VERUSCRIPT

JOURNAL OF ECOACOUSTICS
www.veruscript.com/jea

Emotional associations with soundscape reflect human-environment relationships

Paola Moscoso[1,*], Mika Peck[1], Alice Eldridge[2]

[1] *Department of Evolution, Behaviour and Environment, University of Sussex, Falmer, Brighton, BN1 9QG, United Kingdom*
[2] *Sussex Humanities Lab, School of Media, Film and Music, University of Sussex, Falmer, Brighton, BN1 9QG, United Kingdom*

Original paper

Article history:
Received: 3 July 2017
Accepted: 8 November 2017
Published: 10 January 2018

Check for updates

*Correspondence:
PM: paola.moscoso.rosero@gmail.com

Peer review:
Double blind

Keywords:
emotions; wellbeing; soundscape conservation; sense of place; landscape modification; human perception

Citation:
Moscoso P., Peck M., and Eldridge A. (2018). Emotional associations with soundscape reflect human-environment relationships. Journal of Ecoacoustics. 2: #YLFJ6Q. https://doi.org/10.22261/JEA.YLFJ6Q

Abstract

In line with the development of socio-ecological perspectives in conservation science, there is increasing interest in the role of soundscape perception in understanding human-environment interactions; the impact of natural soundscapes on human wellbeing is also increasingly recognized. However, research to date has focused on preferences and attitudes to western, urban locations. This study investigated individual emotional associations with local soundscape for three social groups living in areas with distinct degrees of urbanization, from pristine forest and pre-urban landscapes in Ecuador, to urban environments in UK and USA. Participants described sounds that they associated with a range of emotions, both positive and negative, which were categorized according to an adapted version of Schafer's sound classification scheme. Analyses included a description of the sound types occurring in each environment, an evaluation of the associations between sound types and emotions across social groups, and the elaboration of a soundscape perception map. Statistical analyses revealed that the distribution of sound types differed between groups, reflecting essential traits of each soundscape, and tracing the gradient of urbanization. However, some associations were universal: Natural Sounds were primarily associated with positive emotions, whereas Mechanical and Industrial Sounds were linked to negative emotions. Within non-urban environments, natural sounds were associated with a much wider range of emotions. Our analyses suggest that Natural Sounds could be considered as valuable natural resources that promotes human wellbeing. Special attention is required within these endangered forest locations, which should be classified as a "threatened soundscapes," as well as "threatened ecosystems," as we begin to understand the role of soundscape for the wellbeing of the local communities. The methodology presented in this article offers a fast, cheap tool for identifying reactions towards landscape modification and identifying sounds of social relevance. The potential contribution of soundscape perception within the current conservation approaches is discussed.

Introduction

Over the last few decades conservation biology has developed into an interdisciplinary field that incorporates social and economic development processes (see Berkes, 2004; Rands et al., 2010; Hobbs et al., 2011; Milner-Gulland et al., 2014). The primary concern of conservation has evolved from a focus on protecting endangered species and natural areas, to considering nature as a complex system in which humans are inherently implicated. In doing so, the importance of links between economic development and biodiversity emerge (Meine, 2010). The concept of "ecosystem services," for example reframes the function of natural ecosystems in economic terms. Although widely adopted internationally, this tendency has been criticized for prioritizing money over nature and, in some cases, generating greater (economic as well as biological) losses than gains (*e.g.*, McAfee, 1999; McCauley, 2006). There is a new direction in conservation that looks beyond a monetized approach, focusing on the assessment of the intrinsic benefits and costs of conservation (Milner-Gulland et al., 2014). At the same time, the definition of environment and conservation are in flux. For example, in Western societies environment has been considered as "external" to the human realm, placing humans outside nature (*e.g.*, Berkes, 2004; Eriksson, 2014) which creates an obvious challenge for integrated accounts. Furthermore, conservation has focused on the negative role of humans, and civilizations on their environment (Widgren, 2012). Hence, a challenge for conservationists is to integrate new concepts, beyond the traditional understanding of conservation, that incorporate a wider spectrum of current thoughts and understanding of humans in order to enhance and enrich the field and its applications in the social realm. One example is the recent inclusion of community and indigenous interests in an integrated model of conservation and governance (Berkes, 2004; Rands et al., 2010).

In the last ten years, a new generation of conservationists have begun to explore the role of biodiversity in human wellbeing (Rands et al., 2010; Milner-Gulland et al., 2014; Palmer Fry et al., 2015; Woodhouse et al., 2015). A focus on human wellbeing may have ethical weight when conservation efforts involve and impact communities, but frameworks for measuring human wellbeing in relation to conservation are undeveloped. Wellbeing can be described along three axes: meeting needs, pursuing goals, and experiencing a satisfactory quality of life (Milner-Gulland et al., 2014). Therefore, changes in human wellbeing can be used as one indicator of conservation impact, which incorporates the participation of local communities and contribute to solutions that enable them to live sustainably alongside nature (Milner-Gulland et al., 2014). As a consequence, more conservation practitioners are talking about the importance of taking a holistic approach to people's relationships with nature, managing biodiversity as a global public good, and understanding ecosystems as complex adaptive systems in which humans are an integral part (Berkes, 2004; MEA, 2005; Rands et al., 2010; Milner-Gulland et al., 2014). For these reasons, new and interdisciplinary approaches are being proposed within conservation science, with an integration of the human realm into the field and a focus on the impacts of conservation on human wellbeing.

Understanding social-ecological interactions through soundscape analysis

Many environmental problems are a consequence of human behavioral choices, and addressing those problems will require understanding and changing those patterns of behavior (Clayton and Myers, 2009). An understanding of the main influences of behavior can allow for positive interventions, such as promoting healthy human-nature relationships, which go hand-in-hand with conservation efforts. One approach that has contributed to the understanding of human-nature interactions, and that has been studied in related fields such as conservation psychology, is the analysis of human perception of natural environments. For example, a number of studies have shown that prevalence and contact with nature is positively associated with human health and wellbeing (Hartig et al., 1991; Kaplan, 2003; Mayer and Frantz, 2004; Keniger et al., 2013). These studies have focused on the effect of natural landscapes on humans; a different branch has explored the effects of soundscape on humans, as soundscapes are a direct connection between natural systems and humans (Gobster et al., 2007).

Soundscape ecology studies the effects of the acoustic environment, or soundscape, on the physical responses or behavioral characteristics of those living within it (Truax, 1999). A few studies within this field, based on human perception of soundscape, have contributed to the comprehension of interactions between soundscape and humans. The focus has been mainly on responses to sounds, by assigning subjective labels to soundscape - such as preference or pleasantness. For example, Axelsson et al. (2010) proposed a model of reduced attribute dimensions (unpleasant-pleasant, uneventful-eventful, chaotic-quiet and boring-exciting) as a framework for soundscape perception analysis. Working with a group of European students, they showed that sound excerpts dominated by technological sounds were perceived as unpleasant, natural sounds were pleasant and human sounds were perceived as eventful. Similar results were found in visitors to the countryside of Hong Kong, where human preference was correlated with the absence or presence of wanted or unwanted sounds (Lam et al., 2010). In this case, most natural sounds were "liked" whereas human-generated sounds, such as transportation noise, were "disliked." Other examples of soundscape perception that showed similar responses can be found in Payne (2008), Szeremeta and Zannin (2009), Kang and Zhang (2010), Ren et al. (2015) and Tse et al. (2012).

Research to date has predominantly been conducted in urban areas or areas where anthrophony, or sounds made by humans, dominates. With respect to natural areas, research on soundscape has focused on open urban-public spaces, such as parks and green areas, and has been conducted with primarily westernized groups. The only sound perception research within ethnic groups, living in natural landscapes, has been restricted to ethnographic descriptions, such as the study of Feld (1990) with the Kaluli people of Papua New Guinea, which highlights the influence of "sounds of the forest" (*e.g.*, birds or water) in a cultural realm (*e.g.*, language, spiritual knowledge, hunting). There is a lack of research exploring the relationships between forests communities and environment through soundscape studies.

Soundscape perception analysis has been applied in other disciplines such as landscape design. For example, it has been reported that soundscape values and perceptions can be valuably incorporated into landscape planning and soundscape conservation efforts, or can influence individuals to change their behaviour toward the soundscape, by highlighting the relevance of preserving it (Harmon, 2003). Soundscape perception is considered a personal process that can depend on the experience and cultural background of individuals (Farina, 2014); whether there are patterns at the societal level is not yet understood.

The aim of the current study is to develop understanding of human perceptions of soundscape in a variety of environments, based on emotional associations with everyday sounds. We present an approach that provides an overview of a range of soundscapes, from forest communities in Ecuador to western urban groups in the USA and the UK. We explore whether the relationships between human emotions and sounds varies according to the degree of urbanization. The consequences of local environmental impacts on human relationships with soundscape are also analyzed. Three questions motivate this study:

1. Which types of every day sounds characterize each environment?
2. How does each social group relate to those sounds? Are there any observable patterns in this emotional association across groups?
3. What are implications of these relationships for the present and future of each environment?

Methods

Three participant groups were selected from communities living along a non-continuous environmental gradient, from pristine forest to inner city: "forest group," "intermediate group" and "urban group." The forest group comprised of three communities that live within distinct forested areas in Ecuador: 1. Indigenous Waorani (Wa), 2. Colonos-Mestizo of Santa Lucia Cloud Forest Reserve (SL), and 3. Colonos-Mestizo of Tesoro Escondido Cooperative (TE) (see section 2.1). "Mestizos" or "half-blood" are descendant from native communities (indigenous or afro-Ecuadorian) and white people. "Colonos" refers to migrants who found a new ecological and social space, where they rebuild their identity and their processes of production (Kingman, 2002). The intermediate group was a community of Colonos-Mestizo in Puerto Quito town (PQ), Ecuador (see section 2.2). The urban group was composed of three communities that live in urban areas: 1. Parker city, Colorado in USA (Pa), 2. Coventry City (Co), and 3. Birmingham City (Bi), the last two situated in the UK (see section 2.3).

Forest group (Wa, SL, TE)

The forest group participants lived within undisturbed or minimally disturbed forests and included 56 participants: 42 indigenous Waorani and 14 Colonos-Mestizo farmers. Waoranis are native indigenous people of a lowland rainforest in the Ecuadorian Amazon who have been in contact with western cultures since 1956. The size of their territory, the Waorani Ethnic Reserve, extends to 679,130 ha (Macía, 2001). Areas of their ancestral homelands are threatened by oil exploration and illegal logging. In the last 40 years, they have shifted from being hunting-gathering societies to societies that live mostly in permanent forest settlements. Some groups have rejected all contact with the "exterior" world and continue to move into more isolated areas; others are adopting the westernized model based on a monetized economy and society. Individuals from the Tiguino, Nenkepare and Qehueirono communities were interviewed (see section 2.4. for method).

The communities that live within the cloud forest, Santa Lucía (730 ha), and the lowland tropical forest of Tesoro Escondido (3000 ha) are families of farmers who migrated to this region, situated in the NW Ecuador (in Pichincha and Esmeraldas Provinces, respectively), no more than 40 years ago. They settled in forested land that has now been transformed into a matrix of forest and pastures with small plantations of fruit and vegetables. The Santa Lucía community lives within the forest, but also spend part of their time in a small town, adjacent to the reserve. Nevertheless, they were considered part of the forest group as they have lived for many years within the forest in the past and spend half of their time within the forest today.

Intermediate group (PQ)

The intermediate group participants live in a recently founded town, which still harbors patches of forest. It can be considered an "intermediate point" between a non-industrialized and an industrialized society. It was comprised of 77 participants from Puerto Quito (PQ), a small town in NW Ecuador (Pichincha Province). Most of the participants (79%) were not born in PQ but in surrounding areas. PQ is a "new" town founded in 1996, and has a population of 19,728 inhabitants (AME, 2015). One of the principal incomes of the town is from ecotourism due to its close proximity to patches of forest and river systems. Agriculture and livestock farming also contribute to the economy of town.

Urban group (Pa, Co, Bi)

Participants belonging to the urban communities live within well-established cities and urban areas, and included 42 participants. The first community (N = 14) is from Parker, a small city in USA, Colorado, and surrounding areas. It was founded in 1864 and has 47,823 inhabitants. The second community (N = 15) is from Coventry, the 10th largest city in England with 337,400 inhabitants. The last community (N = 13) is from Birmingham, the 3rd most populous built-up city in the UK with 1,101,360 residents. It is important to consider that these urban areas also maintain green or open areas, especially Parker which is the smallest city; Birmingham also reports to have 600 parks and open spaces (BCC, 2015).

Procedure

The research was conducted in Ecuador between June-July 2014 and July-August 2015. At all sites the participants (n = 177, men and women, >17 years old) were gathered together and a structured interview was conducted. Participants were recruited via chain sampling, selecting informants until a saturation of participants appropriate for the approach of this investigation was obtained (Garson, 2008), following the sample size suggestions of Nastasi (2004). The interview consisted of associating sounds with five emotional states: "Thinking of your home town, name 3 sounds which you associate with: 1) happiness, 2) sadness, 3) tranquility, 4) fear, and 5) irritation." This study included all the range of emotions that influence human life and were considered as universal responses. Participants provided written responses of up to 15 sounds.

Responses were labelled according to Schafer's classification of everyday sounds (Schafer, 1994). Originally created as a framework to study the functions and meanings of sound, sounds were drawn from anthropological and historical documents. The sources of everyday sounds are grouped into "sound types" – such as bird song, human voice or machine and also arranged hierarchically into "sound categories" – such as natural sounds, human sounds and mechanical sounds. Schafer's scheme was modified for this study by adding sound types that included the observed responses, such as sound of felines, music, leaves or wind (see Appendix 1). The table consisted of 6 main categories or "sound categories" and 53 subcategories or "sound types." The sound categories were Natural Sounds (such as birds, air and water), Human Sounds (such as voice, screams and body), Sounds and Society (such as domestic, digital and music), Mechanical Sounds (such as machines, guns and transportation machinery), Sounds as Indicators (such as bells, horns and explosions) and Other (such as silence, noise, unknown things).

The data obtained (1,313 responses; forest group = 229, intermediate group = 517, urban group = 567) was analyzed using Statistical Package for Social Sciences (SPSS) version 22. In order to explore differences between sound categories (n = 6), sound types (n = 53) and their relationship with emotions (n = 5), comparisons within and between groups were conducted using a Kruskal-Wallis H Test.

A Multiple Correspondence Analysis (MCA) was conducted in order to detect and represent the structure of the dataset and to elucidate any association between sound types. Within the MCA, each sound type was represented in multidimensional space based on the response to emotions of all social groups. The distance between points reflects the relationship between sound types, the shorter the distance, the stronger the relationship (Sourial et al., 2010). The visualization of cloud points projected permitted the classification of sound types into clusters that represent combinations that best describe the differences amongst social groups.

Previous to the field work period, all the activities and procedure conducted during this study were approved by the Social Sciences & Arts Research Ethics Committee of the University of Sussex.

Results

Distribution of responses across sound source categories

As shown in Figures 1–3, the distribution of responses amongst sound categories varied across groups. Significant differences between the forest group and both the intermediate group (PQ), χ^2 (1) = 125,3 p <0.05) and the urban group (Pa, Co, Bi), χ^2 (1) = 147,2 p <0.05) were found; however we found no significant difference between the intermediate group and the urban group (χ^2(1) = 1.61 p = 0.204).

The modal category for the forest group was Natural Sounds, followed by low percentages of Human Sounds, Mechanical Sounds, Sounds & Society, Sounds of indicators and Other. In contrast, no sound category dominated the intermediate group: the main categories in order of importance were Sound & Society, Natural Sounds and Human Sounds, followed by lower percentages of Mechanical Sounds, Sounds as indicators and Other. The urban group responses followed a similar pattern: the main categories were Human Sounds, Sound & Society, Natural Sounds, followed by Sound as Indicators, Mechanical Sounds and Other.

Emotional associations of sound source categories

The association between sound categories and emotions are illustrated in Figure 4. The distribution of associations between sound categories and emotions differed between groups: (forest group, χ^2 (5) = 12,52 p <.05; intermediate group, χ^2 (5) = 69,30 p <.05; urban group, χ^2 (5) = 57,88 p <.05).

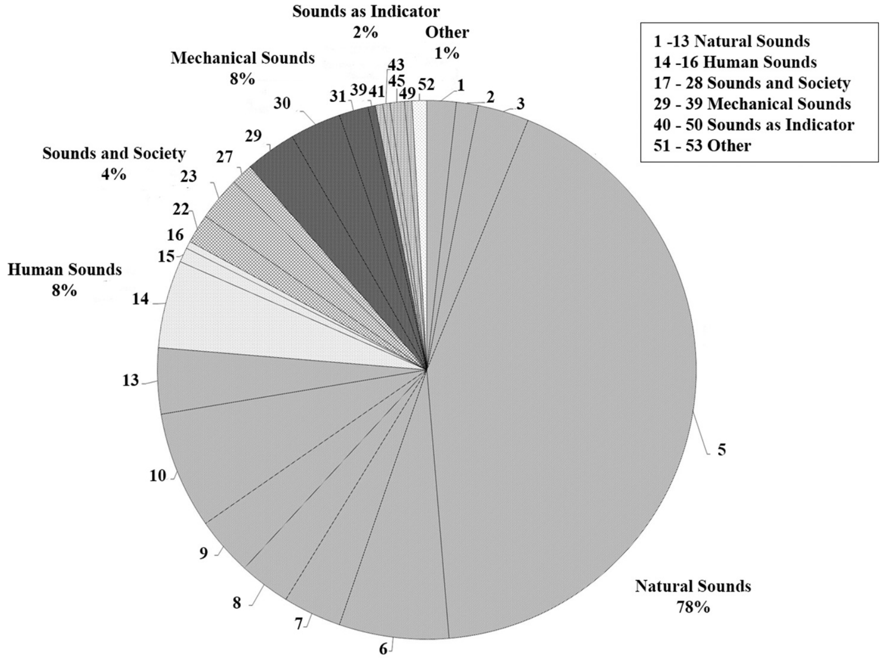

Figure 1. Overall classification of sound categories (n = 6) and count distribution of sound types (n = 53) in a forest group.

The sound types comprise the sound categories classification: Natural sounds (1–13), human sounds (14–16), sounds & society (17–28), mechanical sounds (29–39), sounds as indicators (40–50), other sounds (51–53). Each number corresponds to sound type defined by the soundscape classification table (see Appendix 1 for more detail).

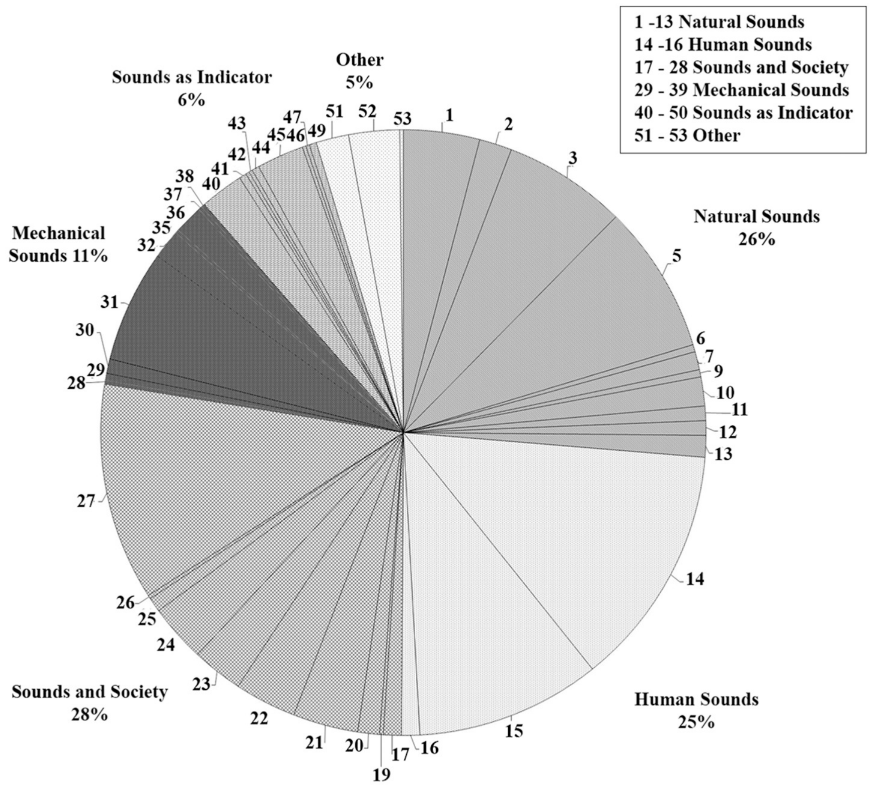

Figure 2. Overall classification of sound categories (n = 6) and count distribution of sound types (n = 53) in an intermediate group.

See legend for Figure 1.

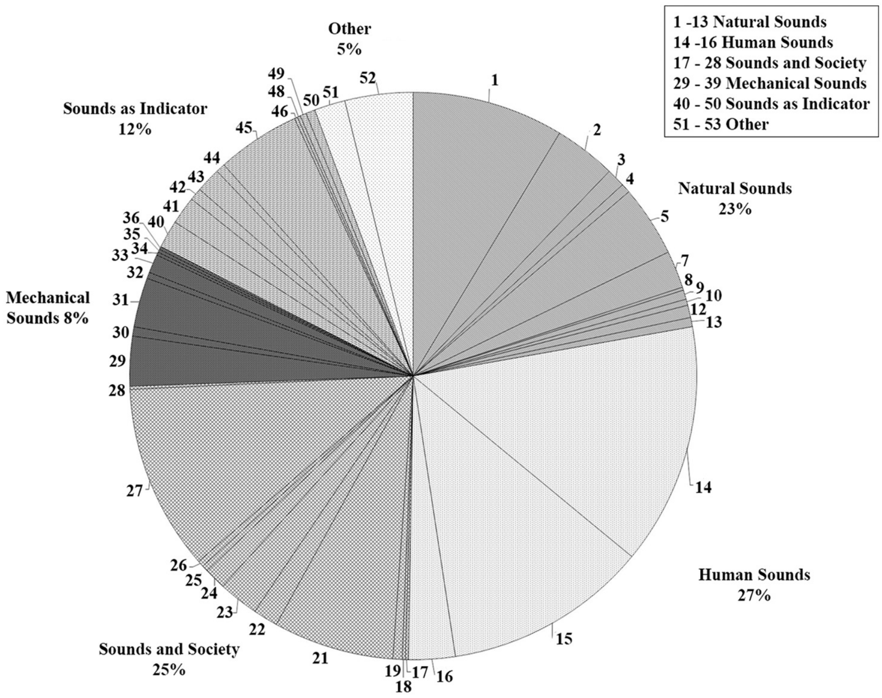

Figure 3. Overall classification of sound categories (n = 6) and count distribution of sound types (n = 53) in an urban group.

See legend for Figure 1.

In the forest group (see Figure 4a), Happiness was mostly associated with Natural Sounds (83.9%), followed by Sounds & Society (8.1%), Human Sounds (4.8%) and, with low association, with Sounds as indicators (1.6%) and Other (1.6%). Sadness was also associated primarily with Natural Sounds (79.2%), Mechanical Sounds (12.5%) and Human Sounds (8.3%). Tranquillity was related mainly to Natural Sounds (81.3%), followed by Human Sounds (12.5%), Mechanical Sounds (3.2%) and Other (3.2%). Fear was related mainly to Natural Sounds (81.8%) and then Mechanical Sounds (7.3%), Sounds as indicators (5.5%), Human Sounds (3.6%) and Sounds & Society (1.8%). Finally, Irritation was also primarily associated with Natural Sounds (58.9%), and to a lesser degree with Mechanical Sounds (17.9%), Human Sounds (10.7%), Sounds & Society (10.7%), and Sounds as indicators (1.8%).

In comparison, the intermediate group responses (Figure 4b) suggested that Happiness was associated with Sounds & Society (35.3%), Natural Sounds (30.2%), Human Sounds (22.4%), and to a lesser degree with Sounds as indicators (7.8%) and Mechanical Sounds (4.3%). Sadness was related mainly to Human Sounds (44%), followed by Sounds & Society (25%), Sounds as indicators (11%), Natural Sounds (7%), Mechanical Sounds (7%) and Other (6%). Tranquility was associated primarily with Natural Sounds (54%), followed by Sounds & Society (20%), Human Sounds (18%), Other (5%), Mechanical Sounds (2%) and Sounds as indicators (1%). Fear was related mainly to Sounds & Society (39.8%) and Natural Sounds (32.4%), and to a lesser degree to Human Sounds (9.3%), Mechanical Sounds (9.3%), Sounds as indicators (5.6%) and Other (3.7%). Lastly, Irritation was associated with Human Sounds (33.3%) and Mechanical Sounds (33.3%), followed by Sounds & Society (15%), Other (9.7%), Sounds as indicators (6.5%) and Natural Sounds (2.2%).

The urban group results (Figure 4c) suggested that Happiness related mainly to Sounds & Society (42.9%), Human Sounds (39.6%) and Natural Sounds (17.5%), followed by Mechanical Sounds (5.3%), Other (1.8%) and Sounds as indicators (1%). Sadness was associated primarily with Human Sounds (39.7%) and Sounds & Society (27.4%), and to a lesser degree with Natural Sounds (12.3%), Sounds as indicator (12.3%), Mechanical sounds (4.7%) and Other (3.7%). Tranquillity was related

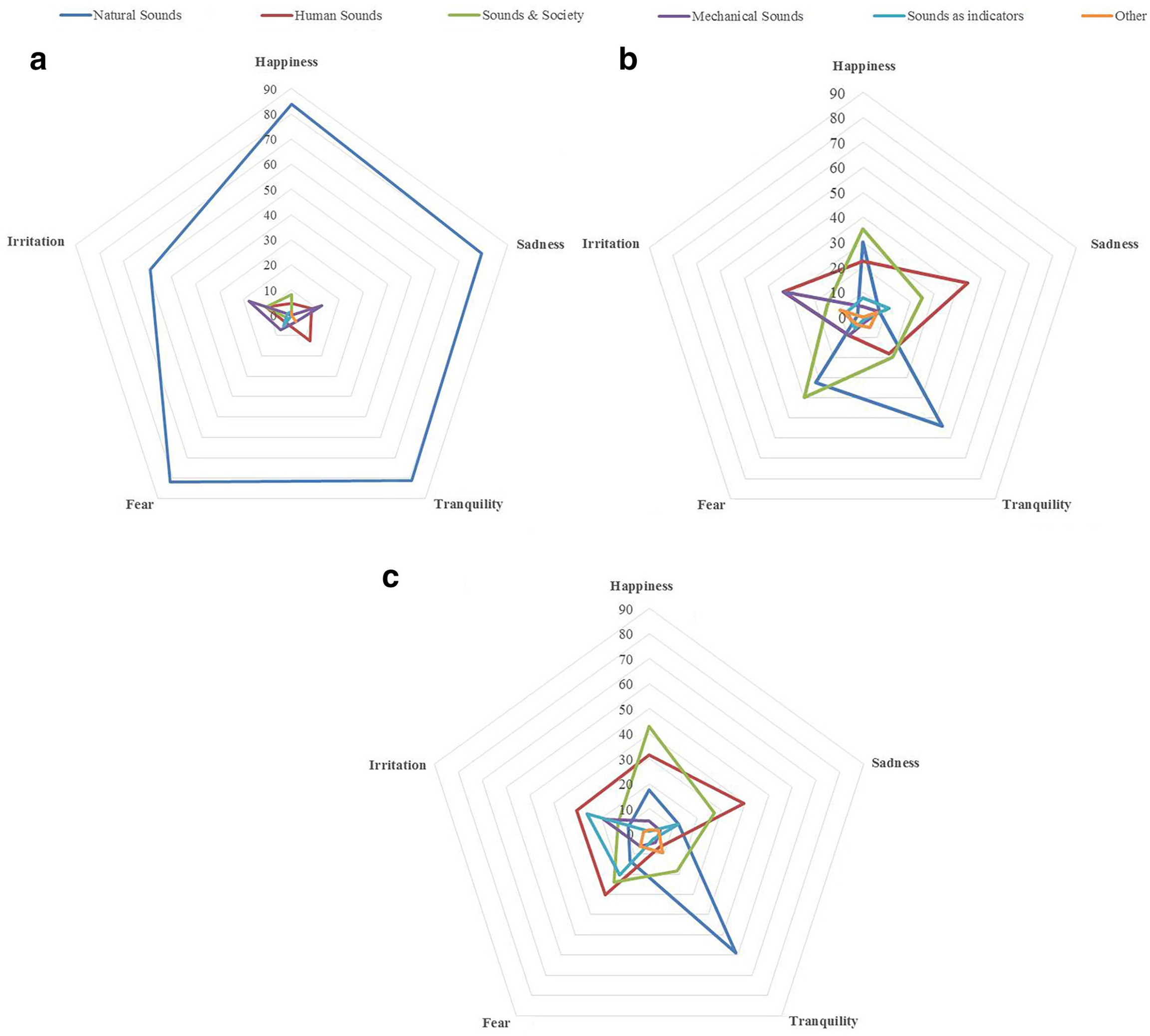

Figure 4. Distribution of emotions (n = 5) across sound categories (n = 6).

for a) the forest group, b) the intermediate group, and c) the urban group.

mainly to Natural Sounds (58.8%), followed by Sounds & Society (18.5%), Other (9.4%), Human Sounds (6.7%), Mechanical Sounds (4.2%) and Sounds as indicators (2.5%). Fear was associated especially with Human Sounds (30%), Sounds & Society (23.9%) and Sounds as indicators (20.4%), followed by Natural Sounds (13.3%), Mechanical Sounds (6.2%) and Other (6.2%). Finally, Irritation was related particularly to Human Sounds (30.4%) and Sounds as indicators (26%), and to a lesser degree to Mechanical Sounds (19.1%), Sounds & Society (13%), Natural Sounds (8.7%) and Other (2.6%).

Distribution of sound source types: Soundscape projections

There were significant differences in the distribution of response across sound sources types reported among all social groups (χ^2 (5) = 108.75 p <.05). Figures 1–3 presents the distribution of sound types reported by each group (see Appendix 1 for the list of recorded sound types).

With MCA, the analysis reduced the data to two dimensions that accounted for 50.4% of the variance. The variables of Dimension 1 have the highest inertia (0.390) and accounts for most of the variance between sound sources types among groups, whilst the variables of Dimension 2 show lower inertia (0.114). The contribution of each sound type in both dimensions and its scores are shown in Appendix 2. Hierarchically, the most discriminant variables for Dimension 1 were, sounds of birds,

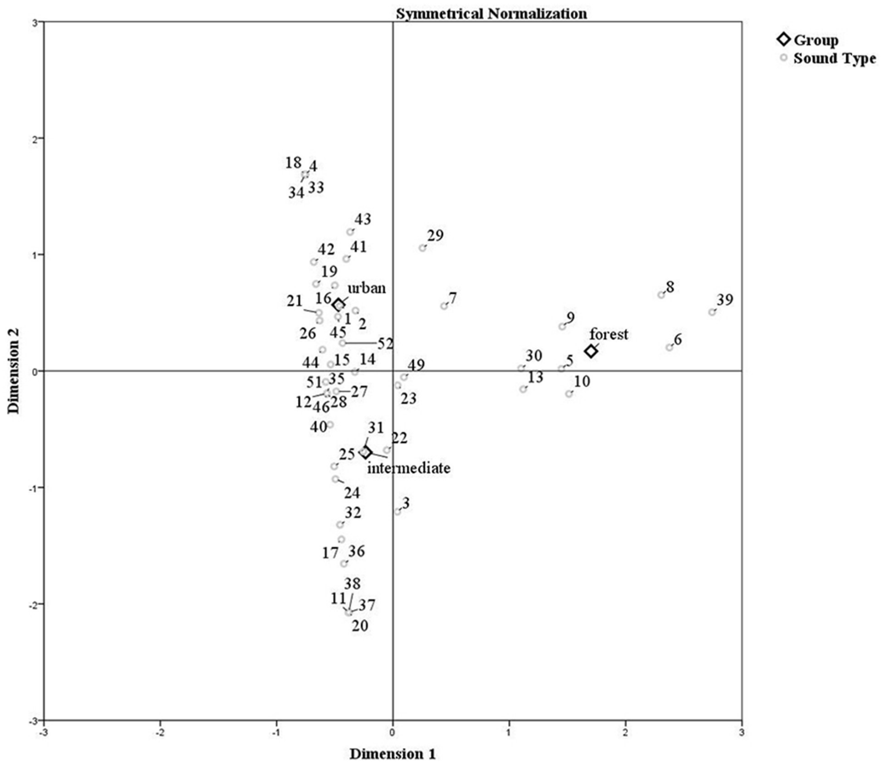

Figure 5. Multiple correspondence analysis. Projections on two dimensions of sound types among social groups.

The X axis represents the first dimension of the data variation, whilst the Y axis represents the second dimension in the MCA. Each number corresponds to a sound type (N = 53) defined by the soundscape classification table (see Appendix 1). The social groups are: 1) the forest group, 2) the intermediate group, and 3) the urban group.

felines, reptiles and mammals; and for Dimension 2 were marine soundscape, sounds of water, construction and demolition equipment, and transportation machines.

Figure 5 maps sound types within the two dimensional space. The relative distance of the points from the origin along each dimension indicate which dimension each variable was best represented by and which variables loaded onto the same dimension. The position of each social group shows which sound types and sound type combinations are strongly associated with them. For example, the forest group was closely related to Dimension 1, and the sound of “birds,” “other animals,” “reptiles,” “industrial and factory equipment,” “thunder and storms,” “felines,” and “mammals.” The intermediate group was mostly related with the negative axis of Dimension 2 and sounds of “social media programs,” “transportation machines,” “trades, professions and livelihood,” “radio,” “films and TV,” “bells, domestic animals,” “leaves and trees,” “forest,” “guns,” and “rural soundscape.” The urban group was equally related to both Dimensions (with the negative axis in case of Dimension 1 and sounds of “water,” “air,” “warning systems and alarms,” “other entertainment,” “domestic soundscape,” “body,” “silence,” “whistles,” “horns,” “telephone,” and “sound of screaming and crying”).

Discussion

Emotional association with sound source categories

Results suggest that, as expected, the soundscapes of forest, pre-urban and urban communities differed in the distribution and composition of sound categories and/or sound types, yet some similarities in patterns were observed in the association of sounds with particular emotions. We also found that the relationship between sounds and emotions was not necessarily related to the dominance of sounds. This was particularly clear for natural and mechanical/industrial sounds. In the case of social sounds, the relationship was different: the Sound of Humans and Sound & Society were associated with the full range of emotions in all groups. According to Stocker (2013) this could be considered a predictable response which expresses human nature and "something about the common experience of safety or vulnerability in humans" (p. 27). For example, the sounds of the voice, such as screams and crying of children, were related to negative emotions (sadness and irritation), whilst laughter and singing were related to positive emotions (happiness and tranquillity). These results therefore could suggest that the relationship between "social sounds" and emotions was consistent across groups.

The relationship between Natural Sounds and emotions was different. In the forest group Natural Sounds dominated and were associated with the full range of emotions, including "negative" attributes (sadness, fear, irritation) although less frequently. The breadth of emotional associations of natural sounds for the forest group tarries with Schafer's (1994) account of a survey of sound preference in Port Antonio, Jamaica, where most of the interviewees described animal and insect sounds as unpleasant. Even though living within a forest landscape could be a confounding factor, or a factor that influenced the high response rate of Natural Sounds, it could also have reflected the high level of integration of the forest communities within their natural environment. The fact that people are living within the forest and depending on it (especially in the Waorani community) could have created a stronger emotional affinity with nature, as the exposure level to the natural environment is greater, as suggested in Kals et al. (1999). In contrast, in the intermediate and urban groups, natural sounds were most strongly associated with tranquility, which aligns with recent research pointing to the calming effect (Kaplan, 2003; Kaplan and Kaplan, 2011; Keniger et al., 2013) and preference for natural sounds (Kang and Zhang, 2010; Lam et al., 2010), rather than non-natural sounds. The "positive" association with natural sounds within urbanized groups could suggest that these sound sources are providing them a "stillness state" that perhaps other sound sources do not provide in their daily acoustic environment. This observation is supported by the Attention Restoration Theory (Kaplan, 1995) which postulates that exposure to natural environment has positive effect on humans, reducing stress and enhancing cognitive capabilities. Furthermore, studies conducted in urban areas revealed preferences for natural settings (Newell, 1997; Clayton, 2000), and its effects on people, such as heightened sensations of restorativeness, tranquility, and lowered sense of danger, and transcendence experiences in comparison to urban settings (Herzog and Chernick, 2000; Williams and Harvey, 2001; Herzog et al., 2002). According to the "biophilia hypothesis" (Kellert and Wilson, 1995), humans have a biologically based need to affiliate with and feel connected to the broader natural world. The response of urbanized groups supports this hypothesis by showing that natural sounds might function as a "link" between the natural world and the senses of affiliation and connection to it, within an urbanized environment.

The relationship between mechanical/industrial sounds and emotions shows a similar pattern among groups and were mostly associated with "negative" emotions. Given that this study did not take the amplitude of each sound source into consideration, we cannot confirm that loudness, and not other qualities of mechanical/industrial sounds, explained this emotional association. Nevertheless, it has been widely reported that the effect of loudness/noise cause discomfort in humans (*e.g.*, Szeremeta and Zannin, 2009; Axelsson et al., 2010; Lam et al., 2010) and even that it is associated with health problems (Stansfeld and Matheson, 2003; Passchier-Vermeer and Passchier, 2000; Farina, 2014). The relevance of identifying "negative sounds," especially in forest communities is discussed further below.

As shown in our analyses, the relationship between sounds and specific emotions reflected similarities across groups, which could suggest that there are patterns occurring at societal level. Furthermore, we found that the shift from forests to urban landscapes is associated with shifts in the distribution (or abundance) of sound sources, which has an effect (negative or positive) on human emotions. General patterns observed, such as the positive association with natural sounds, or the negative association with industrial sounds, could help to gain understanding of the consequences of landscape change on human emotional responses. Nevertheless, further research is needed; especially within forest societies, in order to better understand their unique relationships with natural soundscapes and the consequences of environmental impact on their lives.

It should be noted that our samples confound urbanization and cultural background (urban groups were non-Ecuadorian); in future research we recommend the study be conducted with a single ethnic group living along a gradient of landscape modification.

It is also important to consider that one of the sites of the urban group (Parker) presented similar frequencies of sound categories to Puerto Quito town (intermediate group) (*e.g.*, higher percentages of Natural Sounds and lower percentages of Sound as Indicators'). This similarity could explain some similarities found between the intermediate and urban groups. This shows also that the difference between the definition of a city and a town is not necessarily related to population density (*i.e.*, high population density could be combined with rural ways of living). Furthermore, this study did not make any distinction between age, gender, level of education, etc. and the responses could be influenced by this as well. For example, most of the participants in the forest group were adults (between 20–50 years old), whilst in the other groups all the participants were young adults (around 18 years old). We recommend consideration of these factors in further studies.

Sound source types and soundscapes projection: A new tool for understanding human-environment relations

The analysis of sound source types, composition and frequencies in each group allowed us to better interpret and understand emotional associations with particular sound categories. For example, the strong association between fear and Sounds & Society observed in the intermediate group was related to the presence of sounds of "police and guns," revealed in the soundscape projection; whereas in the forest group, the presence of "feline" (jaguar) and "reptile" (snake), for example, explains the negative association with the Natural Sounds category. Furthermore, sound type composition showed that the diversity of natural sounds, explained as the numbers of words comprising the Natural Sounds category, decreased with landscape disturbance level (*i.e.*, a greater diversity of natural sound types was reported from the forest group). This highlights the differences among groups, which could reflect not only the cultural proximity to nature but also the "landscape state" in terms of biodiversity. Links between biodiversity richness and psychological wellbeing have been shown in a study of urban green spaces by Fuller et al. (2007). They found that people are able to perceive areas with higher species richness (in plants, butterflies and birds), and that those areas produced more restorative effects on them than areas with lower biodiversity. This aspect was not tested in this study but our results contribute to understanding the relationship between human perception, emotion and biodiversity.

As a tool, soundscape projections can provide a means for investigating which sound types best characterize particular soundscapes. For example, the sound type composition in the forest group is principally comprised of natural sounds that describe a biodiverse landscape (especially in fauna). It also revealed the presence of sounds associated with industry and machinery. In comparison, the intermediate group presented a "mixed soundscape," with sounds of an industrialized society (*e.g.*, transportation machinery), that is still influenced by a natural landscape (*e.g.*, forest sound). The urban group was mostly described as a combination of human generated sounds, or "lo-fi" soundscape (Schaffer, 1994), with natural sounds that do not necessarily reflect the existence of a natural landscape, (*e.g.*, water and wind).

Soundscape perception in conservation science

This study highlights the potential for the inclusion of studies of human perception of the environment within the science of conservation, particularly where there is the explicit aim of incorporating the impacts of land use change/conservation on humans. Soundscape perception analyses could contribute to conservation science in the following ways:

1. As a tool for understanding the impacts of environmental disturbance on humans and its effect on people's wellbeing, considering that health and wellbeing are influenced by the sonic environment (Pijanowski and Farina, 2011);

2. By highlighting sounds that are considered relevant sources (of welfare or disturbance) and illustrating "soundscape values" for human communities. These two aspects have been suggested within soundscape conservation strategies (Dumyahn and Pijanowski, 2011);
3. By providing insights into the relationship between humans and nature; and
4. By providing a proxy for the degree of industrialization of a given area, as landscape change has an immediate effect on soundscape (Farina, 2014).

In this study, we gained understanding of different aspects of human-nature relationships that could be considered in future conservation planning. Within the forest group, the presence of industrial machinery, such as those associated with the crude oil industry within the Waorani Ethnic Reserve (Finer et al., 2010), was evident in the analyses. Sounds generated by industrial and factory equipment were viewed negatively by the communities (*i.e.*, associated with irritation). This information corroborates other research that reports that the presence of crude oil companies in the Ecuadorian Amazon has caused negative reactions in the communities (Vallejo et al., 2015) and has even had health consequences (San Sebastian and Hurtig, 2004). Other relevant aspects revealed by the forest communities was their close relationship with nature through natural sounds. This particular association is significant: For the indigenous Waorani for example, the distinction between the natural world and humans is blurred, as their language (huao terero) does not include any words that separate humans from the environment, such as the terms "nature," "ecology," "animals," "plants" (Rival, 2012). This suggests that the value of natural sounds includes broader aspects of human identity and sense of belonging. According to "deep ecology," these findings are explained by the "ecological self" concept which is described as a sense of identity that transcends the individual and encompasses one's position as part of a living ecosystem (Naess and Rothenberg, 1990; Bragg, 1996; Matthews, 2006). Hence, we could consider that changes in soundscape due to habitat intervention, apart from having a negative effect on people's emotional state, could also affect their self-development process, or as Borden (1986) called it, provoke a "crisis of the self." Furthermore, we were able to identify that according to the Soundscape Type classification proposed by Dumyahn and Pijanowski (2011), the forest group classifies as a "Threatened" type of soundscape, which requires specific management goals, such as mitigation of excessive noise, improvement in technologies of sound producing object(s) and limits to additional noise intrusions.

We also found that people from urbanized environments associated natural sounds with a narrower range of emotions than the forest communities and that there was a strong positive emotional association with natural sounds, which can be understood in terms of the restorative, calming effects of these soundscapes. The value of natural sounds within the urbanized groups should also be considered in conservation, inspiring future research for urban design, for example by protecting, creating and/or restoring natural areas that are sources of natural sounds.

Conclusion

The key findings of this research are threefold: Firstly, key soundscape elements differ along a gradient of urbanization; our analyses highlight specific sounds which characterize each environment. Secondly, universal trends in emotional associations of natural versus industrial sounds were observed; analyses of emotional association with sounds enabled exploration of soundscape sensitivities and values amongst groups. Thirdly, sounds reported in response to emotional cues are likely to be those of high personal relevance: sounds that do not have an impact on individual's life are less likely to be mentioned given that sounds have qualities that permeate the subconscious, affecting emotional state in humans (Stocker, 2013). In this light, the soundscape projections created through the analysis can be read as a "phenomenological impression" of the relationship of the social group to their local environment. This impression may also reflect the behavior of the community towards the sonic environment, the soundscape values and the state of industrialization at that location. Our results align with Schafer's (1994) description of soundscape transition from "first soundscapes" to "post-industrial soundscapes" and support the idea that soundscapes have a direct impact on human wellbeing. These findings highlight the need for a greater understanding of which sounds promote healthier environments and the importance of continuing to widen the scope of conservation science research by integrating human perspectives in order to enhance conservation strategies and efforts.

Acknowledgements

We are very grateful to Amilcar Alban Torres, Xavier Neira and Dilon Loor for their help in field work, and to Dr Suhas R. Bhasme and Dr Maria Fernanda Moscoso for their guidance in the study design, and to Josep Navarro for his help in the graphs design.

Funding sources

This study was funded by Ecuador's Secretary of Higher Education, Science, Technology and Innovation (SENESCYT), Ecuador, and the Leverhulme Trust Grant, UK.

Competing interests

Paola Moscoso declares that she has no conflict of interest. Mika Peck declares that he has no conflict of interest. Alice Eldridge declares that she has no conflict of interest.

References

AME (2015). Cantón Puerto Quito. Asociación de Municipalidades Ecuatorianas. http://ame.gob.ec/ec/.

Axelsson O., Nilsson M. E., and Berglund B. (2010). A principal components model of soundscape perception. Journal of the Acoustical Society of America. 128 (5): 2836–2846. https://doi.org/10.1121/1.3493436.

BCC (2015). Population in Birmingham. Birmingham City Council. https://www.birmingham.gov.uk/.

Berkes F. (2004). Rethinking community-based conservation. Conservation Biology. 18 (3): 621–630. https://doi.org/10.1111/j.1523-1739.2004.00077.x.

Borden R. (1986). Ecology and identity. In Proceedings of the First International Ecosystems-Colloquy. Munich: Man and Space.

Bragg E. A. (1996). Towards ecological self: Deep ecology meets constructionist self-theory. Journal of Environmental Psychology. 16 (2): 93–108. https://doi.org/10.1006/jevp.1996.0008.

Clayton S. (2000). Descriptions of an ideal environment debate. Paper presented at The Social Construction of Nature L. Kalof (chair), Metting Society for Human Ecology, Jackson Hole, WY, October.

Clayton S. and Myers G. (2009). Conservation Psychology: Understanding and Promoting Human Care for Nature. EUA: Wiley-Blackwell.

Dumyahn S. and Pijanowski B. (2011). Soundscape conservation. Landscape Ecology. 26 (9): 1327–1344. https://doi.org/10.1007/s10980-011-9635-x.

Eriksson O. (2014). Human niche construction and the rural environment. Rural Landscapes: Society, Environment, History. 1 (1). https://doi.org/10.16993/rl.aa.

Farina A. (2014). Soundscape Ecology: Principles, Patterns, Methods and Applications. Netherlands: Springer Science +Buisness Media Dordrecht.

Feld S. (1990). Sound and Sentiment: Birds, Weeping, Poetics, and Song in Kaluli Expression (Conduct and Communication). United States of America: University of Pennsylvania Press.

Finer M., Moncel R., and Jenkins C. N. (2010). Leaving the oil under the Amazon: Ecuador's Yasuní-ITT Initiative. Biotropica. 42 (1): 63–66. https://doi.org/10.1111/j.1744-7429.2009.00587.x.

Fuller R. A., Irvine K. N., Devine-Wright P., Warren P. H., and Gaston K. J. (2007). Psychological benefits of greenspace increase with biodiversity. Biology Letters. 3 (4): 390–394. https://doi.org/10.1098/rsbl.2007.0149.

Garson G. D. (2008). Ethnographic Research: Statnotes. North Carolina State University, Public Administration Program. Available at http://faculty.chass.ncsu.edu/garson/PA765/ethno.htm. Retrieved 27 March 2011.

Gobster P. H., Nassauer J. I., Daniel T. C., and Fry G. (2007). The shared landscape: What does aesthetics have to do with ecology? Landscape Ecology. 22 (7): 959–972. https://doi.org/10.1007/s10980-007-9110-x.

Harmon D. (2003). The source and significance of values in protected areas. In: The Full Value of Parks: From Economics to the Intangible, edited by Harmon D. and Putney A. D. Lanham, Oxford: Rowman & Littlefield Publishers. 13–27.

Hartig T., Mang M., and Evans G. W. (1991). Restorative effects of natural environment experiences. Environment and Behavior. 23 (1): 3–26. https://doi.org/10.1177/0013916591231001.

Herzog T. R. and Chernick K. K. (2000). Tranquility and danger in urban and natural settings. Journal of Environmental Psychology. 20 (1): 29–39. https://doi.org/10.1006/jevp.1999.0151.

Herzog T. R., Chen H. C., and Primeau J. S. (2002). Perception of the restorative potential of natural and other settings. Journal of Environmental Psychology. 22 (3): 295–306. https://doi.org/10.1006/jevp.2002.0235.

Hobbs R. J., Hallett L. M., Ehrlich P. R., and Mooney H. A. (2011). Intervention ecology: Applying ecological science in the twenty-first century. BioScience. 61 (6): 442–450. https://doi.org/10.1525/bio.2011.61.6.6.

Kals E., Schumacher D., and Montada L. (1999). Emotional affinity toward nature as a motivational basis to protect nature. Environment and Behavior. 31 (2): 178–202. https://doi.org/10.1177/00139169921972056.

Kang J. and Zhang M. (2010). Semantic differential analysis of the soundscape in urban open public spaces. Building and Environment. 45 (1): 150–157. https://doi.org/10.1016/j.buildenv.2009.05.014.

Kaplan K. (2003). Health, supportive environments, and the reasonable person model. American Journal of Public Health. 93 (9): 1484–1489. https://doi.org/10.2105/AJPH.93.9.1484.

Kaplan R. and Kaplan S. (2011). Well-being, reasonableness, and the natural environment. Applied Psychology: Health and Well-Being. 3 (3): 304–321. https://doi.org/10.1111/j.1758-0854.2011.01055.x.

Kaplan S. (1995). The restorative benefits of nature: Toward an integrative framework. Journal of Environmental Psychology. 15 (3): 169–182. https://doi.org/10.1016/0272-4944(95)90001-2.

Kellert S. R. and Wilson E. O. (1995). The Biophilia Hypothesis. United States of America: Island Press.

Keniger L. E., Gaston K. J., Irvine K. N., and Fuller R. A. (2013). What are the benefits of interacting with nature? International Journal of Environmental Research and Public Health. 10 (3): 913–935. https://doi.org/10.3390/ijerph10030913.

Kingman E. (2002). Identidad, mestizaje, hibridación: sus usos ambiguos. Publicado en la Revista PROPOSICIONES 34.

Lam K.-C., Brown A. L., Marafa L., and Chau K.-C. (2010). Human preference for countryside soundscapes. Acta Acustica united with Acustica. 96 (3): 463–471. https://doi.org/10.3813/AAA.918299.

Macía M. J. (2001). Los Huaorani de la Amazonía ecuatoriana. Evaluación de recursos vegetales no maderables en la Amazonía noroccidental. Amsterdam: IBED, Universiteit Van Amsterdam. 53–57.

Matthews F. (2006). The Ecological Self. London: Routledge.

Mayer F. S. and Frantz C. M. (2004). The connectedness to nature scale: A measure of individuals' feeling in community with nature. Journal of Environmental Psychology. 24 (4): 503–515. https://doi.org/10.1016/j.jenvp.2004.10.001.

McAfee K. (1999). Selling nature to save it? Biodiversity and green developmentalism. Environment and Planning D: Society and Space. 17 (2): 133–154. https://doi.org/10.1068/d170133.

McCauley D. J. (2006). Selling out on nature. Nature. 443 (7107): 27–28. https://doi.org/10.1038/443027a.

MEA (2005). Living Beyond Our Means: Natural Assets and Human Well-being. Millenniun Ecosystem Assesment. Washington DC: Island Press.

Meine C. (2010). Conservation biology: Past and present[1]. Conservation Biology For All. 20 (3): 631–651. https://doi.org/10.1111/j.1523-1739.2006.00449.x.

Milner-Gulland E. J., McGregor J. A., Agarwala M., Atkinson G., Bevan P., et al. (2014). Accounting for the impact of conservation on human well-being. Conservation Biology. 28 (5): 1160–1166. https://doi.org/10.1111/cobi.12277.

Naess A. and Rothenberg D. (1990). Ecology, Community and Lifestyle: Outline of an Ecosophy. Cambridge, UK: Cambridge University Press.

Nastasi B. (2004). Qualitative research: Sampling and sample size considerations. In: School-based Mental Health Services: Creating Comprehensive and Culturally Specific Programs, edited by Nastasi B. K., Moore R. B., and Varjas K. M. Washington, DC: American Psychological Association.

Newell P. B. (1997). A cross-cultural examination of favorite places. Environment and Behavior. 29 (4): 495–514. https://doi.org/10.1177/001391659702900403.

Palmer Fry B., Agarwala M., Atkinson G., Clements T., Homewood K., et al. (2015). Monitoring local well-being in environmental interventions: A consideration of practical trade-offs. Oryx. 1–9. https://doi.org/10.1017/S003060531500112X.

Passchier-Vermeer W. and Passchier W. (2000). Noise exposure and public health. Environmental Health Perspectives. 108 (Suppl 1): 123–131. https://doi.org/10.1289/ehp.00108s1123.

Payne S. R. (2008). Are perceived soundscapes within urban parks restorative? In: Acoustics 08, Paris, France, 29 June 2008–4 July 2008. Published in: Proceeding of Acoustics. 08: 5519–5524.

Pijanowski B. C. and Farina A. (2011). Introduction to the special issue on soundscape ecology. Landscape Ecology. 26 (9): 1209–1211. https://doi.org/10.1007/s10980-011-9655-6.

Rands M. R. W., Adams W. M., Bennun L., Butchart S. H. M., Clements A., et al. (2010). Biodiversity conservation: Challenges beyond 2010. Science. 329 (5997): 1298–1303. https://doi.org/10.1126/science.1189138.

Ren X., Kang J., and Jin H. (2015). Residents' sound preference of rural soundscape in China. The Journal of the Acoustical Society of America. 138 (3): 1750. https://doi.org/10.1121/1.4933529.

Rival L. (2012). The materiality of life: Revisiting the anthropology of nature in Amazonia. Indiana. 29: 127–143. https://doi.org/10.18441/ind.v29i0.127-143.

San Sebastian M. and Hurtig A. K. (2004). Oil exploitation in the Amazon basin of Ecuador: A public health emergency. Rev Panam Salud Publica. 15 (3): 205–211.

Schafer M. (1994). The Soundscape: Our Sonic Environment and the Tuning of the World (1977). Reprint, Rochester, VT: Destiny Books.

Sourial N., Wolfson C., Zhu B., Quail J., Fletcher J., et al. (2010). Correspondence analysis is a useful tool to uncover the relationships among categorical variables. Journal of Clinical Epidemiology. 63 (6): 638–646. https://doi.org/10.1016/j.jclinepi.2009.08.008.

Stansfeld S. A. and Matheson M. P. (2003). Noise pollution: Non-auditory effects on health. British Medical Bulletin. 68 (1): 243–257. https://doi.org/10.1093/bmb/ldg033.

Stocker M. (2013). Hear Where We Are: Sound, Ecology, and Sense of Place. New York, NY: Springer Science & Business Media.

Szeremeta B. and Zannin P. H. T. (2009). Analysis and evaluation of soundscapes in public parks through interviews and measurement of noise. Science of The Total Environment. 407 (24): 6143–6149. https://doi.org/10.1016/j.scitotenv.2009.08.039.

Truax B. (1999). Handbook for Acoustic Ecology. World Soundscape Project, Simon Fraser University and ARC Publications.

Tse M. S., Chau C. K., Choy Y. S., Tsui W. K., Chan C. N., et al. (2012). Perception of urban park soundscape. Journal of the Acoustical Society of America. 131 (4): 2762–2771. https://doi.org/10.1121/1.3693644.

Vallejo M. C., Burbano R., Falconí F., and Larrea C. (2015). Leaving oil underground in Ecuador: The Yasuní-ITT initiative from a multi-criteria perspective. Ecological Economics. 109: 175–185. https://doi.org/10.1016/j.ecolecon.2014.11.013.

Widgren M. (2012). Landscape research in a world of domesticated landscapes: The role of values, theory, and concepts. Quaternary International. 251: 117–124. https://doi.org/10.1016/j.quaint.2011.06.021.

Williams K. and Harvey D. (2001). Transcendent experience in forest environments. Journal of Environmental Psychology. 21 (3): 249–260. https://doi.org/10.1006/jevp.2001.0204.

Woodhouse E., Homewood K. M., Beauchamp E., Clements T., McCabe J. T., et al. (2015). Guiding principles for evaluating the impacts of conservation interventions on human well-being. Philosophical Transactions of the Royal Society B: Biological Sciences. 370 (1681): 20150103. https://doi.org/10.1098/rstb.2015.0103.

Appendix 1. Sound classification table created by Schafer (1994) showing basic sound types and sound categories.

Sound category		Type of sound		Forest	Intermediate	Urban
1	Natural sound	1	sound of water	x	x	x
		2	sound of air	x	x	x
		3	sound of forest, nature	x	x	x
		4	sound of fire			x
		5	sound of birds	x	x	x
		6	sound of feline	x	x	
		7	sound of insects	x	x	x
		8	sound of mammals	x		x
		9	sound of animals	x	x	x
		10	sound of reptiles	x	x	
		11	sound of season, day-night		x	x
		12	sound of leaves or trees		x	x
		13	sound of thunders or storms	x	x	x
2	Human sounds	14	sound of human voice	x	x	x
		15	sound of screaming and crying	x	x	x
		16	sound of the body	x	x	x
3	Sounds and society	17	rural soundscape		x	x
		18	town soundscape			x
		19	city soundscape		x	x
		20	marine soundscape		x	
		21	domestic soundscape		x	x
		22	sound of trades, professions and livelihood	x	x	x
		23	sound of domestic animals	x	x	x
		24	sounds of TV, radio, films		x	x
		25	sound of social media programs (FB, WhatsApp, Twitter, etc)		x	x
		26	sound of other entertainment		x	x
		27	music	x	x	x
		28	ceremonies and festivals		x	x

Sound category		Type of sound		Forest	Intermediate	Urban
4	Mechanical sounds	29	machines	x	x	x
		30	industrial and factory equipment	x	x	x
		31	transportation machines	x	x	x
		32	guns		x	x
		33	trains and trolleys			x
		34	internal combustion engines			x
		35	aircraft		x	x
		36	construction and demolition equipment		x	
		37	mechanical tools		x	
		38	instruments of war and destruction		x	
		39	farm machinery	x		x
5	Sounds as indicators	40	bells and gongs		x	x
		41	horns	x	x	x
		42	whistles		x	x
		43	sound of time	x	x	x
		44	telephones		x	x
		45	warning systems, alarms	x	x	x
		46	indicators of future occurrences		x	
		47	**social media alerts**			
		48	**social alerts (*e.g.*, announcements)**			x
		49	**explosions and bombs**	x		x
		50	**social adverts (*e.g.*, advertisements)**			x
6	Other	51	**loud noises**		x	x
		52	**silence**	x	x	
		53	**unknown things**		x	
			Total	25	43	43

Highlighted sound types were added for this study in order to adequately classify the responses of participants. The X shows the responses among the three social groups. The sounds that were added for this research are highlighted.

Appendix 2. MCA dimensions discrimination values.

Sound type	Mass	Score in dimension		Inertia	Contribution of point to inertia of dimension		Contribution of dimension to inertia of point		
		1	2		1	2	1	2	Total
1	.056	-.458	.558	.013	.019	.052	.555	.445	1.000
2	.024	-.320	.520	.004	.004	.020	.413	.587	1.000
3	.036	.034	-1.209	.018	.000	.155	.001	.999	1.000
4	.002	-.750	1.690	.003	.002	.019	.268	.732	1.000
5	.123	1.443	.012	.160	.409	.000	1.000	.000	1.000
6	.013	2.368	.192	.046	.116	.001	.996	.004	1.000
7	.019	.438	.555	.004	.006	.017	.536	.464	1.000
8	.006	2.299	.644	.021	.052	.007	.959	.041	1.000
9	.010	1.451	.375	.014	.033	.004	.965	.035	1.000
10	.020	1.507	-.203	.028	.072	.002	.990	.010	1.000
11	.003	-.383	-2.071	.005	.001	.039	.060	.940	1.000
12	.006	-.567	-.191	.001	.003	.001	.942	.058	1.000
13	.014	1.115	-.162	.011	.027	.001	.989	.011	1.000
14	.120	-.327	-.007	.008	.021	.000	1.000	.000	1.000
15	.091	-.534	.058	.016	.041	.001	.994	.006	1.000
16	.016	-.497	.737	.005	.006	.026	.457	.543	1.000
17	.005	-.445	-1.444	.004	.001	.028	.149	.851	1.000
18	.001	-.750	1.690	.001	.001	.006	.268	.732	1.000
19	.003	-.658	.749	.001	.002	.005	.589	.411	1.000
20	.005	-.383	-2.071	.007	.001	.058	.060	.940	1.000
21	.043	-.634	.502	.015	.028	.032	.747	.253	1.000
22	.022	-.054	-.680	.003	.000	.030	.012	.988	1.000
23	.024	-.135	-.163	.000	.001	.002	.559	.441	1.000
24	.018	-.495	-.926	.008	.007	.045	.346	.654	1.000
25	.005	-.506	-.817	.002	.002	.009	.415	.585	1.000
26	.002	-.628	.436	.001	.001	.001	.793	.207	1.000

Sound type	Mass	Score in dimension		Inertia	Contribution of point to inertia of dimension		Contribution of dimension to inertia of point		
		1	2		1	2	1	2	Total
27	.094	-.486	-.174	.015	.035	.008	.935	.065	1.000
28	.002	-.567	-.191	.000	.001	.000	.942	.058	1.000
29	.019	.255	1.054	.008	.002	.063	.098	.902	1.000
30	.012	1.302	.077	.013	.033	.000	.998	.002	1.000
31	.039	-.254	-.690	.008	.004	.055	.201	.799	1.000
32	.008	-.457	-1.319	.005	.003	.039	.182	.818	1.000
33	.005	-.750	1.690	.006	.004	.039	.268	.732	1.000
34	.001	-.750	1.690	.001	.001	.006	.268	.732	1.000
35	.002	-.567	-.191	.000	.001	.000	.942	.058	1.000
36	.007	-.424	-1.653	.007	.002	.056	.109	.891	1.000
37	.001	-.383	-2.071	.001	.000	.010	.060	.940	1.000
38	.001	-.383	-2.071	.001	.000	.010	.060	.940	1.000
39	.001	2.735	.494	.004	.009	.001	.983	.017	1.000
40	.016	-.541	-.459	.004	.007	.010	.720	.280	1.000
41	.009	-.399	.963	.004	.002	.025	.241	.759	1.000
42	.004	-.677	.937	.002	.003	.010	.491	.509	1.000
43	.008	-.365	1.194	.004	.002	.032	.148	.852	1.000
44	.004	-.603	.185	.001	.002	.000	.952	.048	1.000
45	.032	-.471	.469	.007	.011	.021	.651	.349	1.000
46	.002	-.567	-.191	.000	.001	.000	.942	.058	1.000
47	.001	-.383	-2.071	.001	.000	.010	.060	.940	1.000
48	.001	-.750	1.690	.001	.001	.006	.268	.732	1.000
49	.004	.094	-.054	.000	.000	.000	.849	.151	1.000
50	.002	-.750	1.690	.003	.002	.019	.268	.732	1.000
51	.014	-.576	-.092	.003	.008	.000	.987	.013	1.000
52	.029	-.432	.241	.004	.009	.005	.856	.144	1.000
53	.001	-.383	-2.071	.001	.000	.010	.060	.940	1.000
Active total	1.000			.504	1.000	1.000			