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The Sounds of Silence: Perspectives on Documenting Acoustic Landscapes at the Intersection of Remoteness, Conservation and Tourism

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Abstract: The humanities are often criticised for lacking a way through from the complexity they reveal to the challenges they might hope to address. In the face of the accelerating biodiversity crisis, we present two projects that aim to respond to the limitations and lack of interdisciplinary conversations in conservation and in humanities research. At field sites in Finnish Lapland and the French Pyrenees, we document how conservation humanities research can be used to develop a more pragmatic and integrated transdisciplinary approach to conservation in remote and fragile landscapes. Firstly, we show how sound and *soundscapes* are important subjects of study in both conservation biology and the humanities. We also highlight their importance to conservation planners and policy makers seeking to preserve biodiversity and landscape characteristics, as well as our social values thereof, which, together, are critical to their survival. Secondly, we demonstrate how integrated conservation humanities methods can lead to rich local-level insights on key conservation themes that can then be scaled via existing large-scale acoustic monitoring and spatial datasets to support decision making across much larger areas. Finally, we highlight how the participatory mapping approach at the core of our integrated methodology shows potential to generate change in the real world and meet the classic operationalisation challenge that academia faces.

Keywords: conservation; soundscapes; ecoacoustics; wilderness; protected areas

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1. Introduction

> "The world has problems, universities have departments". G. D. Brewer (1999, p. 328)

Although they appear to share much in common—a desire to study the relationship between humans and biodiversity, a lament for the loss of biodiversity and a search for ways to address this—there is remarkably little shared activity between conservation biology and the conservation humanities. This contradiction is even more remarkable given two other factors. Firstly, whilst the work of conservation biologists has slowed rates of biodiversity loss (Johnson et al. 2017), extinction and habitat loss continue at a rapid rate (Neugarten et al. 2024). To address this, there have been repeated calls within conservation to become more effective by integrating additional disciplines and forms of knowledge, stretching back to the founding documents of modern conservation biology (Soulé 1985) and continuing

into the dawn of the Anthropocene (Palsson et al. 2013; Bennett et al. 2017). Yet, in spite of these calls for genuine interdisciplinarity and the conclusion that 'Our belief that science alone could deliver us from the planetary quagmire is long dead' (Sörlin 2012, p. 788), recent research on human–natural systems continues to neglect the humanities (Elsawah et al. 2019). Existing integration can be limited—for example, visions of interdisciplinary research on coupled human and natural systems (see, for example, Shin et al. 2022) still have a tendency to limit their new, inclusive vision to "*just add social scientists*" when addressing complex environmental and ecological problems. Secondly, although the humanities have been integrated into the work of many prominent thinkers for some time—see, for example, Aldo Leopold's land ethic inspired by philosophy and ecology (Leopold 1949)—humanities scholars have been criticised for failing to achieve 'impact' and change the world through their work. As a broad interdisciplinary movement, the conservation humanities are well geared towards understanding the subtleties of the relationship between society and the 'dynamic milieus' that constitute our multispecies environment (Van Dooren et al. 2014). Whilst there is a stated willingness within both conservation biology and the conservation humanities to work across disciplinary boundaries and to have greater impact, as well as many shared interests, there has been a failure to do so.

This failing can be explained by a number of factors. There is a lack of humanities content in conservation degrees and training and vice-versa, which has shaped the values and worldview of graduates working in these fields (Sandbrook et al. 2019; Luque-Lora et al. 2022; Slater et al. 2024). The structure of academia, such as disciplinary journals, the norms of publication and the organisation of departments, constrains such integration. Whilst there are shared interests, objects of study and vocabulary between conservation humanities and conservation biology, there are also differences in definitions, as well as epistemologies and ontologies (Pooley 2013; Holmes et al. 2022). There is a tension between disciplines being true to themselves, able to speak to debates and developments in their own field, whilst drawing insights from other disciplines and contributing to them and changing the world. Our focus here is on the challenges of integrating the rich data from humanities scholarship with rich environmental data.

Here, we demonstrate that one way of addressing this impasse is through research projects with a shared focus and even shared datasets, as well as ongoing academic–societal partnerships. Specifically, we explore how knowledge of the socio-cultural dimensions of biodiversity can be captured and understood, then 'operationalised' alongside ecological data in the kinds of tools needed by conservation organisations working at regional and national scales, such as National Parks and landscape planners. We also make the case for the importance of sound as a socio-ecological nexus for understanding landscape and 'soundscape' as a useful concept and methodological focus for conservation research (Carruthers-Jones et al. 2019; Eldridge et al. 2020). Sound, in its variety, its presence and its absence, is a part of conservation in three important ways. Firstly, it is part of how ecosystems function, such as the role of birdsong in bird communication, and, thus, worth conserving in its own right. Secondly, measuring sound can be a proxy for measuring other aspects of biodiversity; for example, the recording of birdsong can be used to monitor bird abundance. Thirdly, sound can be part of the ways in which humans relate to and value the environment, such as appreciating the beauty of birdsong or the sense of solitude that comes from silence. It should be noted that these do not always align; for example, humans might value the calls of invasive bird species, whose presence might reflect a damaged environment. Similarly, not all humans relate to and value sounds in the same way; silence can be both comforting and unsettling, and the call of a bird can be an important part of cultural identity to one person and a cacophony to another.

Theoretically, our approach aligns with contemporary environmental humanities perspectives that treat human cultures and ecosystems as an integrated whole. From this perspective, soundscapes are rich with meaning, a critical dimension of the '*ecosemiosphere*' that is shared by all species—and their *umwelts*—a complex cultural-ecological system within which diverse semiotic relations play out (Maran 2021). Human perceptions of soundscapes therefore have potential to provide insights into this space and be interpreted and analysed as indicators of the quality and diversity of the cultural–ecological system (Carruthers-Jones 2019). At the same time, the emerging discipline of ecoacoustics (Sueur and Farina 2015) can provide both a framework to conceptualise the diverse sounds found in the landscape and a robust, low-cost methodological toolkit to monitor them over long time frames, even in remote and logistically challenging environments (Metcalf et al. 2023). We can record environments and analyse the sounds within them using powerful computer tools to provide a relatively easy, cheap and unintrusive insight into the natural world, what is in it and how it functions, thereby offering us a proxy for ecosystem health and status (Eldridge et al. 2018). The discipline of ecoacoustics has emerged as part of broader developments in ecology facilitated by mass-produced and inexpensive instruments to take environmental measurements, as well as computing developments to automatically analyse the large amounts of data produced. Acoustic monitoring offers insights into a shared multispecies space at the interface between human beings and ecological and technological processes and allows us to measure qualitative socio-cultural and quantitative ecological data for the same space.

Grounding these theoretical frameworks in the landscape, we use a participatory mapping approach structured around the concept of the 'transect' as both a landscape element and a transdisciplinary framework through which results derived from multiple approaches can be integrated, cross-fertilized and exchanged (Carruthers-Jones et al. 2019). A path- or transect-based approach has been found to be a useful analytical method and research tool to explore contested issues in relation to urban and landscape planning (Talen 2002; Moccia and Berruti 2018). The idea of a path situated in the landscape speaks to multiple disciplinary approaches and ways of describing data or knowledge. Within environmental history, it is considered to be a way of both accessing knowledge on 'mobility heritage' and a potential mechanism for resolving conflicts arising from competing land uses in remote locations (Svensson et al. 2016). Paths are also shared, co-evolving from human and non-human use of the landscape, serving as an anthropological lens through which to research shared land use and cultural knowledge of places (Van Dooren et al. 2014). We frame the paths walked by participants in these projects as a spatial 'transect' along which different kinds of data are collected. At a minimum, this includes both objective measures of landscape attributes—via ecoacoustics—and subjective human perceptions of that landscape (via mobile ethnographic mapping methods). This allows us to vertically integrate multiple types of data collected laterally along spatial gradients and analyse them as part of the process of constructing knowledge (Ingold 2011, p. 153). Combining the conceptual framework of soundscapes and ecoacoustics with the spatial 'thread' of transect-based mobile ethnographic methods allows us to respond to calls within research on global environmental change for integrated methods that reflect the plurality of representations of landscape and the diversity of human values these represent (Castree et al. 2014).

Practically, our empirical research aims to better understand the challenges facing the conservation of sub-Arctic and high-mountain landscapes, which are increasingly threatened by the dual threats of rapid climate change and growing tourism pressures. The fieldwork unfolds along transects that span gradients of social, cultural and ecological land use at two field sites in Finnish Lapland and in the French Pyrenees. These sites are typical of fragile remote landscapes in Europe where a growth in sustainable tourism threatens

the very thing that people travel to visit and experience (Walter et al. 2024). Our work was aimed at exploring the tensions between multiple land uses, such as cultural heritage and biodiversity conservation, and between different actors in the landscapes (herders, tourists, livestock and predators). Increasingly, the conservation of intact remote landscapes is seen as critical to the future of our biosphere on both ecological and social levels (Di Marco et al. 2019). Although sound has historically been overlooked in conservation when considering the social and ecological heritage value of protected areas (O'Connor 2008), high levels of anthropogenic noise can be detrimental to a range of bird, insect and animal species (Berger-Tal et al. 2019). Equally, intact ecological landscapes with low levels of human impacts such as anthropogenic noise are now considered critical to the wellbeing they provide for humans (Milner-Gulland et al. 2014; Allan et al. 2020). The 'soundscape' found in these remote landscapes is therefore now considered a critical ecological niche for both species communication and for human wellbeing, and developing methods to advance the protection of soundscapes via methods that integrate both humanities and conservation biology is critical to the survival of these fragile landscapes (Eldridge et al. 2020).

2. Listening in—Methods, Machines and Publics

Conservation humanities spans multiple disciplinary silos and, in doing so, opens up much-needed novel pathways for '*conceptualizing*' complex conservation problems' (Holmes et al. 2022). At the intersection of several of these pathways, our field methods combine anthropology and human geography—which exist in the 'fuzzy space' between the humanities and the social sciences—and extend their disciplinary reach further via the discipline of ecoacoustics, which has emerged out of landscape ecology and biology. Beyond the use of multiple disciplinary lenses, our research questions are driven by a pragmatic and 'applied' approach (Sandbrook et al. 2013) to research on conservation to mitigate the biodiversity crisis. Via a focus on our shared experience of the soundscape, we seek to develop a more detailed and nuanced understanding of our interactions with nature. In pursuit of more constructive pathways for coexistence going forward, we use this multiplicity of methodological lenses to triangulate key dimensions of the complex dynamics driving the biodiversity crisis. Bringing the anthropological gaze to bear on these cultural landscapes within mixed-methods walking interview techniques, we then overlay machine-based listening data capturing ecological attributes of the landscape for the same locations.

We tested and developed these methods during two recent research projects, Contours and Corridor Talk. The CONTOURS: Conservation, Tourism, Remoteness (https://www.oulu.fi/en/projects/contours-conservation-tourism-remoteness, accessed on 1 January 2025) project was concerned with protected areas and explored how conservation and tourism practices and processes intersect and how they are understood, implemented and, at times, resisted. Within this wider project at field site 1 in the Kilpisjärvi area of northern Finland (see Figure 1) we used the framework of the soundscape as a conceptual and methodological pathway for linking applied studies of nature tourism and conservation practices with critical research on human–environment relations.

In parallel, the Corridor Talk: Conservation Humanities and the Future of Europe's National Parks (https://conservationhumanities.com/corridor-talk/ (accessed on 1 January 2025)) project was funded jointly by the German Research Council (DFG) and the UK's Arts and Humanities Research Council (AHRC). At multiple field sites, it explored Europe's national parks and the unique challenge they present to conservation work: many of them are not just historically wild and contested places but also sites of more recent geopolitical disputes. Understanding the role these parks play in local perceptions of place, identity, species movements and human rights of access involves conservation as refracted

through multiple languages and cultures: it requires, in short, a humanities-based, as well as a scientific–managerial approach. Within this wider project at field site 2, the concept of the soundscape and the techniques of ecoacoustics were also used in the Pyrenees mountains (see Figure 2) to explore the socio–ecological dimensions of wild landscapes, notably as a method to deepen our understanding of human values for this landscape and the challenges of co-habiting with the other species we share them with, such as the brown bear.

Figure 1. Field site 1 in the Kilpisjärvi area of northern Finland, showing a passive acoustic monitor and a group visiting the popular tourist destination of Saana fell. The passive acoustic monitors were predominantly deployed in the wooded areas, which are visible lower down on the path up to Saana Fell.

Figure 2. Field site 2 in the Pyrenees National Park area of southern France showing a passive acoustic monitor (**left**) and a group visiting the popular tourist area of Pont d'Espagne (**right**).

Together, these two field sites highlight the tensions currently being played out across Europe between growing anthropogenic pressures and accelerating ecological vulnerability. Both of these remote landscapes incorporate strict nature protection areas—designated for

their ecological importance—that are subject to complex anthropogenic impacts via nature-based and leisure tourism, a trend that has only grown post COVID-19. At both these field sites, we used participatory mobile methods to understand how people experience sound and relate to their soundscape (see the location map in Figure 3 below).

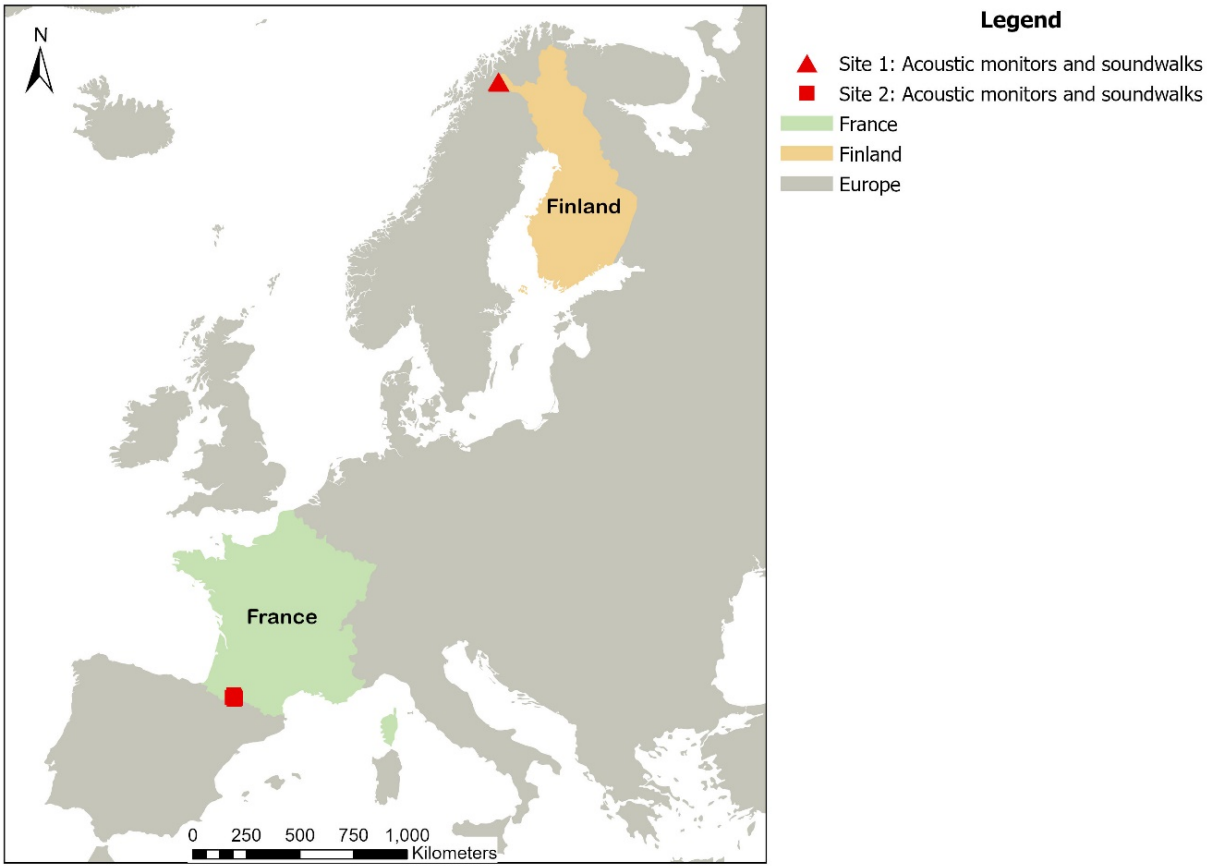

Figure 3. Project location map. Field site 1—Kilpisjärvi in northern Finnish Lapland, close to the border between Norway and Sweden. Field site 2—Hautes-Pyrenees in southern France close to the border with Spain. Passive acoustic monitors were deployed, and soundwalks were conducted at both sites.

In Finland, Kilpisjärvi in northern Lapland was identified by the CONTOURS project as a site of interest for the key themes of tourism, conservation and remoteness (Walter et al. 2024). An unstructured approach to recruiting interviewees was used that identified key spatial areas of interest for the themes at hand—such as National Parks—then invoked an 'accidental' approach to ethnographic recruitment (Fujii 2015) that sought opportunities for interviews with participants encountered along the path in these areas whilst snow shoeing and ski touring or in wilderness huts. In this sense, participants at field site 1 were identified using what has been called the 'convenience/haphazard' method, a description that characterises researchers' first encounters with participants in the field before a more formal 'snowball' method can begin (Guest 2014). These encounters were, by definition, less structured and often initiated by the future participant who enquired as to what the researchers were doing. Upon learning that we were researching the soundscape, the following conversation quickly turned to what they had heard or not heard that day or which noises were the most pleasant for them or, indeed, the most annoying. This combination of a place-based accidental approach to identifying participants with the 'go-along' method (Kusenbach 2003) allowed us to reach participants in the field site who

were often just passing through and who would have been very challenging to recruit using standard methods such as postal or on-line strategies.

As a counterpoint to this, in the Pyrenees at field site 2, the walking interviews were participant-led, and participants were identified using a pre-structured snowball method informed by local conservation experts that aimed to include all those with an interest in the question at hand, to be given a voice (see, for example, Reed et al. 2022). Rather than the research team selecting a walking transect that would impose our idea of wildness or naturalness, we invited individuals or pairs of participants to take us on a walk from an area of low naturalness to high naturalness so that the resulting transects reflected their ideas of naturalness or wildness. We interviewed participants at a series of stops (n = 118) during these day-long walks (n = 25). An initial stop was made at the start of the walk, usually in an urban area; then, participants were asked to identify periodic stops along the walk at locations where they felt that the naturalness of the landscape changed significantly in character. This gave us a set of interview stops along a participant-defined gradient of naturalness. At each stop, we used high-quality, lightweight audio–visual equipment (GoPro Fusion, Zoom H4N and Tascam lavaliere microphones) to record 2 minutes of the soundscape with no talking, then participant answers to a series of questions: (1) How wild/natural does the surrounding landscape sound?; (2) How wild does the surrounding landscape look?; and (3) How likely is it that bears, wolves or lynx move through this area? Participants provided a numerical score (1 (low)–10 (high)) for each question, then an explanation of what landscape elements, thoughts and experiences were driving their score.

At both field sites, these mixed-method qualitative interview techniques were complemented by quantitative ecoacoustic sampling. As outlined above, ecoacoustics is an emerging interdisciplinary science that investigates natural and anthropogenic sounds and their relationships with the environment over multiple scales of time and space. It is used in conjunction with the conceptual framework of the soundscape (Sueur and Farina 2015) that divides the acoustic space into sounds based on their (1) *geophony*, which denotes the sounds made by abiotic processes in the landscape, such as wind and rain; (2) *biophony*, the sounds of animals, birds and insects; and (3) *anthrophony*, the sounds of humans—although the term *technophony* (Gage and Axel 2014) is increasingly used to differentiate the sounds of human speech from those of human machines. At a subset of the same locations as the participant interviews, we deployed long-term passive acoustic monitoring (PAM) devices to record the soundscape. There was a total of 8 recording locations in Kilpisjärvi (Field site 1) and 14 recording locations in the Pyrenees (field site 2), which were used to measure changes in the soundscape over time. These locations served to characterise the interview locations beyond the moment of encounter with participants and included a diverse range of habitats that were also representative of a gradient of landscape change, including (1) highly modified landscapes such as the centre of town or an access car park for a protected area; (2) modified natural areas such as managed forest or areas close to paths where there is high tourism activity; (3) semi-modified natural areas where there is heavy grazing by cattle or sheep in the Pyrenees or reindeer in Finland; and (4) intact natural areas, often at higher altitudes such as birch forests or old-growth forests far from footpaths and often on steep slopes. The distance between the recorders was controlled to ensure that they were not recording the same sounds. By analysing the sound recordings, a suite of acoustic indices can be calculated to quantify the proportion of the soundscape that is coming from these various sources. More simple acoustic descriptors can also be used to measure basic attributes of the soundscape, such as the amount of noise. These can then be plotted to statistically analyse the sonic activity across frequency ranges.

3. Notes from the Field—Findings and Reflections

Walking Interviews

In 2015, the Finnish Tourist Board amended its core destination values to include "Silence, please" (See Figure 4).

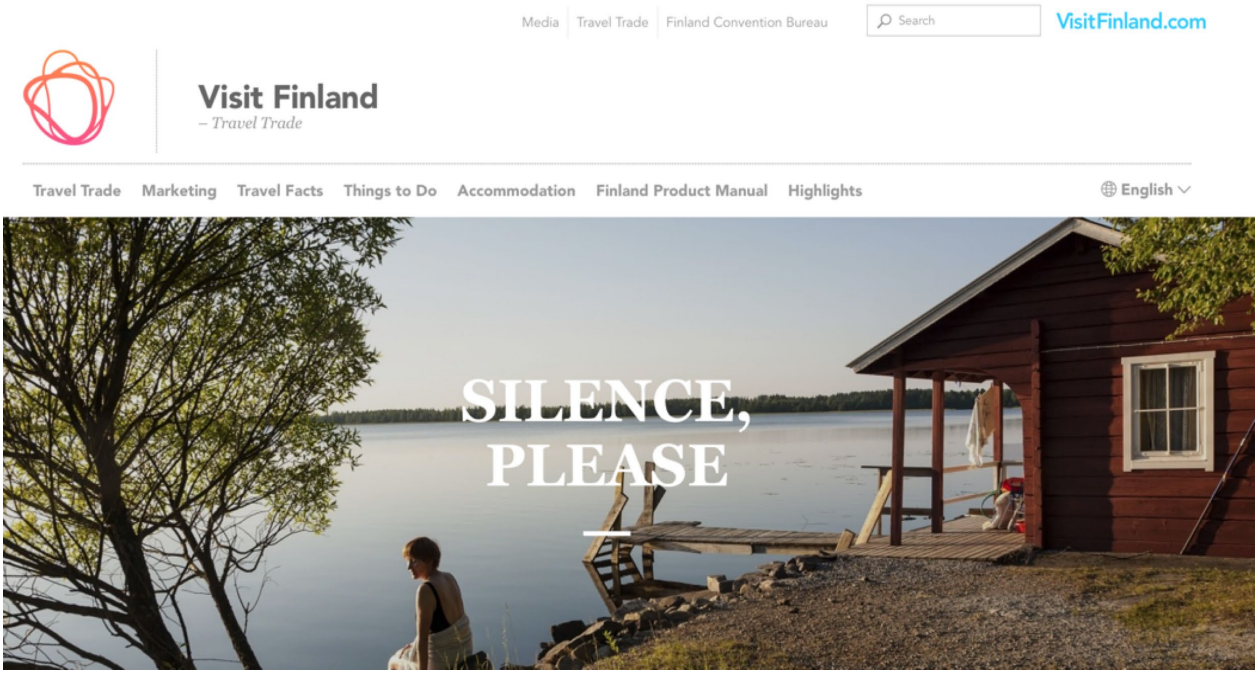

Figure 4. Space, time, peace and quiet—the four elements modern life lacks. Finland offers a chance for downshifting even in the heart of the city, and untouched nature is never more than half an hour away. Stay at a cottage, enjoy a sauna and listen to birds warbling across the lake. Take in the sound of quiet. Hear yourself think.

At both of our field sites, the results of the walking interviews with members of the local community, as well as tourists, highlighted that silence is not, in fact, the absence of any sound, as we commonly understand it but, rather, the absence of human-made sounds. During the more unstructured interviews at field site 1 in Kilpisjärvi in northern Finland, this was summarised by a member of staff at the local national park visitor centre, who highlighted the fact that "*silence includes the sounds of the nature, even the wind. It just does not include human made sounds*". For them, human-made sounds included both the *anthrophony* of human voices, as well as the *technophony* of snowmobiles. In the open topography of sub-Arctic landscapes, with their dwarf birch forests, both of these sound sources can travel long distances, unhindered by the dense forest typical of central and southern Finland. Inevitably, as the number of tourist visitors in these landscapes has grown, this pristine silent promise of the 'Far North' has begun to be threatened. Neither *anthrophony* nor *technophony* 'belongs' in the narrative of these landscapes. Interviews in the picnic hut at the foot of Saana Fell quickly turned to a vision of a pristine landscape where there was a remoteness—often characterised by participants as the sounds of '*the nature*' (*biophony*) and the '*extremes*' of snow and wind (*geophony*). It was this imaginary that had drawn many of the tourists here, whether they had come from other parts of Finland or farther afield in Europe and Asia. Interestingly, the idea that we were in this landscape studying the 'soundscape' was almost always initially greeted with surprise, yet without further prompting, this concept resonated intuitively with all participants, whether they were local residents or tourists. Amongst tourists, this also developed into detailed reflections on sound sources they viewed negatively—such as snowmobiles and helicopters—and

how they impacted on their experience of the landscape they had travelled so far to visit. Amongst members of the local community who practiced fell skiing or non-mechanical activities, these negative sentiments about snowmobiles and helicopters for recreational activity in the remoter parts of the landscape were shared—several commented, "*Why should the actions of one person impact so many others across such a large area?*". In this narrative, the recreational snowmobilers were often perceived as outsiders who had travelled to the area from Norway, coming across the border from the nearest big town, Tromsø, where this kind of recreational winter activity is no longer allowed. The presence of "*weekenders*" from Norway, who come to buy the cheaper food and alcohol at the local K-Market, is a well-established trend, at least according to the local residents and those working at the K-Market. Researching the content of this narrative amongst the visitors from Norway, we spoke, for example, to one weekender who explained that, actually, he towed a caravan from his home in Tromsø to Kilpisjärvi each autumn, then left it there for six months so he could spend his weekends with his friends snowmobiling and drinking in the local bar. As long as he left the caravan there for less than six months, there were no tax implications. He recounted in detail why he loved Finland for its lax legislation on snowmobiling and shared tales of his run-in with the Finnish police who had stopped him to check the depth of the track on his snowmobile. A large man, he had customised his snowmobile so that the tread on his drive track was double the legal limit so that he had better traction in deep snow; but, as he was keen to tell us, "*they never fine me. . ..*". This archetypical local vs. non-local narrative and the negative impact of the behaviour of snowmobilers coming from outside Finland was also emphasised by local tourist operators who organise snowmobile 'safaris'. Operating within local legislative requirements and observing the restrictions on where snowmobiles can go, they do not perceive their activities as a threat to the ecological functioning of the area or as negatively impacting people's experience of place. As we have already noted, however, this stands in stark contrast to the experience of other local people whose winter activities, such as cross-country skiing or snowshoeing, make no sound at all.

In the more structured interview format used in the Pyrenees at field site 2, the idea of soundscapes and a specific set of questions on sound were introduced to participants from the outset (see Section 2 above for more details). Analysis of the transcribed interviews revealed several key themes. Firstly, the interviews clearly highlighted the importance of sound to people's experience of place, an obvious-seeming fact that is, nevertheless, often overlooked in histories and geographical characterisations of landscapes (Farina et al. 2014). Silence was an equally treasured quality of naturalness that, again, was defined not as the absence of any sound but, rather, the absence of human-made sounds. Distinguishing silence from naturalness, the importance of biophony to how natural a place sounds was highlighted by one participant who observed, "*For me, the absence of nature sounds also reduces the [naturalness] score because there isn't the life, the natural life that we would imagine here*". A second key theme to emerge from these interviews was the important difference between the visual quality of a place and the acoustic quality of the same place. This was revealed in the difference in the visually and acoustically perceived naturalness scores given by participants. Usually, this was in the direction of a place sounding much less natural than it looked, often because—as in field site 1—anthrophony or technophony was travelling significant distances or because a single sound source (a rubbish van, for instance) made so much noise that, alone, it was capable of transforming a person's experience of a place. Even in the most natural and remote corners of the Pyrenees, there was still a lack of silence. Prominent technophonic sound sources in the beauty spots of site 2 were drones, and no matter how far we walked into the wilderness and strictly protected corners of the valleys of the Pyrenees, there was still the regular passage of airplanes and the occasional gunshot from a hunter's rifle. This technophony was, as we might expect, highlighted as

a key dimension of participants' acoustic experience: "*We haven't heard any cars come past, so we can listen to everything that is happening, without the bruit parasite [background noise] disturbing us, no man-made sounds masking our experience of the natural background noise [which is] a pureness of sound, the soundscape—the fond sonore*".

4. Integrating Acoustics Data

Whilst we have a wealth of quotes and anecdotes from both sites, as we highlighted above, at both these field sites, we tried to go beyond a traditional qualitative analysis to include other methodological lenses, notably ecoacoustics. The goal of this more integrated and pragmatic approach was twofold. The first goal was to enrich our understanding of the localised interview data by linking the insights from these interviews with data for the same locations collected via passive acoustic monitoring, thus combining momentary qualitative data with a scalable, long-term, quantitative data collection method. Doing so allowed us to apply our research conclusions to areas beyond our field sites, where there are other existing ecoacoustic datasets, thereby supporting informed decision making with respect to conservation across larger areas.

Descriptive Analysis of Sound Recordings

Analysis of the sound recordings for the same locations as the interviews at field site 1 reveal the scale of the impact of these regular technophonic impacts. Mention was often made by participants of the volume of heavy goods traffic in the area. Kilpisjärvi sits on the E8, a major access route for trucks bringing food and supplies to the area and onwards into northern Norway. Simple listening and visual analysis of these sound recordings shows us that even in the dark depths of the sub-Arctic winter at field site 1, across the 8 recorder locations, we see a wide range of soundscapes. This includes high levels of anthropogenic noise dominating the daily soundscape in the form of heavy lorries travelling on to Norway, which are visible as regular peaks, even in the middle of the night (see Figure 5, top), as well as bursts of loud noise from snowmobiles appearing out of the relative silence (see Figure 5, bottom).

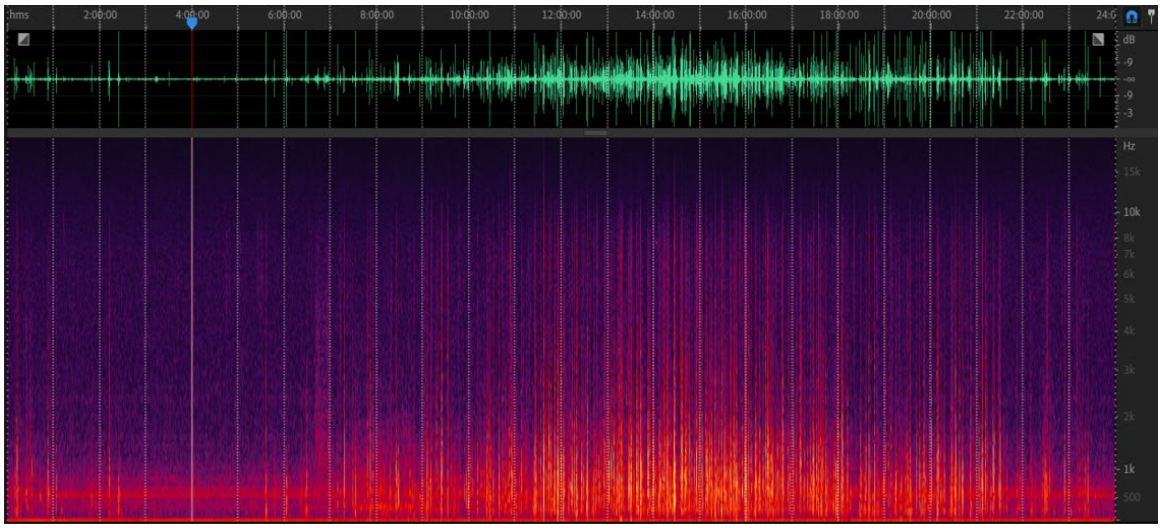

Figure 5. *Cont.*

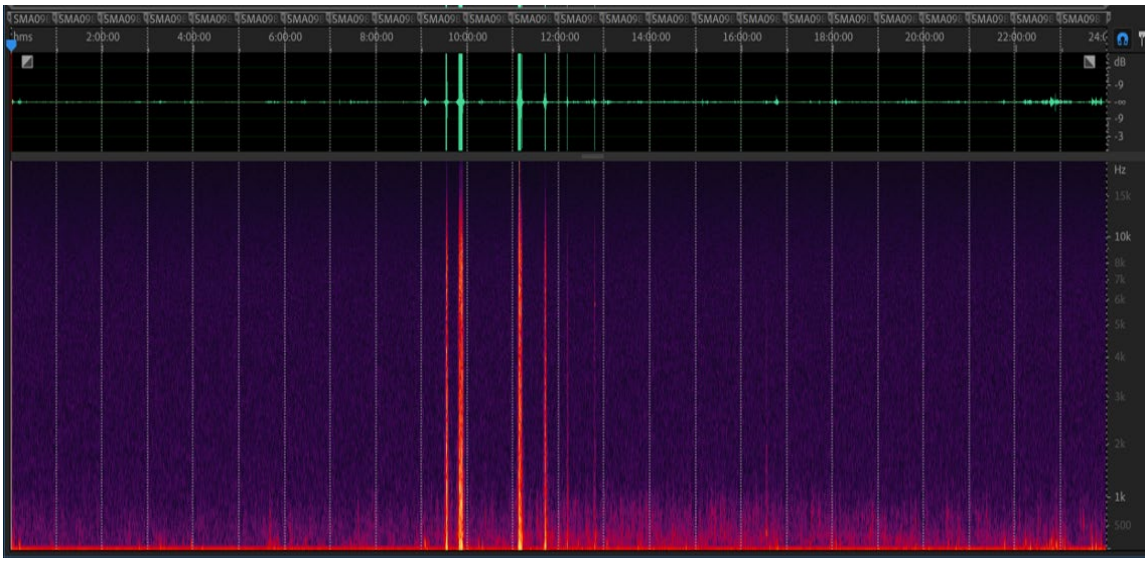

Figure 5. Acoustic plots for a single day (20 November 2022) at two of the eight recorder locations at field site 1 showing sound level (top in green measure in decibels) and the frequency spectrogram (activity in a frequency range in red and yellow). The spectrogram shows how the frequency of sound signals varies over the time duration of a given recording. Lorries travelling on to Norway can be heard and are made visible as regular peaks through the day and even in the middle of the night (**top** image) or as bursts of loud noise from snowmobiles in an otherwise quiet landscape (**bottom** image).

The raw sound recordings can then also be used via advances in machine listening techniques to identify individual bird species (Kahl et al. 2021) and, using community-based confidence thresholds, accurately quantify the different species found at a given location (Funosas et al. 2024). The BirdNet tool can be run on hundreds of thousands of recordings made across the year, providing information on birds present at that location in a way that is difficult and costly to achieve with traditional bird counts. Even the information for a single day at a single location produces results of interest that describe one of the key biophonic attributes of a soundscape—the diversity and abundance of bird species present—which was mentioned by participants (see Figure **??**). Walking the landscape with tourist visitors has highlighted the importance of these biophonic sounds to their experience of silence (see above), as well as the possible encounters with other species they represent.

Selection	View	Channel	Begin Time (s)	End Time (s)	Low Freq (Hz)	High Freq (Hz)	Species Code	Common Name	Confidence
234	Spectrogra	1	1671	1674	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9524
314	Spectrogra	1	663	666	150	12000	grswoo	Great Spotted Woodpecker	0.9519
166	Spectrogra	1	1506	1509	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9429
218	Spectrogra	1	1638	1641	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9391
119	Spectrogra	1	1314	1317	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9355
232	Spectrogra	1	1668	1671	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9319
220	Spectrogra	1	1641	1644	150	12000	leswoo1	Lesser Spotted Woodpecker	0.921
301	Spectrogra	1	525	528	150	12000	grswoo	Great Spotted Woodpecker	0.9184
207	Spectrogra	1	1602	1605	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9141
170	Spectrogra	1	1512	1515	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9128
404	Spectrogra	1	981	984	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9086
117	Spectrogra	1	1311	1314	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9076
297	Spectrogra	1	510	513	150	12000	grswoo	Great Spotted Woodpecker	0.9025
64	Spectrogra	1	1161	1164	150	12000	leswoo1	Lesser Spotted Woodpecker	0.9005
318	Spectrogra	1	669	672	150	12000	leswoo1	Lesser Spotted Woodpecker	0.8995
124	Spectrogra	1	1326	1329	150	12000	leswoo1	Lesser Spotted Woodpecker	0.8909
11	Spectrogra	1	1020	1023	150	12000	leswoo1	Lesser Spotted Woodpecker	0.8901
174	Spectrogra	1	1518	1521	150	12000	leswoo1	Lesser Spotted Woodpecker	0.8854

Figure 6. Extracted results of a BirdNet machine listening analysis for a single day and a single location at field site 1. Each time a bird is identified, the tool records the time of day the recording was made, when during the sound recording the bird was detected, the species name and the level of confidence that the algorithm has correctly identified the species.

5. Statistical Analysis of Sound Recordings and Spatial Data

Advancing the integrated analysis, in addition to quantitative species-focused biophonic data, we also have the first glimpse of the results of a statistical analysis of the ecoacoustic data from field site 2 in the Pyrenees. Our goal here was to *combine* biological and social analysis of the soundscape for the same point in space and time for a better understanding of what types of sounds and silences there are in the landscape, what is producing them, how they might be understood and their implications for conservation. Using acoustic and spatial data, this integrated analysis looked more specifically at how natural a place sounds—is it dominated by biophony or anthrophony—and, when combined with the interviews, provides insights of relevance to human perceptions of soundscapes in terms of biophony, silence and naturalness. This opens up a pathway to make the knowledge measured and useful across multiple scales for both policy makers and those that implement policy in the landscape, such as national parks (Ritson et al. 2024).

For field site 2, we used acoustic indices to analyse the momentary sound recordings made during the 2 min period of silence at the start of the interview stops. As described above, we can analyse the sound frequency spectrum over time to describe different properties of the soundscape, specifically to identify who or what is producing the noise and how much of it is being produced. Simple spectro-temporal features are captured by indices such as the spectral centroid (SC), which are good proxies for the amount of anthrophonic noise in the soundscape (Carruthers-Jones et al. 2019). The spectral centroid can be combined with data on the diversity and abundance of bird species at a given location to identify places where there is a low level of anthrophony and high level of biophony. A group of alpha acoustic indices such as the Acoustic Complexity Index (ACI), Acoustic Diversity Index (ADI) and Biophonic Index (BI) is generally considered to capture the amount of biophony present in the landscape, predominantly coming from bird vocalisation and, depending on the landscape, insect noise (Metcalf et al. 2023). Amongst them, the Normalised Sound Difference Index (NDSI) combines in a single index the proportion of acoustic activity in the lower range of 0–2 KhZ compared to the amount in the higher range of 2 kHZ–10 KhZ. Activity in the lower range is predominantly caused by technophony, and that in the higher range is predominantly caused by biophony.

Whilst this approach provides quantitative numerical values to describe attributes of the soundscape, we sought to take this further by extending the potential of spatial data on landscape naturalness, as well as to assess the implications of acoustic indices for our ideas on how natural a landscape looks and sounds (Carruthers-Jones et al. 2019; Carruthers-Jones et al. 2025) (see Figure 4). In particular, we wanted to know what kinds of sounds were in places that people thought of as more or less natural and how we could scale this up to consider the characteristics of the larger landscape and soundscape.

Looking at the data from a subset of 30 of the stops at site 2, we used a random forest approach to calculate which out of a set of four acoustic indices and five spatial datasets was the best predictor of the scores given by human participants in answer to the question, 'How natural does it sound?'. Four AIs were chosen as the most relevant to the question at hand: the Acoustic Complexity Index (ACI), Acoustic Diversity Index (ADI), Biophonic Index (BI) and Normalised Sound Difference Index (NDSI). Numerical values for the degree of biophysical naturalness, built density, ecological flow, landscape naturalness and tree density were extracted for the area of the 30 stops from national spatial data using the Focal Statistics tool in ArcGIS Pro (ESRI 2024). Multivariate random forest regression models (Breiman 2001) were built using these four AIs, with five spatial datasets used as predictors and human perception of acoustic naturalness as the response (see Figure 7).

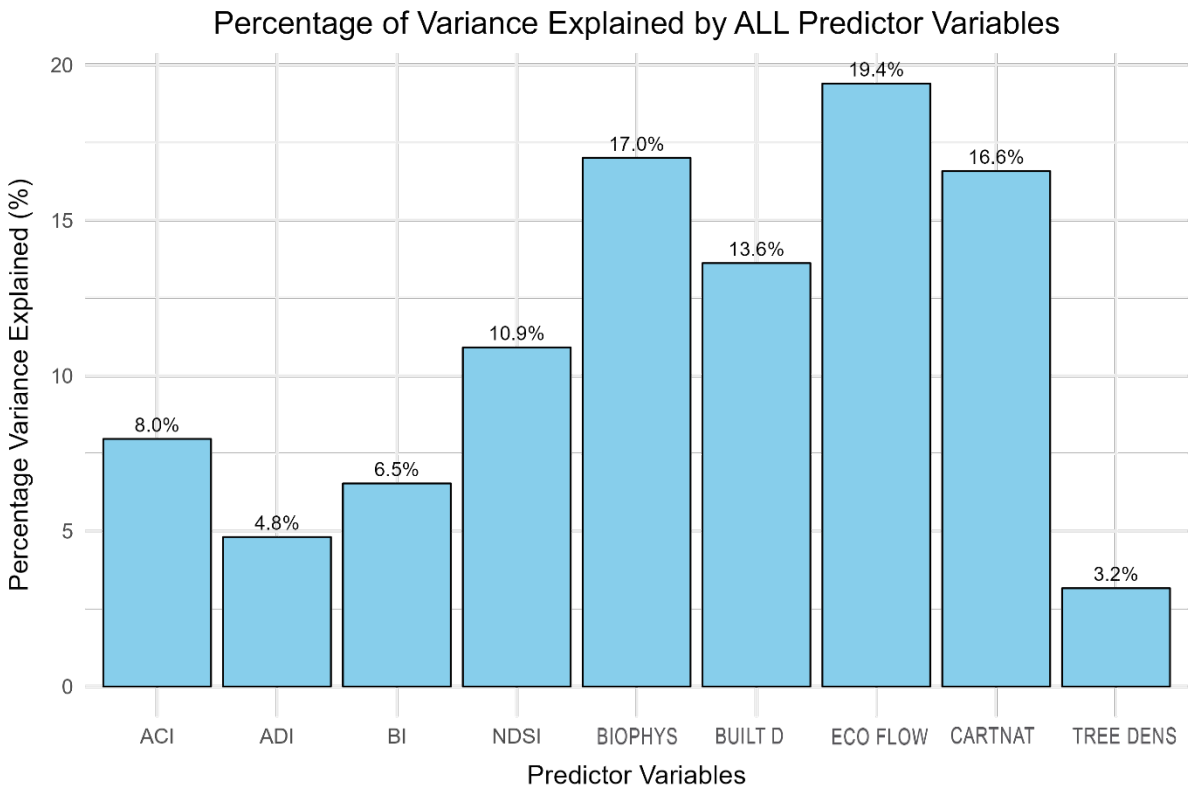

Figure 7. Random forest plot showing percentage variance explained in human perception scores for a set of acoustic indices (Acoustic Complexity Index (ACI), Acoustic Diversity Index (ADI), Biophonic Index (BI) and Normalised Sound Difference Index (NDSI)) and spatial data on biophysical naturalness, built density, ecological flow, landscape naturalness and tree density.

Random forest models of this type allow us to test which of the AIs or spatial data best predict the response variable (human perceptions) and are tolerant of deviations from parametric assumptions and skew in the data. Overall, the predictor variable that best explains the human perception scores of how natural a place sounds is the spatial data on ecological flow. This dataset was built to identify the largest and best structurally connected natural landscape areas in France, as ecological flow is recognised as an indicator of naturalness (see Carruthers-Jones et al. 2025 for details). Amongst the Ais, NDSI scored most highly, suggesting that high human perception scores for acoustic naturalness correlate with high NDSI values, which represent relatively higher levels of biophony compared to anthrophony. This is in line with what participants describe as an important aspect of naturalness and the definition of silence that goes along with this—higher levels of biophony relative to anthrophony.

Using long-term PAM at the same field sites, an additional analysis step is now underway to explore whether the momentary sound recordings used in this analysis are representative of a given location over longer time frames and assess the seasonal shifts in anthrophonic and biophonic activity.

6. From Sound to Conservation Action

This approach has great potential to be extended to other locations and ecosystems. Passive acoustic monitoring is being conducted at many thousands of sites across Europe and beyond. These ecoacoustic indices and BirdNet data are regularly calculated for these locations as part of long-term ecological monitoring, primarily of bird populations. Beyond this biological focus, the insights from our walking interviews, combined with the results of the ecoacoustic analysis, provide conservation planners with an additional

ethnographic perspective for the same areas—that sites with high NDSI values are likely to have soundscapes that people value for their natural quality—which can both inform and give additional weight to the importance of these areas and how they are valued in decision making. Extending our overall integrated conservation humanities approach to demonstrate the connection between human values with respect to a location, acoustic metrics and the spatial data for that same location allows us to interpolate beyond the localised interview and sound recorder locations (Aumond et al. 2018). The spatial data that show potential here—ecological flow data—exist for the whole of France, and similar datasets exist that cover many parts of Europe, highlighting a clear pathway to the scalability of this approach. One ongoing challenge for ecoacoustic monitoring is that PAM data are limited to individual spots where recorders have been placed, and consequentially, the spatial coverage of sound recordings can be limited. A clear advantage of our integrated approach of combining ethnography with ecoacoustics and spatial data that are often available at the national scale is that it offers repeatable and robust methods for use in conservation decision making across larger spatial scales. Additionally, it can then form part of a long-term monitoring strategy to provide decision makers with concrete evidence of how landscapes change over time and support national conservation planning for the recently passed EU Nature Restoration Law (European Commission 2024).

In the process of researching soundscapes, our work had some additional and serendipitous impacts. Our participatory and cross-disciplinary methods brought us into contact with a diverse range of local and regional actors, thereby generating practical impacts beyond the academy. The act of working with the local biological research station at field site 1 in Kilpisjärvi, as well as being out in the field installing sound recorders brought us into contact with a team at the University of Helsinki developing a publicly accessible science trail mobile phone app. The research station is owned by the University and has been active for 60 years. The goal of the science trail is to make the diverse research activities in the area known to the increasing number of people that visit this remote part of the world. Historically, research at the station was exclusively dominated by biological studies on subjects such as lemming populations, lichen and fish species in Arctic lakes. As part of this science communication activity, they were seeking projects that span multiple disciplines and introductory text on the concept of the soundscape and the importance of silence. Sound recordings from our PAM sensors were also included in this app. The local national park visitor centre now encourages tourists to download and use the app to guide their interactions in the landscape (see Figure 8).

At a more political and administrative level, the process of walking with all those who have an interest in the question at hand necessarily involves time spent outdoors with local planners and conservation managers discussing soundscapes and the importance of silence. Walking interviews with specific individuals generated conversations that have now crystallised into the creation of a consortium that recently submitted an application for European Regional INTERREG Aurora funding to design and implement soundscape conservation legislation in national park areas across the three countries adjacent to field site 1 (Finland, Sweden and Norway). In parallel, the local research station manager at site 1 introduced the idea of the soundscape as something worth preserving to the Regional Council of Lapland, and it has now been written into the regional development strategy as a one of several key themes to consider in going forward. Finally, at field site 2, the evidence created by ongoing participatory research and mapping on sound and naturalness has added weight as 'ground truthing' to a national-level spatial analysis, 'CARTNAT', which is now used in the French National Strategy for Protected Areas to identify new areas for strong protection in France in respect of the European Commission biodiversity targets for 2030 and the EU Nature Restoration Law (see Carruthers-Jones et al. 2025).

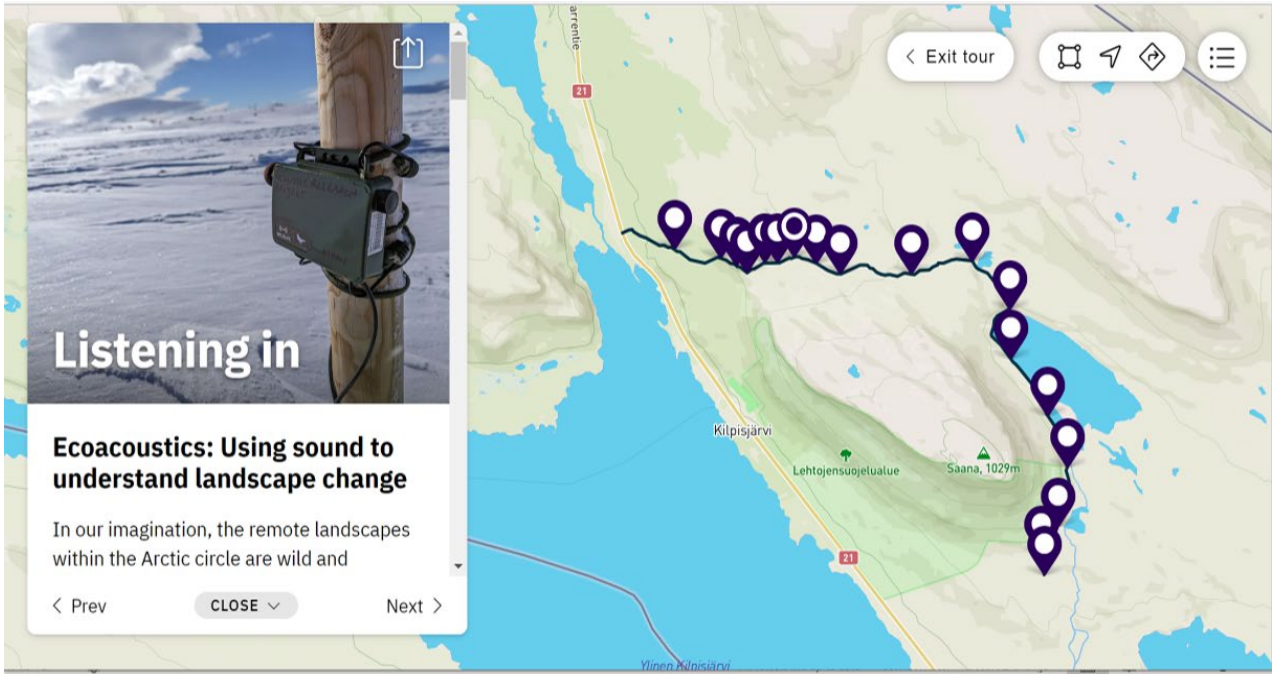

Figure 8. An extract of the soundscape research content from the project that was featured in the Kilpisjärvi Science Trail App (https://www.helsinki.fi/en/research-stations/science-trails/locations/kilpisjarvi-science-trails/download-science-trails-app (Accessed on 28 January 2025)).

7. Conclusions

Together, these projects aimed to respond to the limitations and lack of interdisciplinary conversations in conservation and humanities research. We sought to demonstrate how conservation humanities research could be used to develop a more pragmatic and integrated transdisciplinary approach to conservation and to emphasise the importance of sound to conservation and the humanities. This research does this by advancing methods for understanding and managing soundscapes in the more remote corners of Europe. Our main contributions here are twofold.

Firstly, we show how sound and soundscapes are important subjects of study in both conservation and the humanities and are also of interest to policy makers seeking to maintain biodiversity and preserve landscape characteristics and human relationships to these landscapes. We have argued that the conservation of soundscapes is necessary because it is a critical ecological niche for species communication and for human wellbeing. Recognising the acoustic environment as the nexus of atmospheric, biospheric and anthropogenic processes, the discipline of ecoacoustics provides a methodological framework within which to integrate ecological and anthropogenic perspectives on wilderness (Carruthers-Jones et al. 2019). As such, ecoacoustics can help us respond to calls for new approaches to conceptualising and measuring remote and wild spaces as the site of complex and dynamic human–environment relations (Lesslie 2016; Hennig and Künzl 2016). Equally, the humanities can help us understand the values ascribed to different 'natural' sounds by different groups—for example, whether the sounds of non-native and native species are considered equally 'natural' by the local population or whether indigenous herders in Lapland value or, indeed, use sound differently than other social groups.

Ethnographic walking interviews using a combination of unstructured 'go-along' and structured 'transect'-style approaches highlighted that silence can best be understood as the lack of anthropological or technophonic noise. Biophonic noise such as birdsong is considered an essential part of that 'silence' and is facilitated by the absence of competing

machine noise, thereby allowing species communication. These *natural* soundscapes provide space for functional communication between other species and also create space for humans to encounter and enjoy nature. *Methodologically* exploring this space requires that we leverage insights across multiple disciplines, and conservation humanities is well placed to do this because it brings multiple academic disciplines to bear and requires scholars to conduct research in an engaged way with partners from other academic disciplines. To enrich our existing methods, we recognise that a broader humanities approach including, for example, scholars from environmental history could help us understand the tensions and contradictions that might emerge in the future, such as how the influx of tourists and tourist infrastructure might erode the silence and solitude that attracts tourists in the first place.

Secondly, our work demonstrates the potential of the conservation humanities in *conservation* and a means by which we can move beyond disciplinary silos for new ways of thinking about conservation, as well as new policy insights, which the humanities are well placed to provide. Here, we show how a focus on a shared object of study—in our case, sound and soundscapes—can, via situated research, allow multiple methods and datasets to be analysed together and essentially 'speak' to each other. Although our focus here is on sound and soundscape, we consider that other concepts that are of interest to humanities scholars and conservation scientists, such as resilience, restoration and extinction, could also be a basis for this kind of approach.

The humanities are often criticised for lacking a way through from the complexity they reveal to the challenges they might hope to address. Through our two case studies, we have shown how integrated conservation humanities methods can lead to rich local-level insights on key conservation themes that can then be scaled via existing large-scale acoustic monitoring and spatial datasets to support decision making across much larger areas. We have also highlighted how the participatory methods implemented at the field sites show potential to generate change in the real world and meet the classic *operationalisation* challenge that academia faces. We see great potential for the co-development of these methods with conservation managers and planners to explore how they can be incorporated into existing spatial planning tools to support more informed social, ecological and cultural decision making.

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