.28
Visiting this WP makes me healthier.	0.008	54.94	71.61
The scenery of this WP is beautiful.	<0.001	53.18	75.15
There are sufficient recreational space and facilities in this WP.	0.007	54.73	72.05
The air is clean in this WP.	<0.001	52.23	77.05
There are abundant and diverse animal and plants in this WP.	0.033	55.90	69.70
I learn more about nature/environment when visiting this WP.	0.310	58.31	64.89
Compared with North Daguan Road, the air quality of where you currently stand/sit is	0.027	52.69	66.22

Appendix A - 10 Number of bird reports in the Haizhu National Wetland Park that recorded by citizen scientists



Appendix A - 11 Plant species list in the Tianhe Daguan Wetland Park

NO	Order	Family	Genus	Latin Name	Invasive /Alien /Native	Life form	Vis.	North	Frequency
1	*Alismatales*	*Araceae*	*Philodendron*	*Thaumatophyllum xanadu*	AA	H (Peren.)	3		1
3	*Apiales*	*Araliaceae*	*Hydrocotyle*	*Hydrocotyle verticillata*	AA	H (Peren.)	2	√	1
2		*Heptapleurum*	*Schefflera*	*Schefflera heptaphylla*	N	S (EG.)	4	√	1
4	*Arales*	*Araceae*	*Alocasia*	*Alocasia odora*	N	H (Peren.)	3	√	8
5			*Colocasia*	*Colocasia antiquorum*	AD	H (Peren.)	3	√	4
6	*Arecales*	*Arecaceae*	*Dypsis*	*Dypsis lutescens*	AA	S (EG.)	4		1
7	*Asparagales*	*Amaryllidaceae*	*Zephyranthes*	*Zephyranthes candida*	AA	H (Peren.)	3	√	2
8	*Asterales*	*Asteraceae*	*Bidens*	*Bidens alba*	I	H (Ann.)	3	√	31
9			*Sphagneticola*	*Sphagneticola trilobata*	I	H (Peren.)	3	√	21
10			*Mikania*	*Mikania micrantha*	I	H (Peren.)	2	√	18
11			*Acmella*	*Acmella paniculata*	N	H (Ann.)	2	√	3
12			*Ageratum*	*Ageratum conyzoides*	I	H (Ann.)	2	√	2
13			*Gamochaeta*	*Gamochaeta pensylvanica*	N	H (Ann.)	1	√	1
14			*Cyanthillium*	*Vernonia cinerea*	N	H (Peren.)	2	√	1
15	*Brassicales*	*Brassicaceae*	*Cardamine*	*Cardamine hirsuta*	N	H (Ann.)	1		2
16	*Campanulales*	*Compositae*	*Eclipta*	*Eclipta prostrata*	N	H (Ann.)	2	√	2
17			*Galinsoga*	*Galinsoga parviflora*	AA	H (Ann.)	2	√	2
18			*Youngia*	*Youngia japonica*	N	H (Ann.)	2		2
19			*Adenostemma*	*Adenostemma lavenia*	N	H (Ann.)	1		1
22			*Gynura*	*Gynura divaricata*	N	H (Peren.)	1		1
20			*Artemisia*	*Artemisia argyi*	N	H (Peren.)	2	√	1
21			*Coreopsis*	*Coreopsis basalis*	AA	H (Ann./Bien.)	2	√	1
23	*Caryophyllales*	*Polygonaceae*	*Polygonum*	*Polygonum hydropiper*	N	H (Ann.)	1	√	3
24		*Caryophyllaceae*	*Drymaria*	*Drymaria cordata*	N	H (Ann.)	1		1
25	*Centrospermae*	*Amaranthaceae*	*Alternanthera*	*Alternanthera philoxeroides*	I	H (Peren.)	1	√	8
26			*Alternanthera*	*Alternanthera sessilis*	N	H (Peren.)	1		1
27		*Portulacaceae*	*Portulaca*	*Portulaca oleracea*	N	H (Ann.)	1		1
28	*Commelinales*	*Commelinaceae*	*Commelina*	*Commelina communis*	N	H (Ann.)	2	√	6

29		*Pontederiaceae*	*Pontederia*	*Pontederia cordata*	AA	H (Peren.)	4	√	2
30			*Eichhornia*	*Eichhornia crassipes*	I	H (Peren.)	3		1
31	*Cornales*	*Hydrangeaceae*	*Deutzia*	*Deutzia scabra*	N	S (Dec.)	3		1
32	*Cucurbitales*	*Cucurbitaceae*	*Zehneria*	*Zehneria japonica*	N	H (Ann.)	1	√	1
33	*Cyperales*	*Cyperaceae*	*Cyperus*	*Cyperus involucratus*	AA	H (Peren.)	4	√	14
34			*Kyllinga*	*Kyllinga brevifolia*	N	H (Peren.)	1	√	8
35			*Cyperus*	*Cyperus papyrus*	AA	H (Peren.)	3	√	5
37				*Cyperus haspan*	N	H (Peren.)	2	√	2
36			*Scirpus*	*Schoenoplectus tabernaemontani*	AD	H (Peren.)	4	√	2
38			*Torulinium*	*Cyperus odoratus*	N	H (Peren.)	2	√	1
39			*Cyperus*	*Cyperus rotundus*	N	H (Peren.)	2		1
40	*Eufilicales*	*Lygodiaceae*	*Lygodium*	*Lygodium japonicum*	N	H (Peren.)	1	√	20
41		*Dennstaedtiaceae*	*Microlepia*	*Microepia hancei*	N	H (Peren.)	2	√	1
42		*Osmundaceae*	*Osmunda*	*Osmunda japonica*	N	H (Peren.)	2	√	1
43		*Pteridaceae*	*Pteris*	*Pteris vittata*	N	H (Peren.)	2		1
44	*Euphorbiales*	*Euphorbiaceae*	*Phyllanthus*	*Phyllanthus urinaria*	N	H (Ann.)	1	√	20
45			*Euphorbia*	*Euphorbia humifusa*	N	H (Ann.)	1	√	2
46			*Excoecaria*	*Euphorbia hirta*	AA	H (Ann.)	1	√	1
47	*Gentianales*	*Rubiaceae*	*Paederia*	*Paederia cruddasiana*	N	L (Dec.)	1	√	2
48	*Geraniales*	*Oxalidaceae*	*Oxalis*	*Oxalis corniculata*	N	H (Peren.)	1	√	9
49	*Graminales*	*Gramineae*	*Axonopus*	*Axonopus compressus*	N	H (Peren.)	2	√	16
50			*Digitaria*	*Digitaria sanguinalis*	AD	H (Ann.)	2	√	6
51			*Cynodon*	*Cynodon dactylon*	N	H (Peren.)	2	√	6
53			*Oplismenus*	*Oplismenus undulatifolius*	N	H (Peren.)	1	√	4
52			*Lophatherum*	*Lophatherum gracile*	N	H (Peren.)	2	√	4
54			*Arundo*	*Arundo donax*	N	H (Peren.)	4	√	4
56			*Paspalum*	*Paspalum thunbergii*	N	H (Peren.)	2	√	2
57			*Pennisetum*	*Pennisetum alopecuroides*	AA	H (Peren.)	3	√	2
55			*Phragmites*	*Phragmites australis*	N	H (Peren.)	4	√	2
58			*Panicum*	*Panicum bisulcatum*	N	H (Ann.)	2	√	1
60	*Helobiae*	*Alismataceae*	*Sagittaria*	*Sagittaria trifolia*	N	H (Peren.)	2	√	1

59		*Butomaceae*	*Limnocharis*	*Limnocharis flava*	N	H (Peren.)	2	√	1
61	*Lamiales*	*Acanthaceae*	*Ruellia*	*Ruellia simplex*	AA	H (Peren.)	4	√	3
62	*Malpighiales*	*Euphorbiaceae*	*Acalypha*	*Acalypha australis*	N	H (Ann.)	1	√	2
63		*Violaceae*	*Viola*	*Viola philippica*	N	H (Peren.)	1		1
65	*Malvales*	*Malvaceae*	*Urena*	*Urena lobata*	N	H (Peren.)	1	√	1
64			*Ceiba*	*Ceiba speciosa*	AA	T (Dec.)	5		1
66	*Myrtales*	*Melastomataceae*	*Melastoma*	*Melastoma dodecandrum*	N	S (EG.)	1		1
67	*Myrtiflorae*	*Myrtaceae*	*Syzygium*	*Syzygium samarangense*	AA	T (EG.)	5		7
70		*Onagraceae*	*Ludwigia*	*Ludwigia octovalvis*	N	H (Peren.)	2	√	6
71		*Haloragidaceae*	*Myriophyllum*	*Myriophyllum aquaticum*	AA	H (Peren.)	3	√	3
68		*Myrtaceae*	*Syzygium*	*Syzygium hainanense*	N	T (EG.)	5		2
69				*Syzygium jambos*	N	T (EG.)	5		2
72		*Onagraceae*	*Ludwigia*	*Ludwigia prostrata*	AD	H (Ann.)	2	√	2
73				*Ludwigia adscendens*	N	H (Peren.)	2	√	1
74	*Pinales*	*Taxodiaceae*	*Taxodium*	*Taxodium distichum*	AA	T (Dec.)	5	√	19
75	*Piperales*	*Saururaceae*	*Houttuynia*	*Houttuynia cordata*	N	H (Peren.)	2	√	1
76	*Poales*	*Poaceae*	*Imperata*	*Imperata cylindrica*	AD	H (Peren.)	2	√	17
77			*Arthraxon*	*Arthraxon hispidus*	N	H (Ann.)	1	√	12
78		*Typhaceae*	*Typha*	*Typha orientalis*	N	H (Peren.)	4	√	2
79		*Poaceae*	*Echinochloa*	*Echinochloa crus-galli*	N	H (Ann.)	2	√	1
80			*Zizania*	*Zizania latifolia*	N	H (Peren.)	3	√	1
81	*Polypodiales*	*Thelypteridaceae*	*Cyclosorus*	*Cyclosorus interruptus*	N	H (Peren.)	2	√	25
83		*Blechnaceae*	*Blechnum*	*Blechnum orientale*	N	H (Peren.)	2		2
82		*Nephrolepidaceae*	*Nephrolepis*	*Nephrolepis cordifolia*	N	H (Peren.)	2	√	2
84		*Pteridaceae*	*Pteris*	*Pteris semipinnata*	N	H (Peren.)	1	√	1
85	*Primulales*	*Primulaceae*	*Lysimachia*	*Lysimachia fortunei*	N	H (Peren.)	2	√	1
91	*Rosales*	*Leguminosae*	*Mimosa*	*Mimosa pudica*	I	H (Peren.)	1	√	9
86			*Bauhinia*	*Bauhinia*	N	T (EG.)	5		7
92			*Desmodium*	*Desmodium heterocarpon*	N	S/HS (EG.)	1	√	6
87			*Cassia*	*Senna siamea*	AD	T (Dec.)	5	√	4
93			*Pueraria*	*Pueraria phaseoloides*	N	L (EG)	2	√	2

95			*Tadehagi*	*Tadehagi triquetrum*	N	S/HS (Dec.)	2	√	2
94			*Leucaena*	*Leucaena leucocephala*	I	T (EG.)	5	√	2
97			*Lablab*	*Lablab purpureus*	N	H (Peren.)	2	√	1
96			*Mimosa*	*Mimosa sepiaria*	I	S (Dec.)	4	√	1
90			*Calliandra*	*Calliandra haematocephala*	AA	S (Dec.)	4		1
88			*Acacia*	*Acacia auriculiformis*	AA	T (EG.)	5	√	1
89		*Moraceae*	*Ficus*	*Ficus hispida*	N	T (EG.)	5	√	1
98	*Rubiales*	*Rubiaceae*	*Hedyotis*	*Hedyotis auricularia*	N	H (Peren.)	1	√	11
99	*Sapindales*	*Anacardiaceae*	*Mangifera*	*Mangifera indica*	N	T (EG.)	5	√	1
100	*Scitamineae*	*Zingiberaceae*	*Hedychium*	*Hedychium coronarium*	N	H (Peren.)	3	√	5
101		*Cannaceae*	*Canna*	*Canna indica*	AA	H (Peren.)	4	√	2
104	*Tubiflorae*	*Scrophulariaceae*	*Lindernia*	*Lindernia crustacea*	N	H (Ann.)	1	√	19
102		*Bignoniaceae*	*Jacaranda*	*Jacaranda mimosifolia*	AA	T (Dec.)	5	√	4
105		*Verbenaceae*	*Lantana*	*Lantana camara*	I	S (EG.)	4	√	3
103		*Bignoniaceae*	*Spathodea*	*Spathodea campanulata*	AA	T (Dec.)	5		2
106		*Convolvulaceae*	*Ipomoea*	*Ipomoea triloba*	N	H (Ann.)	2	√	2
108			*Merremia*	*Merremia hederacea*	N	H (Ann.)	2	√	1
107			*Ipomoea*	*Ipomoea cairica*	I	H (Peren.)	2	√	1
109		*Labiatae*	*Origanum*	*Origanum vulgare*	N	H (Peren.)	2		1
111	*Umbelliflorae*	*Umbelliferae*	*Sanicula*	*Sanicula chinensis*	N	H (Peren.)	1		1
110			*hydrocotyle*	*Hydrocotyle sibthorpioides*	N	H (Peren.)	1	√	1
112	*Urticales*	*Urticaceae*	*Pouzolzia*	*Pouzolzia zeylanica*	N	H (Peren.)	1	√	1
113	*Zingiberales*	*Marantaceae*	*Thalia*	*Thalia dealbata*	AA	H (Peren.)	4	√	4
114				*Thalia geniculata*	AA	H (Peren.)	4	√	1

Invasive/Alien/Native: N – native, AA – introduced from abroad, AD – introduced from other regions in China, I – invasive
Life form: T (EG.) – evergreen tree, T (Dec) – deciduous tree, S (EG.) – evergreen shrub, S (Dec.)- deciduous shrubs, HS – half shrub, H (Peren.) – perennial herbaceous, H (Biennial) – biennial herbaceous, H (Ann.) – annual herbaceous
Visibility (Vis):
[5] - [very easy] – plants that can be seen and identified without effort
[4] - [easy] – plants that can be seen and identified with little effort
[3] - [more challenging] – plants that can be seen and identified with some effort
[2] - [difficult] – plants that can be seen and identified with much effort
[1] - [very difficult] – plants that can be seen and identified only when crouch and get very close to them, and with much effort

Appendix A - 12 Records of field surveys for birds

Survey date and time	Weather	Tide/water level	Survey site	Human disturbance	Survey route	N_ species	N_ birds	F_s	F_h
2022-10-08 07:30-09:30	Sunny, light air,21°C-29°C	High	L	Medium	CC	20	179	50	5
2022-10-09 14:00-18:00	Sunny, light air, 19°C-31°C	High	W	Low	NS	23	399	63	4
2022-10-11 07:30-09:30	Sunny, light air, 16°C-27°C	High	L	Medium	C	22	173	61	6
2022-10-11 16:00-18:00	Sunny, light air, 16°C-27°C	High	L	Medium	CC	18	203	59	5
2022-10-12 14:00-18:00	Sunny, light air, 17°C-29°C	High	W	Extremely low	SN	28	322	104	7
2022-10-13 16:00-18:00	Sunny, light air, 16°C-30°C	High	L	Medium	C	18	150	56	1
2022-10-14 14:00-18:00	Sunny, light air, 18°C-31°C	High	W	Extremely low	NS	31	765	132	11
2022-10-18 16:00-18:00	Cloudy, gentle breeze, drizzle, 21°C-27°C	Medium	L	Medium	CC	29	188	78	4
2022-10-19 07:30-09:30	Cloudy, moderate breeze, 19°C-26°C	Extremely high	L	Medium	C	21	164	60	5
2022-10-19 14:00-18:00	Cloudy, moderate breeze, 19°C-26°C	High	W	Extremely low	SN	29	347	117	4
2022-10-20 07:30-09:30	Cloudy, gentle breeze, 19°C-28°C	High	L	High	CC	20	171	68	7
2022-10-20 14:00-18:00	Cloudy, gentle breeze, 19°C-28°C	Medium	W	Extremely low	NS	38	358	130	6
2022-10-21 16:00-18:00	Sunny, light air,19°C-32°C	Medium	L	Medium	C	25	191	63	6
2022-10-23 07:30-09:30	Sunny, light air,20°C-34°C	Medium	L	Medium	CC	20	159	55	11
2022-10-23 14:00-18:00	Sunny, light air,20°C-34°C	Medium	W	Extremely low	SN	26	238	82	20
2022-10-25 14:00-18:00	Sunny, light air,17°C-30°C	Medium	W	Extremely low	NS	30	579	88	23
2022-10-26 14:00-18:00	Sunny, light air,17°C-29°C	Medium	W	Extremely low	SN	33	390	135	18
2022-10-27 07:30-09:30	Sunny, light air,18°C-30°C	Medium	L	Low	CC	22	157	58	19
2022-10-27 16:00-18:00	Sunny, light air,18°C-30°C	Medium	L	Low	C	22	203	72	6
2023-01-11 16:00-18:00	Cloudy, gentle breeze, drizzle, 15°C-17°C	Medium	L	Extremely low	C	30	403	98	3
2023-01-13 07:30-09:30	Cloudy, gentle breeze, 20°C-24°C	Medium	L	Extremely low	C	25	244	79	5
2023-01-13 14:00-18:00	Cloudy, gentle breeze, 20°C-24°C	Medium	W	Extremely low	SN	33	208	109	8
2023-01-14 16:00-18:00	Cloudy, gentle breeze, 13°C-28°C	Medium	L	Medium	CC	23	276	72	5
2023-01-15 07:30-09:30	Cloudy, moderate breeze, 7°C-13°C	Medium	L	Medium	CC	23	250	58	5
2023-01-15 14:00-18:00	Cloudy, moderate breeze, 7°C-13°C	Medium	W	Extremely low	NS	33	228	94	14
2023-01-17 14:00-18:00	Cloudy, gentle breeze, 7°C-9°C	Medium	W	Extremely low	NS	27	187	102	17
2023-01-18 07:30-09:30	Sunny, gentle breeze, 7°C-15°C	Medium	L	Low	C	22	196	55	8
2023-01-18 16:00-18:00	Sunny, gentle breeze, 7°C-15°C	Medium	L	Low	CC	21	224	60	7
2023-01-19 07:30-09:30	Sunny, gentle breeze, 8°C-19°C	Medium	L	Low	CC	25	295	54	2
2023-01-19 14:00-18:00	Sunny, gentle breeze, 8°C-19°C	Medium	W	Extremely low	NS	29	177	92	21
2023-01-20 07:30-09:30	Sunny, gentle breeze, 11°C-21°C	Medium	L	Low	C	29	236	76	12
2023-01-20 14:00-18:00	Sunny, gentle breeze, 11°C-21°C	Medium	W	Extremely low	SN	28	192	124	15
2023-01-21 14:00-18:00	Cloudy, gentle breeze, 13°C-21°C	Medium	W	Medium	NS	30	339	155	5

2023-01-22 14:00-18:00	Cloudy, light air, 14°C-25°C	Medium	W	High	SN	28	175	95	11
2023-01-23 14:00-18:00	Cloudy, gentle breeze, 11°C-22°C	Medium	W	High	SN	30	189	81	14
2023-01-24 16:00-18:00	Cloudy, moderate breeze, 6°C-15°C	Low	L	Extremely high	CC	22	488	52	5

Notes/Abbreviations:
Survey site: W: the Wetlands Phase 1 and 2; L: the Haizhu Lake zone
Extremely high: Intertidal wetlands were flooded; High: Wooden stakes were submerged or some lower beds were submerged; Medium: Wooden stakes appeared, but the inter-tidal sand and mud was completely flooded; Low: inter-tidal sand and mud was totally appeared.
Survey route: CC: walk counterclockwise; C: walk clockwise; SN: walk from south to north; NS: walk from north to south.
N_species: number of species; N_birds: number of all birds (individuals)
F_s: frequency of seeing a bird (birds); F_h: frequency of hearing a bird (birds)

Appendix A - 13 Overview of citizen science data

	2019-10-1 – 2022-09-31	2019-10-1 – 2020-09-31	2020-10-1 – 2021-09-31	2021-10-1 – 2022-09-31	Oct 2022	Jan 2023	Oct 2019-2022	Jan 2020-2023
Number of valid reports	414	66	117	231	7	28	31	156
Number of reports that count the number of individuals	172	47	88	37	1	17	19	91
Total number of species	157	95	100	133	39	72	75	113
Number of species that only recorded once	44	28	28	38	16	16	23	28
Number of species that recorded at least twice	113	67	72	95	23	56	52	85

Appendix A - 14 Bird species list in the Haizhu National Wetland Park

NO	Family	English Name	Latin Name	Ecotype	Residing Status	IUCN	NP	GP	Size	Colour	Vis.	CS	CS-Oct-Jan	SV-Oct	SV-Jan
Anseriformes															
1	Anatidae	Swan Goose	Anser cygnoides	N	F	VU	II	-	9	brown	5	√	√	√	√
2		Mandarin Duck	Aix galericulata		F/W	LC	II	-	5	brown	3			√	
3		Eurasian Wigeon	Anas penelope		W	LC	-	-	5	brown	4	√	√		
4		Mallard	Anas platyrhynchos		F	LC	-	-	6	brown/green	4	√	√	√	√
5		Chinese Spot-billed Duck	Anas zonorhyncha		F	LC	-	-	6	brown	5	√	√	√	√
6		Northern Shoveler	Anas clypeata		W	LC	-	-	5	brown	4	√	√		
7		Northern Pintail	Anas acuta		W	LC	-	-	6	brown	4	√	√		
8		Garganey	Anas querquedula		W	LC	-	-	4	brown	4	√	√		
9		Eurasian Teal	Anas crecca		W	LC	-	-	4	brown	4	√	√		
10		Black Swan	Cygnus atratus		F	LC	-	-	11	black	5	√	√		
Podicipediformes															
11	Podicipedidae	Little Grebe	Tachybaptus ruficollis	N	R	LC	-	-	3	brown	3	√	√		√
Pelecaniformes															
12	Ardeidae	Yellow Bittern	Ixobrychus sinensis		R	LC	-	GP	4	orange	2	√	√		
13		Cinnamon Bittern	Ixobrychus cinnamomeus		R	LC	-	GP	4	orange	2	√	√	√	
14		Black-crowned Night Heron	Nycticorax nycticorax		R	LC	-	GP	6	brown/black + white	4	√	√	√	√
15		Striated Heron	Butorides striata		R	LC	-	GP	4	brown/grey	4	√	√		
16		Chinese Pond Heron	Ardeola bacchus		R	LC	-	GP	5	brown/grey	4	√	√	√	√
17		Eastern Cattle Egret	Bubulcus coromandus		R/P	NR	-	GP	5	white	5	√	√		
18		Grey Heron	Ardea cinerea		R	LC	-	GP	10	grey	5	√	√	√	√
19		Purple Heron	Ardea purpurea		S/P	LC	-	GP	8	brown	5	√	√		
20		Great Egret	Ardea alba		R	LC	-	GP	10	white	5	√	√	√	√
21		Intermediate Egret	Egretta intermedia		R	LC	-	GP	7	Brown +white	5	√	√		
22		Little Egret	Egretta garzetta		R	LC	-	GP	6	white	5	√	√	√	√
Suliformes															
23	Phalacrocoracidae	Great Cormorant	Phalacrocorax carbo	N	F	LC	-	-	9	black	4	√	√	√	√
Accipitriformes															
24	Accipitridae	Black-winged Kite	Elanus caeruleus	R	P	LC	II	-	4	white	1	√	√	√	
25		Jerdon's Baza	Aviceda jerdoni		P	LC	II	-	5	brown	1	√			
26		Crested Serpent Eagle	Spilornis cheela		R	LC	II	-	7	brown	1	√			
27		Crested Goshawk	Accipiter trivirgatus		R	LC	II	-	4	brown	1	√			
28		Japanese Sparrowhawk	Accipiter gularis		W/P	LC	II	-	3	brown	1	√			
29		Besra	Accipiter virgatus		R	LC	II	-	3	brown	1	√	√		
30		Eurasian Sparrowhawk	Accipiter nisus		W	LC	II	-	4	brown	1	√	√		
31		Northern Goshawk	Accipiter gentilis		W	LC	II	-	6	brown	1	√			
32		Black Kite	Milvus migrans		R	LC	II	-	6	brown	1	√	√		

33		Grey-faced Buzzard	Butastur indicus		P	LC	II	-	5	brown	2	√	√		
34		Eastern Buzzard	Buteo japonicus		W	LC	II	-	5	brown	3	√	√		
Falconiformes															
35	Falconidae	Common Kestrel	Falco tinnunculus	R	W	LC	II	-	3	brown	4	√	√		
Gruiformes															
36	Rallidae	White-breasted Waterhen	Amaurornis phoenicurus	G	R	LC	-	-	3	black	3	√	√	√	√
37		Common Moorhen	Gallinula chloropus		R	LC	-	GP	3	black	3	√	√	√	√
38		Eurasian Coot	Fulica atra		W	LC	-	-	4	black	3	√	√		
Charadriiformes															
39	Recurvirostridae	Black-winged Stilt	Himantopus himantopus	G	W	LC	-	GP	12	black+white	5	√	√		
40	Charadriidae	Pacific Golden Plover	Pluvialis fulva		W	LC	-	-	2	brown	1	√	√		
41		Little Ringed Plover	Charadrius dubius		R	LC	-	-	2	brown	1	√	√		
42		Kentish Plover	Charadrius alexandrinus		R	LC	-	-	2	brown	1	√	√		
43	acanidae	Pheasant-tailed Jacana	Hydrophasianus chirurgus		V	LC	II	-	5	black+white	3	√			
44	Scolopacidae	Common Snipe	Gallinago gallinago		W	LC	-	-	3	brown	2	√	√		
45		Black-tailed Godwit	Limosa limosa		W	NT	-	-	4	brown	2	√			
46		Green Sandpiper	Tringa ochropus		R	LC	-	-	2	brown	1	√	√		
47		Common Sandpiper	Actitis hypoleucos		R	LC	-	-	2	brown	1	√	√		√
Columbiformes															
48	Columbidae	Rock Pigeon	Columba livia	T	F	LC	-	-	3	grey	4	√	√	√	√
49		Oriental Turtle Dove	Streptopelia orientalis		R	LC	-	-	3	brown	3	√	√	√	√
50		Eurasian Collared Dove	Streptopelia decaocto		R	LC	-	-	3	brown	3	√	√		
51		Spotted Dove	Spilopelia chinensis		R	LC	-	-	3	brown	3	√	√	√	√
Psittaciformes															
52	Psittacidae	Alexandrine Parakeet	Psittacula eupatria	S	F	NT	II	-	6	green	4	√	√	√	√
53	Cacatuidae	Cockatiel	Nymphicus hollandicus	S	P	LC	-	-	3	white	2			√	
Cuculiformes															
54	Cuculidae	Greater Coucal	Centropus sinensis	S	R	LC	II	-	5	brown	2	√	√	√	√
55		Lesser Coucal	Centropus bengalensis		R	LC	II	-	4	brown	2	√	√		
56		Chestnut-winged Cuckoo	Clamator coromandus		S	LC	-	-	4	orange	1	√			
57		Asian Koel	Eudynamys scolopaceus		R	LC	-	-	4	black/brown	1	√	√		
58		Plaintive Cuckoo	Cacomantis merulinus		R	LC	-	-	2	brown	1	√	√		
59		Large Hawk-Cuckoo	Hierococcyx sparverioides		S	LC	-	-	4	brown	2	√	√		
Strigiformes															
60	Strigidae	Asian Barred Owlet	Glaucidium cuculoides	R	R	LC	II	-	2	brown	1	√			
Caprimulgiformes															
61	Caprimulgidae	Grey Nightjar	Caprimulgus jotaka	S	S	LC	-	-	3	brown	1	√	√		
Apodiformes															
62	Apodidae	Fork-tailed Swift	Apus pacificus	S	R	LC	-	-	2	grey	1	√	√		
63		House Swift	Apus nipalensis		R	LC	-	-	1	black	1	√	√	√	√
Coraciiformes															
64	Coraciidae	Oriental Dollarbird	Eurystomus orientalis	S	S	LC	-	GP	3	blue	2	√			

65	Alcedinidae	White-throated Kingfisher	Halcyon smyrnensis		R	LC	II	-	3	blue	2	√	√	√	
66		Black-capped Kingfisher	Halcyon pileata		R	LC	-	GP	3	blue	2	√	√		
67		Common Kingfisher	Alcedo atthis		R	LC	-	-	2	blue	2	√	√	√	√
68		Pied Kingfisher	Ceryle rudis		R	LC	-	-	3	black+white	2	√			
Piciform															
69	Megalaimidae	Great Barbet	Megalaima virens	S	R	LC	-	-	3	green	1	√	√		
70	Picidae	Eurasian Wryneck	Jynx torquilla		W	LC	-	-	2	brown	1	√	√		
71		Speckled Piculet	Picumnus innominatus		R	LC	-	GP	1	brown	1	√			
Passeriformes															
72	Campephagidae	Ashy Minivet	Pericrocotus divaricatus	P	V	LC	-	-	2	grey	1	√			
73	Campephagidae	Scarlet Minivet	Pericrocotus speciosus		R	LC	-	-	2	red/yellow	2	√			
74	Laniidae	Tiger Shrike	Lanius tigrinus		P	LC	-	-	2	brown	2	√			
75	Laniidae	Brown Shrike	Lanius cristatus		P	LC	-	-	2	brown	2	√			
76	Laniidae	Long-tailed Shrike	Lanius schach		R	LC	-	-	2	brown	3	√	√	√	√
77	Dicruridae	Black Drongo	Dicrurus macrocercus		R	LC	-	-	3	black	3	√	√	√	
78	Dicruridae	Ashy Drongo	Dicrurus leucophaeus		W	LC	-	-	3	grey	3	√			
79	Dicruridae	Hair-crested Drongo	Dicrurus hottentottus		R	LC	-	-	3	black	3	√	√		
80	Monarchidae	Black-naped Monarch	Hypothymis azurea		R	LC	-	-	1	blue	1	√	√		
81	Monarchidae	Asian Paradise-flycatcher	Terpsiphone paradisi		R	LC	-	GP	2	brown/white	2	√			
82	Corvidae	Red-billed Blue Magpie	Urocissa erythroryncha		R	LC	-	-	6	blue	4	√	√		
83	Corvidae	Grey Treepie	Dendrocitta formosae		R	LC	-	-	4	brown	2	√	√		
84	Corvidae	Azure-winged Magpie	Cyanopica cyanus		W	LC	-	-	2	brown	3				√
85	Corvidae	Eurasian Magpie	Pica pica		R	LC	-	-	5	Black + white	4	√	√		√
86	Corvidae	Large-billed Crow	Corvus macrorhynchos		R	LC	-	-	5	black	3	√	√	√	√
87	Paridae	Japanese Tit	Parus minor		R	NR	-	-	1	grey	1	√	√	√	√
88	Pycnonotidae	Red-whiskered Bulbul	Pycnonotus jocosus		R	LC	-	-	2	brown	3	√	√	√	√
89		Light-vented Bulbul	Pycnonotus sinensis		R	LC	-	-	2	brown	3	√	√	√	√
90		Sooty-headed Bulbul	Pycnonotus aurigaster		R	LC	-	-	2	brown	3	√	√	√	√
91		Chestnut Bulbul	Hemixos castanonotus		R	LC	-	-	2	brown	2	√	√		
92		Black Bulbul	Hypsipetes leucocephalus		R	LC	-	-	2	black	2	√	√		
93	Hirundinidae	Sand Martin	Riparia riparia		W/P	LC	-	-	1	brown	1	√			
94		Barn Swallow	Hirundo rustica		R	LC	-	-	2	black	2	√	√		
95		Red-rumped Swallow	Cecropis daurica		R	LC	-	-	2	brown	3	√	√	√	√
96	Pnoepygidae	Pygmy Wren-Babbler	Pnoepyga pusilla		R	LC	-	-	1	brown	1	√		√	
97	Scotocercidae	Mountain Tailorbird	Phyllergates cuculatus		R	LC	-	-	1	green	1	√	√		
98		Manchurian Bush Warbler	Horornis borealis		W	LC	-	-	1	brown	1	√	√		
99		Brownish-flanked Bush Warbler	Horornis fortipes		R	LC	-	-	1	brown	1	√	√		
100	Phylloscopidae	Dusky Warbler	Phylloscopus fuscatus		W	LC	-	-	1	brown	1	√	√	√	√
101		Pallas's Leaf Warbler	Phylloscopus proregulus		W	LC	-	-	1	green	1	√	√		√
102		Yellow-browed Warbler	Phylloscopus inornatus		W	LC	-	-	1	brown	1	√	√	√	√
103		Arctic Warbler	Phylloscopus borealis		P	LC	-	-	1	green	1	√	√		
104		Pale-legged Warbler	Phylloscopus tenellipes		W	LC	-	-	1	brown	1	√		√	

105		Eastern Crowned Warbler	Phylloscopus coronatus		P	LC	-	-	1	green	1	√	√		
106		Sulphur-breasted Warbler	Phylloscopus ricketti		R	LC	-	-	1	green	1	√	√		
107	Acrocephalidae	Oriental Reed Warbler	Acrocephalus orientalis		W/P	LC	-	-	2	brown	1	√	√	√	
108		Black-browed Reed Warbler	Acrocephalus bistrigiceps		P	LC	-	-	1	brown	1	√	√		
109	Locustellidae	Russet Bush Warbler	Locustella mandelli		W/V	LC	-	-	1	brown	1	√	√		
110		Lanceolated Warbler	Locustella lanceolata		W	LC	-	GP	1	brown	1			√	
111	Cisticolidae	Zitting Cisticola	Cisticola juncidis		R	LC	-	-	1	brown	1	√	√		
112		Hill Prinia	Prinia superciliaris		R	LC	-	-	2	brown	1	√			
113		Yellow-bellied Prinia	Prinia flaviventris		R	LC	-	-	1	brown	1	√	√	√	√
114		Plain Prinia	Prinia inornata		R	LC	-	-	1	brown	1	√	√	√	√
115		Common Tailorbird	Orthotomus sutorius		R	LC	-	-	1	brown	1	√	√	√	√
116	Timaliidae	Rufous-capped Babbler	Stachyridopsis ruficeps		R	LC	-	-	1	brown	1	√	√		
117	Leiotrichidae	Hwamei	Garrulax canorus		R	LC	II	-	2	brown	2	√	√	√	√
118		Masked Laughingthrush	Pterorhinus perspicillatus		R	LC	-	-	3	brown	2	√	√	√	√
119		Greater Necklaced Laughingthrush	Pterorhinus pectoralis		R	LC	-	-	3	brown	2	√	√		
120		Black-throated Laughingthrush	Pterorhinu chinensis		R	LC	II	-	3	grey	2	√	√		√
121		White-browed Laughingthrush	Pterorhinus sannio		R	LC	-	-	2	brown	2	√	√	√	
122	Zosteropidae	Swinhoe's White-eye	Zosterops japonicus		R	LC	-	-	1	green	1	√	√	√	√
123	Sturnidae	Crested Myna	Acridotheres cristatellus		R	LC	-	-	2	black	3	√	√	√	√
124		Red-billed Starling	Spodiopsar sericeus		R	LC	-	-	2	grey	2	√	√	√	√
125		White-cheeked Starling	Spodiopsar cineraceus		W	LC	-	-	2	grey	2	√	√	√	√
126		Black-collared Starling	Gracupica nigricollis		R	LC	-	-	3	black+white	3	√	√	√	√
127		White-shouldered Starling	Sturnia sinensis		R	LC	-	-	2	grey	2	√	√		
128	Turdidae	Orange-headed Thrush	Geokichla citrina		W/P	LC	-	-	2	orange	1	√	√		
129		Grey-backed Thrush	Turdus hortulorum		W	LC	-	-	2	brown	2	√			
130		Japanese Thrush	Turdus cardis		W	LC	-	-	2	black/brown	2	√	√		
131		Chinese Blackbird	Turdus merula		R	LC	-	-	3	black	4	√	√	√	√
132	Muscicapidae	Siberian Rubythroat	Luscinia calliope		W	LC	II	-	1	brown	1	√			
133		Orange-flanked Bluetail	Tarsiger cyanurus		W	LC	-	-	1	brown/blue	1	√	√		
134		Oriental Magpie Robin	Copsychus saularis		R	LC	-	-	2	black	3	√	√	√	√
135		Daurian Redstart	Phoenicurus auroreus		W	LC	-	-	1	brown/orange	1	√	√	√	√
136		Plumbeous Water Redstart	Rhyacornis fuliginosa		R	LC	-	-	1	brown	1	√	√		
137		Blue Whistling Thrush	Myophonus caeruleus		R	LC	-	-	3	black	3	√	√		
138		Stejneger's Stonechat	Saxicola stejnegeri		W	NR	-	-	1	brown	1	√	√	√	√
139		Grey-streaked Flycatcher	Muscicapa griseisticta		P	LC	-	-	1	grey	1	√			
140		Asian Brown Flycatcher	Muscicapa latirostris		W/P	LC	-	-	1	grey	1	√	√		
141		Narcissus Flycatcher	Ficedula narcissina		P	LC	-	-	1	brown/yellow	1	√	√		
142		Taiga Flycatcher	Ficedula albicilla		W	LC	-	-	1	brown	1	√	√	√	√
143		Blue-and-white Flycatcher	Cyanoptila cyanomelana		P	LC	-	-	1	brown/blue	1	√	√		
144		Hainan Blue Flycatcher	Cyornis hainanus		S/P	LC	-	GP	1	brown/blue	1	√	√		
145	Dicaeidae	Fire-breasted Flowerpecker	Dicaeum ignipectus		R	LC	-	-	1	brown	1	√	√		
146		Scarlet-backed Flowerpecker	Dicaeum cruentatum		R	LC	-	-	1	brown/red	1	√	√		

147	Nectariniidae	Mrs Gould's Sunbird	Aethopyga gouldiae		V	LC	-	-	1	red/brown	1	√			
148		Fork-tailed Sunbird	Aethopyga christinae		R	LC	-	-	1	brown	1	√	√		√
149	Fringillidae	Eurasian Tree Sparrow	Passer montanus		R	LC	-	-	1	brown	1	√	√		
150		White-rumped Munia	Lonchura striata		W	LC	-	-	1	brown	1	√	√	√	√
151		Scaly-breasted Munia	Lonchura punctulata		W	LC	-	-	1	brown	1	√	√	√	√
152	Motacillidae	Eastern Yellow Wagtail	Motacilla tschutschensis		W	LC	-	-	2	yellow	3	√			
153		Grey Wagtail	Motacilla cinerea		W	LC	-	-	2	yellow	3	√	√		
154		White Wagtail	Motacilla alba		R	LC	-	-	2	black+white	3	√	√	√	√
155		Richard's Pipit	Anthus richardi		W	LC	-	-	2	brown	1	√	√		
156		Olive-backed Pipit	Anthus hodgsoni		W	LC	-	-	2	brown	1	√		√	√
157	Fringillidae	Chinese Grosbeak	Eophona migratoria		W	LC	-	GP	2	brown	1	√	√		√
158		Grey-capped Greenfinch	Chloris sinica		R	LC	-	-	1	brown	1	√	√		
159	Emberizidae	Tristram's Bunting	Emberiza tristrami		W	LC	-	GP	1	brown	1			√	
160		Little Bunting	Emberiza pusilla		W	LC	-	GP	1	brown	1	√	√		
161		Yellow-breasted Bunting	Emberiza aureola		W/S	CR	I	-	1	brown	1	√	√	√	
162		Black-faced Bunting	Emberiza spodocephala		W	LC	-	GP	1	brown	1	√	√		√

Ecotype: N – Natatores, R – Raptors, G – grallatores, S – scansores, P – passeres, T -- terrestores
Residence type: W-Winter visitors, S-Summer visitors, R-Residents, P-Passing migrants, F – Free range
IUCN: NR – Not Recognized as a species; LC – Least Concern; VU – Vulnerable; NT – Near Threatened; CR – Critically Endangered.
(The IUCN Red List of Threatened Species. Version 2021-3.<www.iucnredlist.org>.Downloaded on 18 December 2021.)
Size: [1] <15cm ; [2] 16–25cm ; [3] 26–35cm; [4] 36–45cm ; [5] 46–55cm; [6] 56–65cm; [7] 66-75cm; [8] 76-85cm; [9] 86-95cm; [10] 96-105cm; [11] 106-115cm; [12] 116-125cm
Visibility (Vis):
[5] - [very easy] – birds that can be seen and identified with the naked eyes without effort
[4] - [easy] – birds that can be seen and identified with the naked eyes with little effort
[3] - [more challenging] – birds that can be seen and identified with the naked eyes with effort
[2] - [difficult] – birds that can be seen and identified with the naked eyes with much effort, or when they get close to human.
[1] - [very difficult] – shy birds that can be seen and identified with the naked eyes with much effort, or birds that can be seen and identified with binoculars.
CS: recorded by citizen scientists from 2019-10-01 to 2022-09-31; SV: recorded by site survey by the author

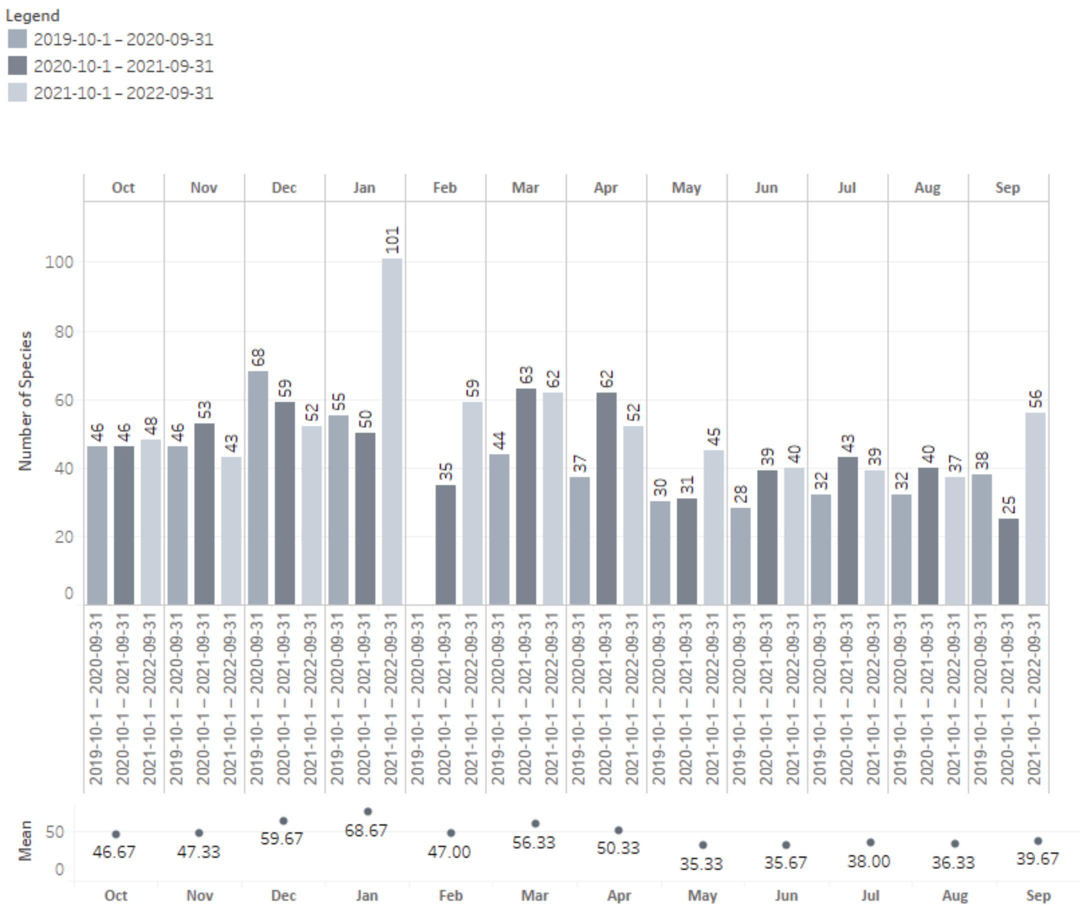
Appendix A - 15 Plants indices within quadrats

Quadrats	Total Score	Shannon Index-trees/shrubs		Shannon Index-ground cover		Proportion of invasive plants		Proportion of native plants		Coverage	
		Sc.	Shannon Index	Sc.	Mean±S.D.	Sc.	Mean±S.D.	Sc.	Mean±S.D.	Sc.	Mean±S.D.
0	7	0	0.00	1	0.05±0.04	1	1.00±0.01	0	0.00±0.00	5	100.00±0.00
1	13	0	0.00	2	0.41±0.26	5	0.09±0.06	1	0.04±0.06	5	89.25±9.29
2	16	0	0.00	3	0.61±0.55	4	0.28±0.29	4	0.72±0.29	5	94.50±4.34
3	8	0	0.00	1	0.19±0.08	1	0.95±0.02	1	0.05±0.02	5	94.00±1.41
4	13	0	0.00	2	0.34±0.28	5	0.03±0.03	1	0.02±0.01	5	99.75±0.50
5	14	0	0.00	1	0.10±0.08	4	0.29±0.44	5	1.00±0.00	4	63.00±47.35
6	12	0	0.00	2	0.47±0.39	5	0.06±0.06	2	0.24±0.41	3	48.75±22.41
7	18	0	0.00	3	0.67±0.25	5	0.17±0.15	5	0.89±0.04	5	100.00±0.00
8	17	0	0.00	3	0.77±0.19	5	0.03±0.05	4	0.80±0.39	5	100.00±0.00
9	17	0	0.00	4	1.05±0.09	5	0.11±0.07	3	0.55±0.43	5	100.00±0.00
10	12	0	0.00	5	1.36±0.23	3	0.50±0.15	2	0.27±0.19	2	28.50±10.66
11	14	0	0.00	3	0.82±0.18	4	0.35±0.24	2	0.27±0.16	5	90.00±20.00
12	15	0	0.00	3	0.84±0.37	4	0.36±0.38	3	0.47±0.30	5	98.75±1.50
13	12	0	0.00	4	0.99±0.36	0	0.00±0.00	3	0.48±0.32	5	96.50±4.36
14	14	0	0.00	3	0.87±0.53	5	0.16±0.13	2	0.21±0.26	4	68.80±15.72
15	16	0	0.00	4	1.00±0.36	5	0.08±0.08	2	0.36±0.31	5	89.25±15.56
16	17	0	0.00	4	0.96±0.37	5	0.18±0.10	3	0.52±0.47	5	97.50±5.00
17	18	1	0.06	4	0.99±0.46	5	0.11±0.19	3	0.58±0.37	5	97.80±29.84
18	13	0	0.00	2	0.45±0.33	5	0.13±0.14	1	0.01±0.02	5	100.00±0.00
19	14	2	0.50	3	0.75±0.18	3	0.53±0.39	1	0.06±0.05	5	92.50±10.38
20	12	0	0.00	1	0.27±0.25	5	0.01±0.03	1	0.07±.07	5	98.00±2.83
21	12	0	0.00	1	0.17±0.14	5	0.02±0.04	1	0.02±0.02	5	94.50±3.42
22	9	0	0.00	2	0.30±0.35	5	0.19±0.38	1	0.15±0.18	1	0.20±0.19
23	13	0	0.00	2	0.42±0.26	5	0.06±0.11	1	0.06±0.06	5	100.00±0.00
24	16	0	0.00	5	1.28±0.33	4	0.21±0.12	2	0.21±0.19	5	93.25±8.06
25	8	0	0.00	3	0.66±0.37	0	0.00±0.00	2	0.27±0.25	3	45.50±8.81
26	8	0	0.00	2	0.58±0.26	0	0.00±0.00	1	0.19±0.18	5	97.50±2.38
27	14	0	0.00	2	0.60±0.13	5	0.04±0.03	2	0.30±0.37	5	100.00±0.00

28	14	0	0.00	5	1.29±0.49	4	0.37±0.33	3	0.49±0.28	2	32.00±12.83
29	15	0	0.00	4	1.03±0.21	4	0.23±0.18	2	0.30±0.21	5	89.75±10.53
30	7	0	0.00	4	0.95±0.31	0	0.00±0.00	0	0.00±0.00	3	40.50±16.92
31	18	3	0.69	4	0.95±0.25	4	0.32±0.20	4	0.68±0.20	3	57.25±17.90
32	12	0	0.00	2	0.42±0.50	0	0.00±0.00	5	0.99±0.03	5	100.00±0.00
33	15	0	0.00	2	0.51±0.59	5	0.03±0.05	3	0.47±0.54	5	100.00±0.00
34	17	0	0.00	4	1.10±0.49	5	0.11±0.11	3	0.40±0.25	5	92.50±13.70
35	12	0	0.00	2	0.44±0.21	5	0.05±0.11	1	0.13±0.15	4	70.25±13.96
36	11	0	0.00	2	0.35±0.39	0	0.00±0.00	5	0.94±0.13	4	72.75±21.84
37	12	0	0.00	2	0.43±0.20	3	0.47±0.45	2	0.30±0.44	5	100.00±0.00
38	18	3	0.69	3	0.77±0.23	5	0.03±0.06	5	0.97±0.06	2	30.50±19.36
39	10	0	0.00	3	0.80±0.59	0	0.00±0.00	3	0.57±0.30	4	75.50±16.62
40	15	0	0.00	3	0.65±0.24	5	0.06±0.04	2	0.21±0.19	5	98.25±3.50
41	12	0	0.00	1	0.23±0.24	5	0.07±0.12	1	0.01±0.01	5	100.00±0.00
42	15	1	0.16	4	0.96±0.40	4	0.39±0.41	1	0.09±0.04	5	100.00±0.00
43	16	4	0.99	4	1.05±0.36	2	0.62±0.29	2	0.37±0.30	4	75.50±16.62
44	7	0	0.00	1	0.28±0.35	0	0.00±0.00	1	0.07±0.13	5	100.00±0.00
45	18	3	0.64	4	0.96±0.40	4	0.38±0.41	2	0.34±0.40	5	100.00±0.00
46	10	0	0.00	3	0.82±0.45	3	0.44±0.49	2	0.29±0.29	2	31.25±8.54
47	12	0	0.00	3	0.89±0.37	4	0.35±0.38	3	0.41±0.42	2	27.25±8.10
48	17	0	0.00	2	0.49±0.41	5	0.15±.15	5	0.85±0.15	5	96.25±7.50
49	13	0	0.00	3	0.85±0.15	4	0.30±0.15	1	0.07±0.07	5	85.75±4.79
50	13	0	0.00	3	0.80±0.34	3	0.48±0.28	3	0.52±0.28	4	75.75±10.47
51	10	0	0.00	1	0.16±0.20	2	0.73±0.45	2	0.24±0.47	5	100.00±0.00
52	19	1	0.23	3	0.69±0.35	5	0.01±0.02	5	0.97±0.07	5	80.00±40.00
53	8	0	0.00	1	0.21±0.17	1	0.94±0.06	1	0.07±0.06	5	100.00±0.00
54	12	0	0.00	3	0.71±0.44	2	0.74±0.28	2	0.21±0.29	5	95.00±10.00
55	18	2	0.42	2	0.42±0.44	5	0.09±0.16	5	0.90±0.16	4	72.00±40.07
56	14	3	0.64	1	0.06±0.07	4	0.25±0.48	1	0.01±0.02	5	100.00±0.00
57	19	4	1.06	2	0.40±0.47	5	0.08±0.15	3	0.43±0.50	5	96.25±7.50

Sc.: score

Appendix A - 16 Number of bird species recorded by citizen scientists in the Haizhu National Wetland Park



Appendix A - 17 Temporal and spatial frequency of occurrence of each species (October 2022)

NO	Species		d – the number of days that encounter a bird species (L – Lake, W – Wetlands Phase 1 and 2, T – Total)			FT – the frequency of encountering a particular bird species during the survey; [+++++] - $80 < FT \leq 100$ [++++]- $60 < FT \leq 80$ [+++] - $40 < FT \leq 60$ [++]- $20 < FT \leq 40$ [+]- $0 < FT \leq 20$ (L – Lake, W – Wetlands Phase 1 and 2, T – Total)						m –the number of plots on which the species occurs (L – Lake, W – Wetlands Phase 1 & 2, T – Total)			FS – the spatial frequency of occurrence of each species (per 250-metre walk) [+++++] - $80 < FS \leq 100$ [++++]- $60 < FS \leq 80$ [+++] - $40 < FS \leq 60$ [++]- $20 < FS \leq 40$ [+]- $0 < FS \leq 20$ (L – Lake, W – Wetlands Phase 1 and 2, T – Total)					
	English Name	Latin Name	L	W	T	L		W		T		L	W	T	L		W		T	
1	Swan Goose	Anser cygnoides	7	0	7	63.64	++++	0.00		36.84	++	2	0	2	14.29	+	0.00		4.44	+
2	Mandarin Duck	Aix galericulata	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
3	Mallard	Anas platyrhynchos	8	0	8	72.73	++++	0.00		42.11	+++	1	0	1	7.14	+	0.00		2.22	+
4	Chinese Spot-billed Duck	Anas zonorhyncha	11	8	19	100.00	+++++	100.00	+++++	100.00	+++++	7	17	24	50.00	+++	54.84	+++	53.33	+++
5	Cinnamon Bittern	Ixobrychus cinnamomeus	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
6	Black-crowned Night Heron	Nycticorax nycticorax	10	7	17	90.91	+++++	87.50	+++++	89.47	+++++	9	8	17	64.29	++++	25.81	++	37.78	++
7	Chinese Pond Heron	Ardeola bacchus	4	6	10	36.36	++	75.00	++++	52.63	+++	4	5	9	28.57	++	16.13	+	20.00	+
8	Grey Heron	Ardea cinerea	11	8	19	100.00	+++++	100.00	+++++	100.00	+++++	9	9	18	64.29	++++	29.03	++	40.00	++
9	Great Egret	Ardea alba	5	0	5	45.45	+++	0.00		26.32	++	2	0	2	14.29	+	0.00		4.44	+
10	Little Egret	Egretta garzetta	10	8	18	90.91	+++++	100.00	+++++	94.74	+++++	7	16	23	50.00	+++	51.61	+++	51.11	+++
11	Great Cormorant	Phalacrocorax carbo	1	0	1	9.09	+	0.00		5.26	+	1	0	1	7.14	+	0.00		2.22	+
12	Black-winged Kite	Elanus caeruleus	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
13	White-breasted Waterhen	Amaurornis phoenicurus	4	7	11	36.36	++	87.50	+++++	57.89	+++	5	16	21	35.71	++	51.61	+++	46.67	+++
14	Common Moorhen	Gallinula chloropus	3	7	10	27.27	++	87.50	+++++	52.63	+++	3	6	9	21.43	++	19.35	+	20.00	+
15	Rock Pigeon	Columba livia	3	1	4	27.27	++	12.50	+	21.05	++	3	1	4	21.43	++	3.23	+	8.89	+
16	Oriental Turtle Dove	Streptopelia orientalis	0	2	2	0.00		25.00	++	10.53	+	0	3	3	0.00		9.68	+	6.67	+
17	Spotted Dove	Spilopelia chinensis	10	7	17	90.91	+++++	87.50	+++++	89.47	+++++	8	11	19	57.14	+++	35.48	++	42.22	+++
18	Alexandrine Parakeet	Psittacula eupatria	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
19	Cockatiel	Nymphicus hollandicus	1	0	1	9.09	+	0.00		5.26	+	1	0	1	7.14	+	0.00		2.22	+
20	Greater Coucal	Centropus sinensis	0	5	5	0.00		62.50	++++	26.32	++	0	12	12	0.00		38.71	++	26.67	++
21	House Swift	Apus nipalensis	2	1	3	18.18	+	12.50	+	15.79	+	2	1	3	14.29	+	3.23	+	6.67	+
22	White-throated Kingfisher	Halcyon smyrnensis	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
23	Common Kingfisher	Alcedo atthis	0	4	4	0.00		50.00	+++	21.05	++	0	5	5	0.00		16.13	+	11.11	+
24	Long-tailed Shrike	Lanius schach	5	5	10	45.45	+++	62.50	++++	52.63	+++	3	5	8	21.43	++	16.13	+	17.78	+
25	Black Drongo	Dicrurus macrocercus	1	4	5	9.09	+	50.00	+++	26.32	++	1	5	6	7.14	+	16.13	+	13.33	+
26	Large-billed Crow	Corvus macrorhynchos	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
27	Japanese Tit	Parus minor	4	3	7	36.36	++	37.50	++	36.84	++	5	3	8	35.71	++	9.68	+	17.78	+
28	Red-whiskered Bulbul	Pycnonotus jocosus	2	6	8	18.18	+	75.00	++++	42.11	+++	3	8	11	21.43	++	25.81	++	24.44	++
29	Light-vented Bulbul	Pycnonotus sinensis	11	8	19	100.00	+++++	100.00	+++++	100.00	+++++	14	26	40	100.00	+++++	83.87	+++++	88.89	+++++

30	Sooty-headed Bulbul	Pycnonotus aurigaster	11	8	19	100.00	+++++	100.00	+++++	100.00	+++++	11	28	39	78.57	++++	90.32	+++++	86.67	+++++
31	Red-rumped Swallow	Cecropis daurica	2	6	8	18.18	+	75.00	++++	42.11	+++	3	6	9	21.43	++	19.35	+	20.00	+
32	Dusky Warbler	Phylloscopus fuscatus	7	8	15	63.64	++++	100.00	+++++	78.95	++++	7	22	29	50.00	+++	70.97	++++	64.44	++++
33	Yellow-browed Warbler	Phylloscopus inornatus	3	1	4	27.27	++	12.50	+	21.05	++	4	1	5	28.57	++	3.23	+	11.11	+
34	Pale-legged Warbler	Phylloscopus tenellipes	1	0	1	9.09	+	0.00		5.26	+	1	0	1	7.14	+	0.00		2.22	+
35	Oriental Reed Warbler	Acrocephalus orientalis	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
36	Lanceolated Warbler	Locustella lanceolata	1	0	1	9.09	+	0.00		5.26	+	1	0	1	7.14	+	0.00		2.22	+
37	Yellow-bellied Prinia	Prinia flaviventris	10	8	18	90.91	+++++	100.00	+++++	94.74	+++++	10	20	30	71.43	++++	64.52	++++	66.67	++++
38	Plain Prinia	Prinia inornata	5	5	10	45.45	+++	62.50	++++	52.63	+++	3	6	9	21.43	++	19.35	+	20.00	+
39	Common Tailorbird	Orthotomus sutorius	7	6	13	63.64	++++	75.00	++++	68.42	++++	8	8	16	57.14	+++	25.81	++	35.56	++
40	Hwamei	Garrulax canorus	3	1	4	27.27	++	12.50	+	21.05	++	2	1	3	14.29	+	3.23	+	6.67	+
41	Masked Laughingthrush	Pterorhinus perspicillatus	1	6	7	9.09	+	75.00	++++	36.84	++	1	8	9	7.14	+	25.81	++	20.00	+
42	White-browed Laughingthrush	Pterorhinus sannio	3	0	3	27.27	++	0.00		15.79	+	3	0	3	21.43	++	0.00		6.67	+
43	Swinhoe's White-eye	Zosterops simplex	11	8	19	100.00	+++++	100.00	+++++	100.00	+++++	14	25	39	100.00	+++++	80.65	+++++	86.67	+++++
44	Crested Myna	Acridotheres cristatellus	9	6	15	81.82	+++++	75.00	++++	78.95	++++	10	8	18	71.43	++++	25.81	++	40.00	++
45	Red-billed Starling	Spodiopsar sericeus	4	5	9	36.36	++	62.50	++++	47.37	+++	4	6	10	28.57	++	19.35	+	22.22	++
46	White-cheeked Starling	Spodiopsar cineraceus	0	4	4	0.00		50.00	+++	21.05	++	0	5	5	0.00		16.13	+	11.11	+
47	Black-collared Starling	Gracupica nigricollis	9	8	17	81.82	+++++	100.00	+++++	89.47	+++++	8	15	23	57.14	+++	48.39	+++	51.11	+++
48	Chinese Blackbird	Turdus mandarinus	11	8	19	100.00	+++++	100.00	+++++	100.00	+++++	13	26	39	92.86	+++++	83.87	+++++	86.67	+++++
49	Oriental Magpie Robin	Copsychus saularis	9	8	17	81.82	+++++	100.00	+++++	89.47	+++++	10	19	29	71.43	++++	61.29	++++	64.44	++++
50	Daurian Redstart	Phoenicurus auroreus	1	2	3	9.09	+	25.00	++	15.79	+	1	4	5	7.14	+	12.90	+	11.11	+
51	Stejneger's Stonechat	Saxicola stejnegeri	5	7	12	45.45	+++	87.50	+++++	63.16	++++	2	9	11	14.29	+	29.03	++	24.44	++
52	Taiga Flycatcher	Ficedula albicilla	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
53	White-rumped Munia	Lonchura striata	0	7	7	0.00		87.50	+++++	36.84	++	0	4	4	0.00		12.90	+	8.89	+
54	Scaly-breasted Munia	Lonchura punctulata	1	8	9	9.09	+	100.00	+++++	47.37	+++	1	9	10	7.14	+	29.03	++	22.22	++
55	White Wagtail	Motacilla alba	10	8	18	90.91	+++++	100.00	+++++	94.74	+++++	6	22	28	42.86	+++	70.97	++++	62.22	++++
56	Olive-backed Pipit	Anthus hodgsoni	1	3	4	9.09	+	37.50	++	21.05	++	1	3	4	7.14	+	9.68	+	8.89	+
57	Tristram's Bunting	Emberiza tristrami	0	1	1	0.00		12.50	+	5.26	+	0	1	1	0.00		3.23	+	2.22	+
58	Yellow-breasted Bunting	Emberiza aureola	0	2	2	0.00		25.00	++	10.53	+	0	2	2	0.00		6.45	+	4.44	+

Appendix A - 18 Temporal and spatial frequency of occurrence of each species (January 2023)

NO	Species		d – the number of days that encounter a bird species (L – Lake, W – Wetlands Phase 1 and 2, T – Total)			FT – the frequency of encountering a particular bird species during the survey; [+++++] - $80 < FT \le 100$ [++++]- $60 < FT \le 80$ [+++] - $40 < FT \le 60$ [++]- $20 < FT \le 40$ [+]- $0 < FT \le 20$ (L – Lake, W – Wetlands Phase 1 and 2, T – Total)						m –the number of plots on which the species occurs (L – Lake, W – Wetlands Phase 1 and 2, T – Total)			FS – the spatial frequency of occurrence of each species; [+++++] - $80 < FS \le 100$ [++++]- $60 < FS \le 80$ [+++] - $40 < FS \le 60$ [++]- $20 < FS \le 40$ [+]- $0 < FS \le 20$ (L – Lake, W – Wetlands Phase 1 and 2, T – Total)					
	English Name	Latin Name	L	W	T	L		W		T		L	W	T	L		W		T	
1	Swan Goose	Anser cygnoides	9	0	9	100.00	+++++			52.94	+++	4	0	4	28.57	++			8.89	+
2	Mallard	Anas platyrhynchos	9	1	10	100.00	+++++	12.50	+	58.82	+++	2	1	3	14.29	+	3.23	+	6.67	+
3	Chinese Spot-billed Duck	Anas zonorhyncha	9	8	17	100.00	+++++	100.00	+++++	100.00	+++++	9	22	31	64.29	++++	70.97	++++	68.89	++++
4	Little Grebe	Tachybaptus ruficollis	1	0	1	11.11	+			5.88	+	1	0	1	7.14	+			2.22	+
5	Black-crowned Night Heron	Nycticorax nycticorax	9	6	15	100.00	+++++	75.00	++++	88.24	+++++	8	4	12	57.14	+++	12.90	+	26.67	++
6	Chinese Pond Heron	Ardeola bacchus	3	6	9	33.33	++	75.00	++++	52.94	+++	3	7	10	21.43	++	22.58	++	22.22	++
7	Grey Heron	Ardea cinerea	9	8	17	100.00	+++++	100.00	+++++	100.00	+++++	7	15	22	50.00	+++	48.39	+++	48.89	+++
8	Great Egret	Ardea alba	2	0	2	22.22	++			11.76	+	2	0	2	14.29	+			4.44	+
9	Little Egret	Egretta garzetta	7	8	15	77.78	++++	100.00	+++++	88.24	+++++	8	16	24	57.14	+++	51.61	+++	53.33	+++
10	Great Cormorant	Phalacrocorax carbo	3	0	3	33.33	++			17.65	+	1	0	1	7.14	+			2.22	+
11	White-breasted Waterhen	Amaurornis phoenicurus	5	7	12	55.56	+++	87.50	+++++	70.59	++++	3	12	15	21.43	++	38.71	++	33.33	++
12	Common Moorhen	Gallinula chloropus	6	8	14	66.67	++++	100.00	+++++	82.35	+++++	5	7	12	35.71	++	22.58	++	26.67	++
13	Common Sandpiper	Actitis hypoleucos	0	1	1			12.50	+	5.88	+	0	1	1			3.23	+	2.22	+
14	Rock Pigeon	Columba livia	1	0	1	11.11	+			5.88	+	1	0	1	7.14	+			2.22	+
15	Oriental Turtle Dove	Streptopelia orientalis	0	4	4			50.00	+++	23.53	++	0	4	4			12.90	+	8.89	+
16	Spotted Dove	Spilopelia chinensis	8	7	15	88.89	+++++	87.50	+++++	88.24	+++++	8	9	17	57.14	+++	29.03	++	37.78	++
17	Alexandrine Parakeet	Psittacula eupatria	1	1	2	11.11	+	12.50	+	11.76	+	1	1	2	7.14	+	3.23	+	4.44	+
18	Greater Coucal	Centropus sinensis	1	0	1	11.11	+			5.88	+	1	0	1	7.14	+			2.22	+
19	House Swift	Apus nipalensis	3	3	6	33.33	++	37.50	++	35.29	++	3	3	6	21.43	++	9.68	+	13.33	+
20	Common Kingfisher	Alcedo atthis	0	5	5			62.50	++++	29.41	++	0	5	5			16.13	+	11.11	+
21	Long-tailed Shrike	Lanius schach	7	7	14	77.78	++++	87.50	+++++	82.35	+++++	4	8	12	28.57	++	25.81	++	26.67	++
22	Azure-winged Magpie	Cyanopica cyanus	0	1	1			12.50	+	5.88	+	0	1	1			3.23	+	2.22	+
23	Eurasian Magpie	Pica pica	1	3	4	11.11	+	37.50	++	23.53	++	1	3	4	7.14	+	9.68	+	8.89	+
24	Large-billed Crow	Corvus macrorhynchos	1	0	1	11.11	+	0.00	0	5.88	+	1	0	1	7.14	+	0.00	0	2.22	+
25	Japanese Tit	Parus minor	9	7	16	100.00	+++++	87.50	+++++	94.12	+++++	12	9	21	85.71	+++++	29.03	++	46.67	+++
26	Red-whiskered Bulbul	Pycnonotus jocosus	1	4	5	11.11	+	50.00	+++	29.41	++	1	5	6	7.14	+	16.13	+	13.33	+
27	Light-vented Bulbul	Pycnonotus sinensis	8	8	16	88.89	+++++	100.00	+++++	94.12	+++++	11	23	34	78.57	++++	74.19	++++	75.56	++++
28	Sooty-headed Bulbul	Pycnonotus aurigaster	6	8	14	66.67	++++	100.00	+++++	82.35	+++++	8	25	33	57.14	+++	80.65	+++++	73.33	++++
29	Red-rumped Swallow	Cecropis daurica	0	3	3			37.50	++	17.65	+	0	2	2			6.45	+	4.44	+
30	Dusky Warbler	Phylloscopus fuscatus	7	7	14	77.78	++++	87.50	+++++	82.35	+++++	5	14	19	35.71	++	45.16	+++	42.22	+++

31	Pallas's Leaf Warbler	Phylloscopus proregulus	5	5	10	55.56	+++	62.50	++++	58.82	+++	6	5	11	42.86	+++	16.13	+	24.44	++
32	Yellow-browed Warbler	Phylloscopus inornatus	3	2	5	33.33	++	25.00	++	29.41	++	2	4	6	14.29	+	12.90	+	13.33	+
33	Yellow-bellied Prinia	Prinia flaviventris	7	7	14	77.78	++++	87.50	+++++	82.35	+++++	9	16	25	64.29	++++	51.61	+++	55.56	+++
34	Plain Prinia	Prinia inornata	1	5	6	11.11	+	62.50	++++	35.29	++	1	4	5	7.14	+	12.90	+	11.11	+
35	Common Tailorbird	Orthotomus sutorius	5	8	13	55.56	+++	100.00	+++++	76.47	++++	4	16	20	28.57	++	51.61	+++	44.44	+++
36	Hwamei	Garrulax canorus	3	0	3	33.33	++			17.65	+	2	0	2	14.29	+			4.44	+
37	Masked Laughingthrush	Pterorhinus perspicillatus	2	6	8	22.22	++	75.00	++++	47.06	+++	1	9	10	7.14	+	29.03	++	22.22	++
38	Black-throated Laughingthrush	Pterorhinus chinensis	0	2	2			25.00	++	11.76	+	0	2	2			6.45	+	4.44	+
39	Swinhoe's White-eye	Zosterops simplex	9	8	17	100.00	+++++	100.00	+++++	100.00	+++++	12	21	33	85.71	+++++	67.74	++++	73.33	++++
40	Crested Myna	Acridotheres cristatellus	6	6	12	66.67	++++	75.00	++++	70.59	++++	10	8	18	71.43	++++	25.81	++	40.00	++
41	Red-billed Starling	Spodiopsar sericeus	1	1	2	11.11	+	12.50	+	11.76	+	2	1	3	14.29	+	3.23	+	6.67	+
42	White-cheeked Starling	Spodiopsar cineraceus	1	1	2	11.11	+	12.50	+	11.76	+	1	2	3	7.14	+	6.45	+	6.67	+
43	Black-collared Starling	Gracupica nigricollis	5	8	13	55.56	+++	100.00	+++++	76.47	++++	7	19	26	50.00	+++	61.29	++++	57.78	+++
44	Chinese Blackbird	Turdus mandarinus	9	8	17	100.00	+++++	100.00	+++++	100.00	+++++	13	30	43	92.86	+++++	96.77	+++++	95.56	+++++
45	Oriental Magpie Robin	Copsychus saularis	9	7	16	100.00	+++++	87.50	+++++	94.12	+++++	9	16	25	64.29	++++	51.61	+++	55.56	+++
46	Daurian Redstart	Phoenicurus auroreus	5	8	13	55.56	+++	100.00	+++++	76.47	++++	7	18	25	50.00	+++	58.06	+++	55.56	+++
47	Stejneger's Stonechat	Saxicola stejnegeri	0	6	6			75.00	++++	35.29	++	0	6	6			19.35	+	13.33	+
48	Taiga Flycatcher	Ficedula albicilla	0	2	2			25.00	++	11.76	+	0	2	2			6.45	+	4.44	+
49	Fork-tailed Sunbird	Aethopyga christinae	4	5	9	44.44	+++	62.50	++++	52.94	+++	7	5	12	50.00	+++	16.13	+	26.67	++
50	White-rumped Munia	Lonchura striata	0	2	2			25.00	++	11.76	+	0	2	2			6.45	+	4.44	+
51	Scaly-breasted Munia	Lonchura punctulata	1	5	6	11.11	+	87.50	++++	35.29	++	1	3	4	7.14	+	9.68	+	8.89	+
52	White Wagtail	Motacilla alba	9	8	17	100.00	+++++	12.50	+++++	100.00	+++++	5	9	14	35.71	++	29.03	++	31.11	++
53	Olive-backed Pipit	Anthus hodgsoni	5	6	11	55.56	+++	87.50	++++	64.71	++++	4	8	12	28.57	++	25.81	++	26.67	++
54	Chinese Grosbeak	Eophona migratoria	4	0	4	44.44	+++	100.00	0	23.53	++	4	0	4	28.57	++			8.89	+
55	Black-faced Bunting	Emberiza spodocephala	0	1	1			100.00	+	5.88	+	0	1	1	0.00	0	3.23	+	2.22	+

Appendix A - 19 Visibility of birds × Plots B Crosstabulation (with pairwise z-test), October

Visibility		Plots B											Total
		Lake	Island I and II	Hide	Island IV	Plank and Islands I	Plank and Islands II	Flower Field	Riverine A	Riverine B	Riverine C	Entrance Deck	
very difficult	Count	0a	16a	14a	2a	22a	38a	10a	10a	7a	13a	2a	134
	%	0.00%	21.90%	17.50%	4.90%	13.30%	20.20%	25.00%	15.20%	35.00%	23.20%	11.80%	17.90%
difficult	Count	1a	0b	2a, b	2a, b	2b	4a, b	0a, b	0b	1a, b	0b	1a, b	13
	%	25.00%	0.00%	2.50%	4.90%	1.20%	2.10%	0.00%	0.00%	5.00%	0.00%	5.90%	1.70%
more challenging	Count	0a, b, c	26a, b, c	21a, b, c	4a	40a, b	60a, b, c	20b, c	22a, b, c	7a, b, c	29c	6a, b, c	235
	%	0.00%	35.60%	26.30%	9.80%	24.20%	31.90%	50.00%	33.30%	35.00%	51.80%	35.30%	31.30%
easy	Count	0a, b, c, d	27b, d	11a	7a, b, c, d	40a, b, c, d	25a	3a	27c, d	5a, b, c, d	9a, b, c, d	6a, b, c, d	160
	%	0.00%	37.00%	13.80%	17.10%	24.20%	13.30%	7.50%	40.90%	25.00%	16.10%	35.30%	21.30%
very easy	Count	3a, b	4c	32a, b	26a	61a, b	61b, d	7b, c, d	7c	0c, d	5c	2b, c, d	208
	%	75.00%	5.50%	40.00%	63.40%	37.00%	32.40%	17.50%	10.60%	0.00%	8.90%	11.80%	27.70%
Total	Count	4	73	80	41	165	188	40	66	20	56	17	750
	%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

χ^2 = 164.172, P <0.001, Cramer's V = 0.234

Each subscript letter denotes a subset of Plots B categories whose column proportions do not differ significantly from each other at the .05 level.

Note: Due to the limited sample size in plot Lake, the statistically significant difference between plot Lake and the others was not considered to be truly significant.

Appendix A - 20 Visibility of birds × Plots B Crosstabulation (with pairwise z-test), January

Visibility		Plots B											Total
		Lake	Island I and II	Hide	Island IV	Plank and Islands I	Plank and Islands II	Flower Field	Riverine A	Riverine B	Riverine C	Entrance Deck	
very difficult	Count	0a, b	6a, b	13a, b	1a	40a, b	39a, b	16b	7a, b	1a, b	14b	5a, b	142
	%	0.0%	11.1%	15.9%	2.7%	26.8%	27.9%	30.8%	12.5%	20.0%	35.9%	20.8%	22.1%
difficult	Count	0a	1a	2a	0a	7a	10a	2a	0a	0a	2a	0a	24
	%	0.0%	1.9%	2.4%	0.0%	4.7%	7.1%	3.8%	0.0%	0.0%	5.1%	0.0%	3.7%
more challenging	Count	1a, b, c, d	18a, b, c, d	9c, d	2a, c	29a, b, c, d	44a, b	20b	15a, b, c, d	3b, d	6a, b, c, d	6a, b, c, d	153
	%	25.0%	33.3%	11.0%	5.4%	19.5%	31.4%	38.5%	26.8%	60.0%	15.4%	25.0%	23.8%
easy	Count	2a, b, c, d, e, f, g, h	22f, h	20a, b, c, d, e, f, g, h	3a, c, d, e	29a, b, c, d, e, f, g, h	14d, e	6c, e	23g, h	1a, b, c, d, e, f, g, h	15a, b, c, f, g, h	11b, f, g, h	146
	%	50.0%	40.7%	24.4%	8.1%	19.5%	10.0%	11.5%	41.1%	20.0%	38.5%	45.8%	22.7%
very easy	Count	1a, b, c, d	7d	38c	31a	44b, c, d	33b, d	8b, d	11b, c, d	0b, c, d	2b, d	2b, d	177
	%	25.0%	13.0%	46.3%	83.8%	29.5%	23.6%	15.4%	19.6%	0.0%	5.1%	8.3%	27.6%
Total	Count	4	56	54	82	5	140	39	52	149	24	37	642
	%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

χ^2 = 177.771, P <0.001, Cramer's V = 0.263
Each subscript letter denotes a subset of Plots B categories whose column proportions do not differ significantly from each other at the .05 level.
Note: Due to the limited sample size in plot Lake, the statistically significant difference between plot Lake and the others was not considered to be truly significant.

Appendix A - 21 Visibility of birds × Plots C Crosstabulation (with pairwise z-test), October

Visibility (Ease of been seen)		Plots C								Total
		Island I	Island II	Island III	Hide and mudflat	Island IV	Floating wetlands	Plank and islandsII	Plank and islandsI	
very difficult	Count	0a, b, c, d, e, f, g, h, i	0f, g, h, i	0d, e, h, i	4a, b, c, d, e, f, g, h, i	1c, e, g, i	2a, b, c, d, e, f, g, h, i	22b	6a, c, d, e, f, g, h, i	35
	%	0.0%	0.0%	0.0%	19.0%	3.2%	15.4%	36.7%	6.8%	12.5%
difficult	Count	0a	0a	1a	1a	0a	0a	1a	1a	4
	%	0.0%	0.0%	2.9%	4.8%	0.0%	0.0%	1.7%	1.1%	1.4%
more challenging	Count	0a, b, c, d, e, f, g	11f, g	2d, e	9c, g	2b, e	7a, c, f, g	17a, b, c, d, e, f, g	21a, b, c, d, e, f, g	69
	%	0.0%	47.8%	5.7%	42.9%	6.5%	53.8%	28.3%	23.9%	24.7%
easy	Count	5a	11a	7a, b	1b	3b	2a, b	4b	15a, b	48
	%	62.5%	47.8%	20.0%	4.8%	9.7%	15.4%	6.7%	17.0%	17.2%
very easy	Count	3a, b, c, d, e, f, g, h	1g, h	25c, d, f	6e, f, h	25b, d	2a, e, g, h	16a, e, g, h	45a, b, c, d, e, f	123
	%	37.5%	4.3%	71.4%	28.6%	80.6%	15.4%	26.7%	51.1%	44.1%
Total	Count	8	23	35	21	31	13	60	88	279
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

χ^2 = 164.172, P <0.001, Cramer's V = 0.234
Each subscript letter denotes a subset of LakeZoneCode1 categories whose column proportions do not differ significantly from each other at the .05 level.
Note: Due to the limited sample size in plot Lake, the statistically significant difference between plot Lake and the others was not considered to be truly significant.

Appendix A - 22 Visibility of birds × Plots C Crosstabulation (with pairwise z-test), January

Visibility (Ease of been seen)		Plots C								Total
		Island I	Island II	Island III	Hide and mudflat	Island IV	Floating wetlands	Plank and islands II	Plank and islands I	
very difficult	Count	0a, b, c, d	1a, b, c, d, e, f	0d	5c, f	0b, d	0a, b, c, d, e, f	16e, f	17a, c, e, f	39
	%	0.0%	7.1%	0.0%	31.3%	0.0%	0.0%	47.1%	26.2%	18.2%
difficult	Count	0a	1a	0a	1a	0a	0a	5a	3a	10
	%	0.0%	7.1%	0.0%	6.3%	0.0%	0.0%	14.7%	4.6%	4.7%
more challenging	Count	3a, b, c	5c	0b	1a, b, c	2a, b, c	2a, c	10a, c	9a, b, c	32
	%	20.0%	35.7%	0.0%	6.3%	5.9%	50.0%	29.4%	13.8%	15.0%
easy	Count	11a	2b	8b	4a, b	2b	1a, b	0b	12b	40
	%	73.3%	14.3%	25.0%	25.0%	5.9%	25.0%	0.0%	18.5%	18.7%
very easy	Count	1a	5a, b	24b, c	5a, b	30c	1a, b, c	3a	24a	93
	%	6.7%	35.7%	75.0%	31.3%	88.2%	25.0%	8.8%	36.9%	43.5%
Total	Count	15	14	32	16	34	4	34	65	214
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

χ^2 = 140.410, P <0.001, Cramer's V = 0.405
Each subscript letter denotes a subset of LakeZoneCode1 categories whose column proportions do not differ significantly from each other at the .05 level.
Note: Due to the limited sample size in plot Lake, the statistically significant difference between plot Lake and the others was not considered to be truly significant.

Appendix A - 23 Average number of species encountered each visit in six days' survey that covering the entire research area

Index		2022-10-19	2022-10-20	2022-10-23	2023-01-13	2023-01-19	2023-01-20
Average number of species encountered each visit (S_d)	S_d_Lake	21	20	20	25	25	29
	S_d_Wetlands Phase 1 and 2	29	38	26	33	29	28
	S_d_Wetlands Phase 1	14	24	19	19	15	18
	S_d_Wetlands Phase 2	29	28	22	29	25	25

Appendix A - 24 Average number of species encountered per 250-meter walk in six days' survey that covering the entire research area

Index		2022-10-19	2022-10-20	2022-10-23	2023-01-13	2023-01-19	2023-01-20
Average number of species encountered per 250-meter walk (S_z)	S_z_Lake	4	4	3	5	4	4
	S_z_Wetlands Phase 1 and 2	4	4	3	4	3	4
	S_z_Wetlands Phase 1	2	4	2	2	2	3
	S_z_Wetlands Phase 2	5	4	3	4	5	4

Appendix A - 25 Cross-tabulation results of demographic information or visiting frequency with photo ranking (wetland types, TDWP)

Ranked as the least preferred (score = 1)							
			marsh	pond	reservoir	χ^2	P
Gender	Male (N=38)	C	18	14	6	9.816	0.020
		%	47.4	36.8	15.8		
	Female (N=35)	C	13	7	15		
		%	37.1	20.0	42.9		
Highest education level	Less-educated (N=23)	C	12	10	1	14.614	0.002
		%	52.2	43.5	4.3		
	Well-educated (N=50)	C	19	11	20		
		%	38.0	22.0	40.0		
Visiting frequency	Less frequently (N=48)	C	17	11	20	16.573	<0.001
		%	35.4	22.9	41.7		
	more frequently (at least once per month) (N=25)	C	14	10	1		
		%	56.0	40.0	4.0		
Ranked as the second preferred (score =2)							
Ranked as the most preferred (score =3)							
			marsh	pond	reservoir	χ^2	P
Gender	Male (N=38)	C	10	11	17	9.699	0.021
		%	26.3	28.9	44.7		
	Female (N=35)	C	6	20	9		
		%	17.1	57.1	25.7		
Highest education level	Less-educated (N=23)	C	3	6	14	14.571	0.002
		%	13.0	26.1	60.9		
	Well-educated (N=50)	C	13	25	12		
		%	26.0	50.0	24.0		

Note:
(1) C: count; %: proportion of that groups of respondents (e.g., proportion of male respondents).
(2) Cells highlighted with light blue indicate that the proportion of that groups of respondents is higher than the proportion of the other group of respondents (highlighted in light green) and that this difference in proportions is statistically significant at the 5% significance level.
(3) The table only displays factors related to the rankings with a confidence level of at least 90%.

Appendix A - 26 Cross-tabulation results of demographic information or visiting frequency with photo ranking (plant diversity, TDWP)

Ranked as the least preferred (score = 1)							
			lake	marsh	Cypress forest	χ^2	P
Season	Winter (N=42)	C	6	22	14	15.245	0.002
		%	14.3	52.4	33.3		
	Summer (N=31)	C	5	6	20		
		%	16.1	19.4	64.5		
Age	18-44 years old (N=57)	C	11	17	29	13.576	0.004
		%	19.3	29.7	50.9		
	≥45 years old (N=16)	C	0	11	5		
		%	0.0	68.8	31.3		
Travel time	< 30 minutes (N=44)	C	3	15	26	13.715	0.003
		%	6.8	34.1	59.1		
	> 30 minutes (N=29)	C	8	13	8		
		%	27.6	44.8	27.6		
Visiting frequency	Less frequently (N=49)	C	10	21	18	10.398	0.015
		%	20.4	42.9	36.7		
	more frequently (at least once per month) (N=24)	C	1	7	16		
		%	4.2	29.2	66.7		
Ranked as the second preferred (score =2)							
			lake	marsh	Cypress forest	χ^2	P
Season	Winter (N=42)	C	15	16	11	11.558	0.009
		%	35.7	38.1	26.2		
	Summer (N=31)	C	4	21	6		
		%	12.9	67.7	19.4		
Age	18-44 years old (N=57)	C	13	33	11	9.126	0.028 a
		%	22.8	57.9	19.3		
	≥45 years old (N=16)	C	6	4	6		
		%	37.5	25.0	37.5		
Cost	0-20 CNY (N=54)	C	12	25	17	10.550	0.014 a
		%	22.2	46.3	31.5		
	>20 CNY (N=18)	C	6	12	0 a		
		%	33.3	66.7	0.0		
Ranked as the most preferred (score =3)							
			lake	marsh	Cypress forest	χ^2	P
Season	Winter (N=42)	C	21	4	17	8.470	0.037 a
		%	50.0	9.5	40.5		
	Summer (N=31)	C	22	4	5		
		%	71.0	12.9	16.1		
Gender	Male (N=39)	C	26	6	7	9.673	0.022 a
		%	66.7	15.4	17.9		
	Female (N=34)	C	17	2	15		
		%	50.0	5.9	44.1		
Cost	0-20 CNY (N=54)	C	35	7	12	8.121	0.044
		%	64.8	13.0	22.2		
	>20 CNY (N=18)	C	8	1	9		
		%	44.4	5.6	50.0		
Travel time	< 30 minutes (N=44)	C	31	5	8	13.641	0.003 a
		%	70.5	11.4	18.2		
	> 30 minutes (N=29)	C	12	3	14		
		%	41.4	10.3	48.3		

Note:
(1) C: count; %: proportion of that groups of respondents (e.g., proportion of male respondents)
(2) Cells highlighted with light blue indicate that the proportion of that groups of respondents is higher than the proportion of the other group of respondents (highlighted in light green) and that this difference in proportions is statistically significant at the 5% significance level.

(3) a. More than 20% of cells in this sub table have expected cell counts less than 5. Chi-square results may be invalid
(4) The table only displays factors related to the rankings with a confidence level of at least 90%.

Appendix A - 27 Cross-tabulation results of demographic information or visiting frequency with photo ranking (HNWP)

			A	B	C	D	E	F	G	H	χ^2	P
Selection of the top 3 photos												
			A	B	C	D	E	F	G	H	χ^2	P
Source	On-site (N=102)	C	79	39	20	12	70	53	18	15	32.756	<0.001
		%	77.5	38.2	19.6	11.8	68.6*	52.0*	17.6	14.7		
	Online (N=96)	C	84	27	21	20	46	33	29	26		
		%	87.5	28.1	21.9	20.8	47.9	34.4	30.2*	27.1*		
Gender	Male (N=82)	C	58	32	17	11	47	36	22	21	18.636	0.017
		%	70.7	39.0	20.7	13.4	57.3	43.9	26.8	25.6		
	Female (N=116)	C	105	34	24	21	69	50	25	20		
		%	90.5*	29.3	20.7	18.1	59.5	43.1	21.6	17.2		
Highest education level	Less-educated (N=64)	C	47	30	12	11	42	31	12	7	22.920	0.003
		%	73.4	46.9*	18.8	17.2	65.6	48.4	18.8	10.9		
	Well-educated (N=134)	C	116	36	29	21	74	55	35	34		
		%	86.6*	26.9	21.6	15.7	55.2	41.0	26.1	25.4*		
Visiting frequency	Less frequently (N=134)	C	117	41	29	21	69	56	36	31	21.566	0.006
		%	87.3	30.6	21.6	15.7	51.5	41.8	26.9	23.1		
	more frequently (at least once per month) (N=64)	C	46	25	12	11	47	30	11	10		
		%	71.9	39.1	18.8	17.2	73.4*	46.9	17.2	15.6		
Ranked as the third preferred (score = 1)												
			A	B	C	D	E	F	G	H	χ^2	P
Source	On-site (N=102)	C	10	18	11	6	23	18	8	8	22.528	0.004
		%	9.8	17.6*	10.8	5.9	22.5	17.6	7.8	7.8		
	Online (N=96)	C	14	4	12	13	13	13	10	18		
		%	14.6	4.2	12.5	13.5	13.5	13.5	10.4	18.8*		
		%	13.6	19.7*	6.1	12.1	18.2	13.6	7.6	10.6		
Highest education level	Less-educated (N=64)	C	6	14	6	6	16	7	4	5	20.050	0.010
		%	9.4	21.9*	9.4	9.4	25.0	10.9	6.3	7.8		
	Well-educated (N=134)	C	18	8	17	13	20	24	14	21		
		%	13.4	6.0	12.7	9.7	14.9	17.9	10.4	15.7		
Visiting frequency	Less frequently (N=134)	C	17	9	15	15	19	24	16	20	20.826	0.008
		%	12.7	6.7	11.2	11.2	14.2	17.9	11.9*	14.9		
	more frequently (at least once per month) (N=64)	C	7	13	8	4	17	7	2	6		
		%	10.9	20.3*	12.5	6.3	26.6*	10.9	3.1	9.4		
Ranked as the second preferred (score =2)												
			A	B	C	D	E	F	G	H	χ^2	P
Gender	Male (N=82)	C	19	4	6	1	14	16	11	10	15.411	0.052
		%	23.5	4.9	7.4	1.2	17.3	19.8	13.6	12.3*		
	Female	C	20	11	10	7	29	25	11	3		

			A	B	C	D	E	F	G	H	χ^2	P
	(N=116)	%	17.2	9.5	8.6	6.0	25.0	21.6	9.5	2.6		
Age	Younger than 45 years old (N=132)	C	30	8	7	8	29	21	17	12	22.952	0.003
		%	22.7	6.1	5.3	6.1	22.0	15.9	12.9	9.1		
	Elder than 45 years old (N=66)	C	9	7	9	0	14	20	5	1		
		%	13.8	10.8	13.8*	0.0	21.5	30.8*	7.7	1.5		
Ranked as the most preferred (score =3)												
			A	B	C	D	E	F	G	H	χ^2	P
Source	On-site (N=102)	C	43	14	1	2	28	11	3	0	19.363	0.013a,b
		%	42.2	13.7	1.0	2.0	27.5*	10.8*	2.9	0.0		
	Online (N=96)	C	56	15	2	2	12	3	4	2		
		%	58.3*	15.6	2.1	2.1	12.5*	3.1*	4.2	2.1		
Gender	Male (N=82)	C	31	18	1	4	15	8	5	0	26.133	<0.001 a,b
		%	37.8	22.0*	1.2	4.9	18.3	9.8	6.1	0.0		
	Female (N=116)	C	68	11	2	0	25	6	2	2		
		%	58.6*	9.5	1.7	0.0	21.6	5.2	1.7	1.7		
Visiting frequency	Less frequently (N=134)	C	75	21	3	0	20	7	6	2	27.618	<0.001 a,b
		%	56.0*	15.7	2.2	0.0	14.9	5.2	4.5	1.5		
	more frequently (at least once per month) (N=64)	C	24	8	0	4	20	7	1	0		
		%	37.5	12.5	0.0	6.3	31.3*	10.9	1.6	0.0		

Notes:
(1) Two on-site respondents quitted before doing the photo ranking task in a hurry to do personal issues.
(2) C: count; %: proportion of that groups of respondents (e.g., proportion of on-site respondents, proportion of male respondents)
(3) Cells highlighted with light blue indicate that the proportion of that groups of respondents is higher than the proportion of the other group of respondents (highlighted in light green) and that this difference in proportions is statistically significant at the 5% significance level.
(4) a. More than 20% of cells in this subtable have expected cell counts less than 5.
(5) b. The minimum expected cell count in this subtable is less than one. Chi-square results may be invalid

Appendix A - 28 Age × Preferred scenery of the flower field Crosstabulation (with pairwise z-test)

Flower field		Age						Total
		18-24	25-34	35-44	45-54	55-64	≥65	
Scenario 1	Count	24 a	31 a	11 a	8 a	6 a	3 a	83
	%	51.10%	49.20%	47.80%	32.00%	35.30%	14.30%	42.30%
Scenario 2	Count	23 a	32 a	12 a	17 a	11 a	18 a	113
	%	48.90%	50.80%	52.20%	68.00%	64.70%	85.70%	57.70%
Total	Count	47	63	23	25	17	21	196
	%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Pearson Chi-Square = 11.175, P=0.048, Cramer's V=0.239								
Scenario 1	Count	55 a		18 a, b		10 b		83
	%	50.0%		39.1%		25.0%		42.30%
Scenario 2	Count	55 a		28 a, b		30 b		113
	%	50.0%		60.9%		75.0%		57.70%
Total	Count	110		46		40		196
	%	100.00%		100.00%		100.00%		100.00%
Pearson Chi-Square = 7.764, P=0.021, Cramer's V=0.199								
Scenario 1	Count	66 a			17 b			83
	%	49.6%			27.0%			42.30%

Scenario 2	Count	67 a	46 b	113
	% within Age	50.4%	73.0%	57.70%
Total	Count	133	63	196
	%	100.00%	100.00%	100.00%
χ^2 = 8.975, P=0.003, Cramer's V=0.214				

Appendix A - 29 Age × Preferred scenery of the trail Crosstabulation (with pairwise z-test)

Flower field		Age						Total
		18-24	25-34	35-44	45-54	55-64	≥65	
Scenario 1	Count	26 a	18 a	7 a	6 a	5 a	4 a	66
	%	55.3%	28.6%	30.4%	25.0%	27.8%	18.2%	33.5%
Scenario 2	Count	21 a	45 a	16 a	18 a	13 a	18 a	131
	%	44.7%	71.4%	69.6%	75.0%	72.2%	81.8%	66.5%
Total	Count	47	63	23	24	18	22	197
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
χ^2e = 11.175, P=0.048, Cramer's V=0.239								
Scenario 1	Count	44 a		12 a		10 a		66
	%	40.0%		26.7%		23.8%		33.5%
Scenario 2	Count	66 a		33 a		32 a		131
	%	60.0%		73.3%		66.5%		66.5%
Total	Count	110		45		42		197
	%	100.00%		100.00%		100.00%		100.0%
Pearson Chi-Square = 4.800, P=0.091, Cramer's V=0.156								
Scenario 1	Count	51 a			15 b			66
	%	38.3%			23.4%			33.5%
Scenario 2	Count	82 a			49 b			131
	%	61.7%			76.6%			66.5%
Total	Count	133			64			197
	%	100.00%			100.00%			100.0%
χ^2 = 4.311, P=0.038, Cramer's V=0.148								

Appendix A - 30 highest education level (reclassified) × Preferred scenery Crosstabulation (with pairwise z-test)

			Highest education level		Total
			Less-educated	Well-educated	
Flower field	Scenario 1	Count	19 a	64 b	83
		% within Age	30.2%	48.1%	42.30%
	Scenario 2	Count	44 a	69 b	113
		% within Age	69.8%	51.9%	57.70%
	Total	Count	63	133	196
		% within Age	100.00%	100.00%	100.00%
	Pearson Chi-Square = 5.649, P=0.017, Cramer's V=0.170				
Trail	Scenario 1	Count	15 a	51 b	66
		% within Age	23.8%	38.1%	33.5%
	Scenario 2	Count	48 a	83 b	131
		% within Age	76.2%	61.9%	66.5%
	Total	Count	63	134	197
		% within Age	100.00%	100.00%	100.0%
	χ^2 = 3.906, P=0.048, Cramer's V=0.141				

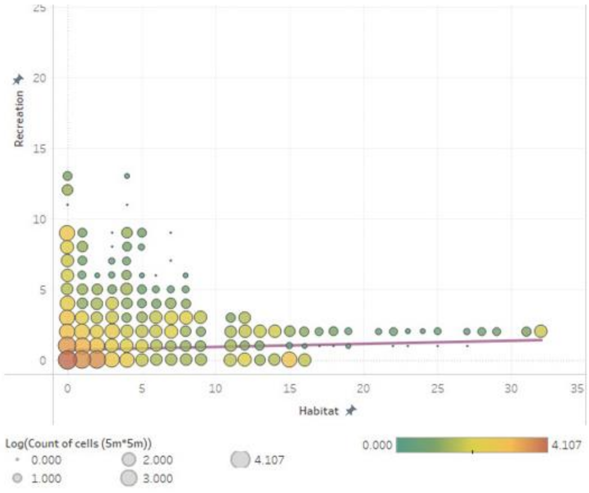
Appendix A - 31 Respondents' descriptions on the photos in the Tianhe Daguan Wetland Park

Panorama (Winter)	Panorama (Summer)	Descriptions (positive)	Descriptions (negative)
 1(a) lake	 1(a) lake	(+) presence of water [12] (+) good-looking plants [5] (+) layering [5] (+) orderly [3] (+) layering (rows of plants) [3] (+) open/spacious [1] (+) flourishing plants [1] (Summer) (+) pavement [1] (+) cool [1]	(-) muddy water [5] (-) ordinary [2] (-) lack of operation [1] (-) unnatural [1] (-) withered plants [1] (summer) (-) could be hot in summer [1]
 1(b) marsh	 1(b) marsh	(+) natural [1] (+) flourishing plants [1] (summer) (+) participatory [1]	(-) withered ground cover and exposed soil [11] (-) messy [5] (-) ordinary [4] (-) open, empty [1] (-) diverse and messy [1] (-) wild but unnatural [1] (-) withered plants [1] (winter)
 1(c) cypress forest	 1(c) cypress forest	(+) pure [1] (+) unique [1] (+) good-looking trees [4] (+) vertical lines [1] (+) intense colour (red) [11] (+) diverse colour [1]	(-) messy [1] (-) ordinary [1] (-) ground cover to hide snakes, insects etc. [1] (-) buildings [5]
 2(a) marsh	 2(a) marsh	(+) diverse colours [5] (+) harmony [3] (+) buildings [1] (+) good-looking trees [1] (+) intense colour [2]	(-) messy [3]
 2(b) pond	 2(b) pond	(+) presence of water [17] (+) presence of hill [3] (+) diverse colour [1] (+) cool [1]	(-) bald ground [2] (-) small body of water [2] (-) not clean [2] (-) narrow space [1] (-) lack of operation [1] (-) withered plants [2] (winter) (-) buildings [1] (-) poles [4]
 2(c) reservoir	 2(c) reservoir	(+) large body of water [12] (+) open/spacious [11] (+) presence of water [3] (+) breeze [2] (+) clean water [2] (+) reflections [2] (+) buildings [4]	(-) ordinary [1] (-) buildings [4]

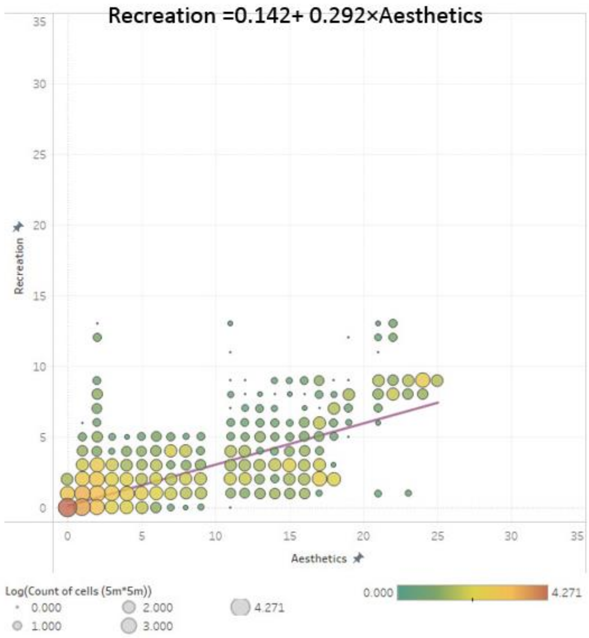
Appendix A - 32 Respondents' descriptions on the photos in the Haizhu Wetland Park

Photos	Descriptions	Photos	Descriptions
 A	(+) diverse [28] (+) clear water [21] (+) layering [11] (+) quite water [2] (+) presence of water [4] (+) shallow water [2] (+) reflections [1] (+) Yijing [2]	 E	(+) open / spacious [24] (+) large body of water [15] (+) clear water [13] (+) reflections [1] (+) quite water [1] (+) presence of water [1] (+) diverse [3] (+) natural [3] (+) fish [1] (+) layering [1] (+) unique [1] (+) Yijing [1]
 B	(+) familiarity [9] (+) rice [7] (+) unique [3] (+) layering [2] (+) golden [2] (autumn) (+) green [2] (+) prospect [2] (+) flower [1] (+) clear water [1] (+) farming culture [1] (-) buildings [1]	 F	(+) diverse [12] (+) quite water [5] (+) presence of water [5] (+) clear water [5] (+) calm [5] (+) natural [2] (+) reflections [1] (+) fish [1] (+) golden [1] (+) Yijing [4]
 C	(+) layering [1] (+) flower [2] (+) green [2] (+) aquatic plants as sign of wetland [1]	 G	(+) birds (incl., ducks) [5] (+) mudflat [2] (+) fish and shrimps [2] (+) sign of operation [2] (+) sign of being in a city [1] (+) dynamic [1] (+) large body of water [1]
 D	(+) quite water [5] (+) diverse [1] (+) calm [1] (+) fruit trees [1] (+) reserved orchards [1]	 H	(+) diverse [1] (+) unique [1] (+) reflections [3] (+) presence of water [1] (+) Yijing [1]
 Trail -1	(+) plant diversity [7] (+) flourishing [4] (+) cool, comfort when walking [4] (+) pavement looks nice [3] (+) flower [2] (+) colour diversity [2] (+) diverse [1] (+) natural [1] (+) layering [1] (+) clear route, not get lost [1] (+) mysterious [1] (-) messy [1] (-) full [1]	 Flower field - 1	(+) natural [1] (+) layering [1] (+) flourishing [1] (+) intense colour and contrasts [2] (+) pavement looks nice [1] (+) presence of water [1]
 Trail -2	(+) Open/spacious [33] (+) presence of water [9] (+) sunlight [5] (+) Unobstructed view [3] (+) Orderly [2] (+) pure [1] (+) layering [1] (+) pavement looks nice [1] (+) cool, comfort when walking [1]	 Flower field -2	(+) bridge looks nice [13] (+) patterned planting [10] (+) large quantity of flowers [9] (+) layering [4] (+) Orderly [4] (+) Open/spacious [2] (+) diverse [2] (+) pure [1] (+) clear route, not get lost [1]

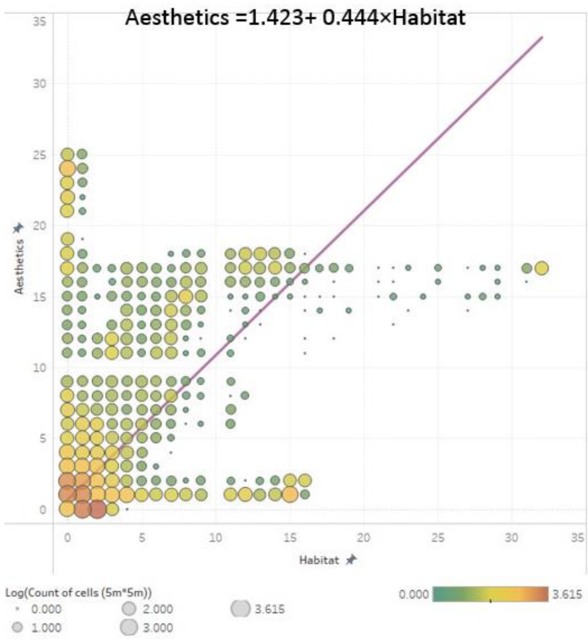
Appendix A - 33 Correlations between ecosystem services: numerical statistics results



(a) Linear regression- habitat and recreation



(b) Linear regression- aesthetics and recreation



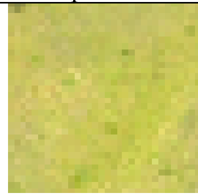
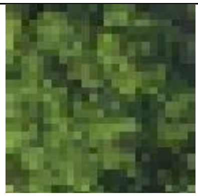
Appendix - B Land use and land cover data preparation for case study sites

(1) Tianhe Daguan Wetland Park

The data source for the LULC data of Tianhe Daguan Wetland Park (TDWP) is drone photography. Because the park is relatively small while the unit area of satellite imagery for sale is usually large (more than 25 km^2), it was not cost effective for purchasing satellite imagery for this WP. DJI Mavic Air 2 drone quadcopter was used to capture photographs with georeferenced data of this WP. The drone flies at low speed and takes photos covering every corner of the WP. The 3D modelling software ContextCapture was used to generate 2D and 3D GIS models. Based on the position and orientation of photos, aerotriangulation was calculated to generate the 3D model (i.e., a 3D mesh). This process is similar to the principle of oblique photography and modelling, but with lower requirements of the camera. The geographic image prepared for TDWP contains three bands (Red, Green, and Blue) in 0.3 metre resolution.

The classification system (Appendix B - 1) with ten classes was developed from that officially used by the United Kingdom and China according to the actual conditions of the site. The remote sensing image processing and analysis software ENVI 5.3 was utilised for the image classification. Unsupervised classification and supervised classification tools provided by the software have been tried, but the accuracy of results using all automatic classifications was lower than 50%. Water and shadows, various type of vegetated areas (e.g., shrub-grassland and marsh), have a high probability of being misclassified. Therefore, a detailed post classification was conducted manually based on visual interpretation. Finally, a class confusion matrix was used to compare the classification results with truth data that collected on site. Data of 30 to 50 regions of interest were input for each class of LULC to validate the classification results. As a result, the overall accuracy of the classification result was 93.03%, with Kappa Coefficient equalled to 0.8849.

Appendix B - 1 Land Use Land Cover classification of Tianhe Daguan Wetland Park

LULC		Examples	Description	LULC		Examples	Description
Woodland	Broadleaved woodland		An area of trees where 80% or more of the tree canopy is of broadleaved species.	grassland	grassland		An area of grassland with tree canopy cover <10%, including seasonal flower field
	Conifer woodland		An area of trees where 80% or more of the tree canopy is of coniferous species.	Water and wetland	water		Areas of still open water e.g., lakes, canals, ponds, mere, water filled gravel pits and reservoirs, and channels of moving water, including rivers and streams.
	Open wooded grassland		An area of grassland with tree canopy cover between 10% and 20%		marsh		Wetlands are areas of land where water-tables are consistently close to the surface for extended periods of time. They are typically located in low-lying regions and often found alongside bodies of open water. The vegetation range is extensive and encompasses reeds, reed grass, sedges, rushes, and often tall herbs. Scattered alder and/or willow may also be observed.
	bamboo		An area of bamboos.	Buildings and structures	Buildings and structures		A substantial and permanent construction for giving shelter, and structures including dams, electric poles.

	shrub		Consisting predominantly of low woody plants and bushes where canopy cover is >50%.		Permanent made surface		Paved surface by the side of the road or a paved space designated for pedestrians. Bridges that carrying a path across water body, wetlands, and other obstacles.

Appendix B - 2 Percentage of each land use land cover type in Tianhe Daguan Wetland Park

LULC	Area (m2)	%	
broadleaved woodland	47975.08	14.23	33.38
conifer woodland	32062.05	9.51	
open-wooded grassland	17059.30	5.06	
bamboo	741.71	0.22	
shrub-grassland	14733.04	4.37	
grassland	25892.38	7.68	7.68
water	139576.13	41.40	46.42
marsh	16924.45	5.02	
building	2461.12	0.73	12.52
made-surface	39782.57	11.80	
Total: 3766354 pixels, 337140.4 m2 Pixel size: 0.30 m			

(2) Haizhu National Wetland Park

Two Worldview-2 images which were granted by DigitalGlobe with an area of 25 km2 chosen by the author, includes the Haizhu National Wetland Park (HNWP) and its surroundings were purchased for the comparison land use and land cover (LULC) change before and after the Quality Improvement Project (QIP). The scenes were acquired on the 14 November 2019 and 24 November 2021. The main sensor specifications are given in Appendix B - 3.

Appendix B - 3 Technical specifications of the WorldView-2 imagery

Sensor specifications：Worldview-2			
Data acquisition	14 November 2019, 03:10:26 UTC		24 November 2021, 03:07:26 UTC
Off-Nadir	12.1°		10.3°
Sun Azimuth	158.9°		158.6°
Sun Elevation	46.3°		43.5°
Cloud Cover	0%		0%
Distribution Level	Ortho-Ready Stand (OR2A)		
Coordinate System	UTM		
Kernel	MTF		
Datum	WGS84		
		Spectral resolution (nm)	Spatial resolution (m)
Panchromatic	Panchromatic	450-800	0.48
8-bands multi colour	Coastal	400-450	2.0
	Blue	450-510	
	Green	510-580	
	Yellow	585-625	
	Red	630-690	
	RedEdge	705-745	
	NIR1	770-895	
	NIR2	860-1040	

Image data was pre-processed using ENVI 5.3. ENVI provides automated pre-processing tools that allows quickly preparation of imageries (e.g., orthorectify imagery, correct imagery for atmospheric distortions, perform pan-sharpening, etc.).

After data pre-processing, the images can be used for LULC mapping. The classification system with 12 classes (Appendix B - 6) was also developed from that officially used by the United Kingdom and China according to the actual conditions of the site. Most LULC classes are the same as that of TDWP, but some LULC types that are unique to this WP was added.

Because the waterway in the high-bed low-ditch orchard system is too narrow to be correctly identified by the supervised classification tool, this study defines the orchards as a single LULC type and calculates the average ditch-bed ratio to determine the area of water and beds in orchards, respectively.

Based on the measurement of 72 beds and ditches respectively on the 2019 satellite image (Appendix B - 4), it was found that the average width of the bed was 10.65 metres (range between 4.2 to 41.54 metres) and the average width of the ditch was 1.26 metres (range between 0.69 to 3.24 metres). The average ditch-bed ratio, namely the water-land was 11.83%. Therefore, the orchard area encompassed 10.58% of the water or wetland area.

Appendix B - 4 Measurement of width of beds and ditches on the 2019 image

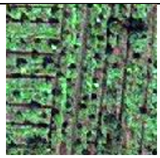
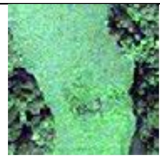
(a) (b)

The images were categorized using ENVI 5.3, a program designed for processing and analysing images acquired by remote sensing. For the automated classification, the supervised object-based classification tool 'example-based feature extraction process' was utilized. It enables users to enter parameters that specify the degree of segmentation and to manually classify certain segmented objects according to their LULC classification. The program then computes and generates a LULC map based on machine learning. In this research, parameters input to the tool include: algorithm = edge, scale level = 40.0, merge setting = full lambda schedule, merge level = 97, texture kernel size = 3. After the automatic classification, some features such as water and shadows, grassland and marsh, woodland and orchards, were found to be misclassified. Therefore, a detailed post classification was conducted manually based on visual interpretation. Finally, a class confusion matrix was used to compare the classification results with truth data that collected on site. Data of 40 to 70 regions of interest were input for each class of LULC to validate the classification results. As a result, the overall accuracy of the classification result of 2019 was 93.54%, with Kappa Coefficient equalled to 0.8665; and the overall accuracy of the classification result of 2021 was 97.30%, with Kappa Coefficient equalled to 0.9612.

Appendix B - 5 Percentage of each land use land cover type in Haizhu National Wetland Park (a)

LULC		2019(m^2)	2019 (%)	2021(m^2)	2021 (%)	Changes (%)	
woodland	woodland	761,483.15	21.22	839,353.95	23.39	↑2.17	↓5.58
	beds in orchards	1113,516.60	31.03	835,406.59	23.28	↓7.75	
grassland	open-wooded grassland	33,732.05	0.94	52,392.34	1.46	↑0.52	↑3.18
	grassland	84,688.98	2.36	161,483.23	4.50	↑2.14	
	field crops	40,191.38	1.12	58,851.67	1.64	↑0.52	
water and wetland	water	951,674.51	26.52	1035,645.79	28.86	↑2.34	↑2.09
	marsh	103,708.12	2.89	114,114.82	3.18	↑0.29	
	inter-tidal sand and mud	24,401.91	0.68	20,095.69	0.56	↓0.12	
	ditch in orchards	131,698.55	3.67	98,684.20	2.75	↓0.92	
	paddy field	2,870.81	0.08	20,813.39	0.58	↑0.50	
made-surface	buildings and structures	54,545.45	1.52	48,086.12	1.34	↓0.18	↑0.53
	made-surface	265,550.20	7.40	291,387.52	8.12	↑0.72	
bare-surface	bare-surface	20,454.54	0.57	12,559.81	0.35	↓0.22	↓0.22
Total: 21347509 pixels, 3,588,516.3 m^2 Pixel size: 0.41 m							

Appendix B - 6 Land Use Land Cover classification of Haizhu National Wetland Park

LULC		Examples	Description	LULC		Examples	Description
Agricultural	Paddy field		Land used for rice cultivation	grassland	grassland		An area of grassland with tree canopy cover <10%, including seasonal flower field
	Field crops		Land under annual tillage including cereals, brassicas, root crops, legumes and other non-horticultural field crops (i.e., linseed, sunflower).	Water and wetland	water		Areas of still open water e.g., lakes, canals, ponds, mere, water filled gravel pits and reservoirs, and channels of moving water, including rivers and streams.
	Orchards		In this context it refers specifically to the High bed - low ditch traditional agricultural system.		marsh		Land with water-tables at or near the surface for prolonged periods of the year, generally low lying and frequently in association with stretches of open water. The range of vegetation is very wide and can include reeds, reed grass, sedges and rushes, often with tall herbs. Some scattered alder and/or willow can also be present.
Woodland	Woodland		An area of trees with tree canopy cover is >20%. Includes mixed woodland, broadleaved woodland, and conifer woodland.		Inter-tidal sand and mud		Unvegetated areas of sand and mud between the mean high and low water marks.
	Open wooded grassland		An area of grassland with tree canopy cover between 10% and 20%	Buildings and structures	Buildings and structures		A substantial and permanent construction for giving shelter, and structures including dams, electric poles.
Bare surface	Bare surface		Areas with no dominant vegetation cover.		Made surface		Paved surface by the side of the carriageway or paved square for use by pedestrians. Bridges that carrying a path across water body, wetlands, and other obstacles.

Appendix – C Questionnaire and interview sheets

Appendix C - 1 Information Sheet, Consent Form and questionnaire for TDWP

尊敬的参与者您好！

我是英国谢菲尔德大学景观学院博士生翟雪竹。我目前在进行一项题为**“天河（大观）湿地公园生态系统服务感知”**的研究，作为我的博士学位课题的一部分。本研究目的是了解公众对湿地公园所发挥作用的感知和看法，为湿地公园的优化、设计提供借鉴。

您作为湿地公园的游客被随机选中。<u>您需要填写问卷并接受采访。调查会占用您大约 5-10 分钟的时间。</u>

参与该项目对您<u>不会造成任何不利后果</u>；<u>如果有您感到不方便回答的问题，您可以跳过该问题。</u>

本次研究<u>问卷全部匿名</u>，收集的信息将<u>严格保密。</u>研究结果会以总体统计数据的方式呈现。

该项目已获得谢菲尔德大学的道德审查批准。

知情同意书

本人确认已阅读并知晓上述信息，并知道我可以就该项目提出任何问题。

我自愿参与该项目，包括填写问卷和参与访谈。我知道在参与过程中我可以随时无理由退出，且不会产生任何不利后果。

我了解<u>我的个人详细信息，如姓名，电话号码和电子邮件地址等，将不会被采集。</u>

我理解并同意我的回答可以在博士论文、出版物、报告、网页、其他研究成果中引用。同时，我允许将我的回答存入［谢菲尔德大学研究数据目录和存储库］，以便用于将来的研究和学习（其他授权研究人员只有在同意保留此表格中所要求的信息的机密性时才能访问这些数据）。

☐ **我认可上述条款，我提供的信息可以由研究人员合法使用**

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如需投诉，请联系：
导师：卡梅隆博士（Dr. Ross Cameron），r.w.cameron@sheffield.ac.uk
院长：乔根森教授（Prof.Anna Jorgensen）a.jorgensen@sheffield.ac.uk
地址：英国 南约克郡 谢菲尔德市 谢菲尔德大学艺术楼 12 楼

本调查中的所有问题均不存在研究人员期望的答案，无需考虑政治正确，研究在乎的是您的真实感受与看法：

1. 您的性别是？（单选题）
☐男 ☐女

2. 您的年龄是？（单选题）
☐未满 18 岁 ☐18-24 岁 ☐25-34 岁 ☐35-44 岁
☐45-54 岁 ☐55-64 岁 ☐65 岁及以上

3. 到目前为止，您的最高学历（包括在读）是？（单选题）
☐初中及以下 ☐高中 / 中专 / 技校 ☐大学专科
☐大学本科 ☐硕士及以上

4. 您一般每次游园多长时间？（对于第一次游园：您计划今天游园多长时间？（单选题）
☐1 小时以内 ☐1-3 小时 ☐3 小时以上

5. 您每月的<u>可支配收入约</u>为？（单选题）
☐0-2999 元 ☐3000-5999 元 ☐6000-8999 元
☐9000-11999 元 ☐12000-14999 元 ☐15000 元及以上
☐不愿透露

6. 您本次游园的花销（如：交通、门票、园内其它消费等）为（人均）？（单选题）
☐0 元 ☐1-20 元 ☐21-50 元
☐51-100 元 ☐101 元以上 ☐不愿透露

7. 您到本园的交通时长（单程）为？（单选题）
☐15 分钟以内 ☐15-30 分钟
☐31-60 分钟 ☐60 分钟以上

8. 您在多大程度上赞同 / 不赞同以下说法：（单选题）

8.1 游览本园时我感到愉悦
☐非常不赞同 ☐不赞同 ☐中立 ☐赞同 ☐非常赞同

8.2 游览本园使我身体更健康
☐非常不赞同 ☐不赞同 ☐中立 ☐赞同 ☐非常赞同

8.3 本园风景优美
☐非常不赞同 ☐不赞同 ☐中立 ☐赞同 ☐非常赞同

8.4 本园游憩（如：散步、坐憩等活动）空间与设施充足
☐非常不赞同 ☐不赞同 ☐中立 ☐赞同 ☐非常赞同

8.5 本园内空气清新
☐非常不赞同 ☐不赞同 ☐中立 ☐赞同 ☐非常赞同

8.6 本园内有丰富多样的动植物
☐非常不赞同 ☐不赞同 ☐中立 ☐赞同 ☐非常赞同

8.7 游览本园，我获得了更多关于自然的知识
☐非常不赞同 ☐不赞同 ☐中立 ☐赞同 ☐非常赞同

9. 您今天在本园进行了 / 将进行哪些活动？（多选题）
☐散步 ☐慢跑 ☐其它运动
☐坐着休息 ☐躺着休息 ☐野餐
☐风景摄影 ☐人物摄影 ☐录制视频、直播
☐观鸟等自然观察 ☐采花草做观赏用途 ☐自然教育活动
☐钓鱼 / 捞鱼 ☐采摘野菜、野果 ☐喂鱼、喂鸟
☐其它______（可口头表述）

10. 与大观北路（本园东侧城市道路）相比，您现在所处位置的空气质量（单选题）
☐差很多 ☐差一些 ☐好一些 ☐好很多
☐两者差不多

11. 假设本园将进行品质提升改造，您是决策者之一，而①优美的风景、②游憩空间与设施、③动植物多样性 三者不可兼得时，您会如何权衡取舍？（>：优先于）（单选题）
☐优美风景 > 游憩空间与设施 > 动植物多样性
☐优美风景 > 动植物多样性 > 游憩空间与设施
☐游憩空间与设施 > 动植物多样性 > 优美风景
☐游憩空间与设施 > 优美风景 > 动植物多样性
☐动植物多样性 > 优美风景 > 游憩空间与设施
☐动植物多样性 > 游憩空间与设施 > 优美风景

问卷部分到此结束，感谢您的认真填写！
接下来是访谈时间

Translation of the Information Sheet for Tianhe Daguan Wetland Park:

Dear Participants:

I am a PhD student from the University of Sheffield named Xuezhu Zhai. I am currently conducting research about 'the perception of ecosystem services of Tianhe Daguan Wetland Park'. This is a part of my PhD thesis. The aim of this research is to understand the perception and views of public on the role played by wetland parks, therefore to provide a reference for the optimisation and design of wetland parks.

You are randomly chosen because you are a visitor of this wetland park. You will be asked to answer a questionnaire, and be interviewed. The survey will take about around 5 to 10 minutes.

There will be no foreseeable disadvantage or risk for taking part in. If there are items you do not feel comfortable answering, please skip them.

All the information that we collect about you during the research will be <u>kept strictly confidential</u>. Your responses will be <u>anonymous</u> and will never be linked to your personality. All the results will be presented in the form of overall statistics.

This project has been ethically approved via the University of Sheffield's Ethics Review Procedure, as administered by the Landscape Department.

Translation of the Information Sheet for Consent Form:

Consent Form

I have read and understood the above information, and I understand that I can ask any questions about the project.

I agree to take part in the project voluntarily. I understand that taking part in the project will include completing a questionnaire, and be interviewed. I understand that I can withdraw from the study during the survey; I do not have to give any reasons for why I no longer want to take part, and there will be no adverse consequences if I choose to withdraw.

I understand my personal details such as name, phone number, address and email address etc. will not be collected.

I understand and agree that my words may be quoted in PhD thesis, publications, reports, web pages, and other research outputs. I know that I will not be named in these outputs. I give permission for data that I provide to be deposited in [The University of Sheffield Research Data Catalogue and Repository], so it can be used for future research and learning. I understand and agree that other authorised researchers will have access to this data only if they agree to preserve the confidentiality of the information as requested in this form.

◯ *So that the information I provide can be used legally by the researchers.*

PhD student: Xuezhu Zhai [xzhai4@sheffield.ac.uk]

If you wish to raise a complaint, please contact:

Supervisor: Dr. Ross Cameron [r.w.cameron@sheffield.ac.uk]

Head of Department: Anna Jorgensen [a.jorgensen@sheffield.ac.uk]

Address: Floor 12, Arts Tower, University of Sheffield, North Yorkshire, UK

Translation of the questionnaire for the Tianhe Daguan Wetland Park:

1. What is your gender? (Single Choice)

◯ *male* ◯ *female*

2.What is your age? (Single Choice)

◯ *<18* ◯ *18-24* ◯*25-34* ◯*35-44* ◯*45-54* ◯*55-64* ◯ *⩾65*

3.What is your highest education level you are currently taking or have completed??(Single Choice)

◯ *middle school and below* ◯ *high school/specialized school* ◯*specialized college* ◯*university/bachelor's degree* ◯*master's degree and above*

4.What is the range of your monthly disposable income??(Single Choice)

◯ *0-2999 CYN* ◯ *3000-5999 CYN* ◯ *6000-8999 CYN* ◯ *9000-11999 CNY*

◯ *12000-14999 CYN* ◯*15000 CYN and above* ◯ *prefer not to say*

5.How long do you usually spend in this WP? (For the first time: How long do you plan to spend in this WP?)

◯ *<1 hour* ◯ *1-3 hours* ◯ *>3 hours*

6.How much did/will you pay for this visit (e.g., travelling fees, drinks/food on-site)?

◯ *0 CYN* ◯ *1-20 CYN* ◯ *21-50 CYN* ◯ *51-100 CNY* ◯*101 CYN and above* ◯ *prefer not to say*

7.How long did you spend travelling here? (one-way)

◯ *<15 minutes* ◯ *15-30 minutes* ◯ *31-60 minutes* ◯*>60 minutes*

8.To what extent do you agree/disagree the following statement?

8.1 I feel pleasant when I visit this WP.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

8.2 Visiting this WP makes me healthier.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

8.3 The scenery of this WP is beautiful.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

8.4 There are sufficient recreational space and facilities in this WP.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

8.5 The air is clean in this WP.

◯ extremely disagree ◯ disagree ◯ somehow disagree

◯ neutral ◯ somehow agree ◯ agree ◯ extremely agree

8.6 There are abundant and diverse animal and plants in this WP.

◯ extremely disagree ◯ disagree ◯ somehow disagree

◯ neutral ◯ somehow agree ◯ agree ◯ extremely agree

8.7 I learn more about nature/environment when visiting this WP.

◯ extremely disagree ◯ disagree ◯ somehow disagree

◯ neutral ◯ somehow agree ◯ agree ◯ extremely agree

9.What activities did/will you participate in during your visit here? (Multiple choices)

◯ take a walk ◯ jogging ◯ other exercise ◯ take a seat

◯ lie down and rest ◯ have a picnic ◯ landscape photography

◯ figure photography ◯ make video or internet broadcast

◯ bird watching or other natural observations ◯ pick flowers and grasses for ornamental purpose

◯ environmental education activities ◯ fishing ◯ pick wild vegetables and fruits

◯ feed fish and birds ◯ others ____________

10.Compared with Daguan North Road, the air quality of where you currently stand/sit is

◯ much worse ◯ worse ◯ better ◯ much better ◯ similar

11. Assuming that there will be a quality improvement of this wetland park, and you were one of the decision makings for the quality improvement project. All three of these features—beautiful landscape, sufficient recreational opportunities, and diverse and rich wildlife—cannot be enhanced at the same time. Is there one of these three that you think ought to be prioritized above the others? What about the least crucial of the three? To indicate importance, please rank them.

◯ aesthetics > recreation space and facilities > biodiversity

◯ aesthetics > biodiversity > recreation space and facilities

◯ recreation space and facilities > biodiversity > aesthetics

◯ recreation space and facilities > aesthetics > biodiversity

◯ biodiversity > aesthetics > recreation space and facilities

◯ biodiversity > recreation space and facilities > aesthetics

Appendix C - 2 Information Sheet, Consent Form and questionnaire (part 1) for HDWP

尊敬的参与者您好！

我是英国谢菲尔德大学景观学院博士生翟雪竹。我目前在进行一项题为“**海珠国家湿地公园生态系统服务感知**”的研究，作为我的博士学位课题的一部分。本研究目的是了解公众对湿地公园所发挥作用的感知和看法，为湿地公园的优化、设计提供借鉴。

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参与该项目对您不会造成任何不利后果；如果有您感到不方便回答的问题，您可以跳过该问题。

本次研究问卷全部匿名，收集的信息将严格保密。研究结果会以总体统计数据的方式呈现。

该项目已获得谢菲尔德大学的道德审查批准。

该调查已获得海珠湿地管理办公室批准。

知情同意书

本人确认已阅读并知晓上述信息，并知道我可以就该项目提出任何问题。

我自愿参与该项目，包括填写问卷和参与访谈。我知道在参与过程中我可以随时无理由退出，且不会产生任何不利后果。

我了解我的个人详细信息，如姓名，电话号码和电子邮件地址等，将不会被采集。

我理解并同意我的回答可以在博士论文、出版物、报告、网页、其他研究成果中引用。同时，我允许将我的回答存入［谢菲尔德大学研究数据目录和存储库］，以便用于将来的研究和学习（其他授权研究人员只有在同意保留此表格中所要求的信息的机密性时才能访问这些数据）。

☐ **我认可上述条款，我提供的信息可以由研究人员合法使用**

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如需投诉，请联系：
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院长：乔根森教授（Prof.Anna Jorgensen）a.jorgensen@sheffield.ac.uk
地址：英国 南约克郡 谢菲尔德市 谢菲尔德大学艺术楼 12 楼

本调查中的所有问题均不存在研究人员期望的答案，无需考虑政治正确，研究在乎的是您的真实感受与看法：

1. 您的性别是？（单选题）

☐男 ☐女

2. 您的年龄是？（单选题）

☐未满 18 岁 ☐18-24 岁 ☐25-34 岁 ☐35-44 岁
☐45-54 岁 ☐55-64 岁 ☐65 岁及以上

3. 到目前为止，您的最高学历（包括在读）是？（单选题）

☐初中及以下 ☐高中 / 中专 / 技校 ☐大学专科
☐大学本科 ☐硕士及以上

4. 您每月的可支配收入约为？（单选题）

☐0-2999 元 ☐3000-5999 元 ☐6000-8999 元
☐9000-11999 元 ☐12000-14999 元 ☐15000 元及以上
☐不愿透露

5. 您一般每次游园多长时间？（对于第一次游园：您计划今天游园多长时间？（单选题）

☐1 小时以内 ☐1-3 小时 ☐3-5 小时 ☐5 小时以上

6. 今天您去过哪些区域？（多选题）

☐海珠湖（免费区） ☐海珠湿地 1、2 期（收费区） ☐海珠湿地 3 期（目前仅对研学和团队开放的区域）

7. 您以前还去过哪些区域？（多选题）

☐海珠湖 ☐海珠湿地 1、2 期 ☐海珠湿地 3 期

8. 您本次游园的花销（如：交通、门票、园内其它消费等）为（人均）？（单选题）

☐0 元 ☐1-20 元 ☐21-50 元 ☐51-100 元
☐101-200 元 ☐201 元及以上 ☐不愿透露

9. 您到本园的交通时长（单程）为？（单选题）

☐15 分钟以内 ☐15-30 分钟 ☐31-60 分钟 ☐60 分钟以上

10. 您在多大程度上赞同 / 不赞同以下说法：（单选题）

10.1 游览本园时我感到愉悦

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

10.2 游览本园使我身体更健康

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

10.3 本园风景优美

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

10.4 本园游憩（如：散步、坐憩等活动）空间与设施充足

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

10.5 本园内空气清新

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

10.6 本园内有丰富多样的动植物

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

10.7 游览本园，我获得了更多关于自然的知识

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

11. 您今天在本园进行了 / 将进行哪些活动？（多选题）

☐散步 ☐慢跑 ☐其它运动
☐坐着休息 ☐躺着休息 ☐野餐
☐风景摄影 ☐人物摄影 ☐录制视频、直播
☐观鸟等自然观察 ☐采花草做观赏用途 ☐自然教育活动
☐钓鱼 / 捞鱼 ☐采摘野菜、野果 ☐喂鱼、喂鸟
☐其它______（可口头表述）

12. 与新滘中路（大塘地铁站所在城市道路）相比，您现在所处位置的空气质量（单选题）

☐差很多 ☐差一些 ☐好一些 ☐好很多
☐两者差不多

13. 您在多大程度上赞同 / 不赞同以下说法：（单选题）

13.1 园内关于动、植物知识的标识牌数量足够

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

13.2 园内关于动、植物知识的标识牌内容通俗易懂

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

13.3 本园内植物种类丰富多样

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

13.4 本园内鱼、虾、蟹种类丰富多样

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

13.5 本园内鸟类种类丰富多样

☐非常不赞同 ☐不赞同 ☐部分不赞同 ☐中立 ☐部分赞同 ☐赞同 ☐非常赞同

Translation of the Information Sheet for Haizhu National Wetland Park:

Dear Participants:

I am a PhD student from the University of Sheffield named Xuezhu Zhai. I am currently conducting research about 'the perception of ecosystem services of Haizhu National Wetland Park'. This is a part of my PhD thesis. The aim of this research is to understand the perception and views of public on the role played by wetland parks, therefore to provide a reference for the optimisation and design of wetland parks.

You are randomly chosen because you are a visitor of this wetland park. Your will be asked to answer a questionnaire, and be interviewed. The survey will take about around 10 to 15 minutes.

There will be no foreseeable disadvantage or risk for taking part in. If there are items you do not feel comfortable answering, please skip them.

All the information that we collect about you during the research will be kept strictly confidential. Your responses will be anonymous and will never be linked to your personality. All the results will be presented in the form of overall statistics.

This project has been ethically approved via the University of Sheffield's Ethics Review Procedure, as administered by the Landscape Department.

This project has been approved by the administrator of Haizhu National Wetland Park.

Translation of the Consent Form for Haizhu National Wetland Park:

It is the same as it for Tianhe Daguan Wetland Park.

Translation of the questionnaire (Part 1) for Haizhu National Wetland Park:

Question 1-4 were the same to those for Tianhe Daguan Wetland Park.

5.How long do you usually spend in this WP? (For the first time: How long do you plan to spend in this WP?)

◯ *<1 hour* ◯ *1-3 hours* ◯ *3-5 hours* ◯*>5 hours*

6.Which of the following parts of this WP have you been visited today? (Multiple choices)

◯ *Haizhu Lake* ◯ *Haizhu Wetlands Phase 1* ◯ *Haizhu Wetlands Phase 2* ◯ *Haizhu Wetlands Phase 3*

7.Which of the following parts of this WP have you been visited before today? (Multiple choices)

◯ *Haizhu Lake* ◯ *Haizhu Wetlands Phase 1* ◯ *Haizhu Wetlands Phase 2* ◯ *Haizhu Wetlands Phase 3*

8.How much did/will you pay for this visit (e.g., travelling fees, drinks/food on-site)?

◯ *0 CYN* ◯ *1-20 CYN* ◯ *21-50 CYN* ◯ *51-100 CNY*

◯ *101-200 CYN*◯*201 CYN and above* ◯ *prefer not to say*

Question 9-11 were the same to those for Tianhe Daguan Wetland Park.

12.Compared with Xinjiaozhong Road, the air quality of where you currently stand/sit is

◯ *much worse* ◯ *worse* ◯ *better* ◯ *much better* ◯ *similar*

13.To what extent do you agree/disagree the following statement?

13.1 The number of signage boards with information about animal and plant in this WP is sufficient.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

13.2 The contents of the signage boards with information about animals and plants in this WP is easy to understand.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

13.3 There are rich and diverse plants in this WP.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

13.4 There are rich and diverse fish, shrimp and crabs in this WP.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

13.5 There are rich and diverse birds in this WP.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

Appendix C - 3 The choice experiment question (with Choice Set 1) for Haizhu National Wetland Park

以下场景描述了假设的海珠湿地公园（包括海珠湖、海珠湿地 1、2 期）的风景、游憩服务、生物多样性和您的支付意愿的不同组合方式。
风景：假设全园均为您偏爱的风景（与 14 题中您的选择同等质量）或均为您不那么喜欢的风景（与 14 题中您未选的同等质量）。
游憩服务、生物多样性：假设在现状基础上增强、降低或维持现状。
支付意愿：您愿意为每次游园花费的费用（人均），包括往返交通费用、门票、园内消费、对园区的捐款等（用于本园的日常维护管理及品质提升）。
共 16 个场景（8 组选择题），该题旨在探索使您及其他参与者游园受益最大化的组合方式，题目相似但对每个变量的赋值不同，请仔细阅读并选择您偏好的场景。

	情境 A	情境 B
风景	您不那么喜欢的 ♥♥♥	您更偏爱的 ♥♥♥♥♥
游憩	同现状 	同现状 
生物多样性	生物多样性增加 20% 	生物多样性减少 20% 
支付意愿	0 元	75 元
您的选择	☐	☐

☐ 既不选 A 也不选 B

CE1

Appendix C - 4 Choice sets 2, 3, and 4

游憩	增加 20% 座椅等休憩设施或 增加 20% 活动类型 	减少 20% 座椅等休憩设施或 减少 20% 活动类型 
生物 多样性	生物多样性减少 20% 	同现状 
支付意愿	150 元	0 元
您的选择	☐	☐
	☐ 既不选 A 也不选 B	

CE2

游憩	增加 20% 座椅等休憩设施或 增加 20% 活动类型 	减少 20% 座椅等休憩设施或 减少 20% 活动类型 
生物 多样性	同现状 	同现状 
支付意愿	0 元	75 元
您的选择	☐	☐
	☐ 既不选 A 也不选 B	

CE3

游憩	增加 20% 座椅等休憩设施或 增加 20% 活动类型 	减少 20% 座椅等休憩设施或 减少 20% 活动类型 
生物 多样性	生物多样性减少 20% 	同现状 
支付意愿	18 元	37 元
您的选择	☐	☐
	☐ 既不选 A 也不选 B	

CE4

Appendix C - 5 Choice sets 5,6, and 7

游憩	减少 20% 座椅等休憩设施或 减少 20% 活动类型 	同现状 
生物 多样性	生物多样性增加 20% 	生物多样性减少 20% 
支付意愿	18 元	37 元
您的选择	☐	☐
	☐ 既不选 A 也不选 B	

CE5

游憩	同现状 	同现状 
生物 多样性	生物多样性增加 20% 	生物多样性减少 20% 
支付意愿	18 元	37 元
您的选择	☐	☐
	☐ 既不选 A 也不选 B	

CE6

游憩	减少 20% 座椅等休憩设施或 减少 20% 活动类型 	同现状 
生物 多样性	生物多样性增加 20% 	生物多样性减少 20% 
支付意愿	150 元	0 元
您的选择	☐	☐
	☐ 既不选 A 也不选 B	

CE7

Appendix C - 6 Choice Sets 8

游憩	增加 20% 座椅等休憩设施或 增加 20% 活动类型 	减少 20% 座椅等休憩设施或 减少 20% 活动类型 
生物 多样性	同现状 	同现状 
支付意愿	18 元	37 元
您的选择	☐	☐
	☐ 既不选 A 也不选 B	

CE8

Translation of the questionnaire (Part 2, choice experiment) for Haizhu National Wetland Park:

The following scenarios illustrate the different combinations of scenery, recreation service, biodiversity, and your willingness to pay in this wetland park (including Haizhu Lake and Wetlands Phase 1 and 2).

Assume that the scenery in this wetland park is of the same quality as the photographs you prefer (the ones you picked in the previous stage) or as the pictures you prefer less (the pictures you did not selected in the last step).

Assuming that recreation services and biodiversity will remain the same, they will either be enhanced or reduced.

Willingness to pay: This is the maximum amount per person that you are willing to spend on a visit, including transportation costs, admission fees, on-site purchases, and contributions towards the operation, maintenance, and quality improvement of the wetland park.

There are 16 scenarios among 8 sets of options. This set of questions is intended to elucidate the most advantageous combinations for you and other participants. Although the selection sets appear identical, the characteristics are distinct. Please read carefully and choose the scenario you prefer.

Appendix C - 7 Questionnaire (part 3) for Haizhu National Wetland Park

15. 您在多大程度上赞同 / 不赞同以下说法：（单选题）

15.1 本园内景观多样

☐ 非常不赞同 ☐ 不赞同 ☐ 部分不赞同 ☐ 中立 ☐ 部分赞同 ☐ 赞同 ☐ 非常赞同

15.2 本园内景观较为特别（与广州其它公园、湿地公园相比）

☐ 非常不赞同 ☐ 不赞同 ☐ 部分不赞同 ☐ 中立 ☐ 部分赞同 ☐ 赞同 ☐ 非常赞同

15.3 本园内景观层次丰富

☐ 非常不赞同 ☐ 不赞同 ☐ 部分不赞同 ☐ 中立 ☐ 部分赞同 ☐ 赞同 ☐ 非常赞同

15.4 本园内植物精致、好看

☐ 非常不赞同 ☐ 不赞同 ☐ 部分不赞同 ☐ 中立 ☐ 部分赞同 ☐ 赞同 ☐ 非常赞同

15.5 本园内植物长势茂盛、生机勃勃

☐ 非常不赞同 ☐ 不赞同 ☐ 部分不赞同 ☐ 中立 ☐ 部分赞同 ☐ 赞同 ☐ 非常赞同

15.6 本园内水体干净清澈

☐ 非常不赞同 ☐ 不赞同 ☐ 部分不赞同 ☐ 中立 ☐ 部分赞同 ☐ 赞同 ☐ 非常赞同

Translation of the questionnaire (Part 3) for Haizhu National Wetland Park:

15.To what extent do you agree/disagree the following statement?

15.1 Landscapes is diverse in this wetland park.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

15.2 Landscape is unique in this wetland park (compared to other parks/wetland parks in Guangzhou)

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

15.3 This wetland park has layering landscape.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

15.4 The plants in this wetland park are exquisite and beautiful

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

15.5 The plants in this wetland park are growing vigorously and vigorously

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

15.6 The water in this wetland park is clean and clear.

◯ *extremely disagree* ◯ *disagree* ◯ *somehow disagree*

◯ *neutral* ◯ *somehow agree* ◯ *agree* ◯ *extremely agree*

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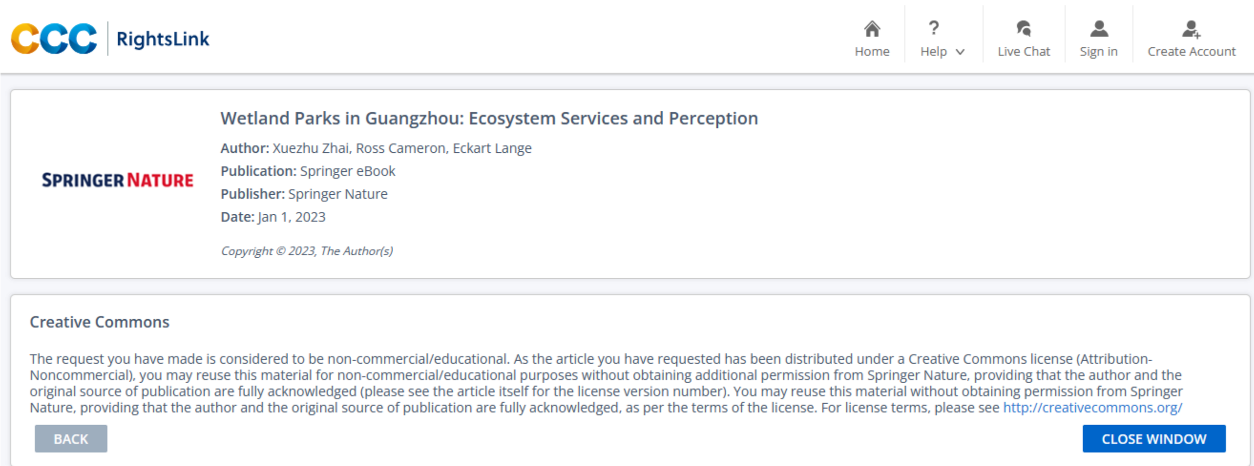
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SPRINGER NATURE

Wetland Parks in Guangzhou: Ecosystem Services and Perception

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