

## Awareness of Noise Hazards and the Value of Soundscapes in Polish National Parks

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The goal of the studies undertaken in Polish national parks was to determine noise threats, examine the resources, assess the quality of soundscapes and identify the possibilities of their protection. The questionnaire method used in the studies made it possible to identify the awareness of noise threats and the value of soundscapes according to the park service staff. In addition, the semantic differential and description methods were used to learn how students assessed the soundscape quality of Polish national parks. Finally, avenues of further research on soundscape in environmentally valuable areas were indicated.

The research findings indicate that each national park in Poland is characterised by diverse and unique soundscapes and is subject to the pressure of road traffic and tourism resulting in noise hazards. The conservation of the acoustic values of parks is necessary and possible.

**Keywords:** landscape perception, noise, soundscape, quiet zone, national parks.

### 1. Introduction

As early as the 1960s, the Canadian composer and musicologist R. Murray Schafer observed the need for a change in how we consider noise abatement and suggested a positive approach to the sounds around us. According to Schafer, “a fascinating macro cosmic symphony is being played ceaselessly around us”. It is a symphony of the soundscapes of the world and we are its listeners, performers and composers at the same time. It is essential to recognize which sounds we wish to preserve, develop, and multiply in order to isolate harmful and wearisome sounds that must be eliminated (SCHAFER, 1976). The invasion of all-pervading noise can be countered by developing auditory sensitivity and improving the aesthetic quality of the acoustic environment through soundscape design. It is important to restore order in the soundscape, to improve, modify and eliminate undesirable sounds or to move them to other sites, and to preserve the sounds of the past. In 1970, at the Simon Fraser University, R. Murray Schafer founded his own research group, the World Soundscape Project, guided by the idea to thoroughly examine the soundscape in all its aspects, giving particular consideration to its determinants associated with human beings. The Project

sought to build a scientific foundation for acoustic design and discipline proposing ecological solutions for improving the aesthetics of the sonic environment. As part of the Project, studies were initially conducted in Vancouver (Vancouver Soundscape) and five European villages (Five Village Soundscapes). Schafer’s initiative has led to the development of an international acoustic ecology movement whose activity includes soundscape studies conducted in many countries as well as a collaboration within the World Forum for Acoustic Ecology. Increasingly often, interdisciplinary projects concerned with soundscapes are being implemented, e.g. Soundscape of European Cities and Landscapes, with 18 countries represented by 35 specialists being involved (BOTELDOOREN *et al.*, 2011; BROWN, 2012). At the intersection of acoustic ecology, bioacoustics, ecology of space and psychoacoustics, a new research field is developing dynamically: soundscape ecology, concentrating on the relationships between sound and landscape from the structural and functional perspective (PIJANOWSKI *et al.*, 2011). The sustainable development of cities depends on the soundscape design and protection of tranquil areas (BROWN, 2012; Designing Soundscape for Sustainable Urban Development; WEBER, 2012). Since 2010, the European Soundscape Award has been awarded to highlight creative solu-

tions to noise problems (the city of Stockholm has been awarded in 2010, the Gerderland Province in 2011 and the city of Berlin in 2012). The role of soundscapes in the modern world has been recognized in the Careggi Landscape Declaration on Soundscapes that emphasizes, among other things, the need to protect soundscapes and consider the acoustic dimension in landscape planning as well as to expand education in terms of developing auditory sensitivity.

In recent years, the subject of soundscapes has been addressed by representatives of various branches of science in Poland (ref. BERNAT, 2008; LOSIAK, TAŃCZUK, 2012) including geographers conducting research on the perception of landscape where sonic stimuli play an important role alongside the visual ones (e.g. PIECHOTA, 2006). So far, however, there have been no comprehensive studies undertaken on the quality of soundscapes in areas of environmental value in Poland, even though these areas are increasingly threatened by noise that, for example, degrades the quality of the environment, leads to the loss of biodiversity, deterioration of health and a distorted perception of attractive landscapes. Although Article 15 of the Act on Environmental Protection (2004) prohibits noise nuisance in national parks and nature reserves, it is doubtful whether the ban is observed and whether the soundscape resources of national parks in Poland are recognized and protected.

The goal of the studies undertaken in Polish national parks was to determine noise threats, examine the resources, assess the quality of soundscapes and identify the possibilities for their protection. The questionnaire method used in the studies made it possible to identify the awareness of noise threats and the value of soundscapes according to the park service staff. In addition, the semantic differential and the description methods were used to learn how students assessed the soundscape quality of Polish national parks. Finally, avenues of further research on soundscape in environmentally valuable areas were indicated.

## 2. Soundscapes as the object of environmental protection

The soundscape, perceived as an “acoustic event”, is formed through the overcrowding and intermingling of many and various sound fields, each of which has a single source. According to SCHAFER (1976), soundscapes consist of a background, referred to as “keynote sounds”, and “sound events” that can be ascribed certain meanings by a specific community. Sound events can be analysed from the perspective of their source (e.g. nature, human beings), function and social context (warning, internal, landmark, relaxing, stress-inducing, status-indicating sounds) as well as associations and symbolism. Certain sound events

are sound signals, i.e. sounds that one pays special attention to. Schafer as a soundmark referred to a sound signal that, for some reason, is unique, or possesses qualities of particular value to a local community. Each sound event has its spatial range, described as a sound profile or acoustic space. It is an “area over which it may be heard before it drops below the level of the ambient noise” (TRUAX, 1999). Azimuth denotes the direction of a sound in the horizontal plane. The acoustic horizon is “the farthest distance in each direction from which sounds may be heard” (TRUAX, 1999). Sound events have a temporal dimension, i.e. a specific rhythm and tempo. Rhythms can assume periodic patterns, isorhythms, or, still wider, cycles. A soundscape can also have a hi-fi or lo-fi quality. Hi-fi refers to an environment “where all sounds may be heard clearly without being crowded or masked”, whereas lo-fi refers to a soundscape where sounds “are overcrowded, resulting in masking and lack of clarity” and perspective (TRUAX, 1999).

Soundscapes are an important element of the natural and cultural heritage, particularly sensitive to changes associated with the development of civilisation. They can also be a significant distinguishing feature of places and regions. Sounds that are unique, or of particular value to a local community, occur in nearly every environment. Soundscapes are a carrier of content, associations and symbolism. Evoked by remembered sounds, particularly sequences of sounds (a tune, piece of music), such associations bind the perceived scenery with the information that one has about a given region. Soundscape research usually makes use of sociological methods (semantic differential, sonic preference test, mental map, questionnaire, interviews, free description) that complement observations (soundwalks) and acoustic measurements carried out in the field (BERNAT, 2008). In soundscape ecology, biophones, geophones and anthropophones are distinguished, the spatial and temporal dynamics of soundscapes are analysed, and human impact on natural soundscapes is evaluated. Within the various types of soundscapes (natural, sensitive, endangered, unique, recreational, representative, cultural, and everyday soundscapes), values, threats, management objectives and monitoring directions are identified as the basis for planning protection (DUMYAHN, PIJANOWSKI, 2011).

The soundscape is a very delicate resource. According to the report “Environmental Quality Objectives. Noise in Quiet Areas”, natural soundscapes are an indicator of environment quality, important for the preservation of biodiversity (WAUGH *et al.*, 2003). Noise intrusions are detrimental to the functioning of nature (e.g. BARBER *et al.*, 2011) and the aesthetic experiences of tourists. Therefore, proper monitoring and management of soundscapes, including the protection of their natural and cultural values, is essential. This

necessity has been recognised in national parks in the U.S. where soundscapes play a major part of the conservation strategy (Management Policies 2006). The restoration of natural soundscapes is part of the national park services' responsibilities, aimed at improving the functioning of the natural environment system. The measures taken include establishing quiet zones, evaluating human impact on the soundscape, surveying the expectations of tourists, monitoring, and educational campaigns. There is some awareness that the above measures should be integrated with road traffic management schemes. Numerous indicators are used in order to evaluate the quality of soundscape, e.g. maximum volume of single sound events (in dB), percent time of human-caused sounds remaining audible above natural ambience, noise-free interval, and number of noise intrusions (ROSSMAN, 2005). Studies are conducted to determine the acoustic quality standards and identify aspects of soundscapes that impact the tourists' experience and nature (e.g. AMBROSE, BURSON, 2004; PILCHER *et al.*, 2009). An important role is played by educational work, supported by an educational programme for listening and recording soundscapes (wild soundscapes in the national parks). Soundscape management plans are developed based on detailed perception and acoustic analyses (sound sources and levels, indicators, and standards).

### 3. National parks in Poland

In Poland, national parks (NP) are regarded as the primary and most effective form of nature and landscape protection despite the fact that they only account for 1% of the country's territory. At present, there are 23 national parks in Poland, representing the main geographical regions and landscape zones. Mountain parks predominate: two in the Sudetes (Tatra Mountains NP and Karkonosze NP) and six in the Carpathians (Babia Góra NP, Gorce NP, Pieniny NP, Tatra NP, Magura NP and Bieszczady NP). Furthermore, there are two coastal parks (Wolin NP and Slovinski NP), four lake district parks (Wigry NP, Bory Tucholskie NP, Drawa NP and NP of Wielkopolska), six in the Central-Polish Lowland (Białowieża NP, Biebrza NP, Narew NP, Polesie NP, Kampinos NP and Ujście Warty NP) and three in the uplands (Ojcowski NP, Roztocze NP and Świętokrzyski NP). The average size of a national park in Poland, at 13 673 hectares (statistical data from Environmental Protection Yearbook 2009), is considerably lower than the average around the world. The smallest park, Ojcowski NP, is 27 times smaller than the largest, Biebrza NP. Forests are the dominant landscape feature in most of the national parks (Table 1); altogether they cover about 60% of the total area of all parks.

Each national park is characterised by its own unique landscape, such as sand dunes, marshes, peat

bogs, primeval forests, lakes, or alpine landscapes with altitudinal vegetation zones. According to a natural environment assessment carried out by the Polish Academy of Sciences Institute of Nature Conservation (DENISIUK, 1992), the Tatra and the Bieszczady national parks are the most comprehensive in terms nature and landscapes (landscape variety and occurrence of unique landscape features). The Ujście Warty and the Gorce national parks are the least attractive in this respect. What is striking is the poor rating of most of the recently established parks: the inhabitants of Poznań regarded the Tatra as the most attractive, while the Polesie, Narew and Magura parks as the least attractive (ADACH, ADACH, 2010).

Studies conducted by ZGŁOBICKI *et al.* (2005) on seven national parks representing different types of landscape (3 mountain, 2 lowland and 2 coastal parks) show that areas with vast landscapes are the most visually attractive. Hence, at the top of the list are the Tatra, Karkonosze and Bieszczady national parks, i.e. mountain parks characterised by very intense tourism traffic. The Narew and the Slovinski parks received the lowest rating. Furthermore, the perception of national parks (the aesthetic evaluation of landscape) was found to correspond to their actual environmental value (ecological evaluation of the landscape).

Being the most attractive areas in terms of nature and landscape, parks are subject to intensive tourism pressure. In 2009, the Tatra and the Karkonosze parks were the most popular among tourists (each attracting more than 2 million visitors). In comparison, the Narew NP was only visited by 8 600 tourists in 2009. As shown by the survey of the inhabitants Poznań, the attractiveness of a given park is most considerably reduced due to a large number of visitors (ADACH, ADACH, 2010).

As regards the tourism-to-park size ratio, the Karkonoski and the Pieniński parks are under the greatest strain (Table 1). The smallest number of tourists was recorded in the Narwiański, Biebrzański, Poleski, Drawieński and Ujście Warty national parks. A network of tourist trails, particularly well-developed in the Biebrzański and the Kampinoski parks, is conducive to large numbers of visitors. The shortest total length of tourist trails exists in the Ujście Warty park. However, the availability of a dense network of tourist trails is not the key factor attracting tourists to a particular national park. Studies conducted by PIETRZAK *et al.* (1999) along the Cyryl Ratajski tourist trail in the NP of Wielkopolska indicated that sound had a considerable impact on the actual visual attractiveness of the landscape.

As studies by LEBIEDOWSKA (2009) indicate, the Kampinoski NP is troubled by transport noise pollution propagated along national roads. According to acoustic measurements carried out in the Tatra National Park, the noise levels in some places, frequented

Table 1. National Parks in Poland. Source: Environmental Protection Yearbook 2009.

National Parks	Year of Foundation	Area in hectares	Area of forest land in %	The number of tourist in th. / in number/hectares	Tourist routes in km
Biebrzański	1993	59223.0	26.2	32.0/0.5	483.1
Kampinoski	1959	38548.5	73.1	1000.0/26.0	360.0
Bieszczadzki	1973	29176.5	84.6	273.0/0.9	245.0
Słowiński	1967	21572.9e	28.7	275.4/12.8	144.3
Tatrzański	(1947)b,1954	21197.3	71.8	2078.7/98.0	275.0
Magurski	1995	19438.9	95.5	50.0/2.6	85.0
Wigierski	1989	14999.5	62.8	120.0/8.0	245.4
Drawieński	1990	11342.0	84.2	23.0/2.0	101.0
Białowiecki	(1932)c,1947	10517.3	94.8	82.3/7.8	38.5
Poleski	1990	9764.3	49.0	15.4/1.6	67.5
Roztoczański	1974	8482.8	95.5	120.0/14.1	61.1
Woliński	1960	8133.1	42.5	1500.0/137.0	50.1
Ujście Warty	2001	8074.0	1.0	20.0/2.5	12.6
Świętokrzyski	1950	7626.4	94.6	210.5/27.6	41.0
Wielkopolski	1957	7583.9	62.0	1200.0/158.2	215.0
Narwiański	1996	7350.0	1.3	8.6/1.2	58.0
Gorczański	1981	7030.8	93.8	60.0/8.5	105.1
Gór Stołowych	1993	6340.4	91.1	354.0/55.8	175.1
Karkonoski	1959	5580.5	72.1	2000.0/358.0	117.6
Bory Tucholskie	1996	4613.0	85.3	60.0/13.0	75.0
Babiogórski	1954	3390.5	95.3	52.0/15.0	53.0
Pieniński	(1932)d,1954	2346.2	71.0	756.0/322.0	35.2
Ojcowski	1956	2145.6	71.2	400.0/186.4	40.7

b – The National Forest Unit “Tatra Parki”, c – Forestry National Park in Białowieża, d – The National Forest Unit “National Park in Pieniny”, e – Excluding coastal water of the Baltic Sea

by numerous tourists (e.g. Wyżnia Kira Miętusia in Kościeliska Valley), corresponded to those of a rather busy street, which compromised the opportunity for people to relax and created adverse living conditions for wild animals (WAGNER *et al.*, 2006). According to studies on the perception of sound in the landscape of the Tatra NP, the sounds most frequently recognised by students were the voices of their colleagues and tourists, the rustle of the wind, the sound of a stream or waterfall, and the singing of birds (MADUROWICZ, SZUMACHER, 2007). The Masurian Lake District (in this proposed Masurian National Park) is described as a “noise zone” due to the roar of boat engines as from May to October as about 60 thousand people per day sail on the lakes.

#### 4. Questionnaire survey

In 2010, a pilot survey was conducted using electronic mail (BERNAT, 2010). The services of all the national parks in Poland were asked: Have any noise measurements been carried out in the ... National Park? Do

the Park Service staff believe there exist noise hazards, and if yes, what are the sources of the noise?

According to the replies received (no replies were received from the Narew, Świętokrzyski and Ujście Warty national parks), noise hazards occur in the majority of national parks (no hazards were found in the Białowieża, Biebrza, Polesie and Słowiński national parks). However, noise measurements were carried out rarely, only in the following parks: Drawa, Gorce, Karkonosze, Ojcowski, Roztocze, Tatra, Wielkopolska and Wolin (most often along roads, as part of tests conducted by the Inspection of Environmental Protection, and as part of environmental impact assessments for investment projects). In addition, general information on noise sources was obtained.

The results of this survey were used to prepare a detailed questionnaire on the perception of sound in the landscape, addressed to the authorities of 23 national parks in Poland. In addition, a separate questionnaire was prepared for students of geography and of tourism and recreation (potential tourists) at Maria Curie-Skłodowska University (UMCS) in Lublin. Both

surveys were conducted at the start of 2011 (BERNAT, 2011). The replies from the national park authorities (the questions were answered by the national park directors themselves or nature conservation experts, scientific research experts, etc.) were compared to the replies from students (87 persons, in this 54 women and 33 men, participated in the survey; 46 respondents were residents of Lublin while the remainder lived mostly in other towns of the Lublin Province) in order to show the similarities and differences in the perception of sound in the landscape of Polish national parks.

The questionnaire for national park authorities consisted of 12 (mostly open) questions concerning noise hazards and the values in soundscapes as well as noise abatement methods. The individual questions involved the importance of sound in experiencing the landscape of a park, characteristic sounds (sounds characteristic of a given park, i.e. typical, representative or distinguishing, unique, special, peculiar, dominant or key sounds), noise sources, degree of noise hazard, places where pleasant and unpleasant soundscapes occurred, the time of day when noise was the least tiresome, changes in acoustic conditions over the previous 10 years, the previous presentation of acoustic values, social conflicts associated with noise nuisance prohibition, attitudes towards the conservation of acoustic values, proposals for noise abatement measures, preservation of noise-free areas and soundscapes.

The questionnaire for students consisted of two tasks. The first one was the evaluation of the soundscape of the selected park (known to the respondent) with regard to two features: the kind of impressions (pleasant/unpleasant) and the noise level (noisy/quiet). The semantic differential method was used (semantic scale 1–10). The analysis included parks that received more than 30 replies, i.e.: Roztocze, Tatra, Ojcowski, Bieszczady, Świętokrzyski, Pieniny, Polesie, Białowieża and Slovinski. The Magura, Narew, Wigry, Biebrza, Drawa and Ujście Warty national parks turned out to be the least known. The second task concerned the characteristics of the soundscape of the selected national park. It was assumed that the free description method would enable, among other things, the identification of characteristic sounds and sources of noise hazards, as perceived by the students, and the overall experience of the national park's soundscape. The selection of a specific park by the respondents was also significant because it reflected their familiarity and thus the frequency of their visits there and/or the degree of the landscape's impressiveness. The tasks for the students complemented the survey for the national park authorities, although it was assumed that the answers given in both questionnaires might correspond with each other.

Sounds were recognised as being very important or important for experiencing the landscape in a consid-

erable majority of the parks (14 and 9 parks respectively). Characteristic sounds, mainly the sounds of nature, were indicated in nearly all the parks (20), e.g. “the howling of wolves”, “the wind blowing in mountain pastures” (Bieszczady NP), “the mating calls of black grouse”, “the clanging of cranes” (Polesie NP), “the hooting of the Ural owl in early spring” (Magura NP), “the grunting of the bison” (Białowieża NP), “the sound of water dripping on the floor of a cave and echoes in the caves” (Ojcowski NP), and “the roar of foehn winds, the rumble of waterfalls, the squishing sound of walking on peat” (Karkonosze NP). In some parks, tranquillity was also indicated as a characteristic sound (Ojcowski NP – “the peace and quiet of the caves”, Karkonosze NP – “the quiet of the peat bogs”, Tatra NP – “the tranquillity of the high mountains” off the tourist trails). A few parks share the same sounds of nature (e.g. the rutting of deer, the sounds of specific bird species). In the case of the Wigry park, the sound of mining machines was mentioned (the facilities of the Suwałki Mineral Materials Mines are located about 2 km from the western boundary of the Park). This sound is not typical of environmentally valuable areas and not desirable though discernible. In the case of four parks (Roztocze NP, Świętokrzyski NP, Ujście Warty NP and NP of Wielkopolska), no characteristic sounds were identified because it is actually difficult to tell to what extent the sounds occurring in a given park “cannot be found anywhere else”.

The perception of the above sounds is mainly disrupted by car traffic and groups of noisy visitors (Fig. 1). Other threats mentioned included mass events, discos in localities close to the park's border (Table Mountains and Białowieża NP), the sounds of neighbouring towns and villages (Polesie NP, Białowieża NP, Karkonosze NP, and Tatra NP), trains (Narew and Biebrza NP), agricultural activity (Biebrza NP), motorised hang gliders (Gorce NP), snowmobiles (Karkonosze NP), sports and recreational events using a PA system (Pieniny and Tatra NP), events at hostels in the Tatras, religious ceremonies and other events at the Święty Krzyż mountain (Świętokrzyski NP), and the sound of mineral aggregate mining machines (Wigry NP). As well as these, a grow-

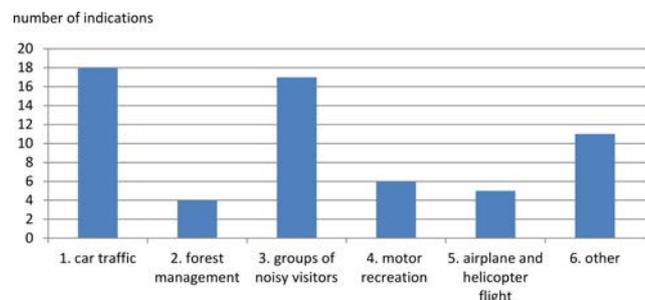


Fig. 1. Threats sources connected with noise in Polish national parks according to services of parks.

ing threat was observed in some parks as a result of the uncontrolled use of quads and motorcycles (individual rallies or company events) in breach of all kinds of regulations. The roar of these vehicles causes panic among walkers, scares away animals, and generally disturbs the peace. In consequence, places that should provide relaxation and rest are deprived of their environmental and aesthetic value, while people's health and even life are endangered.

The noise hazard was most often rated as medium. However, in the case of four parks it was rated as high (Drawa, Ojcowski and Karkonosze NP) or very high (Tatra NP). The greatest noise nuisance occurs in the daytime, particularly in the "rush hours". In most of the parks (14), the acoustic conditions deteriorated over the last 10 years due to an increased number of tourists and increased vehicle traffic on the roads surrounding the park.

According to the park service staff, locations can be identified in the park where the noise is a particular nuisance as well as places with particularly pleasant soundscapes (21 parks). The former are places with considerable vehicle traffic and those having the greatest concentration of tourists. Places with particularly pleasant soundscapes are characterised by a high degree of naturalness (e.g. old alder carrs and other ancient tree stands, hollows between dunes, valleys of streams, banks of permanent and periodic water reservoirs in the Kampinos NP, large forest complexes, valleys of rivers and streams in the Roztocze NP, open peat bogs and wet meadows in the Polesie NP, and mountain top areas in the Gorce NP). In some cases, specific locations are indicated, e.g. the area of Śnieżne Kotły or Wielki Staw in the Karkonosze park (the moraines are barrier to the disturbing urban sounds from Karpacz and Jagniątków).

The need to display the acoustic values is recognised in 14 parks, and museum exhibitions are typically used for this purpose. An example worth mentioning is the Bieszczady park, where sounds characteristic of typical ecosystems are presented as part of spherical panoramas.

In most of the parks, the noise nuisance ban did not cause social conflict. That being said, in as many as 16 parks, interventions and disputes were mentioned concerning, for example, the use of cars, including traffic restrictions (Bory Tucholskie, Roztocze, Gorce and Świętokrzyski parks) and the noisy behaviour of visitors (Wolin, Magura, Drawa and Pieniny parks). Disputes over noise-free zones (acc. to the Act on Environmental Protection Law noise-free zones usually encompass lakes where the use of motorboats and other motor equipment as well as the practicing of water and motor sports are totally prohibited due to the need to maintain suitable acoustic conditions in areas designated for relaxation and recreation; the establishment of noise-free zones through a county council resolution

is binding for spatial planning and development instruments, which means that such an area may not be used for activities that might cause increased noise levels) were mentioned in the case of the Bory Tucholskie park (Lake Charzykowskie) and Pieniny park (Lake Czorszyński). It was discussed for two years whether Lake Czorszyński (part of it being within the park's buffer zone) should be a noise-free zone or whether motorboats could be used on it. The arguments by nature conservationists and enthusiasts of quiet water sports clashed with the interests of motorboat users and owners of the local guesthouses. However, in 2009, the councillors of Nowy Targ County passed a resolution sanctioning a noise-free zone and banning water vessels powered by combustion engines.

In the vast majority of the parks (22), the need to protect the park's acoustic values, including tranquility, was acknowledged. Finally, possible noise abatement measures were proposed, e.g. banning general traffic on some road stretches and introducing transport based on electric vehicles or horse-drawn carriages; moving traffic outside the park (a bypass); eliminating heavy-load vehicle transit; introducing lower speed limits and load weight limits on roads; banning quads, cross-country motorcycles and motorised hang gliders; establishing hedges and noise barriers along roads (subject to an assessment of their impact on the landscape); channelling tourism traffic; limiting the number of tourists; and constant monitoring of tourist trails.

The soundscapes of the national parks in Poland were rated by students as pleasant and tranquil, although there are discernible differences in the evaluation of particular parks (Figs. 2 and 3), as exemplified by a comparison of the Białowieża and the Tatra parks. In the case of the "noisy/quiet" characteristics, nearly 80% of ratings for Białowieża NP were within the range from 7 to 10, i.e. the park's soundscape was rated as tranquil. The rating was similar for Bieszczady NP.

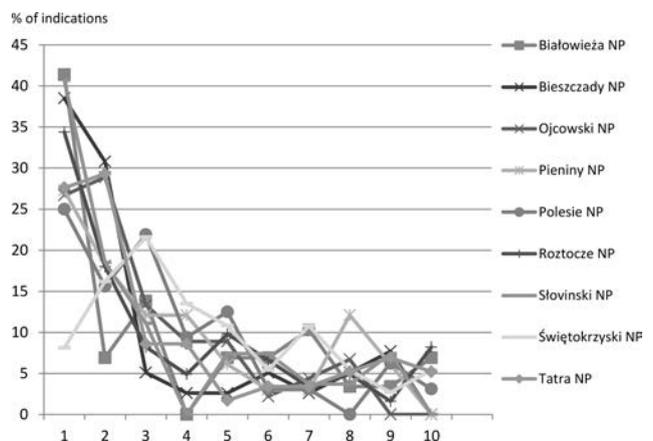


Fig. 2. Soundscape evaluation of Polish national parks in terms of index "pleasant-unpleasant" according to students (scale 1–10); 1 – pleasant, 10 – unpleasant.

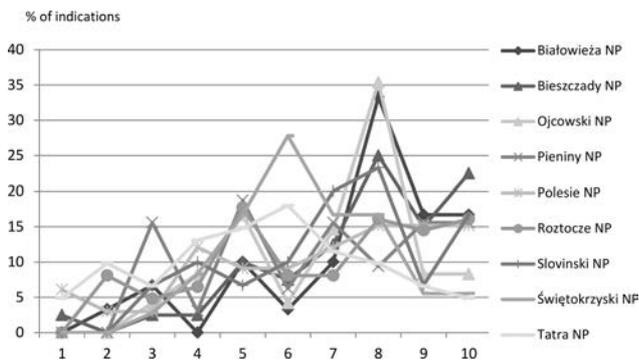


Fig. 3. Soundscape evaluation of Polish national parks in terms of index “noisy-quiet” according to students (scale 1–10); 1 – noisy, 10 – quiet.

The Tatra park was different though: ratings from 7 to 10 accounted for nearly 33% while those from 1 to 4 represented nearly 35% of the responses. These results correspond to the responses of the park service staff about the degree of noise hazard.

The most frequently described parks were the Roztocze (16 respondents), Tatra (12), Bieszczady (11) and Białowieża (6) national parks. Other parks described included Polesie (3 respondents), Słowiński (3), Wolin (2), Ojcowski, Narew, Pieniny, Karkonosze, Świętokrzyski and Bory Tucholskie national parks (one respondent each). The descriptions are of varying quality, although they form a very important source of information about the impressions of the students (potential visitors). For example, the author of a description of the Tatra park emphasised that “in autumn, when most of the tourists have gone, you can hear the wind beating against the rocks higher up the mountains. From below you can hear the sound carried along with the smell of the soil and the forest, the moisture that you can see and hear among the trees. Sometimes you can hear the monophonic sound of a falling stone, disappearing into the silence, a silence that expresses more than many a symphony”. A description of the Karkonoski park mentions “the sounds of the forests and wind rustling in the forest and whistling over open ground, but they are disturbed by relatively large numbers of people who are unable to behave suitably (the excessive use of phones, iPods and other gadgets is irritating)”.

The present survey identified the awareness of noise hazards and the value of soundscapes in particular national parks in Poland, as well as the need to protect soundscapes and possible ways of achieving this. The questionnaire for the national park authorities and the questionnaire for students (potential tourists) complemented one another and gave a more complete picture of the phenomenon. Both groups of respondents were quite consistent in their evaluation of the noise hazards. However, some responses in the questionnaires vary.

The author is aware of the limitations of the research methods used due to their subjectivity. The present findings should be treated as a basis for field research and detailed analysis, also acoustic research. It is the preliminary attempt of assessment the quality of soundscapes of Polish national parks.

To supplement the questionnaire survey, the draft conservation plans for the Bieszczady NP and the Tatra Mountains NP were analysed. These draft plans acknowledge the noise hazards, mainly linked to transport and tourism traffic. The proposed solutions include restricting road traffic crossing the park. Unfortunately, the draft plans make no mention of the perception of sound in the landscape.

## 5. Conclusions and final remarks

The research findings indicate that each national park in Poland is characterised by diverse and unique soundscapes and is subject to the pressure of road traffic and tourism, resulting in noise hazards. The least attractive soundscapes (though not devoid of any value) occur in the most visually attractive parks (in the mountains) and parks most frequented by tourists (Tatra and Karkonoski NP). The most attractive soundscapes are characteristic of parks not subject to intense tourism pressure and located far from transport routes (e.g. Ujście Warty NP, Poleski NP, Narew NP and Białowieża NP). The conservation of the acoustic values of parks is necessary and possible.

It is essential to conduct studies on the perception of sound in the landscape because increased noise has a considerable disruptive effect on the perception of the natural landscape typified by tranquillity, construed as the audibility of the subtle sounds of nature. In environmentally valuable areas, even the distant reverberating drone of heavy vehicles can be perceived as a nuisance, distorting the perception of the landscape to an inadmissible extent. This was the argument for including the impact of noise on the perception of landscape in the environmental impact assessment of the Augustów bypass, that had originally been planned to cross the Rospuda valley. It also is worth noting that the construction of noise barriers along roads may cause a deterioration of the visual aspects of landscapes besides decreasing the noise levels. In order to prevent the excessive use of noise barriers, in September 2012 the Ministry of the Environment raised the permitted noise levels. Therefore, it can be surmised that the soundscapes of environmentally valuable areas will be subject to increasing threat due to road construction.

It is also necessary to eliminate factors threatening the perception of the landscape so that the high acoustic quality can be preserved (valuable/characteristic sounds must be discernible). It is also important to continue studies on soundscapes (e.g. the preferences of tourists by social groups), supported by acoustic

monitoring, field observations and educational activities. The studies require an interdisciplinary approach (combining acoustics, geography, ornithology, psychology, sociology, etc.) as well as the collaboration of park services, inhabitants, tourists and local governments.

The soundscape may be a factor that increases the attractiveness of environmentally valuable areas, including the least visually attractive parks, and it is particularly important in view of the uneven distribution of tourism traffic. Viewing soundscapes as a resource can make the public more attuned to the beauty of tranquillity (the subtle sounds of nature), essential to preserve the values represented by environmentally valuable areas.

It is worth noting the need to take care of green and open areas in cities as they are potential tranquil areas. The protection of tranquil areas has been consistently implemented in London as part of the city's noise strategy (City of London Noise Strategy 2012–2016). Furthermore, attention is paid to the acoustic design of public spaces, e.g. exposing iconic sounds. Since 2012 an international scientific project has been carried out, focussed on developing coherent methods of assessing and managing tranquil areas in cities (WEBER, 2012). In many Polish cities, efforts aimed at designating noise-free zones have been futile.

Noise abatement cannot be limited to observing acoustic standards; it should also include the shaping of high quality soundscapes. The severity of noise nuisance is determined not only by the intensity of sound but also by its perception. Sound in a particular space cannot be evaluated only negatively, as a nuisance, but should also be viewed positively, as a resource and value.

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