

## Article

# Thermal Comfort and Perceptions of the Ecosystem Services and Disservices of Urban Trees in Florence

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**Abstract:** Modern urban lifestyles have most likely generated a loss of awareness of the bio-cultural benefits derived from the presence of trees and forests in cities. The present study aimed at understanding the level of awareness and the ability to express significant relationships, both positive and negative, on ecosystem services and disservices by the citizens of a Mediterranean city where thermal comfort during the summer period can be particularly problematic. A questionnaire consisting of multiple-choice and open-ended questions was disseminated to citizens of Florence, Italy. The open questions allowed respondents space to describe what they perceive are the benefits and disbenefits of urban trees. Meanwhile, geospatial and climate data were processed in order to check the vegetation and microclimate conditions of the city areas where the 592 respondents live. The vast majority of respondents felt Florence is unbearably hot in summer with 93% agreeing the city needs more trees, and shaded places were perceived as the most important feature of urban green space. The results reveal many positive and negative associations to different species of trees and bring out a rich mosaic of perceptions towards urban green spaces and the features they contain. People are generally aware of a wide range of the benefits trees provide to communities and a good knowledge of the microclimate modification properties was revealed. Many of the popular public tree genera in the city, such as *Tilia*, *Platanus* and *Pinus* were favoured by residents however there was some overlap with trees that provoke negative experiences, and this information can be useful to city planners aiming to maximise ecosystem services and minimise ecosystem disservices.

**Keywords:** sense of place; urban heat island; street trees; urban forest; public preferences; city planning



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## 1. Introduction

Green infrastructure is an important component of the built urban environment and confers many localised benefits such as reducing air pollution [1] and providing opportunities for relaxation [2]. Trees play a prominent role in the provision of these Ecosystem Services (ES) [3] and are a key feature of nature-based solutions, which are increasingly being used by municipalities to adapt cities to climate change and increase the liveability of cities for the worlds growing urban populations. There exist also Ecosystem Disservices (EDS) which are the negative impacts of nature on human activity such as pollen allergies and damage to infrastructure [4]. Recent literature has posited a more balanced assessment of the potential of nature-based solutions, which takes the EDS into account alongside the ES [5]. Both ES and EDS are intrinsically linked to personal and societal attitudes and strictly depend upon the perception of the observers and users. What is perceived as beautiful and beneficial by one person may be considered ugly, useless, unpleasant, or unsafe by another [6].

It is essential that the general public are aware of the net benefits of trees, as this will aid in the acceptance and appreciation of urban greening programmes. Humans have an innate attraction for natural settings and processes, which has been termed biophilia [7], and separation from nature, as occurs in cities, has been interpreted as leading to psychological and spiritual impairment [8] while the presence of natural settings has been proved as

beneficial for mental health and human wellbeing (e.g., [9]). There is thus a need for research that unravels society's complex patterns of engagement with urban green space, and the importance we place on it [10]. The restrictions on access to urban green space during the recent COVID-19 pandemic resulted in a re-assessment of its importance for providing places for relaxation, recreation, and respite [11], and we must now plan for a future that incorporates the needs of citizens into green space planning.

Several studies have looked at the factors which influence attitudes to urban trees. Gorman [12] found that residents with a street tree planted in front of their house were more likely to state that street trees are a benefit, demonstrating that increasing the amount of green space will have a direct impact on the appreciation of the benefits. Weather and climate can influence how people interact with nature based on perceived relief or protection from climate-related effects [13]. Socio-economic factors such as age, ethnic origin, social and economic status, and familiarity with green spaces can also influence people's attitudes towards greenery [10]. Lohr et al. [14] found residents of US cities generally feel positive towards trees but young, low income, male, people of colour, and people who have lived in cities their whole life were less likely to agree that trees are important for life quality.

One way to demonstrate people's attachments to urban trees is to assess the value they give to the ES that they provide. In Singapore, air quality, shade, and aesthetics were deemed important, and spiritual benefits the least important ES [15]. Summit and McPherson [16] found that shade and appearance played more of a role in the decision to plant trees than did concerns about energy savings and environmental benefits. Cultural differences were shown previously, with residents of Helsinki, Finland indicating recreation as the main benefit of urban green areas with shading from the sun as least important [17] while in the hotter climate of Bari, Italy, climate modification (local cooling) was the most important function [18]. This link between local environmental/climatic factors and perceptions of nature was also demonstrated by Avolio et al. [19] who found shade trees are preferred in the hotter parts of California. In terms of EDS, allergies and material impacts were more important than financial costs to the city [14].

These studies indicate that people assign importance to urban forests according to a rich array of descriptors, mostly referring to ecological, environmental, and psycho-social themes [20]. The afore-mentioned studies often present participants with a fixed list of ES and EDS, which may fail to capture the full extent of people's knowledge which would be facilitated if they were volunteered without prompting. Cultural services are often overlooked, and this is reflected in the representation of cultural ES within empirical research on urban systems [3].

Shade and cooling tend to be the highest benefit then relaxation is second [14]. Tree shade and relief from high urban temperatures associated with the Urban Heat Island (UHI) effect [21] is perhaps the most tangible of the ES for citizens, and therefore one of the first to be recognised as a benefit. Seeking the cool shade of a park on a hot summer's day or choosing to walk down a street with trees, are activities that all urban residents are familiar with. With climate change predictions showing a rise in the frequency of summer heatwave events, the shade from trees will become even more important to urban citizens [22,23].

In contrast to the study of the health and environmental benefits of green space, social values and attitudes towards green spaces and the cultural services they offer have received less attention [24]. In this exploratory study, we test the level of knowledge and the perceived values of ES and EDS of residents of the city of Florence by allowing survey respondents to describe the elements of urban trees they feel are important via open-ended questions about species preferences and shade quality. There is a lack of studies that have utilised open-ended questions (to our knowledge, only Collins et al. [25]) to capture public opinion on urban trees and we demonstrate the usefulness of this approach in order to identify gaps in public knowledge and thus promote the benefits of trees to ensure public support. It is important to understand the public's beliefs and attitudes towards trees to

get more community involvement. There is an emphasis on thermal comfort within the survey to address current, and predicted future, summer conditions in the city.

## 2. Methods

### 2.1. The Study Site

The city of Florence (43°46'17" N; 11°15'15" E, Alt. 50 m, Popn. 380,000) is situated on a plain to the southwest of the Apennine mountains in central Italy and is characterised by hot, dry summers. Intra-urban differences exist in the thermal conditions, linked to green space provision [26], and rising temperatures in the summer were associated with increases in emergency calls for cardiovascular events and psychiatric disorders [27]. The city thus represents a study site where the issue of thermal comfort is very important. A total of 18.8% of the land cover is green space resulting in 20.7 m<sup>2</sup> per capita in 2014 [28], with a distinct lack of green space in the historic centre. This is less than the national average of 31.2 m<sup>2</sup> per capita for Italy.

### 2.2. Questionnaire

The questionnaire, written in Italian, was hosted online in the summer of 2020 (June to September) using Google forms and advertised and disseminated to citizens of Florence using local social media groups and email (available in the Supplementary Material). The social media groups were chosen based on their membership by residents of Florence (e.g., Facebook “Florence citizens” group) and an email was sent around Florence University staff, asking participants to forward it to friends and family in the city. The survey collected basic demographic information of gender and age bracket and also asked for the street name of their residence in Florence. Participants were informed that the data would be collected anonymously and would comply with EU data protection regulation 2016/679, thus meeting the requirements of the University ethics approval. The start of the questionnaire consisted of multiple-choice questions related to thermal comfort in the city during the summer, including an indication of the outdoor temperature interval at which the respondent feels “too warm”. The next section dealt with access to public or private greenspace near the residence and how often the respondent frequents these spaces, again using multiple choice answers. A series of 5-point Likert scale questions gauged how important various features of public parks are to the participants, from “unimportant” (coded as 1) to “very important” (coded as 5). These features included high biodiversity, fruit trees, well-maintained vegetation, and a place to sit.

Finally, the questionnaire posed three open-ended questions designed to record the attitudes of citizens towards urban trees. Specifically, they requested the name of a favourite and a least favourite species of urban tree and to give the reason why, and also asked how the shade of a tree differs from that of a building. The species part of the answers to these questions were classified into tree genera or species depending on the level of detail in the response. For example, some people listed oaks by using the genus name (*Quercus*, in Italian “quercia”) as their favourite tree, while others more specifically named the holm oak (*Quercus ilex*, in Italian “leccio”). The ES or EDS mentioned as reasons for preference or least preference respectively, were deductively coded by one author based on lists from the literature [29–31]. The coding process was in accordance with that outlined in Olivero-Lora et al. [32]. The ES were assigned to a group in the CICES classification system [31] and EDS were assigned to one of the five categories of EDS proposed in Vaz et al. [30]. If the reason “large tree” or “wide crown” was given, this was assumed to be referring to the shade provision ES. Many responses indicated more than one species, ES or EDS, therefore they received multiple codes.

### 2.3. Geospatial and Climate Data

All geospatial analysis was undertaken in QGIS version 3.10. Multi-spectral satellite data (resolution 10 m, cloud cover 7.8%) from the Sentinel-2 platform were downloaded

from the Copernicus hub [33] for the date 23 June 2019. A Normalised Difference Vegetation Index (NDVI) raster layer was created using the formula

$$\text{NDVI} = \frac{\text{NIR} - \text{VIS}}{\text{NIR} + \text{VIS}} \quad (1)$$

where NIR and VIS stand for near-infrared and visible red spectral bands respectively [34]. This layer was then resampled to only consider pixels over an NDVI threshold of 0.4 which represents medium to high-density vegetation cover, and thus excludes areas of patchy grass and small shrubs. Shapefiles of district boundaries for Florence were downloaded from the online data repository of the Tuscan regional government [35], and also a point shapefile of the public trees in the city with location and species.

The street addresses of participants were geocoded as points using the Google Maps API with the package “ggmap” in R version 4.0.2 [36]. A buffer of 250 m around each residence point (after Petralli et al. [37]), and the afore-mentioned spatial data, were used to estimate the percentage area covered by vegetation around the residences.

Air temperature data from the Genio Civile weather station in central Florence were downloaded for the years 2015 to 2019 [35]. The average number of days a year where the minimum temperature did not fall below 20 °C indicating a “tropical night” [38], was calculated along with the number of days where the maximum temperature exceeded fixed values.

#### 2.4. Analysis

The data were first cleaned by removing any responses from participants who live outside of the Florence district boundary. All analyses were carried out using R. The non-parametric Kruskal–Wallis Chi-squared test was used to test the effect of percentage vegetation surrounding the residence on responses to some questions. In order to reduce the levels of responses to two groups, some combinations were made. The temperature range at which people feel uncomfortable was reduced to a binary category of below or above 36 °C and how Florence is perceived in summer was reduced to hot and very hot.

### 3. Results

The number of responses to the questionnaire by people living in Florence was 592. A total of 73% of respondents were female, and over half (55%) were aged between 41 and 60 with 29% between 21 and 40. Chi-squared tests reveal that the gender distribution does not reflect that of the city (52% female, 48% male, [39]) ( $\chi^2 = 0, p = 1$ ), and neither does the distribution across age groups ( $\chi^2 = 42, p = 0.2$ ), with 11 to 20-year-olds and the over 60 s being under-represented.

#### 3.1. Perceptions of Thermal Comfort

Figure 1 shows that the vast majority (98%) of respondents feel the city of Florence to be hot or very hot in summer, and most (90%) are in agreement that the summer temperatures are unbearable. The reported temperature ranges at which thermal discomfort is subjectively experienced are mostly (88%) between 31 and 40 °C with a small percentage (8%) experiencing discomfort at lower temperatures and 4% only at temperatures above 40 °C. Maximum temperatures in the city between 2014 and 2019 were greater than 31 °C on 82 days per year on average (25 days above 36 °C, and 3 days above 40 °C). The average number of tropical nights the city experienced was 46 per year. A total of 50% of respondents prefer to be constantly in the shade when they go outside in the summer and 48% prefer more time in the shade to sun, and 93% agreed that Florence needs more trees.

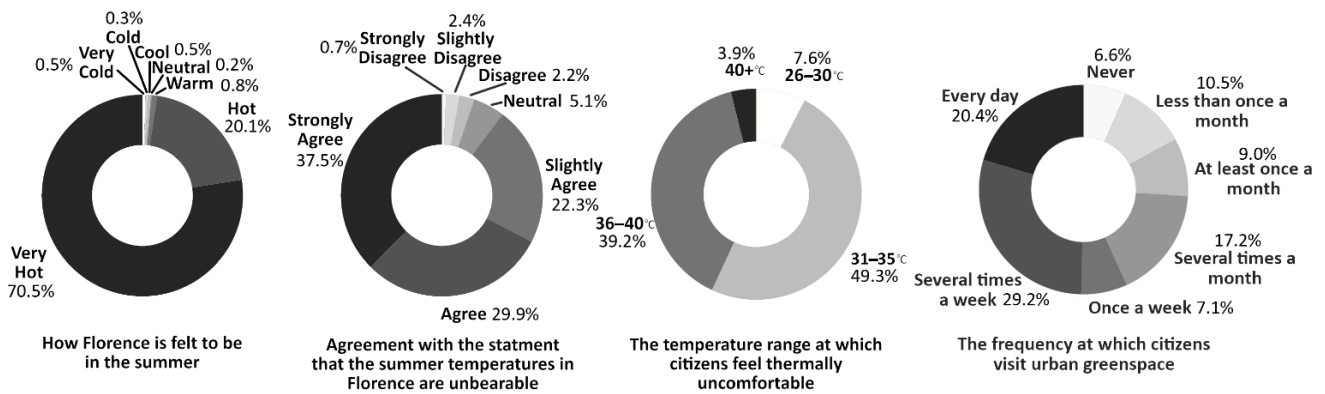


Figure 1. Donut charts representing response proportions to survey questions ( $n = 592$ ).

Urban greenspace is fairly well used in Florence, with around one in six people using it every day and over half using it once a week or more (Figure 1). The number of trees in a 250 m radius of the respondents’ residences had no significant effect on the temperature ranges at which discomfort is perceived, nor whether they feel the city is hot versus very hot (Figure 2). As tree cover increases, the likelihood of seeing trees and having access to public or private greenspace increases significantly, and the greener areas of the city are apparently linked to greater access to private gardens. In terms of proportions, one in five citizens do not see trees from their house and one in four do not have access to greenspace within a two-minute walk. A total of 73% of the respondents have access only to public greenspace.

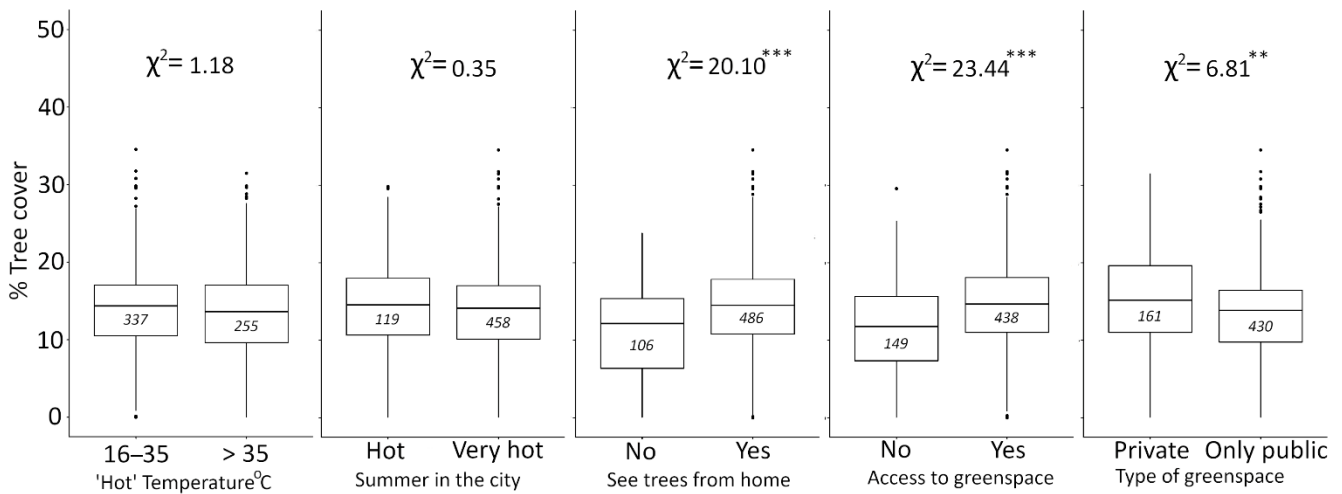
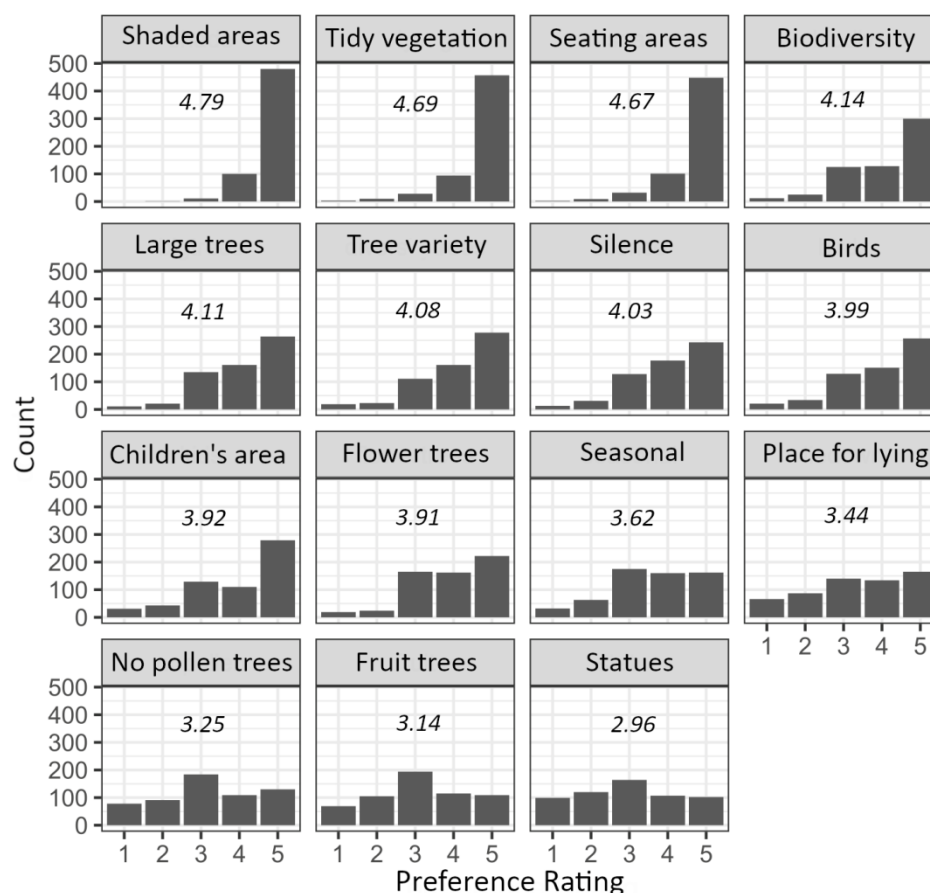


Figure 2. Variation in tree cover in a 250 m radius around respondents’ residences related to survey questions. Sample size in italics and Kruskal–Wallis Chi-square results indicated (\*\* =  $p < 0.01$ , \*\*\* =  $p < 0.001$ ).

### 3.2. Greenspace Features

Figure 3 reveals that shady areas, well-maintained vegetation, and a place to sit are the three most important features of urban greenspace for residents. Fewer pollen-producing trees, fruit trees, and statues are the least important features. Despite fruit and flower trees being of medium to low importance, tree species diversity is considered important.



**Figure 3.** Preference rating from 1 (unimportant) to 5 (very important) for various park features with the mean average vote in italics.

### 3.3. Species Preferences

The complete responses to the three open-ended questions are available as Supplementary Material and summarised in Tables 1 and 2. Not all the respondents gave reasons for their species choices. Some respondents gave generic answers, instead of a specific species, for example, they prefer “large trees” but do not like “pollen producing trees”. A total of 114 of the responses to the least favourite species question gave the answer that they do not have one or that “all trees are good”.

**Table 1.** Frequency table for the top twenty genus or species of (a) favourite and (b) least favourite urban tree with the most frequent reason given and the proportion found within the public tree database for Florence.

(a) Favourite	Reason	<i>n</i>	% of Trees	(b) Least Favourite	Reason	<i>n</i>	% of Trees
<i>Tilia</i>	Scent	101	12.6	None	-	114	
<i>Quercus</i>	Majestic	85	11.5	<i>Pinus</i>	Damaging	67	5.5
<i>Pinus</i>	Scent	45	5.5	<i>Cupressus</i>	Pollen allergy	38	10.5
<i>Platanus</i>	Shade	40	6.0	<i>Tilia</i>	Pollen allergy	22	12.6
<i>Quercus ilex</i>	Evergreen	20	8.7	<i>Ailanthus</i>	Invasive	18	0.25
<i>Magnolia</i>	Flowers	18	0.9	<i>Populus</i>	Pollen allergy	18	3.0
<i>Acer</i>	Autumn colour	17	4.9	<i>Pinus pinaster</i>	Damaging	15	0.02
All species	-	16		<i>Pyrus calleryana</i>	Low shade	14	0.8
<i>Ginkgo biloba</i>	Autumn colour	15	0.5	<i>Abies</i>	Aesthetics	8	0.03
<i>Abies</i>	Shade	14	0.03	<i>Acacia</i>	Bad scent	8	0.04

Table 1. Cont.

(a) Favourite	Reason	n	% of Trees	(b) Least Favourite	Reason	n	% of Trees
<i>Fagus</i>	Shade	13	0.04	Pollen trees	Pollen allergy	8	
<i>Cupressus</i>	Native	12	10.5	Small trees	Low shade	6	
<i>Salix</i>	Peaceful	11	0.1	Conifers	Dirty	5	
<i>Salix babylonica</i>	Aesthetics	11	0.03	<i>Nerium</i>	Toxic	5	0.06
Large trees	Shade	9		<i>Platanus</i>	Aesthetics	5	6.0
<i>Cedrus deodara</i>	Aesthetics	8	0.9	<i>Quercus ilex</i>	Dirty	5	8.7
<i>Celtis</i>	Shade	8	9.4	<i>Magnolia</i>	Damaging	4	0.9
<i>Prunus avium</i>	Flowers	8	0.5	<i>Pinus pinea</i>	Dirty	4	5.1
Deciduous trees	Shade	7		Non-native trees	Invasive	3	
Fruit trees	Food	7		Fruit trees	Dirty	3	

Table 2. Frequency table for the coded responses to open questions regarding (a) favourite urban tree species, (b) least favourite species and (c) the difference between the shade of a tree and that of a building.

(a) Species Ecosystem Service	N	CICES group	(b) Species Ecosystem Disservice	N	EDS Group	(c) Shade Ecosystem Service	N	CICES Group
Shade provision	145	A	Damage infrastructure	56	Material	Reduce local temperatures	254	A
Aesthetics	108	I	Pollen allergies	50	Health	Living/green/natural	81	O
Pleasant scent	71	P	Dirty	50	Material	Produce O <sub>2</sub>	72	A
Seasonal interest	46	I	Low ES provision	40	U*	Peaceful/healthy/relaxing	62	P/M <sub>2</sub>
Suitable for cities (Long lived/strong/robust)	29	U*	Aesthetic issues	26	Cultural	Air quality/Pollution reduction	47	M <sub>1</sub>
Evergreen with year round benefits	14	U*	Invasive species	16	Cultural/Material	Dynamic light quality/energetic	41	P
Associated with pleasant memories	13	I	Unpleasant scents	13	Leisure	Aesthetics	20	I
Deep rooting species	12	U*	Unsuitable for sense of place	10	Cultural	Biodiversity value	19	L
Low maintenance costs	11	U*	Maladapted for urban life	10	Material	Pleasant scent	18	P
Native species	10	L	High maintenance costs	8	Material	Absorb CO <sub>2</sub>	11	A
Peaceful/healthy/relaxing	10	P/M <sub>2</sub>	Harbour pests	7	Health	Pleasant sounds	5	P
Food provision	9	C	Non-native species	4	Cultural	Spiritual associations/life quality	5	S
Air quality/Pollution reduction	9	M <sub>1</sub>	Low biodiversity value	4	Leisure	Food provision	2	C
Landscape suitability and sense of place	7	I	Poisonous/toxic	3	Health	Associated with pleasant memories	1	I
Deciduous allows winter sun penetration	5	A	Take up space	3	Leisure	Water retention/flood protection	1	R
Ancient species or historical value	5	I	Slow-growing species	2	U*			
Spiritual associations	4	S	Negative cultural or spiritual aspects	2	Cultural			

Table 2. Cont.

(a) Species Ecosystem Service	N	CICES group	(b) Species Ecosystem Disservice	N	EDS Group	(c) Shade Ecosystem Service	N	CICES Group
Biodiversity value	2	L	Too common in cities	1	Cultural			
Recreational use (tree climbing)	2	P						
Absorb CO <sub>2</sub>	1	A						
Produce O <sub>2</sub>	1	A						
Water retention	1	R						

Table footnote: The Ecosystem Services are associated with the list of service groups in the Common International Classification of Ecosystem Services (CICES) V5.1 [31] coded as follows: A = Atmospheric composition and conditions, C = Cultivated terrestrial plants for nutrition, materials, or energy, I = Intellectual and representative interactions with natural environment, L = Lifecycle maintenance, habitat and gene pool protection, M<sub>1</sub> = Mediation of wastes or toxic substances of anthropogenic origin by living processes, M<sub>2</sub> = Mediation of nuisances of anthropogenic origin (e.g., sound), O = Other biotic characteristics that have a non-use value, P = Physical and experiential interactions with natural environment, R = Regulation of baseline flows and extreme events, S = Spiritual, symbolic and other interactions with nature. U\* = Related to suitability for urban conditions. Categories for Ecosystem Disservices come from the classification proposed by Vaz et al. [30].

Table 1 reveals that there is a lot of overlap between the species which citizens find appealing or unattractive for different reasons. For example, the smell of *Tilia* flowers was listed many times as a much-loved quality, however, several respondents stated that they dislike the smell. The named trees in the table are represented by 63% (favourite) and 48% (least favourite) of the public trees in terms of quantity and 95% and 89% respectively for all the trees. *Pinus*, *Cupressus*, and *Tilia* are the top three least favourite trees because of pollen allergies and roots damaging pavements. The needles of *Pinus* were also frequently described as a nuisance. *Ailanthus*, *Pyrus calleryana*, and *Acacia* are the top three unique to EDS.

### 3.4. Representation of ES and EDS

The coded ES (Table 2) reveals that 10 of the 14 CICES ES “groups” are represented in the responses. The CICES groups not covered in the responses were “genetic material from plants, pest and disease control”, “water conditions” and “regulation of soil quality”. The ES listed for species and shade differed slightly with aesthetics, scents, and pleasant memories being more prominent when people were prompted to think about their favourite species. When tree shade was compared to building shade, the most common ES mentioned was “freshness” which was interpreted as the additional cooling from evapotranspiration in the vicinity of trees. The production of oxygen, peaceful qualities, and air pollution reduction ES were also mentioned frequently for shade, alongside the inherent living naturalness that trees possess over buildings. More regulation and less cultural and provisioning ES were present in the shade responses compared to the preferred species ones.

Some benefits, denoted U\*, were not specifically classed as ES because they related more to the suitability of the species for urban life, which cannot be considered an ES in itself. A total of 13% of the EDS responses did not specifically mention any EDS and were in fact statements of how the particular genus or species fails to produce ES, and they were mostly lamenting species such as *Pyrus calleryana* and *Cupressus sempervirens* for their low shade provision.

In terms of EDS, most of the major EDS are mentioned apart from air quality impacts from the release of Biological Volatile Organic Compounds (BVOCs) and fear response [30]. The most common reasons given are damage to pavements/buildings, pollen, and invasiveness.



## 4. Discussion

### 4.1. Thermal Comfort and Greenspace

The answers to the thermal comfort part of the questionnaire paint a picture of Florence as a city with a majority of uncomfortable survey respondents in the summer. On the 25 days of the year on average with maximum temperatures above 36 °C, well over half the people stated that they feel uncomfortable, and may suffer adverse health conditions and sleepless nights on the 46 tropical nights a year. Considering the link between high temperatures and an increased frequency in ambulance calls for certain conditions [27], it is clear that this poses a considerable issue for the municipality and there should be a focus on improving the microclimate of Florence in future policy.

Petralli et al. [37] found a 10% increase in the green cover within a radius of 250 m within Florence could reduce the number of times citizens experience thermal discomfort by 30 h, using three different biometeorological comfort indices. In the present study, the amount of green within 250 m of residences predictably influenced the amount of trees people could see or access from home but did not influence subjective comfort indicators. Such an effect may only be seen at the extreme ends of the scale of urban greenness, or perhaps subjective thermal comfort perception may not be affected by a person's current residential environment but by factors that operate on longer timescales such as lifetime climate habituation, or shorter time scales such as recent weather experience [40]. A quarter of residents have no access to greenspace within a two-minute walk and nearly three-quarters rely solely on public greenspaces. This has implications for the adequate provision of greenspace within municipal climate change adaptation goals. This would be challenging in the historic centre of Florence where many narrow alleyways are unsuitable for tree planting and piazzas are reserved for the historical monuments they contain.

Well maintained vegetation and a richness of plant species were the two most important green space characteristics in a study in Portugal [41] and ranked highly in the present study. People feel safer in more managed, less naturalistic, urban green, and find it better for relaxing [42]. It is interesting that biodiversity is high up so confirming previous research results [43,44] and pollen (affecting a third of the population on average) and fruit trees being quite low. Movements towards food sustainability in cities are often not well received by the public, through concerns over the quality of the food produced [45]. Shade, however, is the main feature of urban greenspace considered important in Florence. It is clear that green space offers a respite from high summer temperatures.

### 4.2. Public Perceptions of Trees

#### 4.2.1. Species Preferences

The study has provided a snapshot of how well received the trees of Florence are by the citizens. Many popular street trees such as *Tilia*, *Platanus* and *Cupressus* are appreciated for the diverse benefits they are perceived to confer, such as scent and shade. *Quercus* was often mentioned as being "majestic" or "mighty". This may be an interesting example of culture influencing people's attitudes to trees, as there is a famous idiom "mighty oaks from little acorns grow" which was repeated in the language respondents chose to describe their favourite tree. It is interesting also that people's choices for favourite or least favourite species were influenced by considerations for how well that species is adapted to city life (maintenance costs, cleanliness, pollution resistance, time to maturity, water needs). This may indicate a recognition that urban trees have a common good and contribute to a better quality of life shared by all the citizens, and so trees better suited for that purpose are preferred. Olivero et al. [32] noted differences in the recognition of the ES provided by private trees (provisioning) and public trees (cultural). Or alternatively, it may reflect a general knowledge of the challenges of urban forestry gained from the reporting of storm damage from trees in the local media for example [46]. ES and EDS are generally provided by the same urban greenspace but often EDS are over-reported. That seems at least partially influenced by societal mainstream appreciation while the basic or deep

knowledge on bio-cultural services and disservices shown by the respondents apparently does not influence perception and reporting on the positive value of ES [47].

Unfortunately, many species commonly found in the city, such as *Pinus*, *Tilia*, and *Cupressus*, were noted for their nuisances and this highlights the challenges which urban forest managers face, especially when some trees simultaneously place high on the favourite species lists. The swaying fronds of *Salix babylonica* make several residents feel sad, yet inspire feelings of beauty in others. Certain species, however, appeared solely on the least favourite species list, such as *Pyrus calleryana* (small, scruffy, and high water demand), *Ailanthus* (invasive, damaging), and *Acacia dealbata* (Bad odour, pollen allergies). Unless these species can offer multiple ES to balance out the EDS, then perhaps it is advisable to limit their inclusion in urban tree planting schemes. Currently, several factors seem to influence species selection in Italian cities, such as the aesthetic appeal, historical or cultural reasons, with the ecology of the species rarely forming consistent selection criteria [48].

#### 4.2.2. Ecosystem Services

A wide range of different ES became apparent in the responses. The lists compare well to other studies, where shade and aesthetics are highly valued ES [15,18,25], despite not using the fixed ES lists as in previous studies. The important services of trees listed in Ordóñez et al. [49] were aesthetics, air quality, shade, naturalness, and environmental quality. They concluded that the aesthetic appeal of trees may be the first thing that comes to mind due to that being the conscious experience of the urban landscape and that these themes do not reflect an intellectual response but rather an awareness of the respondent's psychological state. In other words, while the general public may collectively know about the whole range of ES and EDS of urban trees, they will only mention the ones they feel strongly about in the context of the question asked.

It is interesting to note which CICES groups were not mentioned, i.e., genetic material from plants, regulation of soil and water quality, and control of pests. Additionally, some urban tree ES from other groups were notable in their absence such as wind/noise shelter and visual screen for home privacy. These are less obvious ES and perhaps they would have eventually been mentioned with more respondents. Whether this reflects a knowledge gap in the general public or not, it nonetheless highlights areas that would benefit from education. For example, informing the public about how trees retain rainwater and are useful within climate change adaptation plans related to the prevention of pluvial flooding [50].

The diversity of cultural ES was fairly well represented, with frequent mentions of fond memories attached to trees such as climbing them or remembering the favourite species of a departed loved one. There was a repeating motif of the characteristic Tuscan landscape trees being used to extol the suitability of *Pinus pinea* for a Tuscan city, but also some respondents saying it was misplaced as it should be restricted to coastal habitats. This highlights the very subjective nature of cultural ES and the difficulties associated with their quantification [29]. Spiritual connections to trees were often described using ambiguous language ("it gives me energy", "I feel protected") and one participant said trees "change slowly and teach us patience". In fact, the seasonality was a very common aspect be it specific seasonal attributes (*Ginkgo* leaves in autumn, *Prunus* flowers in spring) or just a general appreciation of how trees keep us in tune with the changing seasons. Some respondents expressed awe at the geological perseverance of the "ancient Ginkgo".

Several times deep roots were mentioned as a favourable characteristic, but no reason why was given, presumably as a symbol of resistance to falling and damaging property. One person mentioned the unique smell which comes with the first rains after a prolonged dry period, known as petrichor [51].

When confronted with a choice between contrasting urban landscapes it is interesting to see which benefits rise in importance. The inherent greenness and living quality, production of oxygen, the quality of the light through the branches, and the coolness were all frequently mentioned as qualities that buildings do not have. The cooling property of

tree shade was often described as “freshness”, and air quality was often expressed as “I can breathe better under the trees”. Many respondents displayed in-depth knowledge of microclimate modification by trees, mentioning evapotranspiration and the storage and radiation of heat by building materials. It is not surprising that residents of a Mediterranean city have personal experience of these phenomena, even if they are not aware of the science behind them. Shade and cooling ES were predictably likely to come top of the list in a survey based on thermal comfort, however, it is clear from the frequency and the language used to describe personal experiences, that people generally feel very strongly about the need for shade trees in the city.

#### 4.2.3. Ecosystem Disservices

Despite many people stating that they do not have a least favourite tree and that all trees are good, there was a substantial list of EDS generated and as with ES, there appear to be EDS that come to people’s minds more than others, i.e., property damage, pollen allergy and tree litter (sap, fruit, dead leaves) [14,32]. These are EDS which are likely to impact people on a daily basis, with pavements disturbed by tree roots, and cars covered in sticky sap from *Tilia* trees. The EDS which are less physical in nature, such as wrong sense of place, or non-native species, were much less likely to be mentioned as they are less impactful. Some species were unpopular because they were perceived to be low providers of ES, and therefore intrinsically useless as a city tree. This reaffirms the notion that citizens are generally aware of the communal benefits of public trees and notice when a species fails to deliver.

The aesthetic issues were very subjective and related to not liking the leaf shape of medlar trees for instance. *Cupressus* trees remind one respondent of death because they are commonly planted in Italian cemeteries. Invasive species are often seen as a problem in cities despite the fact that they can be providers of ES [52], due to a fear of displacement of native species. The unmentioned EDS of BVOC production and the link to air pollution is either unknown to the general public or perhaps it is not associated with a particular least favourite tree. The EDS of fear response and crime may not have arisen for individual trees, as this EDS is more linked to parks and wasteland.

While this list was comprehensive and stimulated some passionate descriptions of tree nuisances, it must be noted that EDS are considered by citizens insufficient to justify the removal of trees or planning without trees [14].

#### 4.2.4. Limitations

As with most studies that utilise surveys, there was an apparent bias with more respondents being female and of a certain age group [53]. The socioeconomic distribution of the respondents may not represent that of the city at large and the online nature of the survey may have excluded the participation of some groups, especially the elderly as indicated by the low response rate from the over 60 age group. The invitation to participate mentioned urban green and trees in Florence, at which point people with no interest in trees may decide not to participate. For this reason, the responses may not be an accurate snapshot of the attitudes of the city at large. Although the aim of the study was not to quantify but to qualify and depict the perception of ES and EDS, the fact that the respondents were free to mention whichever ES or EDS they wished to may result in a bias towards the ES and EDS that people feel strongly about when responding to the stimulus (e.g., favourite tree, why tree shade is preferable to building shade) within the question. Therefore, the lists should not be taken as an indication of the depth and breadth of the collective knowledge of these within the population. Finally, the survey, with questions about urban heat and tree shade and being distributed in summer, will have stimulated some respondents towards thinking about the shade and cooling ES which may have influenced their responses to the open questions. Nonetheless, shade and cooling are consistently highly valued attributes of urban trees in studies that rate the importance of lists of ES [14,20].

## 5. Conclusions

Florence is a city with hot summers and residents express discomfort with the frequent high-temperature episodes. According to the results of the survey, and in line with previous research, the respondents generally feel the city needs more trees, and shaded areas were voted the most important feature of urban greenspace. In contrast to other studies where respondents were asked to rate pre-selected, limited lists of ES and EDS, the present study allowed respondents space to describe what they perceive are the benefits and disbenefits of urban trees. The responses revealed that there exist many subjective positive and negative cultural associations to trees, confirming the difficulty of quantifying public perceptions while bringing out a rich mosaic of perceptions, original cultural elaborations, and anecdotal references. There were potential gaps in the general knowledge of ES and EDS, notably water retention/purification and BVOC production. Education and life-long learning opportunities can serve to strengthen the socio-cultural bonds we have with urban trees and form a basis for future community involvement in urban tree planting and maintenance. There was, however, a good knowledge of the microclimate modification properties of trees demonstrated, and this remains a highly popular property of trees in cities that experience hot summers. Many of the public trees in the city were favoured by residents, however, there was some overlap with the trees which provoke negative experiences, and this information can be useful to city planners aiming to maximise ES and minimise EDS. The frequency that the services were mentioned may be an indication of which to prioritise.

**Supplementary Materials:** The following are available online at <https://www.mdpi.com/article/10.3390/f12101387/s1>. Supplementary material 1—Questions used in the online survey, Supplementary material 2—Coded responses to the online survey.

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