

Master of Science HES-SO in Life Sciences Av. de Provence 6 CH-1007 Lausanne



Master of Science HES-SO in Life Sciences

Orientation : Natural Resource Management

Public perception of the biodiversity and other Nature's Contributions to People offered by urban ponds in Geneva, Switzerland

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"Perto de muita água, tudo é feliz." (Guimarães Rosa)

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Abbreviations

ES	Ecosystem service
NBS	Nature-based solutions
NCP	Nature's contributions to people

Abstract

Within the current and future scenario of climate change, of biodiversity decline and of urban densification worldwide, there are several concerns with regards to the conservation and enhancement of urban biodiversity, the management of freshwater resources, and the improvement of people's quality of life. Proposing new solutions to address these social challenges is essential, such as bringing nature (e.g., blue and green infrastructure) into the city. Ponds and pondscapes (networks of ponds) can potentially play a crucial role in conserving and promoting biodiversity and other types of ecosystem services that are needed in the urban environment (e.g., regulation of water quantity and quality, leisure, aesthetic enjoyment). Therefore, it is important to understand people's perceptions of the contribution that these ponds/pondscapes make in their daily lives. This will help to accept, to conserve, to design, to manage and to improve urban ponds for the benefit of more people to enhance their quality of life. The aim of this study is to know the value that the public perceives in the multiple Nature's Contributions to People (NCPs) provided by urban ponds, and especially regarding biodiversity.

To achieve this goal, a questionnaire was designed to be carried out face-to-face among visitors, in 3 urban parks hosting a pond in the city of Geneva (Switzerland). For highlighting the specificities of the contributions of urban pondscapes, we conducted the same inquiry also in two rural pondscapes hosting natural ponds. This investigation constitutes for Switzerland the first systematic and statistically sampled study to assess public perception of ecosystem services provided by urban ponds. The main results of this research are synthesized and presented in a manuscript that was submitted in February 2023 to the journal *Urban Ecosystems*. The results pointed out that people highly value the different contributions provided by urban ponds and that contact with nature is the main motivating factor for visiting an urban pondscape. It evidenced the public acceptance of these ponds, due to their positive impact on the quality of life. Additionally, the biodiversity of urban ponds was highly appreciated. However, there was an indication of a gap of knowledge with regards to biodiversity conservation, as public did not make a difference between native species and exotic species. It was also found that gender and income do not influence public perception of the contributions provided by urban pondscape. Nevertheless, women evaluated the overall contributions provided by urban ponds cape. Nevertheless, women evaluated the overall adapted and accepted in cities, and they should be in the future part of the greening (and bluewing) in cities planning to conserve and enhance freshwater biodiversity while also provided NCPs.

Key Words: Urban ponds and pondscapes, constructed wetlands, public perception, urban biodiversity, nature's contribution to people, ecosystem services, urbanisation, questionnaire, face-to-face interview

1. Introduction

Within the current and future scenario of climate change, of biodiversity decline and of urban densification worldwide, there are several concerns with regards to the conservation and enhancement of urban biodiversity, the management of freshwater resources, and the improvement of people's quality of life (McKinney, 2006; FOEN, 2012; Juffe-Bignoli et al., 2016). Proposing new solutions to address these social challenges is essential, such as bringing nature (e.g., blue and green infrastructure) into the city. Ponds and pondscapes (networks of ponds) can potentially play a crucial role in conserving and promoting biodiversity and other types of ecosystem services that are needed in the urban environment (e.g., regulation of water quantity and quality, leisure, aesthetic enjoyment) (Oertli and Parris, 2019; Cuenca-Cambronero et al., 2023; Oertli et al., 2023 under review). Therefore, it is important to understand people's perception of the contribution that these ponds/pondscapes make to their daily lives. This will help to accept, to conserve, to design, to manage and to improve urban ponds for the benefit of more people to enhance their quality of life. The aim of this study is to investigate the value that the public perceives in the multiple Nature's Contributions to People (NCPs) provided by urban ponds, and especially regarding biodiversity.

Based on these very relevant challenges, this Master's project aims to answer the following research questions:

- What value does the public perceive of the biodiversity and other NCPs provided by urban ponds?
- Is there a difference in public perception of the ecosystem services provided by urban pondscapes, compared to more natural pondscapes (rural pondscapes)?
- Does gender or income have any influence on the perception of NCPs provided by urban ponds?

To answer these questions, a questionnaire was designed to be carried out face-to-face among visitors, in 3 urban parks hosting a pond in the city of Geneva (Switzerland). For highlighting the specificities of the contributions of urban pondscapes, we conducted the same inquiry also in two rural pondscapes hosting natural ponds. This investigation constitutes for Switzerland the first systematic and statistically sampled study to assess public perception of ecosystem services provided by urban ponds.

This master thesis is organized in 3 sections: (1) A state of the arts reviewing the literature on (i) development of urbanisation, biodiversity conservation, nature in cities, and social perception of nature in cities, (ii) methodologies used for the assessment by population of nature in cities, (2) The main results of this research, synthesized and presented in a manuscript that was submitted on the 27th of February 2023 to the journal *Urban Ecosystems*, (3) a general discussion and a conclusion. Finally, several appendixes present the details of the results synthetized in the manuscript.

2. State of the Art

2.1. Development of urbanisation

Currently, more than half the world's population lives in cities, and it is expected that by 2050 two thirds will live in urban areas (UN DESA, 2019). Furthermore, according to the United Nations (2019), Switzerland's population is projected to be less than 20% in rural areas by 2050. Among the main problems and challenges caused by rapid urbanisation are increasing use of freshwater resources and their pollution, social inequality, infectious diseases and environmental degradation (Zhang, 2016; Alirol et al., 2011; Best, 2019; Strokal et al., 2021). A detailed discussion on this topic can be found in the works by Ancillotto et al. (2016), Birch and Wachter (2011), and Goldstone (2010).

2.2. Biodiversity conservation

2.2.1. Global biodiversity

In recent decades, increasing urbanisation and climate change have led to changes in ecosystem dynamics, a decline in biodiversity and a threat to human well-being (Wilby and Perry, 2006). Pollution and destruction of ecosystems, such as the loss of over 85% of wetland areas, has resulted in about a million species of plants and animals being threatened with extinction. The Living Planet Index (LPI) also revealed a massive 84% decline in global populations of wild freshwater species between 1970 and 2016, due mainly to habitat loss and degradation (Brondizio et al., 2019; Almond et al., 2020). In Switzerland, due to high landscape fragmentation, persistently isolated populations with low genetic diversity will have their ability to adapt to new climate change limited and will be doomed to extinction (Vittoz et al., 2013). As a result, the biodiversity that is essential to human life on this planet is decreasing at an alarming rate, prompting a dismal outlook for the Earth. It is extremely important to optimally manage ecosystems for both human productivity and biodiversity (Pimentel et al., 1992). In 2012, Switzerland proposed the Swiss Biodiversity Strategy (FOEN, 2012) with 10 different objectives (see Appendix I), but just like the rest of the planet, the decline in biodiversity continues. Concrete strategies on biodiversity conservation are needed, and biodiversity must play a key role in political and social decisions to change current and future scenarios (Heller and Zavaleta, 2009; Miller, 2005).

2.2.2. Urban biodiversity

The decline in biodiversity results in a significant drop in ecosystem services and human well-being, having a direct impact on issues such as the supply of food and materials, access to water, the increase in diseases and epidemics, vulnerability to natural disasters, among others (Díaz et al., 2006; Schmeller et al., 2020). The urban environment has an important role to play in conserving and supporting the biodiversity that the planet urgently needs. Cities can support biodiversity conservation and ensure the survival of endangered species by increasing and raising awareness of green and blue spaces, restoring native species of flora and fauna, and creating biodiversity-friendly habitats within urban space (Beninde et al., 2015; Shaffer, 2018).

The study by Theodorou et al. (2020), evidenced that well-managed cities can contribute to the increase bees and thus to their pollination services. Therefore, urban habitats such as gardens, parks, water catchment areas, and open spaces can provide opportunities for wildlife and human contact with nature (Adams, 1994). It is important to highlight that urban water bodies and their landscape not only provide recreational services to the population, but can also prevent flooding by stormwater runoff, provide vast habitats for biodiversity including beneficial insect pollinators, provision of water and food, the regulation of climate, air quality, and water quantity and quality (Elmqvist et al., 2013).

With rapid and increasing expansion of global urbanisation, citizens' lack of contact with urban nature may have implications for the future development of conservation ethics and human-environment relations (Kinzig et al.,

2005). A very impressive example for better addressing the issue of nature in the urban environment is the canton of Geneva in Switzerland, which pioneered the adoption of a law on biodiversity in 2012. In 2018, the Geneva Biodiversity Strategy 2030 (see Appendix II) was drawn up with the aim of sustainable development with the conservation of local biodiversity, thus ensuring the quality of life of the population through ecosystem services (DETA-DGAN and CCDB, 2018). Two years later, its action plan (see Appendix III), consisting of 117 concrete measures which help to achieve the objectives of the strategy was adopted by the Council of State (DT, 2020). Through such a strategy and action plan, it is possible to maintain and promote urban biodiversity to make cities more liveable, sustainable, and resilient.

2.2.3. Pond biodiversity

Creating small and diversified wetlands as ponds is within the Geneva biodiversity action plan mentioned above to strengthen the blue corridors and their biodiversity. All ponds, natural or man-made, provide habitats for wildlife having a high biodiversity conservation value (Biggs et al., 1994). According to Downing et al. (2006), the number of these precious habitats in the world is estimated to reach about 300 million. Ponds contribute significantly to biodiversity, especially for regional biodiversity (Biggs et al., 2005). Indeed, when compared to other types of water bodies (such as streams and lakes), ponds have the highest regional species richness of wetland plants and macroinvertebrates, as well as the highest value of rare species compared to other habitats (Davies et al., 2008). The abundance of some groups of species in the ponds are highly associated with other species, as is the case of the aforementioned groups of macroinvertebrates and macrophytes. The latter contributes to the colonisation and diversification of the former by providing them food, protection against predators, substrate with more stability to lay their eggs, as well as other benefits (Bella et al., 2005; Hassall et al., 2011).

Ponds are important habitats for native fish species and especially for the conservation of those which are threatened (Copp et al., 2007). In the study of the Cerrado pond biodiversity in Brazil (De Marco et al., 2014), it was found that the richness of fish species (also Odonata) is correlated positively with the pond size. It is worth saying that developing management strategies for invasive species is very important to avoid negative impact on local biodiversity (Oertli and Parris, 2019). Indeed, exotic species may negatively interfere with the ecosystem and put pressure to the normal development of some native species (Brönmark and Hansson, 2002).

Besides the species groups supported by the ponds mentioned above, avifauna and their diversity are highlighted in the studies by Deguchi et al. (2020), Kantrud and Stewart (1984), and Sebastián-González et al. (2010). Birds are also used to assess the quality of wetlands and their landscapes (Mistry et al., 2008), as these places can provide them a regular diversity of food sources (such as macroinvertebrates, fish, seeds and small fruits), refuge in wintering, protection from predators, breeding sites and safety nesting habitats. A study carried out by Broyer and Curtet (2012) in French fishpond systems showed that the abundance of macrophytes is directly associated with the richness of bird species during their breeding period. All these studies show that the ponds, either natural or artificial, are fundamental to the existence of the various diverse waterbird communities.

Other studies have highlighted mammal biodiversity in areas with ponds (Harper et al., 2019; Ushio et al., 2017). Ponds are important for the survival of certain semi-aquatic (such as European beaver, European otter, and European water vole) and terrestrial mammals (such as Red deer, Eurasian lynx, and European badger) by providing sites for drinking water, bathing, foraging, and breeding (Klymus et al., 2017).

Therefore, ecosystem restoration in cities is possible and highly recommended through conservation and creation of urban ponds, promoting a network of blue ecological corridors to connect and diversify communities of species (Elmqvist et al., 2015). Due to all high concentrations of relevant and diverse species (biodiversity indicators), ponds are nowadays recognized as very important biodiversity 'hotspots' (Hassall, 2014). Thus, ponds, regardless of their size and type, should be treated as strategic priority components for the conservation, enhancement, and management of biodiversity in different environments (Oertli et al., 2002; Hill et al., 2018).

2.3. Nature in cities

2.3.1. Green areas

Urban green areas are open spaces with the presence of vegetation in cities and their presence promotes several benefits (WHO, 2017a). These areas have social, health, economic, and environmental relevance (Aldous, 2006; Faivre et al., 2017).

The increase of green spaces in the city has the advantage of providing spaces for social integration, recreational, cultural, educational, physical and wellness activities, as well as aesthetic improvement and an increase in biodiversity in the landscape. These interactions are essential for the physical and mental health of citizens and also enable social inclusion and community bonding (Berg et al., 1998; Ulrich et al., 1991).

According to the World Health Organisation (2017b), depression affects around 300 million people worldwide and it is one of the leading causes of disability and suicide. Many studies have found positive relationships of exposing people to urban green spaces and the psychological and health benefits obtained by them (Fuller et al., 2007; MacKerron and Mourato, 2013; Tzoulas et al., 2007; Ulrich, 1984). Thus, nature in cities has a direct impact on quality of life by reducing illness and increasing wellbeing and life expectancy (De Vries et al., 2003; Gascon et al., 2016).

Natural areas are of great importance for sustainable development. People are increasingly looking for green spaces to live in because of the quality of life they offer. Nature in cities is therefore becoming a factor of economic value, tourism potential and attractiveness (Choumert and Salanié, 2008; Terkenli et al., 2020). As discussed above, green spaces can contribute to disease recovery and prevention by having a positive impact on the public health system, as well as the improvement of citizens' performance and well-being at work (Gilchrist et al., 2015; Largo-Wight et al., 2011). In addition to this, the services provided by nature in the city can not only reduce vulnerability to risks, but also represent less costly solutions from an economic and energy point of view, reducing the pressure on natural resources (Jaeger, 2018).

The reduction of energy consumption, pollution, urban heat, and the development of local agriculture contribute to restructuring and balancing ecosystems, along with increasing biodiversity in the city. Sustainable strategies of increasing urban green areas can reduce the warming trend and the intensity of the urban heat island effect (Jay et al., 2021). Furthermore, urban ecosystems can serve as models to better understand and reduce the effects of future environmental changes in non-urban areas by integrating measures to mitigate future urban expansion (Dearborn and Kark, 2010).

For an increasingly urbanised society and a busy urban environment, promoting urban green spaces is a way to minimise the effects of strong urban pressure on the environment, as well as contribute to the conservation of biodiversity and increase the quality of life of citizens (Raymond et al., 2017).

2.3.2. Blue areas

2.3.2.1. Introduction

Cities need to integrate, maintain and improve green and blue areas, as these can offer a range of benefits for the population, biodiversity, and sustainable development (Oertli and Parris, 2019; López et al., 2021). Sustainable development has social, economic, and environmental dimensions, which are directly connected to the limits and management of water resources. In the World Development Report by Connor (2015), it was recognized that "water is at the centre of sustainable development".

Wetlands are extremely important ecosystems, bringing with them their high biodiversity and economic value. With intensifying urbanisation and the increasing effects of climate change, these valuable wetlands face challenges while also being the solution for climate mitigation and water management (Finlayson and D'Cruz, 2005; Russi et al., 2013; Oertli and Parris, 2019). There is a reduction in freshwater availability, with water pollution expected to get worse in the coming decades (Sala et al., 2000; IFPRI and Veolia, 2015; UN, 2021). Human beings need this valuable resource for surviving, producing food and materials, sewage treatment, recreational purposes and maintaining a healthy environment (Darwall et al., 2018; Boretti and Rosa, 2019).

There are different types of urban water bodies, such as rivers, lakes, lagoons, streams, and ponds. According to their characteristics and dimensions, they have important effects on urban ecosystems and the local temperature (Steele and Heffernan, 2014). Among their most important roles are supporting environmental connectivity and biodiversity (Serrao-Neumann et al., 2017), providing ecological services such as water and air purification, and cooling the urban climate, making cities more liveable (Sun and Chen, 2012). Although urban blue areas are not treated separately from green areas in many studies, these spaces are beneficial for human health and well-being, establishing an important contact between people and nature (Völker and Kistemann, 2011).

Therefore, it is necessary to manage urban freshwater, taking into account not only social, aesthetic and recreational benefits, but also ecological and biodiversity improvements (Cottet et al., 2013; B Oertli, 2018).

2.3.2.2. Urban Ponds and wetlands

Ponds and wetlands are small and complex ecosystems that are extremely important urban environments for biodiversity and its maintenance, creating habitats and shelter for a considerable number of threatened species. Moreover, they prevent flooding, contribute to carbon storage, microclimate, water purification, and provide opportunities for recreation, learning, and inspiration for people (Hassall, 2014; Oertli and Parris, 2019). Therefore, accelerated degradation and loss of wetlands due to human pressures can compromise the quality of human life and the survival of many species (Finlayson et al., 2005a; Reid et al., 2005).

Biodiversity has a deep connection with water; hence, ponds and wetlands help to conserve and enhance the diversity of species (Verones et al., 2013). In order to be able to maintain and increase ponds' biodiversity, it is important to create them with a variety of sizes and types of vegetation (Blicharska et al., 2016). Some studies have highlighted the importance of promoting dragonfly diversity through urban ponds (Goertzen and Suhling, 2013; Simaika et al., 2016).

With the temperatures expected to rise due to climate change and its impact on flood risk and urban quality of life, the number of artificial urban ponds is expected to increase to provide greater adaptability and development in cities (Oertli and Parris, 2019).

Therefore, urban ponds and wetlands need to be recognized as valuable because they can restore ecological functions, promote biodiversity, contribute to people's well-being, and make the city a more habitable place (Finlayson et al., 2005b; Nordh et al., 2011; Alikhani et al., 2021; Hill et al., 2021).

2.3.2.3. Urban Ponds in Switzerland

Switzerland, a small country known for its lakes and its wonderful landscapes, contains 6% of Europe's freshwater reserves (SFDFA, 2021a). Among these, there are around 32,000 ponds, which make an important contribution to the conservation of local, regional and national biodiversity (Oertli et al., 2005). Unfortunately, this number is certainly much smaller than it used to be. According to Imboden (1976), since the beginning of 19th century, about 90% of the wetlands in Switzerland, including the ponds, have been lost. The ponds are highly threatened environments that harbour large biodiversity, including groups of species in the Swiss endangered species list (Oertli et al., 2002).

The Swiss population is mostly urbanised with almost 75% living in urban areas (SFDFA, 2021b). Swiss ponds with their different designs are often found in urban lowland environments and serve as flood prevention to these areas

(Oertli, 2018). These precious small bodies of water have characteristics that set them apart from natural ponds, which include their size, artificial structures, exotic species, water quality, and more (Oertli and Parris, 2019).

A study conducted between 2011 and 2013 (Oertli and Ilg, 2014), collected data on biodiversity from 102 water bodies (ponds and pools) in the urban gradient area of the canton of Geneve, Switzerland. The results showed that urban ponds have a medium diversity of flora and fauna, containing a high floristic richness with 18 species unique to these urban water bodies. Among these 18 unique species, 7 were endangered, 4 vulnerable, while 2 species were critically endangered on the Swiss Red List. Overall, there were few rare or endangered species. This study also highlights the great potential of urban ponds to host and enhance urban biodiversity through appropriate management, and presents a management guide divided into three topics (design, maintenance and social aspects) with measures and recommendations that can promote biodiversity in urban ponds. Therefore, a proper management is needed to conserve existing ponds and promote the creation of new ones, adapted both for social and economic ecosystem contributions and for biological and ecological contributions(Biggs et al., 1994; Oertli and Parris, 2019).

The Swiss urban ponds, perhaps not as majestic as the lakes and its landscapes, with their various functions and contributions for their citizens, are indispensable for the conservation of biodiversity and ecosystem health (Oertli et al., 2000).

2.3.2.4. Potential Ecosystem services delivered by Swiss urban ponds

Swiss urban ponds represent a Nature-based solutions (NBS), defined as solutions based on nature conservation standards that provide environmental, social and economic benefits (Dumitru and Wendling, 2021, Cuenca-Cambronero et al., 2023; Oertli et al., 2023 under review). These provide a diversity of ecosystem services, also recently known as Nature's Contributions to People (NCP), separated into three broad groups: regulatory, material, and non-material, which will be described below (Díaz et al., 2018) (see Figure 1).



Figure 1. The 10 NCPs that are potentially provided by Swiss urban ponds. The colours indicate each group of contributions. Source: Icons taken from Canva.com.

Regulating contributions

Habitat creation and biodiversity: A pond is a remarkable, vital ecosystem and an ideal environment to
create diverse habitats for numerous freshwater species such as aquatic plants, benthic invertebrates,
amphibians, fish, and mammal species. This environment can provide places of shelter, nesting, breeding,
refuge, connection and conservation for many regional and threatened species associated with these potential
biodiversity hotspots (EPCN, 2008; Hassall, 2014; Oertli and Ilg, 2014; Oertli and Parris, 2019).

- **Pollination:** Despite the few studies on the potential of ponds, especially urban ponds, for pollination and seed dispersal, they are favourable habitats for beneficial insects, such as wild bees and syrphid flies. This is due to the surrounding vegetation and the water supply in the pond landscape. The aquatic environment is essential for some insect groups that have their larval stage in the water, such as some hoverfly genera (EPCN, 2007; Stewart et al., 2017).
- **Climate:** Ponds can influence the microclimate by cooling or warming the surrounding air through the process of evapotranspiration in urban areas (Jacobs et al., 2020; Oertli et al., 2023 under review). Moreover, ponds have the potential to sequester high levels of greenhouse gas which contribute to climate regulation. Carbon capture and storage is achieved through wetland vegetation (Downing, 2010; Rosset and Oertli, 2011). However, ponds are also potential sources of greenhouse gases, such as methane (Holgerson and Raymond, 2016).
- Air quality: Ponds can purify the air by filtering and/or absorbing contaminants through vegetation and soils (Moore and Hunt, 2012).
- Water quantity: A pond, being a water reservoir, can contain a certain level of stormwater and serve to reduce the amount of water delivered downstream (Oertli and Parris, 2019; Satriani et al., 2021; Oertli et al., 2023 under review).
- Water quality: Ponds can be important in purifying water against pollutants, such as pesticides, by retaining them through algae, plants and other organisms present in the environment (Steidl et al., 2008; Oertli and Parris, 2019; Manzo et al., 2020).
- Hazards and extreme events: Since there is a reduction of the infiltration rate in urban areas, ponds act to prevent flooding during heavy rainfall events. This capacity to store water and mitigate hazards is often the main purpose of its construction (Ghermandi et al., 2010; Ardeshir et al., 2013; Manzo et al., 2020)

Material contributions

• Water and food: In Switzerland, the water in urban ponds is not suitable for human consumption, and its secondary production, such as fish and vegetation, is also not consumed or harvested. The water is also not used for livestock watering.

Nonmaterial contributions

- **Physical and psychological experiences:** The surroundings of the urban ponds are designed to welcome the public, thus providing a great environment in which people can exercise and relax (Finlayson et al., 2005); Reid et al., 2005; Pedersen et al., 2019).
- Learning and inspiration: The ponds and their landscape have a great diversity of species, and people can learn and be inspired by contact with nature. This space can also be used and studied for educational programmes (Moore and Hunt, 2012; Ngiam et al., 2017).

All 3 contributions

• **Maintenance of contributions:** Pondscapes have the ability to maintain the above contributions, provided by their biodiversity and design, in order to support a good quality of life.

2.4. Survey of people perception of nature in cities

2.4.1. Nature in urban areas

Several studies provide valuable results on the interaction of urban nature and population (Nordh et al., 2011; Paul and Nagendra, 2017). For instance, nature in cities, in its various types such as parks, urban forests, and stream corridors, is linked to physical and psychological experiences, aesthetics, recreation and leisure, human well-being and health, according to the interviewees (Matsuoka and Kaplan, 2008). The perception of the population is important for the creation of spaces that directly influence their quality of life, behaviour, and well-being.

2.4.2. Blue network

During the last half century, river and stream corridors are being considered as important components of nature areas within cities that provide a great range of ecological and cultural values (Kaplan, 1977; Cook, 1991; Alikhani et al., 2021). In the review by Matsuoka and Kaplan (2008), 5 studies evaluate people's perception of urban stream corridors in Japan, the United Kingdom and the USA, where the value of the aesthetic preference over contact with nature, followed by recreation and leisure, stands out. Within that same review, only 3 of these studies included needs based on human interaction and only citizen participation was evidenced. Neither social interaction and privacy nor sense of community identity were mentioned.

It is important to integrate vegetation together with urban streams in order to create a more suitable environment for people. Recreational use, participation, nature and landscape, sanitary maintenance, and water safety were among the perception factors identified (Asakawa et al., 2004). It is necessary to consider different groups of people when creating different programmes to facilitate the implementation strategies in urban blue network spaces.

2.4.3. Urban ponds and wetlands

In the recent study by Pedersen et al. (2019) the authors found that the importance of highlighting the cultural values offered by wetlands, which are high near residential areas, is an incentive for the creation of wetlands in cities. Other studies have shown that urban ponds are highly valued for their biodiversity and ecological services, as well as for their cultural services (Cottet et al., 2013; Dobbie, 2013; Oertli and Parris, 2019). A study by Ngiam et al. (2017) developed in London highlighted the socio-ecological relationship between humans, ponds and dragonflies. Although people appreciate dragonflies, they are not able to relate their diversity to the wildness of urban ponds. Citizen participation is an extremely important tool to be used in the management of urban ponds (Jones, 1999). This is evidenced in the study by Meilland (2018), where a survey in 3 public parks in Geneva was conducted. It highlighted the benefits of ponds for visitors' well-being, biodiversity and aesthetics, and encouraged the creation of new, more natural looking ponds in the city.

Gaps in research urban ponds were found for Switzerland in relation to proposing strategic ecological intervention measures with habitat creation and biodiversity enhancement; educational intervention (such as signposting, workshops, and games) to prevent area degradation and to improve ecological knowledge, familiarity, and appreciation of nature; and comparing perspectives on the ecosystem values given to different types of Swiss ponds, such as rural and urban.

2.5. Survey methods (technical aspects)

2.5.1. Global survey methods

The purpose of a social survey is not simply to provide information but also a way to study the social conditions, relationships and behaviours of specific people or groups (Moser and Kalton, 2017). In the field of social sciences

there are several methodological theories for the study of environmental perception. These can be used for evaluations, and their choice will depend on the evaluation questions, context, target group, financial and human resources available, among others. Here follows a non-exhaustive list of some evaluation methods from a descriptive approach to a participatory approach in increasing complexity: document analysis, questionnaire research, semi-directive interviews with interview guide, participant observation, focus groups, facilitated workshops, and collaborative field projects (Javeau, 1988; Morgan, 1996; Huntington, 1998; Huntington et al., 2002; Singly, 2012; Fenneteau, 2015). There are different strategies in the social research process. These strategies are quantitative research, allowing for testing of theory with a natural science model orientation, and qualitative research, allowing for generation of theory with an interpretative orientation (Bryman, 2016). The combination of these two strategies has been widely used to bring the natural sciences and social sciences closer together (Drury et al., 2011; Mohajan, 2018).

2.5.2. Questionnaire methodology to assess urban nature perception by people

Within social science research, the questionnaire is an important and popular tool to acquire useful information about public knowledge and its perceptions of urban nature (Bulmer, 2004). Questionnaires can be administered via an interviewer (personal, telephone, or online interview) or self-administered (postal or web-based). The different methods and application modes will depend on the information sought, the characteristics of the target audience, and the time and budget available (Fenneteau, 2015).

In Table 1 it is possible to identify some studies correlated with urban nature perception by people.

2.5.3. Questionnaire methodology to assess ponds and wetlands perception by people

Several studies show that water is an aspect of the environment that is highly valued by people, bringing psychological benefits (Finlayson et al., 2005b; Völker and Kistemann, 2011). As water is an attractive element, its relationship with its surroundings is important and preferable, i.e. the whole of the water and its landscape (Kaplan and Kaplan, 1989). In Table 2 below, it is possible to identify 15 important studies conducted in wetlands and ponds, where questionnaires were used as the main tool for data collection. In these studies, the following application methodologies were identified: 67% face-to-face interview (10), followed by 13% postal questionnaire (2), 7% telephone interview (1), and 13% with hybrid approaches (2) (one involving face-to-face interview and web-based questionnaire, and another involving face-to-face and telephone interviews together with postal questionnaire). Based on these works and their advantages and disadvantages presented in Table 3, the face-to-face method of questionnaire application is the best alternative due to its efficiency and wide applicability in scientific research. It may also be combined with the postal questionnaire with QR code and web-based method for a more effective and modern data collection, with respect to other survey modalities.

Table 1. Selected questionnaire surveys related to urban nature.

Topic of	Number of	Quest	ionnaire	Location	Pacaarahara	
research	interviewees	Method	Mode	LUCATION	Researchers	
Abandanad	60	self- administered	Postal	Canada	Hands and Brown (2002)	
land or disused	12	via an interviewer	Personal interview	Canada	De Sousa (2003)	
	200	via an interviewer	Personal interview	Greece	Damigos and Kaliampakos (2003)	
Blue and green spaces	113	via an interviewer	Personal interview	Germany	Voelker and Kistemann (2015)	
	15	via an interviewer	Personal interview	EUA	Austin (2004)	
	1200	self- administered	Postal	Denmark	Nielsen and Hansen (2007)	
	467	self- administered	Postal	Netherlands	Chiesura (2004)	
Green urban	154	self- administered	Web-based	Norway	Nordh et al. (2011)	
spaces	179	self- administered	Postal	Canada	Balram and Dragicevic (2005)	
	800	via an interviewer	Personal interview	Italy and the UK	Lafortezza et al. (2009)	
	83	via an interviewer	Personal interview	France	Marion (2014)	
	123	via an interviewer	Personal interviews	India	Paul and Nagendra (2017)	
Landscape view	27	via an interviewer	Personal interviews	Canada	Zacharias (1999)	
Nature observation	133	via an interviewer	Personal interview	EUA	Rodiek and Fried (2005)	

 Table 2. Surveys by questionnaire related to urban ponds and wetlands.

Legend: Face-to-face interview, C: Telephone interview, C: Postal questionnaire, and : Webbased questionnaire.

		Qu	estionnair	e		Location	
Topic of research	Research Question / Objective	Period	Nº of intervie wees	Method	Problems found / suggestions	and Research ers	
Ponds – their role as Nature-based solutions (NBS)	How can ponds help society to tackle climate change, while providing ecosystem services and deaccelerating biodiversity decline?	December 2021 – November 2022	unpubli shed	<u> </u>		8 countries, PONDER FUL (unpublis hed)	
Wetland – Attractivenes s and aesthetics	Understanding the public aesthetic preferences for wetlands in (sub)urban landscapes to ensure sustainable wetland management.	No reported	241	*	Preference for wetlands may vary by category, but the origin of these preferences was not properly understood.	Australia, Dobbie (2013)	
preferences of the public	People's perception of wetlands and how this perception correlates to wetland recovery and restoration.	July to September 1998	158	(83) (19) (19) (56)		United States, Nassauer (2004)	
	Usage of urban blue spaces and influencing factors.	October to November 2019	203	• <u>•</u>	Conclusions do not apply to all users and barriers to usage were not identified.	Scotland, Smith et al. (2022)	
Wetland – public perception and its management of	To highlighting local people's perspectives on water in urban parks using public intercept interviews.	Summer 2015	113		-Interoperability between PC and Mac devices. -Make careful selection of research staff. -Use of new technologies (iPad).	United States, Flint et al. (2016)	
recreational spaces	To know the representation and perception of users and public actors of recreational lagoons sites (accessibility, distance from home, management, types of users).	May to July 2014	127	. B	-Difficulty of collecting samples (flow of people and high number of refusals). -Overrepresentation of a certain type of public (housewives and pensioners).	France, Audouit et al. (2015)	
Wetland – residents' well-being	Can wetlands have a positive contribution to local residents' well- being and how is it compared to other types of green areas in the urban context?	Not reported	473 (40% respons e rate)	لی	Test same approach in larger urban areas and in zones with warmer climate.	Sweden, Pedersen et al. (2019)	

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Wetland – residents' well-being	Health factors brought by urban water canals to local residents based on their experiences.	Early 2018	200	5	The suggested framework might be used in future research on the health benefits brought by green and blue spaces to local residents.	Iran, Vaeztava koli et al. (2018)
	Identification of cultural ecosystem services by local residents and tourists in connection to ecological restoration.	July to September 2015	232			Spain, Pueyo- Ros et al. (2019)
Wetland restoration - cultural ecosystem services and public acceptance	Analyse the importance of wetland ecosystem services for different user groups by exploring the socio-cultural dimension of wetland restoration.	April and May 2014	102	.	The linkages between different ecosystem services in connection to people and nature interaction deserve further research.	Bulgaria, Scholte et al. (2016)
	To understand the residents' perceptions of restored urban stream corridors.	May 2001	415 (61% respons e rate)	∩≌		Japan, Asakawa et al. (2004)
Urban lakes, ponds, and watersheds – water quality	How different knowledge and methods of assessing urban lake quality can shed light on the management of urban lakes and ponds to strengthen ecological conservation, diverse social uses and amenities in the urban context.	June to September 2013	159	• <u>•</u> •		France, Mitroi et al. (2022)
and public perceptions	Explore the degree to which perceptions of water quality are spatially correlated across two watersheds.	Not reported	1017 (25.4% respons e rate)	Â	Further research on the relationship between social networks, environment perception and corresponding actions.	United States, Brody et al. (2005)
Urban pond –	Asses the public interest in urban ponds at parks	July and August 2018	92			Switzerla nd Meilland (2018)
public interest and biodiversity assessment	Ponds and dragonflies' appreciation, as well as environmental factors determining dragonfly diversity in urban green spaces.	June and July 2015	360		Qualitative questions should be included in future research as well as a more diverse public from different regions and cultures.	United Kingdom, Ngiam et al. (2017)

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Table 3. Advantages and disadvantages of the four different survey methods (Bonnel, 2003; Granello and Wheaton, 2004).

Survey method	Advantages	Disadvantages			
⊔ Postal questionnaire	 ✓ Self-administered ✓ Lower cost ✓ No interviewer influence 	 No monitoring Lower response rates or lower quality Respondents do not always follow the instructions Difficulty in obtaining address database No collection of spontaneous responses 			
Telephone interview	 ✓ Lower cost ✓ Better supervision and monitoring of interviewers ✓ Better distribution of interviewers over the survey zone ✓ More rapid data availability as a result of direct data entry systems 	 Need an interviewer Availability of interviewees Difficulty in obtaining telephone database No visual information Interview time constraints 			
Face-to-face interview	 Quality of the responses Better supervision and monitoring of interviewees Better distribution of interviewees over the survey zone More rapid data availability as a result of direct data entry systems 	 Need an interviewer High cost Availability of interviewees Interview time constraints Interviewer may influence 			
 Web-based questionnaire	 Self-administered Lower cost Speed and efficacy of data collection No interviewer influences Reduced response time Flexibility and control over format Up to date technology tools In line with current technology trends 	 No monitoring No collection of spontaneous responses Representativeness of the sample Technical issues 			

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3.1. Introduction

A questionnaire was used to evaluate the population's perception of the ecosystem values offered by Swiss urban ponds and to answer the research questions of this project (see section 1). Regarding data collection, extensive research was conducted to compare the available methodologies, their use in the literature, and their advantages and disadvantages (see section 2.5). The face-to-face interview method was chosen with a questionnaire containing 14 questions that were formulated to be answered in less than 10 minutes. The questionnaire was administered by author of this thesis (Fernanda Vasco) from Thursday to Sunday between 9am and 6pm on days with good weather conditions during the summer 2022, from 22 June to 28 August in the urban pondscape (Parc des Franchises, Jardin de la Paix, and Parc Bertrand) and the rural pondscape (Moulin-de-Vert and Bois des Mouilles) located in Geneva, Switzerland (see Appendix IV). Their geographic location is presented in Figure 2, and the ponds' pictures are presented in Figure 3.



Figure 2. Canton of Geneva (black region in the upper left map of Switzerland) and the location of the three public urban parks in the urban pondscape and the two nature reserves in the rural pondscape where social surveys were conducted.

A total of 331 interviews (288 from the urban pondscape and 43 from the rural pondscape) were carried out. The data used in this research study is presented in Appendix V.

The main results of this thesis are synthesized in a paper that is presented thereafter (section 3.2). This is the first systematic and statistically sampled paper assessing the public perception of ecosystem services provided by urban ponds in Switzerland. The manuscript was submitted on the 27th of February 2023 to the journal *Urban Ecosystems*.



Figure 3. Ponds' pictures of each location where social survey were conducted in Geneva (Switzerland). Ponds a, b, and c are located in public urban parks (urban pondscape), and ponds d and e are located in nature reserves (rural pondscape).

3.2. Submitted Scientific Paper

The manuscript was submitted on the 27th of February 2023 to the journal *Urban Ecosystems*. The current status (on March 17th 2023) is "peer review".

Urban pondscape connecting People with Nature and Biodiversity in a medium-sized European city (Geneva, Switzerland)

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Abstract

The current progressive increase in urbanisation is a contributing factor to the alarming rate of decrease in biodiversity worldwide, so it is critical that new solutions that bring nature, and their associated benefits, back to cities. Ponds and pondscapes are potential Nature-based Solutions that play a crucial role in the conservation and promotion of biodiversity, as well as providing other ecosystem services. Therefore, it is important to understand people's perception of the contribution that urban ponds/pondscapes make in their daily lives. This will help conserve and improve urban ponds for the benefit of more people, with the support of the local community. The aim of this study was to assess public perception of the value of the multiple ecosystem services provided by urban ponds, with a focus on biodiversity. To achieve this aim, we conducted a face-to-face questionnaire survey among 331 visitors of urban parks and nature reserves in a medium-sized European city (Geneva, Switzerland). The results show that people highly value the different contributions provided by urban ponds, and that contact with nature is the main motivation for visiting urban pondscapes. The evidence suggests that public acceptance of these ponds is due to their positive impact on quality of life. Additionally, the biodiversity of urban ponds was highly appreciated, but there was evidence of knowledge gap relating to biodiversity conservation, as both native and exotic species were valued equally. We also found that gender and income does not influence public perception of the contributions provided by urban ponds and ponds appendict acceptance of the contributions provided by urban ponds appendict acception of the contributions provided by urban ponds was highly appreciated, but there was evidence of knowledge gap relating to biodiversity conservation, as both native and exotic species were valued equally. We also found that gender and income does not influence public perception of the contributions provided by urban pondscape.

Keywords: Urbanisation; Urban ponds and pondscapes; Constructed wetlands; Public perception; Aquatic biodiversity; Nature's contribution to people

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3.2.1. Introduction

Currently, more than half the world's population lives in cities, and this number is expected to increase to two-thirds by 2050 (UN DESA, 2018). This global trend coupled with greater densification in cities and thus a greater need to improve the quality of life of their inhabitants. Associated with climate change, the increasing urbanisation has affected ecosystem dynamics, leading to a change in land use, an impact on freshwater availability, and a decline in biodiversity, resulting in a reduction in the human quality of life (McKinney, 2006; Wilby and Perry, 2006). The decline in biodiversity results in a significant decrease in ecosystem services and people's quality of life, has a negative impact on the food and materials supply chain and access to water (Chapin III et al., 2000; Díaz et al., 2006). Additionally, this leads to an increase in diseases and epidemics, vulnerability to natural disasters, among other issues that further jeopardise human life on earth (Schmeller et al., 2020).

Cities can support biodiversity conservation and ensure the survival of endangered species. This can be achieved by increasing and raising awareness of green and blue spaces, restoring native species of flora and fauna, and creating biodiversity-friendly habitats within urban spaces (Botkin and Beveridge, 1997; Beninde et al., 2015; Shaffer, 2018). It is therefore extremely important to manage cities for both human well-being and biodiversity in an optimal way. One of the innovative solutions proposed during the last two decades to bring nature into cities is the creation of ponds and pondscapes (networks of ponds). These small waterbodies have well-known functions of preventing flooding by stormwater runoff and also to bring an esthetical and educational value to urban landscapes (parcs, gardens). They can also potentially have a crucial role in the conservation and promotion of biodiversity and ecosystem services in urban areas (Bastien et al., 2012; Oertli and Parris, 2019).

A pond is an inland freshwater body with a surface area of 1 m2 to 5 hectares and a maximum depth of 8 m. It supports environmental connectivity and biodiversity (Oertli et al., 2005; Persson, 2012). A large proportion of existing ponds are today linked to human activities and are artificial (Oertli, 2018). These types of constructed wetlands, particularly in cities, represent Nature-based Solutions (NBS) (Cuenca-Cambronero et al., 2023; Oertli et al., 2023 under review) as they are "solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience" (Dumitru and Wendling, 2021). Indeed, urban ponds and other artificial ponds, offer collectively a diversity of Nature's Contributions to People (NCPs) or Ecosystem Services (ES), including a habitat for biodiversity (Cuenca-Cambronero et al., 2023). Since the term ES has been mainly used in an economic perspective, the nomenclature NCPs was created to be more inclusive from social sciences perspective (Díaz et al., 2018). For clarification, we will use the term NCPs in this paper.

Biodiversity appears to be well-represented in ponds in cities despite the multiple urban anthropic pressures, such as pollution, lack of connectivity and mismanagement (Hassall, 2014; Oertli and Parris, 2019). Several case-studies have highlighted the importance of promoting diversity in urban ponds, for example for dragonflies (Goertzen and Suhling, 2013; Simaika et al., 2016). They have found that urban ponds enhance people's experience of green space because dragonflies are appreciated for their colour and high visibility. Ngiam et al. (2017) highlighted in London (UK) the socio-ecological relationship between humans, ponds, and dragonflies. Other investigations have shown that vegetation characteristics and abundance can affect public preference for urban wetlands in Victoria (Australia), Minnesota (USA), and Sapporo (Japan) (Asakawa et al. 2004; Nassauer, 2004; Dobbie, 2013).

The interaction of population with urban nature has been extensively described by several studies (Nordh et al., 2011; Paul and Nagendra, 2017). For instance, enquiries made among citizens evidence that nature in cities (e.g., parks, urban forests, stream corridors) is linked to physical and psychological experiences, aesthetics, recreation and leisure, human well-being and health (Matsuoka and Kaplan, 2008). Recreational use, participation, nature and landscape, sanitary maintenance, and water safety were among important factors identified by the public (Asakawa et al., 2004). Urban ponds seem also to benefit of a generally positive view from citizens, related mostly to their aesthetic aspect, as evidenced by several social surveys (Hassall, 2014). Additionally, these ponds contribute to nature-culture interactions, adding local distinctiveness, therefore being involved in people's sense of place and neighbourhoods' identity (Gledhill et al., 2005).

Highlighting the cultural values offered by wetlands, which are high near residential areas, is important to encourage the creation of wetlands in cities (Pedersen et al., 2019). Social participation is an extremely important tool to be used in the management and creation of urban ponds as it helps to accept, conserve, design and improve them for the benefit of more people (Jones 1999; Lamond and Everett, 2019). Such social engagement is also reported in a survey in three public parks in Geneva (Meilland, 2018). It highlighted the benefits of ponds for visitors' well-being, biodiversity and aesthetics, and encouraged the creation of new, more natural-looking ponds in the city.

However, past investigations also show that there is still a need for more information with regards to understanding how people perceive and accept the values of the NCPs offered by the urban pondscape. Specifically, there are open questions remaining: (i) Does the public accept this type of ecosystem (urban pond) and feel an improvement in their quality of life? (ii) Is the perception of urban pond different from more natural ponds (e.g., rural pondscape)? (iii) What are the NCPs expected by the visitors? (iv) Is biodiversity perceived as an important NCP, and what type of biodiversity (e.g., which taxa)? (v) Do socio-demographic factors (gender or income) have any influence on visitors' perception of urban pondscape?

These questions constitute the aim of this study which was carried out in Geneva (Switzerland), a medium-sized European city. We conducted a face-to-face questionnaire survey, among 331 visitors of three urban parks and of two rural natural reserves. Our study is relevant in the context of medium-sized European cities (Kendal et al., 2020).

3.2.2. Material and methods

3.2.2.1. Study sites

The study was conducted in western Switzerland, Canton of Geneva, which include an urban area and a rural area hosting more than 200 ponds (Oertli et al., 2018). The urban area is the city of Geneva, capital of the canton of Geneva, with an area of 16 km2 and a population of over 204,000 inhabitants, it is the second largest and the second most populous city in Switzerland. About 75% of the city is composed of building and transportation areas, and about 19% are wooded and recreational areas (FSO, 2020). Due to the high density of buildings, urban ponds are mostly small in surface area (mean surface area of about 100 m²).

The survey was carried out in three urban parks – Parc des Franchises, Jardin de la Paix, and Parc Bertrand – and in two rural nature reserves – Moulin-de-Vert and Bois des Mouilles – (Fig. I). These urban parks and rural nature reserves were chosen because they have at least one pond, they are well-known to the public and therefore receive significant numbers of visitors.



Fig. I. Canton of Geneva (black region in the upper left map of Switzerland) and the location of the three public urban parks in the urban pondscape (urban environment) and two rural nature reserves in the rural pondscape (peri-urban and rural environments) where social surveys were conducted. The pictures of each location are identified by numbers from 1 to 5 at the bottom of the figure. The urbanisation gradient is represented from urban to rural areas (shown by different colours).

3.2.2.2. Data Collection and Analysis

The data used in this study were collected from face-to-face interviews through a questionnaire survey of visitors of the urban parks and the nature reserves. The surveys were collected during the peak visitor months of June to August 2022 between 09:00 and 18:00 on days with good weather conditions, giving a total of 31 collection days and 331 interviews. The research was conducted by the same person (by the first author of this paper), with visitors randomly chosen in the proximity of ponds. Before starting the interview, the research description, confidentiality and assurance of anonymity were provided verbally.

The questionnaire consisted of 14 easy-to-understand questions (13 closed questions and one optional open question) to be completed within 10 minutes (see Appendix A). The questions were formulated to assess the perception of the population of the ecosystem values offered by Swiss urban ponds. The questionnaire was divided into four sections, addressing questions on: (i) frequency of visits to ponds and motivations of visitors, (ii) contributions provided by ponds (NCPs), (iii) pond features and facilities, and (iv) interviewee profile (sociodemographic). For the questionnaire, we identified a list of 10 NCPs from the 18 NCPs proposed in the IPBES report 2019 (Díaz et al., 2019), that were selected for their relevance in our study. These 10 NCPs were transformed into 12 NCPs to adapt them to the local context and to make them easier to understand by the interviewees (see Table I). The 12 NCPs were listed in question number 6 of the questionnaire (see Appendix A) and set to be measured on 5-point Likert scale. In the analysis of question 6 "I don't know" answers were not considered.

Questions 6, 3, 7 and 8 of the questionnaire (Table II) were analysed to investigate whether the public identifies biodiversity as an important NCP offered by urban ponds. However, for question 8, in the choice of answers, we didn't make a difference between native and exotic species to prevent bias.

Question 6 (Table II) was explored to investigate whether there was a difference in public perception of the NCPs provided by urban and rural pond landscapes (hypothesised to be lower for urban ponds). The rural pondscape (comprises the two nature reserves in the peri-urban and rural environments) with 43 interviewees, while 288 in the urban pondscape (comprises the three parks in the urban environment), was underrepresented and was used for comparison purposes in this study.

Question 5 and 6 (Table II) were used to investigate the public acceptance of urban ponds and whether these ponds provide an improvement in people's quality of life.

Questions number 6, 5 and 7 (Table II) were used to discover whether gender (female and male) or income (low and high) has any influence on the public perception of the NCPs provided by the urban pondscape.

The completed questionnaires were manually entered into a LimeSurvey database (http://www.limesurvey.org) that we developed for this study. The data analysis was carried out with Microsoft Excel (Excel®) for descriptive statistics, and with Minitab statistical software (MINITAB®) for inferential statistics using the one-way analysis of variance (ANOVA) with subsequent Tukey's post-hoc, T and χ 2 tests.

NCPs Category	Reporting categories of selected NCPs (Díaz et al., 2019)	The 12 NCPs investigated in present study			
	Habitat creation and maintenance	Habitat creation and maintenance (Biodiversity)			
	Pollination and dispersal of seeds and other propagules	Diversity of pollinating insects (Pollination)			
	Regulation of air quality	Regulation of air quality (Air quality)			
	Regulation of climate	Regulation of climate: microclimate (Refreshment)			
Regulating	Regulation freshwater quantity, location, and timing	Regulation freshwater quantity (Water quantity)			
	Regulation of freshwater and coastal water quality	 Regulation freshwater quality (Water quality) 			
	Regulation of hazards and extreme	Regulation of hazards: flooding (Flood prevention)			
	events	Regulation of hazards: fires (Fire prevention)			
	Learning and inspiration	• Learning and inspiration (Learning & inspiration)			
Non-material		Aesthetic value (Aesthetic)			
	Physical and psychological experiences	Physical and other psychological experiences (Sport & leisure)			
Regulating, Non- material, and Material	Maintenance of options	Maintenance of options			

Table I.	The NCPs	selected	and	investigated	in	present study	
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 Table II. Questions in the questionnaire directly related to our investigations.

Question							
Number	Intended to assess	Description	Туре				
3	The interviewees' motivation to visit Geneva's urban pondscape	What motivates you to come to this particular place?	Multiple choice				
5	The participation of urban ponds in the interviewees' quality of life	To what extent does this pond and its surroundings contribute to your quality of life?	Five-point Likert scale				
6	The interviewees' perception of the contribution of ponds to each of the 12 NCPs	Which of the following do you think are the most important positive contributions of this pond (and other ponds too)?	Five-point Likert scale				
7	The importance for interviewees of the role of urban ponds in protecting endangered biodiversity in Switzerland	How important do you think this pond is for the protection of endangered animals and plants in Switzerland?	Five-point Likert scale				
8	The characteristics of urban ponds most appreciated by interviewees	What are the 5 elements you appreciate (or would appreciate, if absent) most about the pond at the selected site?	Multiple choice				

3.2.2.3. Profile of interviewees

In total, 331 voluntary visitors were interviewed, 288 in the urban pondscape and 43 in the rural pondscape. The gender of the interviewees was very homogenous with about 50% being female and 50% male. With regards to income, about 21% of the interviewees declared themselves to be low income, 41% medium income, 25% high income, and 13% did not want to say. A table with details on the interviewees profile is presented in the Appendix B.

3.2.3. Results

3.2.3.1. Does the public identify biodiversity as an important NCP offered by urban ponds?

To find out whether the public identifies biodiversity as an important NCP offered by urban ponds, we analysed the responses to questions 6, 3, 8, and 7 of the questionnaire (see Table II) among 288 visitors in three urban public parks.

Among 12 NCPs, interviewees identified biodiversity as the most important NCP offered by urban ponds (Fig. II). The NCP "biodiversity" had the highest mean score (4.39 in a maximum scale of 5), however, there was no significative statistical difference with the five following best scored NCPs: "learning & inspiration", "aesthetic", "maintenance of options", "pollination", and "refreshing" (Tukey's ANOVA test; p>0.05). The NCPs identified with the lowest importance were "fire prevention" and "flood prevention", with mean scores of 3.41 and 3.47, significantly lower than most of the other scores (p<0.05). See Appendix C for the detailed results of the statistical tests.

The main motivation that leads interviewees to visit urban parks is "contact with nature", followed by "leisure", "landscape/aesthetics", and "the local biodiversity of flora and fauna", respectively (Fig. III).

Concerning the role of urban ponds for the conservation and protection of threatened biodiversity in Switzerland, all visitors expressed a certain level of importance (none was 0%), with the importance qualified as high or very high for 79% of the interviewees (Fig. IV).

The 5 features most appreciated in urban ponds by the 288 interviewees are, in decreasing order of importance, "presence of frogs", "presence of ducks and other water birds", "trees and associated shading", "presence of dragonflies", and "presence of fishes" (Fig. V). All these ponds' features are directly linked to biodiversity, with four of them connected to aquatic biodiversity. Among amphibians, a group typical of ponds, the presence of toads was clearly not appreciated (7%) contrarily to frogs (49%). The frogs that were present in these urban ponds, and were appreciated, were mainly represented by Pelophylax sp., an invasive non-indigenous group of species. Toads were represented by Bufo bufo, a native species, listed as vulnerable on the Swiss red list.



Score given by interviewees

Fig. II. Public perception of the importance of 12 NCPs provided by Geneva's urban pondscape, represented by the mean score (\pm CI 95%), according to 288 interviewees. Five-point scale ranging from 1= "not important at all" to 5= "extremely important". ANOVA (p<0.05). The grouping according to Tukey's post-hoc test (differences with p>0.05) is indicated by the letters A to G.



Fig. III. Interviewees' motivation for visiting Geneva's urban pondscape (n=288 interviewees). Note that each person could choose up to 4 reasons from the list.

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Fig. IV. Importance of the visited urban pond for conservation and protection of threatened biodiversity in Switzerland, as expressed by 288 interviewees.



Fig. V. Material features and biodiversity (aquatic or terrestrial) of urban ponds most appreciated by interviewees (n=288). Note that each person could choose up to 5 features.

3.2.3.2. Is there a difference in the public perception of the NCPs provided by urban ponds compared to more natural ponds?

To find out if there is a difference in the public perception of NCPs provided by urban and rural pondscapes, we compared the results of question 6 of the questionnaire (see Table II) conducted among interviewees in three urban public parks (n=288) with the results collected in two rural nature reserves (n=43).

Interviewees mostly did not express a difference in the importance of a given NCP provided by urban ponds, compared with the same NCP provided by more natural (rural) ponds. For 10 of the 12 considered NCPs, there was no statistical difference (p>0.05; T test) (Fig. VI). Interviewees identified a difference (p<0.05) only for the two NCPs "flood" and "fire prevention", considered as less important in the urban area. Nevertheless, considering all 12 NCPs, the scores attributed to each of them were always higher for natural ponds. Globally, a higher score is attributed to rural ponds (mean=4.20), if compared with urban ponds (mean=4.02) (statistically significant difference; appaired T-test; p< 0.001; i.e., Appendix C).



Fig. VI. Public perception of the 12 NCPs provided respectively by urban and rural pondscapes in the Canton of Geneva, represented by the mean values of the score (five-point scale ranging from 1= "not important at all" to 5= "extremely important"). The number of interviewees of urban and natural pondscapes are 288 and 43, respectively (T-test: *for p<0.05, ** for p<0.01, and ns for p>0.05; see Appendix C).

3.2.3.3. Does the public accept this type of ecosystem (urban pond) and feel an improvement in quality of life?

To investigate the public acceptance of urban ponds and if the presence of these ponds leads to an improvement in people's quality of life, we analysed the answers to question 5 of the questionnaire (see Table II) for 288 visitors in three urban public parks in the city of Geneva.

The clear majority of interviewees (71.2%) thought that urban ponds make a high or very high positive contribution to their quality of life (Fig. VII).



Fig. VII. Contribution that urban pond makes to the quality of life of 288 interviewees in Geneva's urban pondscape.

3.2.3.4. Does gender or income have any influence on perception of pondscape?

In order to find out if gender (female and male) or income (low and high) has any influence on the public perception of NCPs provided by urban pondscape, we separated the answers collected in three public parks in the urban area

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of Geneva (n= 288 interviewees) by genders (145 males, 143 females). We also extracted the two most contrasted classes of income (61 low-income, 71 high-income).

Gender

The perceptions of the importance of each of the 12 NCPs provided by the urban pondscape were all statistically similar for female and male (T-test, p>0.05) (Fig. VIII). Nevertheless, if all 12 NCPs are considered globally, females attributed a much higher score to all NCPs (mean=4.18) compared to males (mean=3.18) (T appaired test; p<0.001; i.e., Appendix C).

With regards to the perception of the urban pond's contribution to quality of life by gender, 73% of the female and 70% of the male groups agreed that the contribution was high or very high (no significant differences; χ 2: p>0.05; i.e., Appendix C).

Concerning the role of urban ponds for the protection of threatened biodiversity in Switzerland according to gender, a higher proportion of females (85%) ranked the importance as high or very high, compared to males (73%) (significant differences; χ^2 : p=0.036; i.e., Appendix C).



Fig. VIII. Public perception according to gender of 12 NCPs provided by Geneva's urban pondscape, mean values and standard deviations. Five-point scale ranging from 1= "not important at all" to 5= "extremely important". The sample sizes of females and males are 143 and 145, respectively. There are no statistical differences for all 12 pairs of answers (T-test: p>0.05). The difference is nevertheless highly significant for the 12 NCPs considered together (T-test; p<0.001).

Income

Considering the different income levels, the perceptions of each of the 12 NCPs provided by the urban pondscape were statistically similar (T-test, p>0.05; i.e., Appendix C) (Fig. IX).

In context of the contribution of these urban ponds towards the quality of life, according to income, 76% high-income and 69% low-income groups agreed the contribution qualified as high or very high (no significant differences; $\chi 2$: p>0.05; i.e., Appendix C).

On the role of urban ponds for the protection of threatened biodiversity in Switzerland, both income categories (86% high-income and 77% low-income) expressed high or very high importance to the issue. No statistically significant differences were found (χ 2: p>0.05; see Appendix C).



Fig. IX. Public perception, according to high and low income, of the 12 NCPs provided by Geneva's urban pondscape, mean values and standard deviations. Five-point scale ranging from 1= "not important at all" to 5= "extremely important". The number of interviewees of high and low incomes are 71 and 61, respectively. There are no statistical differences for all 12 couples of answers (T-test: p>0.05).

3.2.4. Discussion

3.2.4.1. Public awareness of the importance of urban ponds for biodiversity and other NCPs

Our study revealed that the public interviewed in the Canton of Geneva are aware of the importance of urban ponds for biodiversity, as this NCP was identified as the most important NCP provided by ponds. Furthermore, a high level of importance for the conservation and protection of threatened biodiversity was recognised. It is important to highlight that the respondents also highly emphasized the importance of several other NCPs offered by ponds. This is in agreement with other studies where people acknowledged the benefits provided by urban ponds and wetlands (Manuel, 2003; Nassauer, 2004; Scholte et al., 2016; Ngiam et al., 2017). The fact that "landscape/aesthetics", and "the local biodiversity of flora and fauna" were among the main motivators that leads interviewees to visit the urban pondscapes studied further provides evidence that visitors have a high awareness of the importance of the ponds and pondscapes for biodiversity.

The contact with nature was emphasised by the respondents, showing the necessity to integrate green and blue spaces in urban environments to reverse the ongoing trend towards dissociation between people and nature (Soga and Gaston, 2016), and improving the inhabitants' quality of life. Thus, it reflects the basic human need (Seymour, 2016; Baxter and Pelletier, 2019) to be connected with nature because of the physical and mental health benefits resulting from it. This is supported by several previous studies (Hart, 2019; Vandergert et al., 2021; Zhang et al., 2021) which show that contact with nature provides an opportunity to divert negative emotions, increase attention span and reduce the effects of stress. The maintenance or the improvement in quality of life supposes that people have access to ponds and find the most propitious conditions in terms of aesthetic preference (Dobbie, 2013; Hayden et al., 2015; Arnberger et al., 2021), refreshing space in summer and the range of facilities required for visitors (Parker and Simpson, 2018; Liu and Xiao, 2021).

Overall, we observed that the interviewees thought urban ponds were of lower value than rural ponds. Nevertheless, if considered individually, a similar importance was recognised for most of the NCPs (10 from 12) delivered by both types of ponds. Interviewees identified that ponds in rural pondscapes were more important for the regulation of

flooding and fire events than urban ponds. This is in line with the fact that rural ponds were clearly larger in terms of surface area: they have therefore a higher capacity for buffering water runoff during storm events, and also the water can be used by firefighters to extinguish forest fires.

The challenge of conciliating pond ecological quality with users' perceptions (Hassall et al., 2016; Martin et al., 2016) is important for site managers. To address this issue, we asked the interviewees about the importance given to biodiversity conservation. All interviewees who gave their opinion were aware of the importance of urban ponds for the conservation and protection of threatened biodiversity in Switzerland. Overall, 79% of the interviewees qualified the importance of biodiversity as high or very high, with women scoring higher than men. This high score indicates a positive perception, and therefore an opportunity to strengthen public perception of the importance of these spaces as key areas to preserve biodiversity in the urban environment. It could be a motivating factor for the local community to become more engaged in the preservation and conservation of these ecosystems (Sterrett et al., 2019), creating plans and strategies to preserve and restore these natural spaces within cities, and taking part in environment education program by understanding the threats and cause of extinction of some species (Jarić et al., 2020).

To promote pond conservation and raising awareness about their biodiversity, it may be helpful to identify flagship species (Sousa et al., 2016). Urban ponds were here essentially appreciated for the aquatic biodiversity observed by the interviewees. Aquatic wildlife was cited as a priority, in particular the presence of frogs, water birds, dragonflies, and fish. It should be noted that most interviewee linked biodiversity with exotic species (such as the introduced fishes, ducks, and frogs) or even invasive species (mostly Pelophylax frogs) that may in fact constitute one of the main threats to native biodiversity (e.g., to other amphibian species or dragonflies). From this result, it is possible to infer that the public has little to no knowledge about the national or international strategies for biodiversity conservation. Due to this lack of information, the public itself is prone to continue accepting invasive exotic species, which are generally very colourful and draw public attention. Previous studies have already highlighted this gap in biodiversity knowledge, with people generally having poor biodiversity identification skills (Dallimer et al., 2012).

This level of awareness of biodiversity among interviewees raises questions concerning strategies for the conservation of ponds (Hill et al., 2018) because there is a constant tension between the ideal pond for visitors (including exotic species for our case studies) and ponds of high quality for biodiversity conservation (for native species). The perception of what makes an 'attractive' and 'natural' pond varies among the study population (Hoyle et al., 2019), their backgrounds, their location and their level of knowledge. Human preferences represent therefore an obstacle to the implementation of pond restoration, depending on its objective. This brings to the fore the need to reconcile the local expectations with the scientific requirements of pond restoration (Oertli et al., 2010). As a consequence, the challenge is to improve the multifunctionality of the ponds or to promote ponds with diverse uses in a same pondscape. Ponds are indeed complex and multifunctional ecosystems, and they are extremely important for biodiversity in the urban environment (Hassall, 2014; Oertli and Parris, 2019). They can also prevent flooding, contribute to carbon storage, microclimate, water purification and provide opportunities for recreation, learning and inspiration for people (Alikhani et al., 2021; Krivtsov et al., 2022). The creation and restauration of urban ponds in line with local expectations and scientific requirements is a political decision that could change the functioning of ponds, the habitats for species, the relation between ponds and visitors and the current trade-offs in pond management (Faith and Walker, 2002; Hambäck et al., 2023) with potential conflicts (land use, rampant urbanisation, waste water etc). Therefore, it is crucial to have an efficient management of urban ponds to provide ongoing benefits to the population and biodiversity (Shrestha et al., 2021). This requires information on the different NCPs and individual preferences of the local community to provide a comprehensive overview to underpin recommendations to decision-makers.

3.2.4.2. Urban ponds: acceptance and improvement in quality of life of visitors

The study presents evidence of public acceptance of urban ponds due to their positive NCPs assessment. These valuable spaces can be used as tools to improve the quality of life of people in cities and to promote environmental sustainability. The creation of ponds as NBS require that the public acceptance (Giordano et al., 2020; Anderson and Renaud, 2021) of these spaces for their long-term success. The role of NCPs assessment help to review the
pros and cons of prioritising NCPs in pond conservation and restoration. Additionally, it can be seen as an incentive for the development of public policies and programs to ensure the preservation and restoration of urban ponds.

The way to improve the social acceptance of new ponds in urban areas presuppose considering the diversity of people that live in cities. There is an unequal access to ponds because of their location in specific neighbourhoods. This unbalanced spatial distribution could result indifferences between visitors and local inhabitants and possibly requires a public planning strategy and zoning that distribute ponds spatially also to the most deprived areas of cities. That's why we are interested in representing the diversity of the interviewees in terms of gender and income.

In contrast to other studies that showed that social factors can influence the perception and use of public spaces (de la Barrera et al., 2016; Schüle et al., 2017), in this study no relationship was found between these factors and the perception of the contributions provided by urban ponds. Our results then suggest that people of different genders and incomes have a similar positive perception of the contributions provided by urban ponds. If male and female both stressed the importance of the NCPs provided by urban ponds, and especially biodiversity, this position was much more pronounced and marked by females. The consensus among gender and incomes is important in ensuring that these spaces are accessible and valued by a variety of individuals. It can be seen as an opportunity to create blue and green spaces that promote equity and inclusion for all individuals regardless of their socio-economic background. It is worth noting that further studies regarding these socio-demographic factors are needed to grasp if pond are attractive to the local community they increase the value of a particular area, contributing to the phenomena of gentrification (Anguelovski et al., 2022).

Alongside the inclusion issue, the question of acceptance also relates to the freedom to roam as right of public access to wilderness. In an urban context, wilderness is not relevant because of nature is seen historically as something to be tamed and conquered. But pond creation and access to ponds is fully in tune with the right to the city (Lefebvre, 1967), as proposal to reclaim the city as a co-created space. Therefore, the restoration and creation of urban ponds merits special attention by allowing the provision of NCPs as connection of people to nature as well as other contributions (habitats for biodiversity, small thermal effect in climate-responsive design practice (Jacobs et al., 2020), aesthetic appeal). Urban ponds have many particular features that differentiate them from rural pondscapes: artificial structures (e.g., artificial substrate and shorelines, barriers around the pond, fountain, public benches), a lower surface area, the presence of many exotic species, and the high public attendance (Oertli and Parris, 2019). It is worth noting that as urban pondscapes are important areas adapted for humans use, some environmental factors in these areas can be easily controlled and modified with good management.

3.2.5. Conclusion

For an increasingly urbanised society and a busy urban environment, integrating and promoting blues spaces, such as ponds, is a way to minimise the effects of strong urban pressure on the environment and biodiversity, while improving the quality of life of the population (Chiesura, 2004; Raymond et al., 2017). This can lead to more sustainable cities and greater connections of people with nature.

As demonstrated in our study, public perceptions of urban ponds can provide interesting insights into the role of these small water bodies, their importance and public preferences. There is evidence that urban ponds are widely valued by the interviewees because of their benefits for quality of life and the environment, as well as being important spaces for contact with nature. The biodiversity represented in these ponds is also highly valued by the public, who also expressed their importance for the conservation and protection of threatened species. However, there was a clear gap in public knowledge about the conservation of biodiversity, with the presence of exotic and often invasive species being accepted and even welcomed. This stresses the importance of environmental education, and urban ponds could constitute an important tool (knowledge of species, understanding of the functioning of an ecosystem, and of the impairment through urban pressure). It is important to understand people's perception of the contributions of urban ponds in order to accept, conserve, design, manage and improve them for the benefit of more people, thus contributing to their sense of belonging and quality of life. In light of this, conservation and maintenance actions should be taken to ensure that these urban ponds continue to play a key

role in biodiversity conservation, improving people's lives, and inclusiveness. Furthermore, it is important to promote public awareness about biodiversity conservation and the benefits of urban ponds.

In conclusion, ponds are Nature-based Solutions very well adapted and accepted in cities, and they should be in the future part of the greening (and bluewing) in cities planning to conserve and enhance freshwater biodiversity whilst also provided NCPs.

3.2.6. Acknowledgement

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3.2.7. Data accessibility

Data are available in the master thesis by F. Vasco (2023) and also on request.

3.3. Appendices of the Scientific Paper

3.3.1. Appendix A. Survey questionnaire

Questionnaire for the general public on the perception of ponds in the canton of Geneva

DESCRIPTION

My name is Fernanda Vasco. I am a master's student at the HES-SO (University of Applied Sciences and Arts of Western Switzerland) and my project focuses on the perception of the population of the utilities and services provided by urban ponds. Your opinion on the subject is very important for me and for the success of this study. Please note that, there is no right or wrong answer, all answers are legitimate. Your responses are strictly confidential and anonymous. This survey will take less than 10 minutes. Thank you very much in advance for your time.

If you have any questions, please contact me by email: fernanda.vasco@master.hes-so.ch.

FREQUENCY, GEOGRAPHICAL PROXIMITY AND MOTIVATIONS

- 1. In which site are you located? * Please choose only one answer. (NPA = Postal code)
- □ Parc des Franchises (NPA 1203) or Jardin de la Paix (NPA 1201)
- Parc Bertrand (NPA 1206)



Moulin-de-Vert (NPA 1288) ou Bois des Mouilles (NPA 1233)



La Plaine de la Haute-Seymaz ou autre zone agricole à Genève



Some of the following questions will only concern the site you have selected above.

2. How often do you visit the ponds in this area? * Please choose only one answer.

Once a day

2 to 3 times a month

1 to 5 times a year

1 to 3 times a week

Once a month

3. What motivates you to come to this particular place? * Please choose up to 4 reasons that you consider most important.

	Contact with nature		Dog walking		Leisure - time with family and friends
	The local diversity of animals and flowers that can be observed		Practising sport (for example., walking or running)		Facilities available on site (for example, playground and benches)
	The presence of a pond		Daily commute (for example, home-work commute)		No particular motivation
	Landscape / Aesthetics		Working / Studying		Other:
<u>UTIL</u>	ITY OF PONDS (ECOSYSTEM	SERVIC	ES / NCPs)		
4. Do	you think that the presence	of thi	s pond makes a positive cont	tributic	on to the area?
	one Low Me	dium	High Very h	nigh	☐ No opinion
5. To	what extent does this pond	and it	s surroundings contribute to	your q	uality of life?
	lone Low M	dium	High Very	high	🗌 No opinion

6. Which of the following do you think are the most important positive contributions of this pond (and other ponds too)? * Please select using a ranking of importance.

Co	ontributions	Not important at all	Not important	Relatively important	Very important	Extremely important	l don't know
& @ ≯¥	Habitat for animals and plants						
***	Diversity of bees and other pollinating insects						
	Better water quality (less polluted)						
	Water reservoir for irrigation						
000 💥	Reservoir for flood prevention						
2	Water reservoir for fire protection						
	Milder temperatures in the in the surroundings						
	Cleaner air (less polluted)						
*	Aesthetic value (beauty of the landscape)						
@#"\$	Contact with nature (inspiration, relaxation, education)						
x x 🐽	Leisure activities (walking, sports, picnics)						
H ()	Ensuring our adaptation to future threats						

* Plea	v impor se cho	tant do you t ose only one	hink this pond is answer.	for the protect	ion of	endangered ar	imals and plants in Switzerland?
No No	ne	Low	Medium	High		Very high	☐ No opinion
FACIL 8. What selected	.ITIES at are t ed site	the 5 elemen ? * Choose f	nts you appreciat F rom 1 to 5 most	e (or would ap important ele	oprecia ments	ate, if absent) r s.	nost about the pond at the
	Prese	nce of drago	onflies			Fountain	
	Prese	nce of insec	ts			Fence around	d the pond
	Prese	nce of fish				A bridge or fo	ootbridge
	Prese	nce of frogs				Explanatory p	panels on local biodiversity
	Prese	nce of toads				Observation	point
	Prese	nce of ducks	s and other wate	r birds		Public bench	es
	Prese	nce of aquat	tic plants			Walking path	
	Areas	with colourf	ul flowers			Other:	
	Trees	and associa	ated shading				
9. Cor	nment	(optional):					
<u>PROF</u> 10. Ar	ILE e you?	i.					
PROF 10. Are B Res Sw Too	ILE e you? sident iss res urist	of the Canto ident (outsid	n of Geneva le Geneva)				
PROF 10. Ard Res Sw Too 11. Wit	ILE e you? sident iss res urist hat is y	of the Canto ident (outsid vour gender?	n of Geneva le Geneva) ? * Please choose	e only one and	swer.		
PROF 10. Ard Re: Sw Tot 11. Wit Ma	ILE e you? sident iss res urist hat is y le	of the Canto ident (outsid vour gender?	n of Geneva le Geneva) ? * Please choose 	e only one ans ≂emale	swer.] Non-binary / Other
PROF 10. Ard Re: Swith Tou 11. With Main 12. With	ILE e you? sident iss res urist hat is y le hat is y	of the Canto ident (outsid vour gender? vour age rang	n of Geneva le Geneva) * * Please choose ☐ F ge? * Please cho	e only one ans Female lose only one	swer. answe	er.] Non-binary / Other
PROF 10. Art Re: Sw Tou 11. Wit Ma 12. Wit 18	ILE e you? sident iss res urist hat is y le hat is y to 24 y	of the Canto ident (outsid vour gender? vour age rang	n of Geneva le Geneva) * Please choose ☐ F ge? * Please cho 5 to 34 y/o [e only one ans ⁼ emale ⊡ose only one] 35 to 49 y/	swer. answe	er. 50 to 65 y] Non-binary / Other r/o □ More than 65 y/o
PROF 10. Ard Re: Sw Too 11. With Maa 12. With 18 13. With	ILE e you? sident iss res urist hat is y le hat is y hat is y	of the Canto ident (outsid vour gender? vour age rang v/o □ 2 vour professi	n of Geneva le Geneva) * * Please choose ge? * Please cho 5 to 34 y/o [onal situation? *	e only one ans ⁻ emale lose only one] 35 to 49 y/ Please choos	swer. answe o e only	er.] Non-binary / Other r/o □ More than 65 y/o
PROF 10. Art Re Sw Too 11. WI Ma 12. WI 18 13. WI Stu	ILE e you? sident iss res urist hat is y le hat is y hat is y hat is y	of the Canto ident (outsid vour gender? vour age rang v/o 2 vour professi	n of Geneva le Geneva) * Please choose ge? * Please cho 5 to 34 y/o [onal situation? * Self-	e only one ans Female tose only one 35 to 49 y/ Please choos employed	swer. answe only	er. 50 to 65 y one answer.] Non-binary / Other r/o □ More than 65 y/o
PROF 10. Art Sw Tou 11. WI Ma 12. WI 18 13. WI Stu No	ILE e you? sident riss res urist hat is y le hat is y hat is y ident o gainfu	of the Canto ident (outsid vour gender? vour age rang vour age rang vour profession	n of Geneva le Geneva) * Please choose ge? * Please choose 5 to 34 y/o [onal situation? * Self- C Retii	e only one ans Female Dose only one 35 to 49 y/ Please choos Femployed red	swer. answe o e only	er. 50 to 65 y one answer.] Non-binary / Other r/o □ More than 65 y/o
PROF 10. Art Sw Tou 11. Wi Ma 12. Wi 18 13. Wi Stu Stu En	ILE e you? sident iss res urist hat is y le hat is y hat is y ident o gainfu	of the Canto ident (outsid your gender? your age rang your age rang ulactivity d	n of Geneva le Geneva) * Please choose ge? * Please choose 5 to 34 y/o [onal situation? * Self- Retii Othe	e only one ans Female 00se only one 1 35 to 49 y/ Please choos remployed red er :	swer. answe o e only	er. 50 to 65 y one answer.] Non-binary / Other r/o ☐ More than 65 y/o
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Thank you very much for your attention and support! 🙂

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			POND	SCAPE	
		URBAN		RURAL	
		Sites: Parc des Franchises, Ju	lardin de la Paix,	Sites: Moulin de Vert and Bo	ois des Mouilles
		and Parc Bertrand (n=288)		(n=43)	
Question	Answer	Number of interviwees	Percentage	Number of interviwees	Percentage
Q1a. Do you live	Yes	152	52.8%	20	46.5%
in this region?	No	136	47.2%	23	53.5%
	Once a day	53	18.4%	e	7.0%
Q2. How often do	1 to 3 times a week	110	38.2%	10	23.3%
you visit this	2 to 3 times a month	37	12.9%	12	27.9%
area?	Once a month	19	6.6%	8	18.6%
	1 to 5 times a year	69	24.0%	10	23.3%
	Resident of the Canton of Geneva	247	85.8%	36	83.7%
Q10. Are you?	Swiss resident (outside Geneva)	20	6.9%	2	4.7%
	Tourist	21	7.3%	c)	11.6%
Q11. What is your	Male	145	50.4%	23	53.5%
gender?	Female	143	49.6%	20	46.5%
	18 to 24 y/o	52	18.1%	2	4.7%
Mhot of India Cho	25 to 34 y/o	59	20.5%	5	20.9%
	35 to 49 y/o	84	29.2%	14	32.6%
age range r	50 to 65 y/o	44	15.3%	8	18.6%
	More than 65 y/o	49	17.0%	10	23.3%
	Student	46	16.0%	ę	7.0%
Q13. What is your	No gainful activity	19	6.6%	e	7.0%
professional	Employed	139	48.3%	23	53.5%
situation?	Self-employed	25	8.7%	2	4.7%
	Retired	59	20.5%	12	27.9%
	Very low	19	6.6%		
Do ton	Low	42	14.6%	,	
consider vour	Medium	119	41.3%	,	
income?	High	62	21.5%	,	
	Very high	6	3.1%		
	I don't know	37	12.9%		

3.3.2. Appendix B. Profile of the interviewees

3.3.3. Appendix C. Results of the statistical tests used to analyse the interviews data

In the treatment of the data, the very low- and low-income categories were assumed as low income and the high and very high-income categories were assumed as high-income. Significance level $\alpha = 0.05$. Means that do not share a letter are significantly different. *For p <0.05, ** for p<0.01.

		One W	Vay ANOVA	V Test and Tu	key-Kramer								T-Test							
:							Donder	3000							Urban Pon	dscape				
(əle			Urban Pc	ndscape (n=2	38)		LOUGS	ahas		l		Gend	er				Incom	e		
eos						Urban	(n=2.88)	Rural	(n=43)		Female(I	n=143)	Male (r	i=145)		Low-Incol	me(n=61)	High-Inco	ne (n=71)	
Likert	NCP	Mean	Standard Deviations	95% CI	Tukey grouping	Mean	Standard Deviations	Mean	Standard Deviations	P-Value	Mean	Standard Deviations	Mean	Standard Deviations	P-Value	Mean	Standard Deviations	Mean	Standard Deviations	P-Value
a oint	3 iodive rsity	4.39	0.75	(4.28, 4.50)	A	4.39	0.75	4.58	0.59	0.18	4.55	0.61	4.23	0.84	1	4.2	0.88	4.56	0.61	0.85
<u>نه</u> d-s	ollination	4.18	0.98	(4.06, 4.30)	A, B, C, D	4.18	0.98	4.29	0.77	0.13	4.37	0.88	3.99	1.05	0.97	3.95	0.97	4.35	0.89	0.85
) sp	Nater quality	3.92	1.05	(3.78, 4.05)	D, E	3.92	1.05	4.07	0.87	0.07	4.09	0.87	3.75	1.17	0.94	4.07	0.87	4.1	1.02	0.84
≤ ouo	Nater quantity	3.76	1.09	(3.62, 3.88)	E, F	3.76	1.09	3.91	1.24	0.07	3.94	1.01	3.58	1.15	0.89	3.84	0.96	3.76	1.11	0.93
<u>تت</u> d ۸c	⁻ lood prevention	3.47	1.11	(3.33, 3.59)	F, G	3.47	1.11	3.72	1.33	0.028 *	3.66	1.08	3.3	1.12	0.73	3.66	0.98	3.51	1.14	1
i pa	ire prevention	3.41	1.25	(3.28, 3.54)	U	3.41	1.25	3.82	1.18	** 600.0	3.57	1.23	3.27	1.25	0.67	3.67	1.06	3.35	1.31	1
piv.	Refreshment	4.18	0.92	(4.06, 4.29)	A, B, C, D	4.18	0.92	4.33	0.77	0.12	4.29	0.88	4.07	0.95	0.97	4.25	0.83	4.19	1	0.77
Þ.o	Air quality	4.10	1.04	(3.98, 4.22)	B, C, D	4.1	1.04	4.18	0.88	0.11	4.27	0.85	3.93	1.18	0.99	4.11	0.99	4.17	0.95	0.91
► ICb	Aesthetic	4.27	0.86	(4.16, 4.39)	A, B, C	4.27	0.86	4.44	0.71	0.15	4.36	0.81	4.19	0.9	0.98	4.23	0.88	4.32	0.87	0.83
ند ۲ N	.earning&inspiration	4.37	0.83	(4.26, 4.48)	A, B	4.37	0.83	4.63	0.58	0.18	4.55	0.65	4.19	0.94	0.99	4.44	0.87	4.48	0.79	0.86
تع اه	port & leisure	4.06	0.94	(3.95, 4.18)	C, D	4.06	0.94	4.14	0.71	0.10	4.2	0.89	3.92	0.97	1	4.02	0.98	4.29	0.85	0.81
ء ز زار	Maintenace of options	4.19	0.97	(4.06, 4.30)	A, B, C, D	4.19	0.97	4.36	0.86	0.12	4.33	0.83	4.05	1.08	0.93	4.28	0.91	4.32	0.87	0.86
⊲ o uo	ANOVA											CI	ii-Square Te	st						
itq	Carried ad Variation	5	4	140	ų,							Gend	er				Incom	e		
erce	SOURCE OF VARIATION	8	ď	CIM	r Value						Female(n=143)	Male (r	=145)		Low-Incol	me(n=61)	High-Inco	ne (n=7 1)	
l Z od o	VCPs	275.6	11	25.05	26.16 0.00						df		P-Va	lue		Ø	f	P-V	lue	
ilduq	error	2898.9	3027	0.96		Contribution scale):	of the pond to	the quality i	of life (5-point	Likert	m		0.0	54				0	6	
F	Total	3174.5	3038			Contribution Switzerland (5	of the pond in si 5-point Likert sca	afeguarding e ile):	ndangered bioc	iversity in	4		0.03	* 9		2		0.4	61	

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4. Discussion and Implications for Further Research

In response to the first research question, the survey showed that the public perceived a high importance (i.e., above average value) for all the NCPs provided by the urban ponds of the city of Geneva, with biodiversity taking the first place of importance among them. This is in line with other studies where people recognised the benefits provided by urban ponds (Ngiam et al., 2017; Scholte et al., 2016). The presence of biodiversity is confirmed as the features of urban ponds most appreciated by interviewees with the presence of aquatic wildlife (frogs, water birds, dragonflies, and fishes) among the first positions. Other evidence in this study supports the public's awareness and importance of biodiversity, which is among the main motivations that lead them to visit urban pondscapes. Additionally, high importance was given to urban ponds in the role of conservation and protection of threatened biodiversity in Switzerland. It is worth pointing out that this perception of the interviewees reflects a lack of knowledge about the conservation of biodiversity, as the aquatic wildlife mentioned is mostly linked to exotic (such as the introduced fishes, ducks, and frogs) or even invasive species (mostly Pelophylax frogs), which may harm native species (such as dragonflies).

In response to the second research question, the survey showed that respondents perceived the contributions provided by the urban pondscape to be lower overall than in the rural pondscape, although all have a high value (i.e. above the mean value). However, when comparing statistically and individually, similar importance was recognized for 10 out of 12 NCPs provided by these pondscapes. The interviewees considered that rural ponds are more important for flood and fire regulation than urban ponds. This perception is consistent with the fact that rural ponds generally have a larger surface area, which allows them to better dampen water flow during storms and can also be used by firefighters to extinguish forest fires. Nevertheless, it is important to remember that because of the generally small size of urban ponds and its low or no surface infiltration rate, these ponds may not play such a significant role in regulating the flow of water and reducing the occurrence of flooding in these areas (Oertli et al., 2023 under review). However, they may still provide many other benefits such as improving urban heat island effect and local biodiversity, as well as providing a pleasant space for recreation and relaxation for people in the urban area.

In response to the third research question, the research showed that gender and income do not influence the perception of the NCPs provided by urban ponds. Although there is a general positive perception among people of different genders and incomes towards the contributions of urban ponds, women seemed to value them more, especially in terms of biodiversity. This is important to ensure the accessibility and appreciation of these spaces by everyone.

For future research on this topic, it is suggested to:

- Increase the sample size of the rural pondscape. By considering a larger sample size in the rural pondscape it would be possible to verify the consistency of the results.
- Expand the targeted public. It would be interesting to interview other groups with a more specialized opinion such as farmers, nature protectors (NGOs, associations, among others), and managers of these urban areas hosting a pond. It would also be interesting to carry out a survey in urban parks without a pond.
- Carry out an in-depth study of socio demographic factors, considering the employment situation as well as the level of education.
- Address the public perception of the "disservices" offered by urban ponds. This would allow to propose possible
 management measures for them.

In summary, the results discussed highlight the importance of ponds in urban areas. Urban ponds were valued by interviewees as bringing added value to their experience of green spaces and their biodiversity was highly appreciated, although, there is a gap in public knowledge about native biodiversity conservation of urban ponds.

Furthermore, it was found that the perception of the contributions of urban ponds was not influenced by social factors such as gender and income, which may be an opportunity to create and integrate blue and green spaces that promote equity and inclusion for everyone. For future research it is proposed to increase the sample size of rural pondscape, expand the targeted public, include socio demographic factors, and address the public perception of the "disservices" offered by urban ponds.

5. Conclusion

It is worth noting that urban ponds have multiple benefits in different proportions and contexts for people and biodiversity. This work is an invitation to carry out social research and participatory processes to understand the perceptions and needs of the public in order to be able to integrate and adapt urban ponds into urban green spaces and ensure greater acceptance, visitation frequency and conservation of these spaces.

In conclusion, public perception is important for the creation of public spaces, such as urban parks that contain a pond, because it can have a direct impact on how these spaces are used, perceived, and valued by their visitors. This can be a valuable source of information for a proper design, decision-making and management of such areas. Indeed, understanding people's perceptions can help to create spaces that meet the community's needs, preferences, and desires, leading to urban parks which are more likely to be used and valued, contributing to people's sense of belonging and quality of life.

Lausanne, March 17th, 2023.

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7. Appendices

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APPENDIX I. The 10 objectives of the Swiss Biodiversity Strategy

Taken from https://www.ge.ch/document/7302/telecharger



APPENDIX II. The Geneva Biodiversity Strategy 2030

The 12 application fields and the key ecosystem services they provide. Taken from https:// www.ge.ch/document/7302/annexe/0

1. Infrastructure écologique

En 2030, le déplacement des espèces sauvages est assuré dans l'ensemble du bassin genevois par une infrastructure écologique de qualité, prise en compte en amont de tout projet, afin d'éviter ou de compenser systématiquement leurs impacts négatifs. Pour cela, les échanges au sein des administrations et avec les partenaires civils sont devenus la règle, y compris au niveau transfrontalier.

2. Sites protégés

En 2030, le canton abrite un ensemble de réservoirs de biodiversité protégés sur 17 % de son territoire. Ils sont fonctionnels grâce à une mise en réseau et à une gestion active garantissant la qualité de leurs habitats naturels. Ce patrimoine offre une opportunité de découverte pour la population genevoise dans le respect de ses valeurs naturelles.

3. Forêt

2

En 2030, la forêt genevoise couvre toujours 12 % du territoire genevois et bénéficie d'une gestion favorable à la biodiversité. Les populations d'ongulés sont présentes, maintenues à des niveaux compatibles avec le renouvellement de la forêt. Les activités récréatives et l'exploitation forestière sont encouragées en garantissant la préservation du patrimoine naturel.

En 2030, la campagne genevoise est

préservée de l'urbanisation et abrite une

biodiversité riche et diversifiée, grâce

notamment à des surfaces de promotion de

la biodiversité de qualité, à une utilisation

réduite d'intrants et un plus grand respect

des sols. Les agriculteurs sont soutenus

dans leur travail, tant au niveau des

débouchés pour leur production (circuits

courts) que par des incitations en faveur de la biodiversité et du paysage.

4. Arbres

En 2030, le canton abrite un patrimoine arboré de haute valeur pour la biodiversité grâce à une diversité de taille et d'âge des arbres, à la campagne comme en ville. L'urbanisation prévoit suffisamment de place pour renouveler les grands arbres. Les propriétaires et gestionnaires des espaces arborés sont soutenus dans leurs efforts pour maintenir les arbres remarquables et les sujets âgés.

7. Espace bâti

En 2030, l'espace bâti genevois comprend une mosaïque de sites à caractère naturel permettant à la faune et à la flore de prospérer et aux habitants de garder le contact avec la nature. Les initiatives sont soutenues pour développer ces sites de nature en zones bâties. Le réseau d'espaces verts, les cours d'eau et les pénétrantes de verdure garantissent la circulation des espèces y compris dans l'espace urbain.

10. Formation

En 2030, les habitants du canton ont acquis au travers de leur parcours de formation une compétence et un savoir-être suffisants pour apprécier la valeur de la biodiversité et des services qu'elle rend. Ils ont à cœur de la préserver et de la promouvoir à travers leur vie quotidienne et leurs gestes citoyens.

5. Cours d'eau et lac

En 2030, les cours d'eau genevois abritent une faune et une flore plus riches qu'aujourd'hui, grâce en particulier à la gestion intégrée de l'eau par bassin versant et à une collaboration transfrontalière efficace. Les activités sociales autour des milieux aquatiques sont développées dans le respect du patrimoine naturel.

8. Faune et flore

En 2030, la faune et la flore genevoises sont plus riches, résilientes et diverses grâce à une gestion durable des milieux et à une infrastructure écologique transfrontalière fonctionnelle. Le statut des espèces menacées s'est amélioré et les espèces exotiques envahissantes sont sous contrôle.

11. Outils analytiques

En 2030, la biodiversité est suivie et évaluée périodiquement grâce à un dispositif performant qui permet de réajuster les mesures mises en œuvre et d'anticiper l'évolution des situations. La population participe à cette action grâce à des outils adaptés.

9. Sensibilisation

6. Aire agricole

En 2030, la population, en particulier celle habitant en ville, connaît la valeur de sa nature, en apprécie les bénéfices et s'engage activement en sa faveur.

12. Outils administratifs

En 2030, les prestations de la biodiversité sont reconnues par tous et valorisées à leur juste prix par la collectivité. La promotion de la biodiversité est assumée naturellement par toutes les politiques publiques, car les mesures en sa faveur sont perçues comme un investissement pour notre existence économique, culturelle et sociale.



Champs d'a	application	écologique	écologique s et réserves			et Lac				on et	t activités scolaire	iques et de	istratifs et
Services éc	osystémiques	1. Infrastructure du territoire	2. Sites protégé naturelles	3. Forêt	4. Arbres	5. Cours d'eau e	6. Aire agricole	7. Espace Bâti	8. Faune et flore	9. Sensibilisation information	10. Formation el dans le cadre	11. Outils analyt suivi	12. Outils admin politiques
	Production d'oxygène	-	9	**	-	??	**			•	•	•	-
	Stockage du dioxyde de carbone	-	•	**	-	**	-		?	•	•	•	-
Soutien	Macroclimat	-		??	-	**		•		•	•	•	-
	Cycle des nutriments	-	•	**		**	•		**	•	•	•	
	Fertilité des sols	-	•	-	-		-	**	-	•	•	•	
	Qualité de l'air	-		••	-	•	•	••	•	•	•	•	••
	Microclimat		•	••	-	-	?	••	•	•	•	•	
	Qualité de l'eau			•		••	•	?	- •	•	-	1 e	
Régulation	Rétention eau (protection contre crues)		-	•		**	•	**	•	-	•	•	-
	Réduction de l'érosion		?	-			**	??	•	-	- ?	•	
	Pollinisation		-	**		•	**	**	**	•	-	•	-
	Prévention des maladies et indésirables			**		**	??	**	**	•	- 📍	•	
	Eau potable	•		•		••	••			-	•		
	Alimentation			•	•		**	••		•		•	••
Approvisionnement	Ressources médicinales			-			•		-		•		••
	Engrais					•	••	1		•	-	•	••
	Bois									•	•	•	
	Énergie			-		-	-	••		-	•	•	
	Détente et bien-être	**	77	-	-		-	**	**	77	-	•	
	Loisirs et écotourisme	-	-	-	-		**	**		-	-	•	-
Culture	Valeur scientifique		-	-	-		-	-	-	-	-	-	
	Valeur esthétique	-	-	-	-		-	-	-	-	-	•	
	Valeur spirituelle, identification		-	-	-	-		-		-	-	•	-

APPENDIX III. The Geneva Biodiversity Plan 2020-2023

It consists of 117 actions within the 12 fields of application. Taken from https://www.ge.ch/document/7302/annexe/1

Plan Biodiversité 2020-2023

de la Stratégie Biodiversité Genève 2030

«117 actions menées dans 12 champs d'application »







12 actions en cours ou à renforcer 6 nouvelles actions à lancer

15 partenaires de mise en oeuvre



actions en cours ou à renforcer
 nouvelles actions à lancer
 partenaires de mise en oeuvre



1 action en cours ou à renforcer 0 nouvelle action à lancer 10 partenaires de mise en oeuvre



actions en cours ou à renforcer
 nouvelles actions à lancer
 partenaires de mise en oeuvre



actions en cours ou à renforcer
 nouvelles actions à lancer
 partenaires de mise en oeuvre



action en cours ou à renforcer
 nouvelles actions à lancer
 partenaires de mise en oeuvre

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APPENDIX IV. Field pictures of conducted interviews by Fernanda Vasco

Locations: A- Parc des Franchises, B- Parc Bertrand, C- Moulin-de-Vert, and D- Bois des Mouilles.



APPENDIX V. Main data collected from interviews

NCPs= Nature's Contributions to People, SD= Standard Deviation, and %= percentage.

n=288

Does the public identify biodiversity as an important NCP in urban ponds?

PUBLIC PERCEPTION OF THE NCP PROVIDED BY URBAN PONDSCAPE IN GENEVA (Q6)

	Urban ponds	cape
NCPs	mean	SD
Fire prevention	3.41	1.25
Flood prevention	3.47	1.11
Water quantity	3.76	1.09
Water quality	3.92	1.05
Sport & leisure	4.06	0.94
Air quality	4.1	1.04
Pollination	4.18	0.98
Refreshment	4.18	0.92
Maintenance of options	4.19	0.97
Aesthetic	4.27	0.86
Learning &inspiration	4.37	0.83
Biodiversity	4.39	0.75

INTERVIEWEE'S MOTIVATION FOR VISITING PONDSCAPES (Q3) up to 4 reasons can be chosen

	Urban ponds	саре
Motivation	answers	%
Contact with nature	220	76.4%
Leisure	176	61.1%
Landscape/Aesthetics	103	35.8%
The local biodiversity of flora and fauna	81	28.1%
Practising sport	77	26.7%
The pesence of a pond	60	20.8%
Facilities available on site	55	19.1%
Dog walking	41	14.2%
Working/Studying	27	9.4%
Other	23	8.0%
Daily commute	15	5.2%
No particular motivation	1	0.4%
Other:		
Lunch break	11	
Tranquility	9	
To paint	1	
On the way	1	
I don't have a balcony	1	

IMPORTANCE OF THE VISITED URBAN POND IN SAFEGUARDIND ENDANGERED FAUNA AND FLORA IN SWITZERLAND (Q

	Urban ponds	cape
	answers	%
Very high	133	46.2%
High	95	33.0%
Medium	38	13.2%
Low	9	3.1%
None	0	0.0%
No opinion	13	4.5%

MOST APPRECIATED CHARACTERISTICS OF URBAN PONDS (Q8) 1 to 5 elements can be chosen

	Urban ponds	cape
ELEMENTS	answers	%
Presence of frogs	140	48.6%
Presence of ducks and other water birds	134	46.5%
Trees and associated shading	126	43.8%
Presence of dragonflies	123	42.7%
Presence of fish	118	41.0%
Presence of aquatic plants	96	33.3%
Areas with colourful flowers	84	29.2%
Fountain	83	28.8%
Public benches	77	26.7%
Explanatory panels on local biodiversity	72	25.0%
Walking path	66	22.9%
A bridge or footbridge	58	20.1%
Presence of insects	47	16.3%
Observation point	29	10.1%
Fence around the pond	28	9.7%
Presence of toads	21	7.3%
Other	3	1.0%

Is there a difference in public perception of the ecosystem services provided by urban versus natural pondscapes?

PUBLIC PERCEPTION OF THE NCP PROVIDED BY URBAN AND NATURAL PONDSCAPES IN GENEVA (Q6)

	Urban ponds	cape	Natural ponds	саре
NCPs	mean	SD	mean	SD
Biodiversity	4.39	0.75	4.58	0.59
Pollination	4.18	0.98	4.29	0.77
Water quality	3.92	1.05	4.07	0.87
Water quantity	3.76	1.09	3.91	1.24
Flood prevention	3.47	1.11	3.72	1.33
Fire prevention	3.41	1.25	3.82	1.18
Refreshment	4.18	0.92	4.33	0.77
Air quality	4.1	1.04	4.18	0.88
Aesthetic	4.27	0.86	4.44	0.71
Learning &inspiration	4.37	0.83	4.63	0.58
Sport & leisure	4.06	0.94	4.14	0.71
Maintenance of options	4.19	0.97	4.36	0.86

Does the public accept this type of ecosystem (urban pond) and feel an improvement in well-being?

n=288

CONTRIBUTION OF THE POND TO THE QUALITY OF LIFE OF THE INTERVIEWEES (Q5)

	Urban pone	Urban pondscape		
	answers	%		
Very high	97	33.7%		
High	108	37.5%		
Medium	47	16.3%		
Low	5	1.7%		
None	6	2.1%		
No opinion	25	8.7%		

Does income have any influence?

: Low income n=61 and High income n=71

PUBLIC PERCEPTION OF THE NCP PROVIDED BY URBAN PONDSCAPE IN GENEVA FOR LOW AND HIGH INCOMES (Q6)

	Low income		High income	
NCPs	mean	SD	mean	SD
Biodiversity	4.2	0.88	4.56	0.61
Pollination	3.95	0.97	4.35	0.89
Water quality	4.07	0.87	4.1	1.02
Water quantity	3.84	0.96	3.76	1.11
Flood prevention	3.66	0.98	3.51	1.14
Fire prevention	3.67	1.06	3.35	1.31
Refreshment	4.25	0.83	4.19	1
Air quality	4.11	0.99	4.17	0.95
Aesthetic	4.23	0.88	4.32	0.87
Learning &inspiration	4.44	0.87	4.48	0.79
Sport & leisure	4.02	0.98	4.29	0.85
Maintenance of options	4.28	0.91	4.32	0.87

CONTRIBUTION OF THE POND TO THE QUALITY OF LIFE ACCORDING TO INCOME (Q5)

	Low income		High income	
	answers	%	answers	%
Very high	19	31.2%	32	45.1%
High	23	37.7%	22	31.0%
Medium	9	14.8%	11	15.5%
Low	2	3.3%	1	1.4%
None	4	6.6%	1	1.4%
No opinion	4	6.6%	4	5.6%

IMPORTANCE OF THE VISITED URBAN POND IN SAFEGUARDIND ENDANGERED FAUNA AND FLORA IN SWITZERLAND ACCORDING TO INCOME (Q7)

	Low income		High income	
	answers	%	answers	%
Very high	30	49.2%	39	54.9%
High	17	27.9%	22	31.0%
Medium	9	14.8%	6	8.5%
Low	3	4.9%	2	2.8%
None	0	0.0%	0	0.0%
No opinion	2	3.3%	2	2.8%

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Does gender have any influence?

Female n=143 and Male n=145

PUBLIC PERCEPTION OF THE NCP PROVIDED BY URBAN PONDSCAPE IN GENEVA ACCORDING TO GENDER (Q6)

	Female	Female		
NCPs	mean	SD	mean	SD
Biodiversity	4.55	0.61	4.23	0.84
Pollination	4.37	0.88	3.99	1.05
Water quality	4.09	0.87	3.75	1.17
Water quantity	3.94	1.01	3.58	1.15
Flood prevention	3.66	1.08	3.3	1.12
Fire prevention	3.57	1.23	3.27	1.25
Refreshment	4.29	0.88	4.07	0.95
Air quality	4.27	0.85	3.93	1.18
Aesthetic	4.36	0.81	4.19	0.9
Learning &inspiration	4.55	0.65	4.19	0.94
Sport & leisure	4.2	0.89	3.92	0.97
Maintenance of options	4 33	0.83	4.05	1.08

CONTRIBUTION OF THE POND TO THE QUALITY OF LIFE ACCORDING TO GENDER (Q5)

	Female		Male	
	answers	%	answers	%
Very high	53	37.1%	44	30.34%
High	51	35.7%	57	39.31%
Medium	22	15.4%	25	17.24%
Low	3	2.1%	2	1.38%
None	3	2.1%	3	2.07%
No opinion	11	7.7%	14	9.66%

IMPORTANCE OF THE VISITED URBAN POND IN SAFEGUARDIND ENDANGERED FAUNA AND FLORA IN SWITZERLAND ACCORDING TO INCOME (Q7)

	Female		Male	
	answers	%	answers	%
Very high	77	53.8%	56	38.6%
High	45	31.5%	50	34.5%
Medium	15	10.5%	23	15.9%
Low	3	2.1%	6	4.1%
None	0	0%	0	0%
No opinion	3	2.1%	10	6.9%

APPENDIX VI. Public perception of the contribution of the pond to the quality of life according to gender in Geneva's urban pondscape

Scale ranging from very high to none. The sample sizes of female and male are 143 and 145, respectively (χ^2 : p>0.05)



APPENDIX VII. Importance of the visited urban pond in safeguarding endangered fauna and flora in Switzerland according to gender

Scale ranging from very high to none according to interviewees. The sample sizes of female and male are 143 and 145, respectively (χ^2 : p=0.036).



APPENDIX VIII. Public perception of the contribution of the pond to the quality of life according to income in Geneva's urban pondscape



The number of interviewees of high and low incomes are 71 and 61, respectively (χ^2 : p>0.05).

APPENDIX IX. Importance of the visited urban pond in safeguarding endangered fauna and flora in Switzerland according to income.



The sample sizes of high and low incomes are 71 and 61, respectively (χ^2 : p>0.05).