



# Analysis and evaluation of soundscapes in public parks through interviews and measurement of noise

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## ABSTRACT

The purpose of this work was to investigate the sound environment of public parks using a soundscape study model that analyzes not only noise but also all the types of sound of a given area, as well as other environmental factors. To this end, acoustic measurements were made in the parks under study and interviews were held with their frequent visitors. Noise measurements were conducted in 55 points, and a total of 335 people were interviewed in the 4 parks studied. The parks selected for this study are located in areas very close to streets with intense vehicle flow, raising the hypothesis that this proximity impairs the acoustic comfort of their visitors. The findings confirm the strong influence of traffic noise on the soundscapes of the parks. Noise measurements showed that in all parks, between 50 and 100% of the points evaluated displayed sound levels above 55 dB(A), the level established by Curitiba's Municipal Law 10625 as the limit permitted for green areas during daytime. Other conditions in the parks' environments were also identified, which interfere jointly in the soundscape and in its perception, such as spatial factors of each park, the urban setting of its surroundings, and the sounds originating inside the parks.

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## 1. Introduction

The soundscape of a city is an important environmental reference of the quality of life in the urban setting (Pereira, 2003; Raimbault and Dubois, 2005). However, the continuous technological advances of industrialization and their essential introduction into the life of society over the last century have led to considerable negative impacts on the urban soundscape, since the noises created by humanity multiply continuously through these advances (Zannin et al., 2001, 2002, Raimbault and Dubois, 2005). This fact, combined with the expansion of urban populations and the lack of information and sensitiveness about the problem of noise pollution, has generated a widely diverse range of unpleasant noises (Pimentel-Souza, 1997).

Researchers and society in general are increasingly concerned about this issue, and there has been a surge in the development of researchers and the creation of laws and regulations to mitigate the impact of these disagreeable noises in the social environment, emphasizing the fight against this current and harmful type of pollution (Brown, 1994; Pandya, 2001; Zannin et al., 2001; Zannin and Szeremeta, 2003; Alves Filho et al., 2004; Krüger and Zannin, 2004; Brambilla, 2004; Diniz and Zannin, 2004; da Paz et al., 2005; Zannin et al., 2006).

In Curitiba, noise pollution is monitored based on ABNT (2000) and Prefeitura Municipal De Curitiba (2002). The Standard and the Law dispose about urban noises and protection of public well being, establishing permissible limits of noise by urban zone and times of the day. In the case of “green areas”, the permissible limit for daytime is the equivalent continuous sound level  $L_{Aeq} = 55$  dB.

The Canadian musician and composer R. Murray Schafer (2001) introduced the concept of a “soundscape”, describing it as any sample of the sound landscape classified as a field of study. According to Schafer (2001), the analysis of all types of sounds in a given area or region is called “soundscape”. In other words, the soundscape consists not only of noises (unpleasant sounds) but also of a wide range of other sounds that are indispensable in distinguishing and identifying a place, although in urban environments these sounds are mostly masked by environmental noise, particularly originating from automotive vehicle traffic (Schafer, 2001; Pereira, 2003; Hokao, 2004; Downing and Hobbs, 2005).

As they involve human perception, studies on soundscapes should not be restricted to acoustical determinations (Zannin et al., 2003). It is thus of relevance to associate and correlate acoustical measurements with other parameters of evaluation, as for example interviews conducted with the population (Zannin et al., 2003). According to Pereira (2003), the concept of noise discomfort depends on the circumstance, on the personal activity being carried out, and the object of attention and interest of a certain person or group of people.

Since they are open urban areas, parks are considered “green” areas and their various roles in a city are of crucial importance, contributing significantly to the quality of life. Green urban area is

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therefore considered a special type of free space with a predominance of planted areas, which should fulfill three main functions: esthetic, ecological and leisure (Milano, 1984; Nucci, 2001).

Therefore, although Curitiba has established many parks in the last two decades, little is known about the environmental factors or agents that influence the way the community uses these sites and how the users perceive and evaluate these spaces from a social or ecological standpoint. It is extremely important, therefore, to study aspects of the acoustic comfort of these places by the relation of the soundscape of these areas with their active visitors (Nucci, 2001).

The parks chosen for this study are located in strictly urban areas, surrounded by streets with intense vehicle traffic, which leads to the hypotheses that Municipal Law 10625 is being violated and that the acoustic comfort of the parks' users is not being respected. This study assesses the soundscape of public parks in Curitiba based on acoustic field measurements and on interviews with the users of these areas to ascertain how they perceive their local soundscape. Curitiba is located in south Brazil and has an estimated population of 1.8 million people.

## 2. Materials and methods

Curitiba is known both nationally and internationally for its tradition of preserving green areas. Considering only green areas equal to or larger than 2000 m<sup>2</sup>, the municipality's forest cover in 1985 was about 15.1% and corresponded to a mean value of 50.2 m<sup>2</sup> per inhabitant.

The green areas selected for this study were the following parks: Barigüi, São Lourenço, Jardim Botânico and Passeio Público. Table 1 displays the area of each Park, its year of foundation, and distances from city center.

The criterion for this choice was based mainly on the fact that these parks are located in areas of great urban density, surrounded by streets with heavy vehicle traffic (Zannin et al., 2006). Another factor underpinning the choice of these parks was the extent (Table 1) and therefore the diversity of uses and functions these parks make available in the city.

### 2.1. Acoustic and spatial data

The acoustic measurements served to assess and analyze mainly the influence of vehicle traffic in the surroundings of the parks' soundscapes. The locations and numbers of points assessed in each park were chosen based on the analysis of aerial photographs and on technical visits. The measurements were taken on the trails or paths (bicycle paths) where the visitors walk and/or carry out their activities. Thus, the location and number of points measured were defined so as to encompass the internal area of the parks and corresponded to the sites frequented by the parks visitors, aiming to standardize and control the data and ensure their reliability.

All the measurements were taken on weekdays (Tuesdays, Wednesdays and Thursdays) in May, August and September 2006, between 2:00 and 5:00 p.m. This time frame was chosen to avoid the peak traffic times around noon and late afternoon.

The sound levels were measured with a Brüel & Kjaer 2238 sound level meter. The entire measuring procedure was conducted according to the ABNT (2000) and the Prefeitura Municipal De Curitiba (2002).

A total of 55 points were measured (see Table 2). Each point was measured for 5 min, on days without rain or strong winds. This

**Table 2**

Number of points measured in each park.

Urban parks	Number of points measured
Jardim Botânico	15
Passeio Público	15
Parque São Lourenço	12
Parque Barigüi	13

measuring time was chosen so that all measurements in each park could be carried out in a single day within the stipulated time frame. The Brazilian Standard NBR 10151, which details the measurement procedures for environmental noise in Brazil, does not set a minimum duration for the measurements, but states the following: "Measurement time must be set as to allow the characterization of the noise under study". The methodology here employed has been already used in other studies, such as in Zannin et al. (2006). In this cited study, only noise measurements have been used to characterize the condition of noise pollution in parks, and measurements had the duration of 3 min, whereas 5 min were employed here. It should be highlighted that in each park several points have been assessed, to ensure an adequate characterization of its noise levels (see Table 2). Another relevant aspect is that the interviews have been conducted at the same time, in the same locations of the noise measurements (see Section 2.2).

It was also decided to take only one sampling of acoustic data in each park. Thus, no repetitions were made since observations of the areas and their surroundings indicated that the flow of vehicle traffic (the main noise source) in the measured time period remained constant on weekdays, except on holidays. No measurements were therefore taken during weeks which had a holiday.

### 2.2. Interviews

The interview system employed in the four parks of this study was personal and individual, involving users of these areas and carried out simultaneously to the measuring process by five previously trained interviewers. A random criterium was employed for the selection of the interviewed people. People have been approached during their activity inside the Parks in the walking/jogging lanes, volunteering for the survey. To avoid inducing responses, the interviewees were instructed not to mention, under any circumstance whatsoever, that the research was aimed at analyzing the soundscape or the acoustic comfort of the site. Instead, they were to explain that the interview was about the park's environmental quality, giving the proposal a more general aspect.

The questionnaire used for this interview consisted of closed-ended and open-ended questions, which were divided into three main sections. The first section comprised identifying data of the interviewee, the second involved characteristics of the user's profile in terms of his use of the park, and the third covered aspects of his perception of the soundscape and environmental quality of the park. The third section of the questionnaire was prepared based on a methodology tested and validated by Pereira for the study of sound perception in public spaces in the city of Rio de Janeiro (Pereira, 2003), with a few minor adaptations for the present study. This part consisted of five open-ended questions (1–5) and 2 closed-ended questions (6 and 7) on a Likert scale:

1. In your opinion, what is the most pleasant aspect of the park's environment?
2. What is the aspect of the park you find the most unpleasant?
3. With regard to the sounds you are hearing, which of them can you identify?
4. Which of these sounds do you consider pleasant?
5. Which of these sounds do you find unpleasant?
6. What do you think of the volume of the environmental sound?
7. Does this volume bother you?

**Table 1**

Area, distance from the city center, and year of foundation of the parks.

Urban parks	Founded	Area (m <sup>2</sup> )	Distance from the center (km)
Passeio Público	1886	69,285	Downtown
Barigüi	1972	1,400,000	5.00
São Lourenço	1972	203,000	3.50
Jardim Botânico	1991	270,000	2.50

Note that none of these questions involved the word “noise” in order to avoid inducing responses about this issue. The word “noise” (negative connotation) was replaced by “sound” (neutral connotation). Another aspect of non-induction is that spontaneous remarks about the soundscape in questions 1 and 2 were considered, advancing progressively toward the user’s perception of sound but not leading him to this aspect from the start.

In question 3, all the sound-related events identified by the interviewee were recorded. These events were catalogued according to their referential aspects, based on Schafer (2001), which was used in one of the subprojects of the World Soundscape Project: a) Traffic sounds, b) Human sounds, c) Natural sounds, d) Bird sounds, e) Machine-related sounds, f) Music-related sounds, g) Communication or Signaling-related sounds, and h) Others (that do not fit the aforementioned items).

Questions 4 and 5 concerned the users’ opinions about the esthetic quality of the sounds they identified. The importance of these questions lies in the fact of knowing which sounds should or should not be preserved in the environment under study.

### 3. Results and discussion

#### 3.1. Acoustic data

Fifty-five points were assessed in the four parks studied. Table 3 shows the equivalent continuous sound level  $L_{Aeq}$  and its corresponding maximum and minimum values; that is, the maximum A-weighted level  $L_{AMax}$ , and the minimum A-weighted level  $L_{AMin}$ .

Data in Table 3 shows that in Jardim Botânico Park 53.3% of the evaluated points are above the limit set for sound emissions of  $L_{Aeq} = 55$  dB(A), the level established by Curitiba’s Municipal Law 10625, for green areas during daytime. In Passeio Público Park, 100% of the evaluated points are above the established noise limits. These 2 parks have a common characteristic, they are surrounded by urban streets with intense traffic flow. In Barigüi Park 53.8% of the evaluated points are above the limit. The fourth park, São Lourenço, displayed 50% of the evaluated points above the allowed limit. These last 2 parks have only part of their frontiers sided by streets of heavy traffic flow.

#### 3.2. Interviews

A total of 335 people were interviewed in the 4 parks of this study. Table 4 shows Number of interviews in each park, identification data, and forms of usage by the park’s visitors:

**Table 4**  
Number of interviews in each park, identification data, and forms of usage by the park’s visitors.

	Total number	Percent (%)
<i>Gender</i>		
Male	211	63
Female	124	37
<i>Age</i>		
17 to 29 years old	143	42.7
30 to 40 years old	76	22.7
41 to 51 years old	64	19
Over 51 years old	52	15.6
<i>Level of schooling</i>		
Elementary	55	16.4
High school	145	43.3
Higher education	135	40.3
<i>Time spent in the park</i>		
1 h	136	40.6
2 h	88	26.2
3 h	85	25.4
Passing through	26	7.8
<i>Weekly visits to the park</i>		
More than 3 times	130	38.8
3 times	57	17
Twice	57	17
Once	91	27.2
<i>Type of activity engaged in the park</i>		
Physical activity	176	52.5
Reading	40	12
Watching nature	77	23
Passing through	20	6
Others	22	6.5

#### 3.2.1. Sound and environmental perception in the parks

The answers of the 335 interviewees in the 4 parks to questions 1 and 2 indicate a higher rate of spontaneous evocation of pleasant aspects of the soundscape (23%) than of disagreeable ones (4.5%).

The answers to the question about the most agreeable aspects (Fig. 1) referred mostly to the visual landscape (53%), particularly the beauty and exuberance of the vegetation in the parks. This is congruent with Milano (1984), who states that the vegetation is responsible for the creation of esthetically pleasing environments, which give value to an area and act as a stress-mitigating element (Fig. 1).

**Table 3**

Sound levels measured in each park: maximum A-weighted level ( $L_{AMax}$ ), A-weighted equivalent continuous sound level ( $L_{Aeq}$ ), and minimum A-weighted level ( $L_{AMin}$ ).

Measured point	Urban parks											
	Jardim Botânico			Passeio Público			São Lourenço			Barigui		
	$L_{AMax}$	$L_{Aeq}$	$L_{Min}$	$L_{AMax}$	$L_{Aeq}$	$L_{Min}$	$L_{AMax}$	$L_{Aeq}$	$L_{Min}$	$L_{AMax}$	$L_{Aeq}$	$L_{Min}$
1	70.8	60.1	49.4	77.9	65.4	58.1	66.3	50.6	40.9	73.2	56.7	51.8
2	65.6	51.7	45.9	81.5	68.5	57.9	71.1	56.5	42.3	69.8	59.4	53.8
3	66.2	55.5	49	88	67	56.7	69.5	59.9	51.8	70	56.3	49.8
4	76.9	64.5	53.8	71.4	59	52	68.7	59.2	55.6	63.6	53	46
5	89.9	69.5	52.9	77.2	62.5	58.5	69.2	57.3	45.5	76.7	56	46.7
6	78.2	62.1	50.2	78.7	64.1	56	70.8	55.3	44.8	72.8	56.4	44.7
7	75.6	63.2	46.8	78.6	63.9	54.3	63.2	51.6	42.8	70.9	53.8	47
8	70.7	55.8	52	82	67.5	53.8	70.2	55.2	44.2	85	63.7	50.4
9	77.6	64.8	56.6	74.6	59.4	53.2	66.3	53.5	42.2	72.6	53.2	44.1
10	76.7	52	46.9	78.5	60.3	53.9	66.4	52	43.4	69.1	50	42
11	69.6	53.2	48.4	65.5	58.6	53.4	67.3	49.2	39.2	71	56	48.4
12	70.2	52.4	48.2	81.4	64.3	59.8	64.5	53.1	43.4	72.2	51.7	45.9
13	67.2	53.4	48.9	64.7	57.2	53				73.1	51.4	45.8
14	68.1	53.2	50	71	59.8	52.5						
15	74	51.5	46.9	71.7	60.2	55.4						

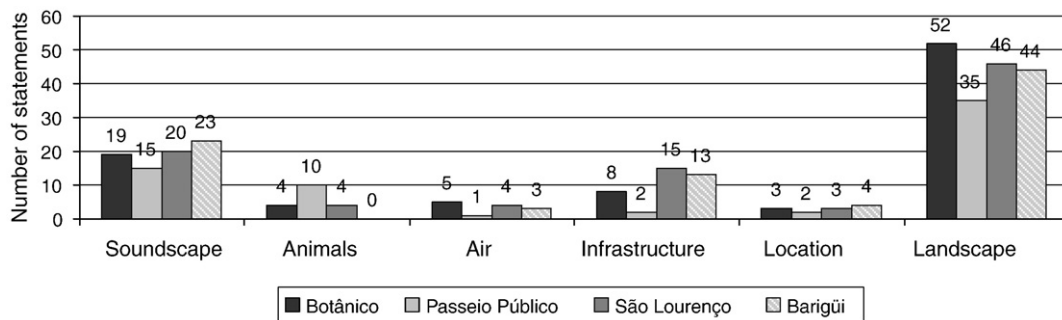


Fig. 1. Number of statements about the pleasant aspects of each park.

In the Jardim Botânico, 21% of the interviewees who spontaneously mentioned the soundscape in the question about the pleasant aspects (19 instances), 11 referred to the park's tranquility, 6 mentioned birdsong, and 2 mentioned the silence. In the Passeio Público, of the 24% of interviewees spontaneously mentioning the soundscape (15 instances), 8 referred to the tranquility and 7 to birdsong. In São Lourenço park, of the 20 people who mentioned the sound environment (22%), 7 referred to the park's silence, 7 to the tranquility and 5 to the birdsong. In Barigüi park, of the 26% interviewees who spontaneously referred to the soundscape (23 instances), 15 mentioned the tranquility, 3 talked of birdsong, and 2 mentioned music.

The most frequently cited unpleasant aspect of São Lourenço and Barigüi parks was water pollution. In the Passeio Público, the factor causing the most distress was the presence of prostitutes and vagrants in the park. In the Jardim Botânico, most of the interviewees (55%, 50 instances) stated they found no unpleasant aspect in the environment (Fig. 2).

With respect to the soundscape in Jardim Botânico, only 7.6% of the interviewed people spontaneously evoked any sound as being disagreeable (7 occurrences), 5 mentioning the surrounding traffic noise and 2 mentioning the noise from lawn mowers. In the Passeio Público, only one person specifically mentioned the noise of buses from the surroundings. In São Lourenço park, only 2 interviewees mentioned feeling bothered by the noise of surrounding traffic. In Barigüi park, 5.7% of the interviewees (5 instances) mentioned sound-related aspects, while 3 mentioned the quality of the music coming from the snack bars situated in the park.

In answer to question 3, about the identification of sounds, most of the interviewees mentioned more than one sound event and also different categories. Together, the 335 interviewees identified 852 sound events, according to their referential aspect (Schafer, 2001), distributed in 10 groups: birds, vehicle traffic, people, other sounds of nature, machines, music, air traffic, warning signals, trains, and others.

The sounds of birds, vehicle traffic, other natural sounds and people were identified regularly in the area of the 4 parks, making up a total of 89.9% of the sample and confirming that these are the principal sounds that make up the soundscape of these areas. Thus, 32.6% of the references involved birdsong, 28.5% vehicle traffic, 15.8% other natural sounds, and 13% referred to human sounds (Table 5).

An individual analysis of each park revealed that the sound most frequently identified in the Passeio Público, São Lourenço and Barigüi parks was birdsong, which was mentioned by 39.4%, 36% and 26.5% of the interviewees, respectively. This was followed, in the same park, by vehicle traffic sounds, which were mentioned by 26%, 30% and 23.8% of the interviewees.

In contrast, in the Jardim Botânico, the sound most frequently mentioned was noise from surrounding vehicle traffic (34.4%). However, birdsong was mentioned less frequently (31.6%). In this park in particular, train sounds were also mentioned 12 times (5.6% of the interviewees), since a railroad passes right alongside the park.

Although the Passeio Público is located downtown, where it is easy to see the negative impact of intense vehicle traffic on its soundscape, this park is the one with the highest percentage of identified natural sounds. Together, the "bird sounds" and "other natural sounds" corresponded to 59.4% of the sounds perceived in this area. The reason for these answers may be the fact that this space is covered in abundant vegetation, in addition to the presence of various species of bird and monkeys in cages, which sing and scream loudly.

Barigüi was the only park where other natural sounds were mentioned fewer times than human sounds, i.e. 13.7% versus 18%. This is understandable when one considers that this park has a much larger area and receives more daily visitors than the other parks of this study (Hildebrand, E, personal communication). Barigüi park also had a more diversified soundscape than the other parks because the types of sounds identified were more uniformly distributed. For example, in addition to the types of sounds that were common to the four parks, machine sounds were reported by 8.2% of the interviewees (21

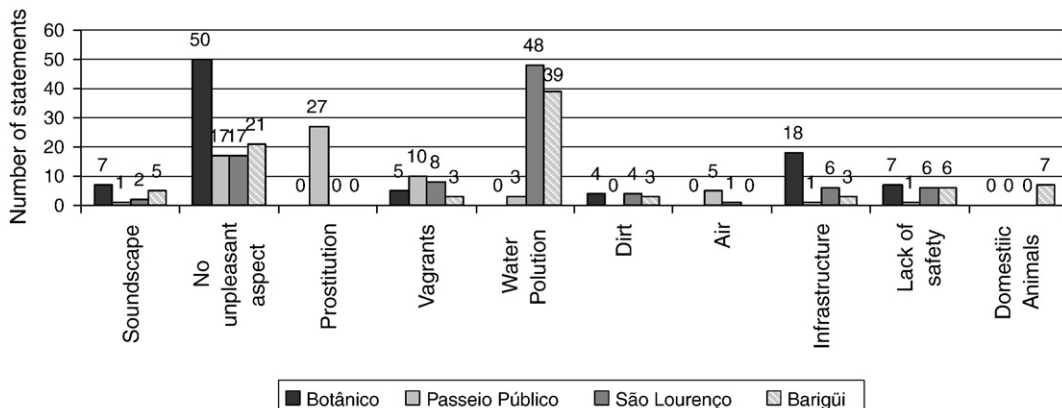


Fig. 2. Number of statements about the unpleasant aspects of each park.

**Table 5**  
Number (absolute frequency – AF) and percentage of references to the types of sounds in the parks.

Question 3	Parks							
	Botânico		Passeio Público		São Lourenço		Barigüi	
Identified sounds	%	AF	%	AF	%	AF	%	AF
Birds	31.6	68	39.4	59	36	83	26.5	68
Vehicle traffic	34.4	74	26	39	30	69	23.8	61
Other sounds of nature	13.4	29	20	30	17.6	41	13.7	35
People	10.7	23	10	15	11.2	26	18	46
Machines	1.4	3	0	0	0	0	8.2	21
Music	0	0	1.3	2	0	0	5.8	15
Air traffic	1.9	4	0	0	0	0	2	5
Warning signals	1.0	2	2	3	0	0	1.2	3
Trains	5.6	12	0	0	0	0	0	0
Others	0	0	1.3	2	5.2	12	0.8	2
Total	100	215	100	150	100	231	100	256

instances) and musical sounds by 5.8% (15 instances). The sound of machines came from lawnmowers and from an amusement park set up on the park's grounds and the music originated from the park's snack bars and restaurants.

Thus, given the answers provided to question 3, it is apparent that even in conservation areas such as public parks, traffic noise is easily perceived, adding up to 28.5% of all sounds mentioned in the 4 parks. However, it does not dominate the soundscape of these spaces as it does in most open urban environments, since people are able to identify different sound events. This demonstrates the diversity of sounds in the soundscape, as well as the intelligibility of this environment, where sounds can be heard distinctly. In other words, the surrounding traffic noise does not mask other sounds coming from inside the park, especially birdsong, human sounds and other sounds of nature (wind, water, trees and other animals).

With regard to the opinion (questions 4 and 5) about the esthetic quality of the sounds, 68.2% of the 852 sound events identified were considered pleasant and 31.8% unpleasant. In the response to question 4, all the "bird" and other "natural" sounds identified were deemed pleasant by the interviewees in the 4 studied areas. Human sounds were also mostly considered pleasant (86.4%). Fig. 3 displays the number of assertions relative to pleasant sounds identified in each park.

In response to question 5, most of the sounds identified as vehicle traffic were considered unpleasant (84.2%) in the 4 parks, although some of the interviewees had classified this sound as pleasant in the previous question. This was particularly true in Barigüi park, where, of the 61 references to this type of sound, 36% considered it pleasant. At the Jardim Botânico, 19% of the 74 references to this type of sound considered it pleasant. Fig. 4 displays the number of assertions concerning disagreeable sounds identified in each park.

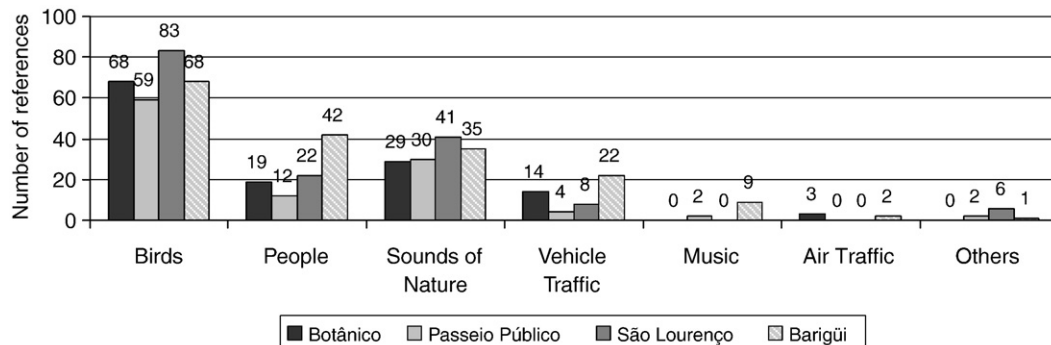
Analyzing the responses to questions 4 and 5, one can see that birdsong, human sounds and other sounds of nature should be preserved in the parks' environments. To this end, effective alternatives should be sought to protect these areas from exposure to the various polluting agents common to urban areas since one of the roles of parks, in their capacity as institutions of conservation, is to protect the natural elements, thereby ensuring their best environmental quality. Therefore, a policy of protection of the surroundings, especially insofar as land use is concerned, should be taken into account in the pre-and post-implementation of parks. Poor planning may impair the vegetation and/or fauna of these sites, and hence, their soundscapes, since a well balanced soundscape requires a well balanced environment. Indeed, an analysis of the number of references to the type of sounds identified by the interviewees, as well as the acoustic data, indicate that traffic noise, which the majority (84.2%) considered unpleasant, is present quite intrusively even in places such as these parks. Table 6 displays the percentage and absolute number of opinions referring to the level of noise in each park.

As for questions 6 (Table 6) and 7 (Table 7), the opinion of most of the 335 interviewees about the sound level of the environment is that it is normal (72%) and not irksome (81.5%), although all the parks showed between 50% and 100% of the measured points with sound pressure levels exceeding the limit of  $L_{Aeq} = 55$  dB, permitted by Curitiba's municipal law 10625. Table 7 displays the percentage and number of opinions referring to the irksomeness from the sound levels detected in each park.

Although the Jardim Botânico ranked second in this study in terms of sound levels, with a spatial average of 61.6 dB(A), showing the strong influence of the intense traffic in the surrounding streets, most of the interviewees considered the sound level of the environment normal (62.6%) and only 26.4% stated they found this sound level irksome to some extent ("a little", "more or less", or "very" irksome). However, among the spaces studied here, this is the one with the highest percentage of people bothered by the sound level, although more than half of them (14.3%) were only "a little" bothered.

The Passeio Público, located downtown and completely surrounded by streets with heavy vehicle traffic, showed the highest sound pressure levels of the four parks, with a spatial average of 63.9 dB(A). Even so, most of its visitors considered the ambient sound level normal (73.8%) and only 23,1% stated they irked by it. However, compared to the other parks, this one presented the highest percentage of people who stated they were "more or less" (12.3%) or "very" (4.6%) bothered.

At São Lourenço park, the responses to questions 6 and 7 showed values very similar to those of the Passeio Público, although it presented relatively much lower sound levels (spatial average of 55.6 dB(A)) and dissimilar spatial characteristics. One example of this is that it is located in a much quieter neighborhood (strictly residential), while the Passeio Público is situated downtown. Thus, 72% considered the sound level normal and only 21.7% found it irksome.



**Fig. 3.** Number of references to pleasant sounds identified in the parks.

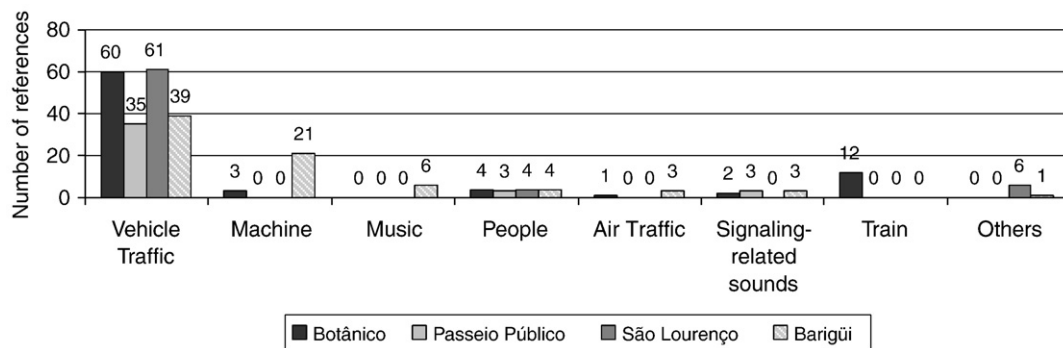


Fig. 4. Number of references to unpleasant sounds identified in the parks.

Barigüi park showed a spatial average sound level of 56.9 dB(A), which was attributed to the fact that it is surrounded mostly by residential areas and high traffic streets in the surroundings exert less influence on its soundscape especially due to its large size. This size, in response to question 7, stood out for presenting a much lower rate (3.5%) of irked people compared with the other parks. This finding was corroborated by the lowest and highest percentage of answers rating the environment's sound level, respectively, as "high" (2.3%) and "low" (16%).

A comparison of the interview data and the results of the acoustic measurements indicated the visitors to these spaces have a certain tolerance to high sound levels. In fact, of the 335 people interviewed in the four parks, only 18.5% stated the "sound volume" bothered them to any extent ("a little", "more or less", or "very"), while a minority (11.3%) judged it to be high.

In the Passeio Público and Jardim Botânico this tolerance was even higher, since both presented far higher sound pressure levels than that permitted by Municipal Law 10625.

It should also be kept in mind that traffic noise from the surroundings was the second type of sound most frequently identified in all the parks except the Jardim Botânico, where it topped the list of identified sounds. This response makes the influence of traffic noise more evident and was confirmed by the acoustic measurements of the soundscape of these green areas, thus emphasizing the visitors' tolerance to high sound pressure levels.

This tolerance was revealed by the fact that the interviewees identified more pleasant sounds of nature (68.2%) than unpleasant sounds (31.8%). In other words, the perceived ambient sound level was composed not only of traffic noise and other unpleasant noises but also, and mainly, of pleasant natural sounds. Another point that reinforces this idea and justifies the reported lack of irksomeness is that the interviewees made more spontaneous reference to the soundscape in terms of its pleasantness (23%) than its unpleasantness (4%). These findings confirm that, in the presence of a pleasant sound such as birdsong, for example, the degree of irksomeness of the sound level prevailing in the soundscape is relatively low. Thus, the presence of

pleasant sounds can improve acoustic comfort considerably, even when the sound level is quite high (Feiber, 2004; Yang and Kang, 2005).

Another factor that may have influenced the perception of the ambient sound "volume" is the parks' visual landscape, especially their vegetation, which was found to be judged the most pleasant aspect. Previous studies have shown that the mere presence of vegetation renders the environment pleasing (Milano, 1984; Pereira, 2003), and may thus reduce the feeling of irksomeness caused by high sound levels.

#### 4. Conclusions

This study led to the following conclusions about the four parks: The sound level at most of the points evaluated (65.45%) in the parks exceeded the 55 dB(A) limit established by Prefeitura Municipal De Curitiba (2002) as acceptable for Green Areas. These acoustically polluted sites are located around the park's perimeter and are therefore closer to the streets with intense vehicle traffic, confirming the influence of these noise sources on the soundscapes of these public spaces.

The Jardim Botânico and Passeio Público parks, whose spatial averages of sound pressure levels were 61.6 and 63.9 dB(A), respectively, are completely surrounded by streets with heavy traffic and they border on different areas of the city. On the other hand, São Lourenço and Barigüi parks, whose spatial averages were closer to the legally established limit, i.e., 55.6 dB(A) and 56.9 dB(A), respectively, border mainly on strictly residential areas. Therefore, heavy street traffic in the surroundings does not affect the soundscapes of these parks to any appreciable extent since they are not completely surrounded by such streets, unlike the case of the two former parks.

An analysis of these urban elements and other spatial and acoustic characteristics of each of the four areas under study indicated that their soundscapes are affected by several factors. These factors include environmental and urban zoning, land use, main traffic routes, residential streets, vegetation, type of public transportation, and the park's typology and the sounds coming from inside it.

Table 6

Number and percentage of references to sound levels of the parks' environments.

Level of ambient sound	Parks							
	Botânico		Passeio Público		São Lourenço		Barigüi	
	No.	%	No.	%	No.	%	No.	%
Noticed nothing	7	7.7	2	3.1	6	6.5	1	1.2
Low	14	15.4	4	6.1	8	8.5	14	16
Normal	57	62.6	48	73.8	66	72	70	80.5
High	13	14.3	11	17	12	13	2	2.3
Total	91	100	65	100	92	100	87	100

Table 7

Number (absolute frequency – AF) and percentage of references to the irksomeness of the sound level in the parks' environments.

Irksomeness	Parks							
	Botânico		Passeio Público		São Lourenço		Barigüi	
	AF	%	AF	%	AF	%	AF	%
None	67	73.6	50	76.9	72	78.3	84	96.5
A little	13	14.3	4	6.2	10	10.9	2	2.3
More or less	8	8.8	8	12.3	7	7.6	0	0
Very	3	3.3	3	4.6	3	3.2	1	1.2
Total	91	100	65	100	92	100	87	100

It was therefore found that the identification and study of these factors can serve as an important tool to define an urban project compatible with the functions and uses of green urban areas. Provided they are used correctly and are based on proper planning and management, these factors can promote a greater sense of acoustic comfort. The assimilation of these factors also demonstrates the importance of interdisciplinarity in the study of different soundscapes. In other words, assessments of the sound environment should not be based solely on acoustically measurable data, but should include the analysis and correlation of other parameters.

The results of the interviews clearly indicate this need. This method enabled us to discover how people perceive the soundscape of the parks and to gain a better understanding of acoustic comfort. It was found that the level of discomfort or comfort of a population is not necessarily connected only to sound levels, but includes other factors (acoustic and non-acoustic) in the environment and in the receiver himself.

With regard to the question about unpleasant aspects, which aimed to elicit spontaneous references to the soundscape, the responses of most of the interviewees indicated that issues relating to noise pollution take a back seat to concerns such as water pollution and social problems (prostitution and vagrancy). These findings have important implications: 1) the visual features (non-acoustic conditions) of the landscape, such as vegetation, fauna, the contrast to its grey urban surroundings, and the sound qualities (acoustic conditions) perceived for being different from traffic noise, such as the sounds of birds, wind, water, and even of people inside the park, overcome the negative impact of the noise produced in the surroundings and jointly affect the perception of the soundscape. 2) The lack of concern on the part of the authorities and the visitors' lack of information about sound pressure levels may cause them to remain exposed to noise pollution for long periods and not demand that the authorities take steps to remediate the situation.

Another finding was that traffic noise ranked in second place among the most frequently identified types of sound and was considered unpleasant by the majority. However, that does not mean this element does not strongly affect the soundscapes of open urban environments and that it should not be given its due importance so that measures can be taken to mitigate its environmental impact. Nevertheless, in terms of the sound level, this type of sound did not have the same impact on the perception of the interviewees, most of whom considered the ambient sound level normal and not irksome. It should be noted that the interviewees were not asked specifically about the sound level of the traffic noise, but the question considered the "volume" of the soundscape as a whole. This was because the sound environment of parks is composed of different kinds of sounds, indicating that these places have a "sound identity" even when located in the midst of an environment that is prone to noise pollution. This definitively confirms the importance of analyzing the environment according to the soundscape study model. If the parks' sound environments were evaluated based solely on comparisons of the ambient sound levels and the limit established by law, or only on the visitors' opinions about these levels, any judgment about the acoustic comfort of these sites would undoubtedly be arbitrary.

In short, the opinion of the population in conjunction with the analysis of quantitative parameters is effective and can be very important for a better understanding and identification of the qualities that confer environmental comfort, in order to provide effective support for urban projects.

This study is considered innovative in its use of the soundscape assessment model in open areas in the city of Curitiba. The aim was to obtain an initial impression of how the parks' visitors relate to their soundscapes. No doubt increasingly in-depth studies and analyses

involving professionals from different fields of knowledge will provide additional information and further interpretations about the soundscapes of parks and other public spaces, revealing the wealth of detail of the subject and the complexity of man's relation with the sound environment.

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