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What ideal green spaces for the city of tomorrow, providing ecosystem services?

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Abstract

The present study comes within the scope of a research program, which was funded by the French Region Centre-Val de Loire and questioned the fallout of urban green spaces (UGS) for city dwellers and municipalities. Here, the purpose is to identify the ideal UGS for a better urban future. We base our proposal on our knowledge of cultural and supporting ecosystem services (ES) provided by these spaces.

The six medium cities of the Region Centre-Val de Loire were chosen to study these cultural and supporting ES provided by urban nature. Public UGS, higher than 1 ha, were inventoried then classified into five categories. Six of these UGS were selected and subject of a more in-depth study. Their biodiversity (based on the arthropods frequency) and their soils quality (pedology, agronomy and microbiology) were analyzed. In the same time, 321 users and 12 managers of UGS were interviewed.

According to the interviewees, UGS contribute to the urban life quality, the well-being of city dwellers and even the city identity. They are thus approved by all. Users come first in these spaces for the quiet and to feel closer to nature. And indeed, these spaces are biodiversity spaces and they have quite good soils indicators. They provide a diversity of ES, especially cultural services.

All UGS are approved – except for those where traffics are suspected. The reasons and the time of their frequenting differ according to their facilities and their localization. However, the functions can be more numerous than the assigned ones – example of allotment gardens, which are places to cultivate but also to relax, meet and learn. Belonging to the five identified categories, the UGS are complementary. It is also valid for biodiversity because this one varies according to the land use, to the plant species. The ideal UGS could be a multifunctional UGS.

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Keywords: Urban nature; green spaces; ecosystem services; cultural services; supporting services; biodiversity; soil quality; urban life quality; city dwellers; green spaces users; green spaces managers; interviews

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1. Introduction

In occidental countries, especially in France, the city dwellers express a growing desire of nature, which should be linked to the "greening of the occidental society" [1] (transl. by the authors). From this observation, a research program was launched, funded by the French Region Centre-Val de Loire – SERVEUR (http://serveur.msh-vdl.fr/). The purpose was to identify the fallout of urban green spaces for city dwellers as for municipalities. In this framework the following question emerged: What kind of urban green spaces can offer a better quality of life in the future to city dwellers? This article aims to answer. The proposal is based on the study of ecosystem services provided by these spaces.

The concept of "ecosystem services" was popularized in 2005 by the Millenium Ecosystem Assessment [2]. In this reference book, ecosystem services are defined as "the benefits people obtain from ecosystems" [2]. They are classified according to a typology, which we consider here. Four categories are distinguished:

- provisioning services such as food, water, timber and fiber;
- regulating services that affect climate, floods, disease, wastes and water quality;
- cultural services that provide recreational, aesthetic and spiritual benefits;
- supporting services such as soil formation, photosynthesis and nutrient cycling. [2]

We decided to focus on cultural and supporting services. Indeed, the contribution of urban nature to the well-being of city dwellers can first be estimated in terms of recreational benefits, thus cultural services: "Urban green spaces provide important recreational services for urban residents" [3]. But we cannot disregard the supporting services, which are the base of other services and allow them to remain. To study these ecosystem services provided by urban green spaces, some methods were defined. They are set first out, before that the results are detailed then discussed.

2. Methods used to study cultural and supporting services of urban green spaces

The first stage of the research was to identify the study spots. We decided to focus on the six medium cities of the French region Centre-Val de Loire – located in the center of France (Fig. 1), because the urban nature is less studied in this kind of cities than in the bigger ones. In these six cities, the most significant green spaces were inventoried, considering public spaces, whose area was higher than 1 ha. 52 urban green spaces were thus identified [4]. They were then classified according to the following criteria:

- area,
- population density in a buffer zone of 250 m,
- diversity of the land use (including the percentage of floral ornamentation / of forest…).

These criteria lead us to distinguish three main categories of urban green spaces:

- Forests or semi-natural spaces;
- Ornamental gardens, including three subcategories: historical gardens, neighborhood parks and large green spaces;
- Allotment gardens (community gardens).

Among the 52 ones, we selected 6 urban green spaces to conduct a more in-depth study (Fig. 2). The criteria were to have one urban green space in each studied city and to select representative sites, belonging to each identified subcategory [4].

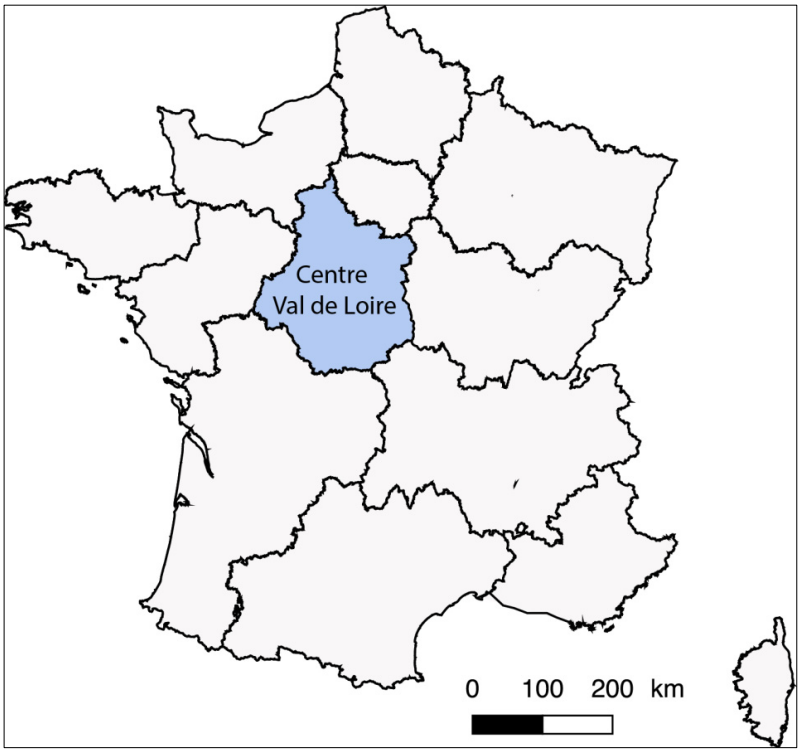


Fig. 1. Localization of the Region Centre-Val de Loire in France.

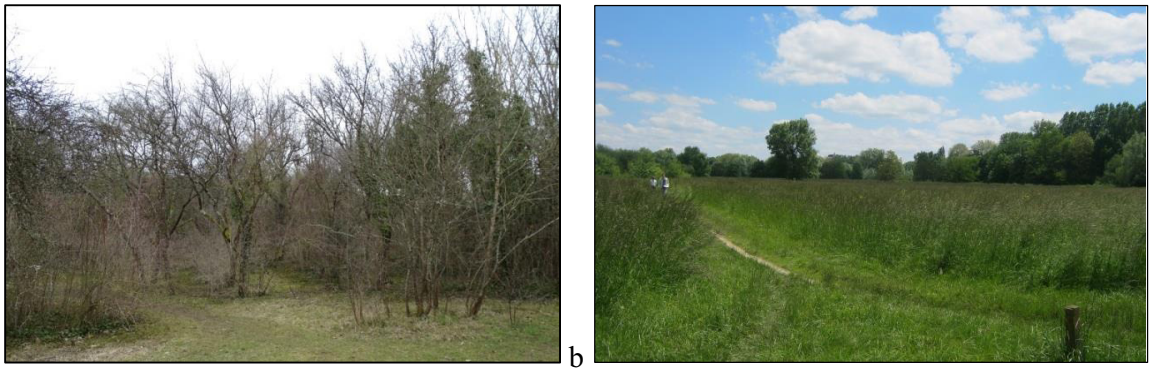


Fig. 2. Selected urban green spaces for a more in-depth study: Forests or semi-natural spaces: (a) Lazenay garden (Bourges) and (b) Saint-Gildas meadow (Châteauroux); Ornamental gardens: (c) Pasteur park (Orléans, historical garden); (d) Central park (Chartres, neighborhood park) and (e) Arrou park (Blois, large green space); Allotment gardens: (f) Bergonnerie gardens (Tours). Shots: J. L. Yengué (2013-2014) and A. Robert (2014-2015).

321 users were interviewed individually in the six selected urban green spaces, by structured and semi-structured manners. The number in each city varied, mainly due to the difference of frequenting of the parks (Tabl. 1). These interviews were completed by *in situ* observations, direct and without participation, in the same urban green spaces. The purpose was to identify the practices of the users, what contribute to their well-being and why they come in these spaces, in other words what kind of cultural ecosystem services (or also disservices) these gardens provide. It also guided the semi-structured interviews conducted with the managers that also aim to obtain another point of view. An elected representative, a head of department and a technician in charge of the urban green spaces management were questioned in four cities (Tabl. 1).

Table. 1. Number of users and managers interviewed in each city and in total.

	Blois	**Bourges**	**Chartres**	**Châteauroux**	**Orléans**	**Tours**	**Total**
Users	86	20	69	22	28	96	321
Managers	3	3	3	3	0	0	12

We were thus able to identify cultural ecosystem services provided by these urban green spaces but these services cannot exist without supporting services. Do these gardens provide also this kind of services? To obtain parts of answer, other studies were conducted in the same urban green spaces. The first one concerned biodiversity. It was based on the arthropods frequency because they are good biodiversity indicators, varying according to the practices and the vegetation types [5]. Indeed, they actively take part in the stability of ecosystems (pollination, decomposition of organic matter, base of the food chain) and they are particularly sensitive to environmental disturbances (short lifetime and rapid reproduction rate). The arthropods frequency was known by catching them thanks to passive methods, using Barber trap and Malay tent. These traps were placed in two different areas of each selected green space. Facing with constraints (short time and limited human resources), surveys were conducted during the same week to mitigate weather bias between the parks. They were repeated three times (in spring, early and late summer) and they lasted each time 48 hours. The caught arthropods were classified in morpho-species, basing on the RBA method (Rapid Biodiversity Assessment, developed in 2011). They were then sorted out according to their ecological roles. Another study was conducted in the same green spaces to know the soil quality [6, 7]. The survey spots were chosen according to the geological and anthropogenic environment and land use maps. The purpose was to identify local indicators of biodiversity, through the knowledge of soil parameters. The study thus took into account elements pertained to pedology (horizons, physical parameters including porosity, size grading...), agronomy (chemical composition including pH) and microbiology (characterization of microbial communities: diversity and density by MicroResp™ method – based on microbial breathing – biomass, metabolic quotient...).

The three studies (on city dwellers preferences, biodiversity and soil quality) were conducted in the same urban green spaces. This choice allows us to put in perspective each one of these studies by comparison with the two others. We thus obtained results at the same time and in the same spaces on cultural and supporting services. All urban green spaces provide ecosystem services, explaining that they have to be considered for the city of tomorrow.

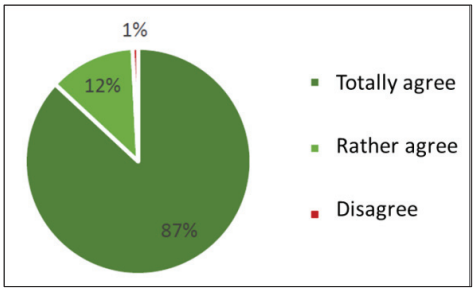
3. Results: The services provided by urban green spaces (well-being, biodiversity and soil quality) or the importance of urban green spaces for the city of tomorrow

In a general way, urban green spaces contribute to the urban quality of life. All interviewees, users or managers, are unanimous. They asserted this opinion whatever the urban green space is. This idea is not specific to the studied area, even France. It can be generalized. Indeed other researches lead to the same conclusion, as the assertion of A. Voigt *et al.* [3] proved, knowing that they conduct their study in public parks in Berlin (Germany) and Salzburg (Austria):

"Both quantity and quality of urban parks are increasingly recognized as important for the quality of urban life regarding a wide range of benefits and ecosystem services (e.g., Burgess *et al.* 1988; Chiesura 2004; Breuste *et al.* 2013[8-10] […])."

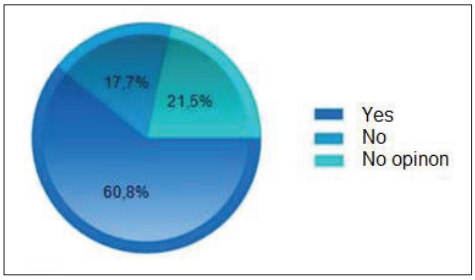
Almost all users think that urban green spaces are more or less important in the city (Fig. 3.a) and 60% of them even believe that studied parks or gardens contribute to the identity of the city and its inhabitants (Fig. 3.b). According to the literature and the accounts of the users, there is no doubt that the urban green spaces contribute to the well-being of city dwellers. The interviewed managers confirm, even if they moderate this idea, underlying some disservices. They indeed hear the complaints of some city dwellers [11] especially about inconveniences from trees (due to leaves fall and pollen) and about weeds. From then on, what kind of urban green spaces is more appreciated? Is it park without trees? The answer seems to be unquestionably no. These complaints maybe concern more urban nature outside urban green spaces. Indeed, trees are the first elements contributing to the well-being that users feel in green spaces (Fig.4). In importance order, the following elements are water and birdsong, then silence. Users thus come in urban green spaces to be closer to nature and/or to be quiet: urban green spaces are enclaves in the noisy cities. When users are questioned about the reason of their frequenting, we find the same elements, except that calm comes first. Some users also seek recreation and animation but they seem minority. This point moderates the importance of facilities and amenities and, by the same way, the assertion of some authors, who conclude that

"infrastructural facilities and amenities have a large impact on the recreational value of an urban park" [3]. In fact, the interviewed users consider that the first interest of these spaces is to spend time with family (45%). Urban green spaces are social place. This point is still truer than we consider that 35% users award importance to these spaces because they can meet people there. Consequently, urban green spaces provide cultural services that could all the more be considered as ecosystem services than they would be not so much derived from anthropic facilities and amenities. But are these spaces ecosystems, providing also supporting services?



Answer of some users of the six studied green spaces to the following questions:

a. "Urban green spaces are important in a city", what do you think about this assertion? – Source: Launay, 2014 [12], transl.



b. Do you think that this urban green space contributes to the identity of the city and its inhabitants? – Source: Cosquer, 2014 [13], transl.

Fig. 3. Opinion of users about the importance of urban green spaces.

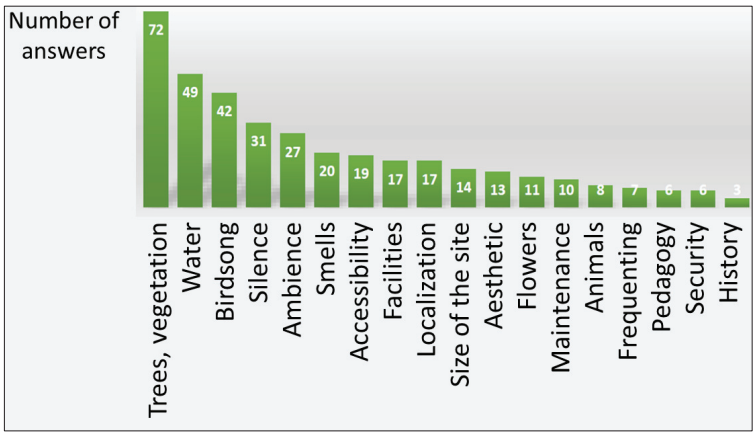


Fig. 4. Elements that contribute to the well-being in urban green spaces, according to users accounts. Source: Cosquer, 2014 [13], transl.

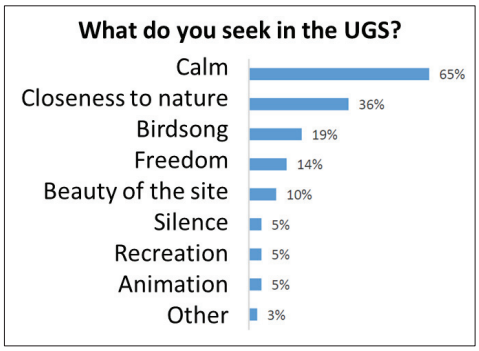


Fig. 5. What users seek in urban green spaces, according to their accounts? Source: Launay, 2014 [12], transl.

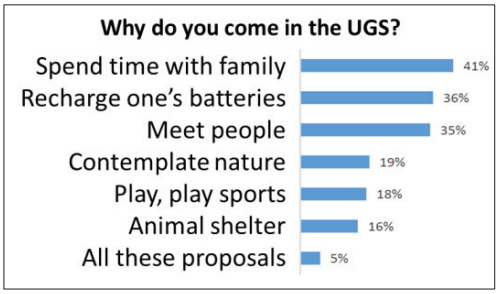


Fig. 6. The reasons of the interests taken in urban green spaces, according to the users accounts. Source: Launay, 2014 [12], transl.

The study on biodiversity was based on the arthropods frequency and different elements were considered [5]. The first one was the diversity of the categories included in this group, particularly the ratio between predators-parasitoids and pests. The second focus element was the time evolution between the three trap periods, to know if the urban ecosystems are stable. This survey conducted in the six chosen sites allows us to conclude that urban green spaces are biodiversity sites. Indeed, all the categories are well present. Only the frequency of phytophagous species, who are at the bottom of the food chain, is higher. If we analyze the time evolution in a general way, we can note a peak of morpho-species diversity in the early summer (maximal appearances and minimal disappearances). The stability of these urban ecosystems was evaluated thanks to the calculations of the biocontrol index, which consists in the ratio between natural enemies (predators and parasitoids) and pests. If this index is included between 0.2 and 1, the rate of predators is enough to maintain the balance of the ecosystem. Such a result was obtained for all studied green spaces, except Saint-Gildas meadow (in Châteauroux) because of an incidental phenomenon: the proximity of an ant-hill (Fig. 7). We can thus conclude that urban green spaces are biodiversity spaces and stable ecosystems, even if the research has to be continued.

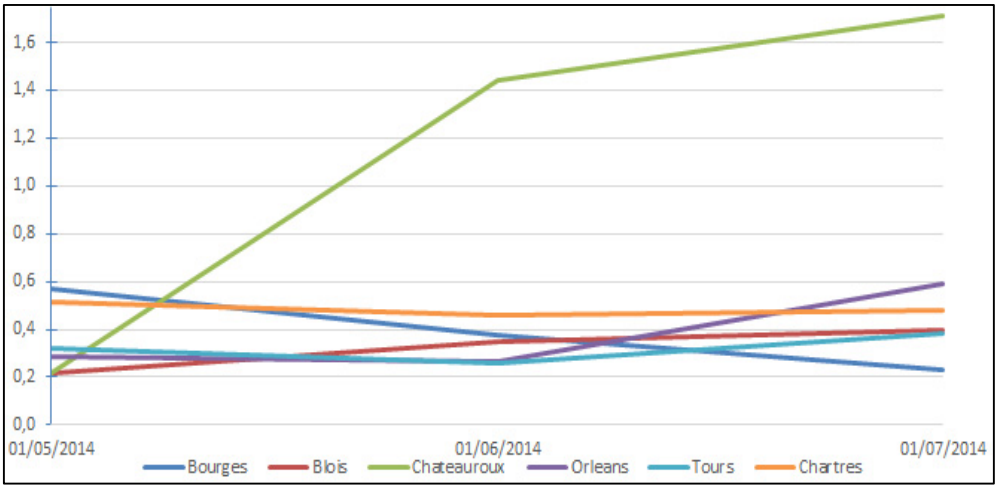


Fig. 7. Evolution of the bio-control index calculated for the six studied urban green spaces, between the three trap periods (May, June and July 2014). Source: Cornillon, 2015 [5]

If we now consider the soil quality, are the results also positive? In other words, are the soils fertile and are they characterized by a micro-biological diversity? The analysis focused on pedological, agronomic and micro-biological elements [6,7]. Concerning the pedology, some differences exist but we can draw up some general conclusions. Indeed, globally, the air flow in the soils is satisfactory. The texture is often clayey. Consequently, the soils constitute good reserves of water and nutrient elements and they have a stable structure (favorable for an easy rooting). They are also well drained. From agronomic point of view, the soils have a low acidification potential (pH between 7.1 and 7.6). In a general way, the concentrations in chemical elements are homogenous in a given park. The ratio between organic Carbone (C) and total Nitrogen (N) indicates the biological activity. It is low for all the soils samples taken in the studied urban green spaces. We can thus conclude that the organic matter decomposes quickly. According to the biomass calculations conducted in the framework of the micro-biological study, this organic matter is also abundant and this condition is favorable to the microbial development. The microbial communities are not in stress state, according to the obtained metabolic quotients (qCO2). These ones allow to know the physiologic state of the micro-organisms, especially their ability to use the carbone available in the soil for the biosynthesis. In the studied spots, they remain low (less than 0.04). The soils are rich in organic carbone and their structure is stable: these conditions explain that the microbial communities are also characterized by a quite high diversity, as the calculations of catabolic equitability index prove it.

At this stage of the reflection, we can assert that urban green spaces provide cultural and supporting ecosystem services. Users and managers agree on the fact that they contribute to the well-being of city dwellers: they are leisure, relaxing or meeting areas. They are also biodiversity spots and the quality of their soils is good, favorable to the development of important and diverse microbial communities. These spaces have thus to be included in the city of tomorrow. But there is a diversity of urban green spaces. In our research, we distinguished five types, including the three subcategories of ornamental gardens. Which one constitutes the ideal green space?

4. Discussion: The ideal urban green spaces, multifunctional green spaces

If we generalize the results obtained from the interviews, all urban green spaces are appreciated. Indeed, according to the accounts, users seek calm, closeness to nature and meeting people. The facilities and amenities seem to be not so important. Consequently, all urban green spaces can provide them these services. But if we analyze in detail the results, some differences appear and reveal that the different characteristics are complementary.

All urban green spaces are approved but some are less frequenting. Among the ones we studied, users were less numerous in Lazenay garden (Bourges) and Central park (Chartres). They belong to different categories of urban green spaces, what allows us to conclude that the reason has to be researched elsewhere, more in the environment, maybe in the fact that they are places, where traffics are suspected, according to some accounts. But, through the example of Lazenay garden, an element has to be questioned: the maintenance of vegetation. Indeed, Lazenay garden belongs to the forests or semi-natural spaces category. Questioned on this point, a majority of users underline the importance of maintenance (66% of the interviews) but largely to deplore the negative consequences: they think that a space less managed (shearing, pruning) is less clean (31% of them), less aesthetic (37%), even adding that it can hamper the activities (21%) [13] – this point of view can be linked to the city dwellers complaints mentioned by managers. But for others, the importance is positive. They are favorable to a lesser maintenance because of the interest for animals (20%) and the more natural aspect (16%). If we consider the other results of our study, ornamental gardens are more managed than forests and semi-natural spaces but biodiversity and the soils quality is satisfactory in both cases, even if some differences can be noted between green spaces.

The differences between urban green spaces are first in terms of maintenance. But it allows to satisfy the expectations of users, which are contradictory, as we underlined. Thus the idea of the complementary of urban green spaces emerges and it is confirmed by the analysis of the frequenting characteristics. Indeed, the reasons and the time of frequenting differ according to the facilities and the localization of the urban green space:

- Located at the heart of Orléans city, the Pasteur park is a historical ornamental garden (Fig. 2.c). It is almost frequented during the week by users working in the area [12]. They come there during their beaks, when the weather is mild. Because the park is near a high school, the users are quite young. During the week-end, the frequenting is still a closeness frequenting but the users are different, consisting mostly in families living in the area, in apartments. They appreciated the facilities for children but, like the users of the week, they come there because this urban green space is nearer and they could go in another one if this one was not here. Consequently, even if this park is appreciated, it is not representative of the expectations of city dwellers in terms of urban nature and it cannot give us an idea of the ideal green space for the city of tomorrow. But it is interesting to take into account this frequenting because it shows the request of green spaces inside the city heart, just to have a break.
- Arrou park (Blois) and Saint-Gildas meadow (Châteauroux) belong to different urban green spaces categories but their frequenting has similarities, maybe because they are outside the center of the city and they are more vast. The users are mainly between 30 and 50 years (60% of them). They come several times a week but mainly during the week-end and holidays [12]. They live in the city, not necessary near the studied park, in houses. These urban green spaces are indeed used like closeness park by area residents, who come there for their daily break – like in Pasteur park (Orléans) – but they are also frequented by other city dwellers coming for their week-end outing, with the purpose to escape from the city. The activities are various. While in Pasteur park (Orléans), the main activity is the relaxation, it is here the walk but the users also come to do sport and to go fishing. Indeed these two spaces include a lake (Pinçonnière lake in Arrou park) or a river (Indre river in Saint-Gildas meadow). Some families also frequent these parks to go out with their children. But it is truer for the Arrou park and the reason is the presence of playgrounds. Here the importance of amenities finally appears.
- The frequenting of another urban green space have to be detailed to understand the nature request from city dwellers and thus to identify the ideal green spaces. It concerns Bergeonnerie gardens (Tours), which are allotment gardens. The users are gardeners, who rent there a plot to cultivate. They are mainly older than 50 year and they live in apartments in the city [12]. The gardening is here the main activity but not the only one. Indeed, the gardeners also come there to relax, to meet people, to learn to their children and even to do sport, while others users come there to walk like in other green spaces.

Through this last example, we can note that the services can be more numerous than the assigned ones. The users can practice different activities in urban green spaces that contribute to their well-being: relaxation, walk, sport, fishing, gardening, learning, plays. Some involve amenities but not all. Belonging to the five identified categories, urban green spaces are complementary, all the more since they include different land uses, with areas more managed and others less maintained, with open vegetal formations and closed ones, also with water areas. This offer can be

proposed in different urban green spaces but also in only one, which can be considered as the ideal green space for the city of tomorrow. This one would be multifunctional to answer the expectations of the different city dwellers, providing a diversity of cultural ecosystem services but also supporting services.

The implications of a multifunctional urban green space are also positive for the urban ecosystems. Indeed, beyond the general conclusions, the studied parks and gardens are characterized by a diversity of situations, which illustrates the importance of the heterogeneity for biodiversity. The samples taken within St Gildas meadow in Châteauroux reveal a small presence of pollinators (nectarivores) during the three periods of trapping, and a strong presence of predators. In Arrou park in Blois, the results of the survey are different: pollinators are numerous (in June and July). In fact, these differences in the results have to be linked to land use, the functions associated with urban green spaces that will be more favorable for some species than others:

- the tall grasses of St-Gildas meadow are particularly suited to predators;
- Arrou park is more favorable to pollinators, due to the presence of water and flowers;
- Central park and Lazenay park are two different parks but they are similar because of the lack of trend (partly because the surveys were less important).

Beyond these differences, all these urban green spaces are characterized by a quite important biodiversity. But these differences contribute to the biodiversity that is present in the city. And it is evident that promoting multifunctional green spaces, including different land uses, will contribute to reinforce this biodiversity, all the more since urban ecosystems remain stable ecosystem – as our survey proves it, with the calculations of biocontrol index, even if research has to be continued.

5. Conclusion

In occidental countries, the social request of nature is high, so much so that some authors speak about “green fever” [14]. In the city, the urban green spaces are appreciated and even required because they are considered as contributing to the well-being of city dwellers. The idea is unanimously approved. It appears in the literature [15, 16, 17] and it is confirmed by users and managers of green spaces. The point of view of these ones was collected in the framework of this study, whose purpose was to identify cultural and supporting ecosystem services provided by urban nature. Interviews were thus completed by surveys on biodiversity and soil quality. All studies were conducted in the same green spaces to allow the comparison of the results. These spaces belong to different categories of urban green spaces because the purpose was also to identify the ideal one for the city of tomorrow. The general conclusions allow us to confirm the importance of urban green spaces for this one. These spaces are leisure, relaxing or meeting areas. They are also biodiversity sites, where the soils quality is quite satisfactory, characterized by a microbiological diversity. But to identify the ideal green space, we have to consider also the particularities of each studied one, to compare the individual results. We thus learn that users have different expectations and the reason and the time of their frequenting vary. The different urban green spaces are complementary and the ideal park seems to be a multifunctional space, with different areas corresponding to the different practices of users: to walk, to relax, to play, to do sport, to meet people, to learn, to fish and even to cultivate. This last service belongs also to provisioning services – according to the ecosystem services typology proposed by the Millenium Ecosystem Assessment [2]. These ones appear to be more important in the cities of southern countries. Indeed, urban nature there provides to the households food products but also firewood and timber. Knowing that these city dwellers often combine these gatherings with recreational activities [18], it confirms the idea that the ideal urban green space for the urban future should be multifunctional.

Acknowledgements

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