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Human and policy dimensions of soundscape ecology

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ABSTRACT

Soundscape ecology is an emergent and potentially transformative scientific discipline. However, the majority of research within the field has been conducted by natural scientists focused on quantifying the characteristics and dynamics of soundscapes and examining their effect on non-human biota. A more holistic approach to the science and management of soundscapes requires full integration with the social and policy sciences. To facilitate the development of this integration, we propose an integrative human and policy dimensions of soundscape ecology framework that conceptualizes the complex and dynamic relationships between humans and their acoustic environments. The framework is grounded in four distinct disciplines – health, psychology, economics and anthropology – that have used different methodologies and metrics to focus on certain aspects of human–soundscape interactions. We provide a review of previous empirical research within each of these fields. Along the way, we identify unexplored avenues of discipline-specific research that can further the field of soundscape ecology. The human and policy dimensions of soundscape ecology framework provide the logic and structure upon which an interdisciplinary body of scholarship can be built in the future. We conclude by utilizing our review and integrative framework to propose specific focused soundscape policy and management recommendations. We argue the anthropogenic dominance of soundscapes can be mitigated through more proactive, integrative and holistic soundscape policies and management practices.

1. Introduction

Soundscape ecology is an emergent and potentially transformative scientific discipline (Servick, 2014). The field originated in the 1970s, grounded in the hypothesis that "every location on earth has a unique acoustical bio-spectrum that provides information on the dynamics of ecosystems in that place" (Krause, 1987, p. 15). Individual non-human species were suggested to occupy an aural niche within a specific geographic location. This hypothesis was a dramatic departure from previous bioacoustics research focused solely on single-animal vocalizations given it suggested the acoustic properties of individual locations play an integral role in ecosystem structure and functioning (Farina, 2014a). By collecting acoustic recordings of specific locations over time, soundscape ecologists believed they could better understand how certain changes in anthropogenic, biological and geophysical sounds affect the health of an ecosystem (e.g., biological diversity, provisioning of ecosystem services, etc.). Similar to the field's theoretical innovation, the methods and metrics proposed and utilized by soundscape ecologists differed dramatically from the use of traditional ecological indicators, such as population counts for key species.

The theories and methodologies employed by soundscape ecologists have expanded greatly over the past several years with improvements to recording hardware, processing software and statistical models (Pijanowski et al., 2011b). However, to date, the vast majority of soundscape ecology research has been conducted by natural scientists and has remained focused on quantifying how the acoustic dynamics of a place, such as the presence/absence and amplitude of anthropogenic noise, affect non-human biota (e.g., Kuehne et al., 2013; Proppe et al., 2013; Tucker et al., 2014). While this research is essential to advancing our knowledge of bioacoutics, a more comprehensive understanding of soundscape ecology can be built through alternative perspectives offered by other fields including spatial ecology, psychology and the humanities (Pijanowski et al., 2011a). For example, spatial ecology can provide insight as to how geophysical spatial patterns such as topography and vegetation influence the composition and dynamics of a location's soundscape (e.g., Pekin et al., 2012).

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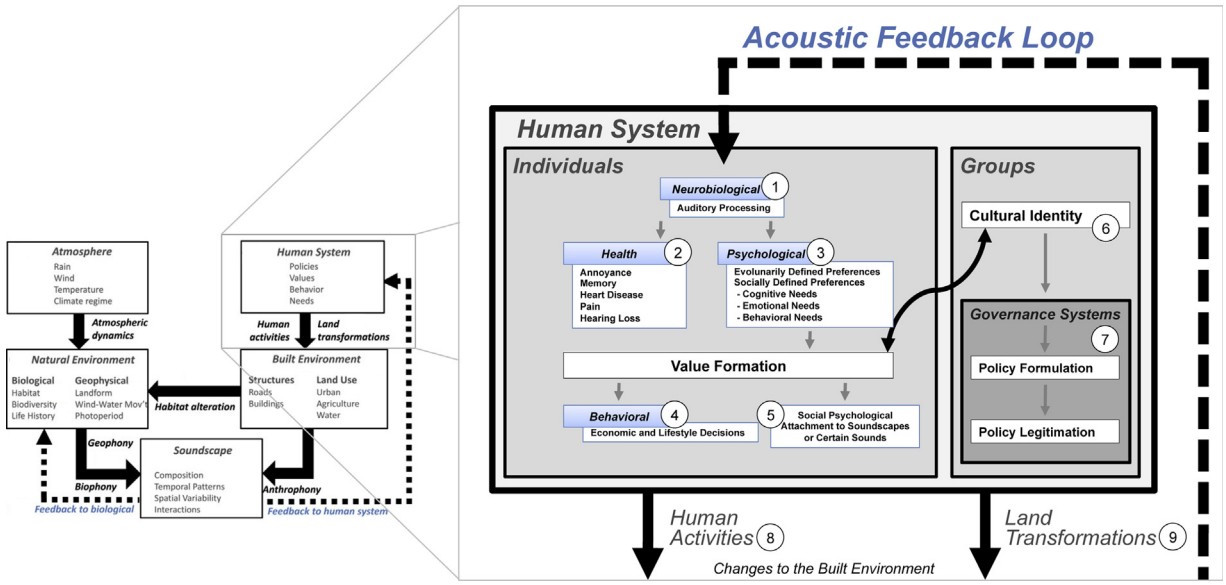

Fig. 1. The human and policy dimensions of soundscape ecology framework.

Similarly, psychology can be employed to better understand how humans perceive and respond to a place's aural dimensions (e.g., Guastavino and Katz, 2004).

Recognizing the need for more integrative approaches to soundscape ecology, Pijanowski and his colleagues (2011a) developed a model in which soundscapes were conceptualized as the product of coupled natural and human systems (Fig. 1). The intent was to provide an organizing framework for understanding the factors shaping the characteristics and dynamics of soundscapes. The framework is grounded in the principles of land change science, which acknowledge that landscapes are temporally and spatially variable systems perturbed by both natural and anthropogenic drivers (Turner et al., 2007). Collectively, these driving factors shape the composition and dynamics of a specific geographic locations' acoustic environment. For example, atmospheric processes such as rain, thunder and wind movement interact with the biogeophysical properties of a landscape (topography, land cover, etc.) to produce sounds that vary across time and space. The properties and dynamics of soundscapes, in turn, feedback into and shape both natural and human systems. For example, the acoustic characteristics of a landscape can have a significant effect on animal species' ability to perceive biologically important sounds (e.g., mating calls) and consequently affect their own vocalization patterns (Barber et al., 2010; Laiolo, 2010). Similarly, humans are also functionally connected to the acoustic characteristics of landscapes. Psychological attachments are formed to specific places because, in part, the sounds heard in those places contribute to unique and memorable experiences (Morgan, 2010; Ryden, 1993). Indeed, soundscapes are creations of both natural and human systems, but they also have important, but often poorly understood, feedbacks into these systems (Pijanowski et al., 2011a).

Pijanowski and his colleagues emphasized their framework was not exhaustive, noting each component of the framework (atmospheric processes, biogeophysical properties, human systems and the built environment) were in and of themselves complex systems with many research questions yet to be explored. The role of sound within each of these systems has been examined to varying degrees. Our understanding of the interactions between sound and biogeophysical processes continues to grow rapidly (Fletcher, 2007). However, research focused on the interaction between sound and human systems remains fragmented among different disciplines, each of which utilizes its own epistemologies, theories and methodologies (Dumyahn and Pijanowski, 2011a,b; Farina, 2014b).

The objectives of this paper are threefold: First, to present an integrative *human and policy dimensions of soundscape ecology framework* that provides the logic and structure upon which an interdisciplinary body of scholarship can be built in the future. Second, to review the literature from four distinct disciplines – health, psychology, economics and anthropology – that have either directly or indirectly investigated how soundscapes affect human psychology, behavior or governance systems. Throughout our review, we highlight unexplored avenues for future research. By distilling large and often disparate bodies of the literature and previous findings, the integrative framework and disciplinary reviews allow us to achieve our third objective of developing focused and scientifically informed soundscape policy and management recommendations.

2. Soundscapes and soundscape ecology: a brief introduction to definitions and concepts

Because the breadth of soundscape research is so broad, being explored independently by different disciplines, there are numerous ways to define what a soundscape is. Most definitions agree on two points: First, the term refers to the totality of a sonic environment and second, that the aggregate composition of sounds is tied to a specific place. The Oxford dictionary is most succinct on these two points, defining a soundscape as "the sounds heard in a particular location, considered as a whole." Similarities are apparent in soundscape management policies, such as those that exist in the UK which describe soundscapes as "the totality of all sounds within a location with an emphasis on the relationship between [an] individual's or society's perception of, understanding of, and interaction with the sonic environment" (2009, p. 7). More recent conceptualizations have expanded upon the anthropocentric focus of these definitions to encompass non-human ecological processes as well. Specifically, Pijanowski et al. (2011b) define the term as all sounds – those produced from human activity, those created by biological sources and those generated as a result of geophysical processes – emanating from a given landscape. Building upon early work within the field of soundscape ecology (e.g., Krause, 1987; Schafer, 1977; Truax, 1999), Pijanowski and his