

Tooting the Latin American horn: advances in the scholarship of ecoacoustics and soundscape ecology is occurring with vigor

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Background

Soundscape ecology (Pijanowski *et al.*, 2011a, b; Pijanowski & Farina, 2011), ecoacoustics (Sueur & Farina, 2015) and bioacoustics (Laiolo, 2010; Aide *et al.*, 2013) have witnessed an explosion of work over the last decade due to the advances in passive acoustic recorders, new conceptual frameworks that integrate the study of sound into environmental change research, abilities to store and analyze massive data, and the growing need to understand how the rapid declines in species richness and abundances can be addressed with intervention policies at the landscape level. Also of note are the tremendous contributions to these acoustic-based fields of research that are occurring from all across the global academy, with advances being made by researchers working in just about every continent and country. The contributions from Latin America are impressive and play an important and unique role in our understanding of how a variety of sound sources – from biological organisms (i.e., the biophonies), to the geophysical world (i.e., geophonies) and those from humans (i.e., anthrophonies or technophonies) – are used to assess how important Latin American ecosystems are being altered. The purpose of this paper is to provide a summary of the multi-faceted work being conducted in Latin America as represented in the exceptional papers of this special issue on ecoacoustics and soundscape ecology, placing these in the context of the growing scholarship in these acoustics-based areas of study.

Summary and synthesis of the special issue

There are 13 papers in this special issue on a variety of topics related to the use of sound to study the

environment in Latin America. Over fifty co-authorship contributions speak to the nature of the highly collaborative work being conducted here. Few papers are from single institutions which also underscores the commitment that researchers in Latin America are making to work across traditional institutional barriers. Several co-authors are also from outside Latin America and many of the papers involve collaborations across academia and the not-for-profit community. Although mostly representing scholars from Colombia, those from Venezuela, Costa Rica and Brazil have made contributions as well. Within this special issue are articles that focus on methodological approaches (3), life history and bioacoustics (4), soundscape ecology (5) as well as one review paper that assesses the current status of work across Latin America using a literature review as its basis of assessment.

As is the case with any new field of discovery, methodological advances are needed to address important problems. Hoyos-Cardona *et al.* (2021) explored the use of some automated call detection techniques that identify the Choco's owl from over 6800 recordings by modifying several *autodetect* parameters in the popular *warlbeR* package (Araya-Salas & Smith-Vidaurre, 2017). They found that overall performance of the tools to identify owl calls was poor, which highlights the challenges the field of bioacoustics and soundscape ecology experience with recognizing species-specific animal signals in audio recordings. Cifuentes *et al.* (2021) tested how the length of a recording might influence the values of a variety of acoustic indices. They varied the length of audio recordings from short to long and found that short recordings provide adequate information to calculate an index, thus providing researchers with the ability to leave recorders for long periods of time in the field

without having to retrieve data and refresh batteries. The paper by [Martinez-Medina *et al.* \(2021a\)](#) focuses on describing the key features of bat echolocation recordings that would support a standardized library that could be used all across Colombia. This paper represents a first step toward creating a standardized library of bat echolocation signals to be shared throughout Colombia and, potentially, all of Latin America.

Four papers in this special issue focused on the use of sound to understand the life histories of animals. The work of [Guaitarilla *et al.* \(2021\)](#) focuses on the variety of calls (vigilance, alertness, territorial defense and courtship) and their acoustic structure as it is related to important behaviors. They were able to show that for sympatric species from the genus *Cacicus*, the call structures were similar. This research confirms that animal communication forms important social interactions which can be used as part of any acoustic monitoring program or study of their behavioral systems as it relates to their reproductive success. Amphibians are some of the planet's most threatened group of animals with declines being assessed across all major groups as climate change and disease are reducing abundances in tropical and temperate ecosystems ([Stuart *et al.*, 2004](#)). The work of [Rojas-Morales *et al.* \(2021\)](#) focuses on an interesting species complex of nurse frog and mechanisms that prevent hybridization through acoustic partitioning. As many studies on the topic on acoustic partitioning have occurred in frogs over the years, this study dives both into the life history, genetics, physiology as well as mate attraction calls. Call confusion could result in creating sterile hybrids; thus, natural selection should favor greater call discrimination between closely related species. This work underscores not only the importance of understanding the mechanisms underlying reproduction in amphibians but also the need to integrate the study of animal communication with other dimensions of the life history of a species, including those involving phylogenetics, behavior, and morphophysiology. With fisheries around the world being pushed to critical tipping points, the work of [Muñoz-Duque *et al.* \(2021\)](#) makes important advances in our understanding of the role that acoustic communication plays in the breeding success of a freshwater fish that has economic importance to Colombia but is also considered a threatened species. The fourth methodological paper by [Paulo-Morelo & Sánchez-Palomino \(2021\)](#) dives into the complex vocal repertoire of the endangered Cotton-top tamarin monkeys, *Saguinus oedipus*. This monkey has been a common target species for understanding the role of human speech perception development and how

learning of language at a young age is generalizable across the primate auditory system ([Ramus *et al.*, 2000](#), [Cleveland & Snowdon 1982, 1984](#)). Regrettably, much is not known of their wild calls and how these are related to behavioral traits. Using several phonetic acoustic metrics, they were able to identify 11 phonetic groups that were then associated with a variety of behaviors. New phonetic signals increased the known language phonetic library by 25%; thus underscoring the need to understand animal communication in the wild.

Papers that focus on soundscape ecology and ecoacoustics form the majority of the papers in this special issue. The work of [Gonçalves-Santos *et al.* \(2021\)](#) examines the role that road noise, a form of anthropony/technophony, plays in masking animal communication in forested ecosystems. As noise continues to permeate every place on the planet – terrestrial and aquatic systems – a better understanding of how animals adjust to this new “acoustic pollution” is needed. The research presented in the [Gonçalves-Santos *et al.* \(2021\)](#) paper adds to our understanding of noise propagation into forests as these researchers were able to demonstrate that power spectral density levels and measures of acoustic complexity using the Acoustic Complexity Index (ACI) were greatest at the edge of a forest compared to its interior, results that could be linked to behavioral responses of species that communicate in noisy areas. In the only study from Costa Rica in this special issue, the work by [Retamosa Izaguirre *et al.* \(2021\)](#) extends their strong existing work in soundscape ecology in Costa Rica ([Retamosa Izaguirre & Ramírez-Alán, 2018](#)) by studying the impacts of vegetation structural complexity, species richness, road noise and acoustic complexity and composition. Examining two different tropical landscapes in a National Park in Costa Rica, the researchers were able to provide an excellent example of how noise is affecting animal communication in a negative way but they also found that understanding the interactions of multiple geographic and environmental factors (e.g., location, noise, diversity of vegetation) on species richness requires a species by species understanding of stressor-response relationships. Soundscape ecological research requires a rigorous experimental design that addresses critical research questions with analytical approaches yielding clear conclusions. The paper by [Tovar-García & Acevedo-Charry \(2021\)](#) exemplifies the need of such network design, addressing questions related to the use of acoustics to understand the spatial-temporal patterns of biodiversity in a private natural reserve in the Colombian Andes. The paper also emphasizes the need to have proper data curation and

the publication of raw, original data for use by other scientists in the field. The paper by [Morales-Rozo *et al.* \(2021\)](#) examines important landscapes of Colombia that contribute to food production. Silvopastoral and traditional pastoral landscapes of the Eastern Cordillera foothills provide critical ecosystem services to locals. The silvopastoralist and traditional pastoralist landscapes support cattle ranches. By using a geographic information system where they calculated distance to roads and rivers, they were able to show how the soundscape is influenced by a variety of landscape features that are both anthropogenic and natural. They argue that their study provides a baseline from which to study the relationships between agricultural landscapes and the ecosystem services that are tied to soundscapes. The study by [Hernández-Leal *et al.* \(2021\)](#) addresses the space use by insectivorous bats in three types of ranching landscapes. They found no difference in species composition between the silvopastoralist system and the conventional livestock management landscapes. However, the conventional livestock system had a slightly greater species richness. This study does highlight the important role that acoustics can play in assessing the interaction of landscapes, patterns of species presence and overall biodiversity.

One of the highlights of this special issue was the extensive review by a large cadre of researchers who assessed the status, development and trends in wildlife acoustics studies in Colombia. [Martínez-Medina *et al.* \(2021b\)](#) conducted a literature review of the peer-reviewed papers, theses and conference presentations, involving research conducted in Colombia on the topic of bioacoustics, ecoacoustics and soundscape ecology over a thirty-year period (1990 to 2020). They found that 321 papers were published of which 36.6% were on birds, 35% on amphibians and the rest were on other sound producing animals (insects, fish, reptiles, and mammals). They also classified each of the papers into categories of research and determined that the most common type of paper was descriptive. Much of the work that they found was conducted by undergraduate students at Colombian universities and there has been a noticeable uptick in research productivity in this area in Colombia over the last 10 years. Several gaps that they identified included the low numbers of papers on insects, and few studies in the Amazonian region of Colombia. They concluded that much of the work that is being conducted has significant application for conservation as the information from these studies helps to understand population and community dynamics at landscape scales.

Concluding remarks

With only 13 papers in this special issue, it is clear that the current status of work in acoustics-based fields of ecology is vigorous and the future is bright. There are efforts in all dimensions to these fields, from methods, data science, applications and networking. Latin America contains some of the most important biodiversity hotspots, has tremendous cultural diversity and the ability to conduct highly technical work is very evident from these papers. Collaboration is extensive and the numerous institutions involved in this work is impressive. Latin America, and especially the work in Colombia, represents one of the “hotspots” of scholarship.

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