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The relationship between the Acoustic Complexity Index and avian species richness and diversity: a review

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ABSTRACT

Technologies to monitor species are constantly evolving including the use of acoustic recordings to determine species presence, activity patterns and population dynamics. The Acoustic Complexity Index (ACI) aims to determine ecologically relevant changes in the soundscape by measuring the variability within biotic sounds whilst remaining insensitive to anthrophony. Previous findings relating to this index and its correlations with avian species richness and diversity, environmental and anthropogenic factors were amalgamated in this review to guide the future use of this monitoring technique. A total of 25 papers were returned following a literature search in June 2020 targeting studies in which these relationships were analysed. Current literature shows inconclusive relationships between the ACI and avian species richness and diversity. Also, those studies analysing relationships between the index, environmental and anthropogenic factors provided contrasting results due to the lack of replication between studies. The future implementation of a standardised approach towards data collection should lead to more compelling conclusions. Relationships between the soundscape and the environment should be evaluated on an individual site basis due to the influence species composition has on the acoustic environment. Further study is required to determine the relationship between anthropogenic factors, the ACI and avian assemblages.

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Acoustic Complexity Index; anthropogenic; avian diversity; avian richness; environmental

Introduction

Monitoring species via acoustic recordings is an increasingly common method used by researchers across a range of environments globally as data from the soundscape enables multidisciplinary investigations into species, sounds and the environment (Pieretti et al. 2011; Shonfield and Bayne 2017; Ross et al. 2018; Campos-Cerqueira et al. 2019; Sugai et al. 2019). The fields of bioacoustics and ecoacoustics enable study into a range of topics, including activity patterns, population dynamics, species distributions, detection of rare and cryptic species, anthropogenic impacts and the overall health and stability of ecosystems (Pijanowski et al. 2011a; Ospina et al. 2013; Fuller et al. 2015; Campos-Cerqueira et al. 2017, 2019; Deichmann et al. 2017; Shonfield and Bayne 2017; Wrege et al. 2017).

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The extension of bioacoustic monitoring beyond species counts towards acoustic habitat mapping and soundscape monitoring will be vital for conservation in the future (Dumyahn and Pijanowski 2011; Shonfield and Bayne 2017). Monitoring along ecological gradients in multiple habitat types can enable an understanding of the relationship between environmental factors and the soundscape, and the influence these relationships have on diversity patterns, occupancy models and behavioural changes in species across their range (Depraetere et al. 2012; Llusia et al. 2013; Figueira et al. 2015; Gil et al. 2015; Campos-Cerqueira et al. 2019; Sugai et al. 2019). Changes to the soundscape can often be subtle yet reflect important changes in ecosystem health, and therefore an understanding of the acoustic environment and its ecological stressors is vital (Ross et al. 2018). Birds act as indicator species of ecosystem health and therefore play an essential part in acoustic monitoring programmes with high levels of vocal activity and species-specific vocalisations, making them appropriate for this method of study (Farina et al. 2011; Cook and Hartley 2018).

Acoustic indices

The use of acoustic recordings to conduct rapid acoustic surveys is a non-invasive and relatively cost-effective method towards completing overall biodiversity assessments (Sueur et al. 2008). These rapid surveys act as a potential solution for large-scale monitoring of multiple taxa in remote locations that were previously inaccessible by inferring biodiversity at higher levels of organisation through analysis of acoustic recordings. The development of Acoustic Indices (AIs) that predict an aspect of biodiversity is essential for the successful implementation of rapid acoustic surveys. AIs aim to capture the distribution of acoustic energy across time and frequency from a fixed length audio file (Eldridge et al. 2018). The use of AIs as ecological indicators relies on the assumption that the acoustic community is representative of the wider ecological community and measurable changes in the acoustic environment are ecologically relevant (Gasc et al. 2013; Eldridge et al. 2018). From these assumptions, it is predicted that higher species richness will produce a broader range of signals resulting in a greater acoustic diversity (Sueur et al. 2008; Gasc et al. 2013). However, there remain several critics as to how ecologically relevant changes in the acoustic environment are with studies finding that higher diversity in the soundscape is not reflective of habitat status nor biocondition, and therefore, may not be sufficient in explaining ecosystem function. Although findings from these studies which show the importance of young, developing forests to avian communities are important there still remain limitations to the use of AIs as a high species richness may not reflect ecosystem resilience and value (Depraetere et al. 2012; Fuller et al. 2015; Eldridge et al. 2018). Without this correlation, the use of AIs as a tool in long-term conservation studies may not be possible. Despite these findings, AIs still present multiple benefits and several AIs have been created to measure different aspects of sound, including frequency and amplitude. These AIs aim to interpret audio data by examining the complexity, diversity and evenness of biophony whilst remaining insensitive to anthrophony, and therefore provide a method to quickly monitor animal dynamics (Pieretti et al. 2011; Eldridge et al. 2018).

The Acoustic Complexity Index

The Acoustic Complexity Index (ACI) was introduced by Pieretti et al. (2011) and aims to quantify complex biotic sounds by measuring the variability in sound intensities within a recording by examining short-time averaged changes in acoustic energy across frequency bins (Farina et al. 2011; Eldridge et al. 2018; Ross et al. 2018). The ACI aims to capture changes in biotic sounds without being impacted by the constant presence of anthropogenically produced sounds (Pieretti et al. 2011; Eldridge et al. 2018). The ability to distinguish between biotic and anthropogenic sounds is based on the observation that bird songs contain a variety of intensities in a short period of time, whereas human-generated noise remains constant in intensity (Pieretti et al. 2011).

Previous research using the ACI has shown correlations with the number of bird vocalisations (Pieretti et al. 2011) and has evidenced its effectiveness in detecting shifts in songbird phenology (Buxton et al. 2016; Shonfield and Bayne 2017). However, the ability of the ACI to act as an accurate index of avian diversity and richness remains unclear, especially in the presence of other influential factors, which include vegetation structure, weather, and other complex biotic sounds such as high levels of insect calls (Farina et al. 2011, 2015; Eldridge et al. 2018; Ross et al. 2018). If a clear relationship between the ACI and avian species richness is established, it will be an important tool for the long-term monitoring of bird assemblages, especially in remote locations, to gain insight into the overall health of populations.

The ACI presents new opportunities to monitor bird communities faced with anthropogenically produced challenges such as land use changes (Pieretti et al. 2011). The nature of the ACI makes it more suitable to monitor avian communities than other AIs as bird song contains a great variability in intensity even within a single frequency bin (Farina et al. 2011; Cook and Hartley 2018). In addition, other AIs focus on more specific aspects of the soundscape such as measuring anthropogenic disturbance (Normalised Difference Sound Index) or the changes in habitats along a gradient of degradation (Acoustic Diversity Index, Acoustic Evenness Index) (Villanueva-Rivera et al. 2011; Kasten et al. 2012; Eldridge et al. 2018). In combination with the field of soundscape ecology, there is the opportunity to use the ACI to study the spatial and temporal distribution of sound through landscapes and gain an insight into how ecosystem processes, landscape structure and anthropogenic disturbance alter the acoustic environment (Pijanowski et al. 2011a, 2011b; Kasten et al. 2012; Towsey et al. 2014). After ten years since the introduction of the ACI, a review of the results from previous studies investigating the relationship between the ACI and avian communities and how they might be influenced by environmental and anthropogenic factors is needed to summarise current knowledge and identify areas for future research. The aim of this study is to carry out a systematic review of the current knowledge of these relationships and highlight potential directions for future research within the field of acoustic monitoring.

Materials and methods

Literature search

A literature search was conducted in June 2020 using the databases Web of Science (https://webofknowledge.com) and Google Scholar (https://scholar.google.com/). Despite its low precision Google Scholar has high coverage, and therefore, it is suitable for use in systematic reviews with a reduced probability of missing relevant references (Esteve-Altava 2016). Both databases were used to search for peer-reviewed original research articles, written in English, with no time limit, using a combination of keywords to investigate (i) correlations between the ACI and species richness and/or diversity in bird assemblages and (ii) the relationships between the ACI, avian communities, environmental and/or anthropogenic factors. The following keyword combinations were searched for using both databases: (acoustic complexity index OR ACI) AND (bird OR avian) AND (species richness OR species diversity). The review protocol was applied following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (http://www.prisma-statement.org/) (Moher et al. 2009).

Relationship between the ACI and species richness and/or species diversity

The database searches returned 875 studies that were subsequently screened by reading the title and abstract. To be included in the analysis, the studies had to directly investigate if the ACI correlated with either species richness or species diversity in bird assemblages estimated using direct point counts or by listening to the audio recordings. The studies could focus on any species, occur in any environment and may be part of a wider study of additional acoustic indices. Following the screening of the results and removal of duplicates, eight studies met the inclusion criteria and were retained for full-text analysis. A further five studies were included following the screening of the reference sections of the analysed texts, resulting in a total of 13 studies.

Relationships between the ACI, avian communities, environmental and/or anthropogenic factors

The following keyword combinations were searched for: (acoustic complexity index OR ACI) AND (environment OR vegetation OR landscape OR canopy) AND (anthropogenic OR human OR vehicle) AND (bird OR avian). The databases returned 178 studies that were screened by reading the title and abstract. To be included in the analysis, the articles had to investigate the relationship between vocalisations produced by avian communities measured using the ACI and an environmental and/or an anthropogenic factor. The studies could focus on any species of bird, include a variety of environmental factors and/or any aspect of anthropogenic disturbance. Following the screening of the results, eight studies met the inclusion criteria and were included in the full-text analysis. A further four studies were included following screening of the reference sections of the analysed texts, resulting in a total of 12 studies.

Evaluation of original research articles

Relationship between the ACI and species richness and/or species diversity

Following full-text analysis information was extracted from each study, including: (1) year of publication; (2) length of study; (3) number of recorders; (4) habitat type; (5) type of count: direct or indirect; (6) variable used, e.g. species richness or species diversity; (7) positive or negative correlation with ACI; and (8) other influential factors. Habitat type was grouped by the most predominant habitat used within the study, as the physical structure of landscapes can alter the detectability of birds using acoustic monitoring (Sugai et al. 2019). Direct counts referred to point counts undertaken in the field to estimate bird diversity or richness, whereas indirect referred to estimates made by listening back to the audio recordings. Other influential factors may include the presence of sounds that can skew the results, such as insect chorus' or heavy rainfall.

Relationships between the ACI, avian communities, environmental and/or anthropogenic factors

The following information was extracted after full-text analysis of each study: (1) year of publication; (2) length of study; (3) number of recorders; (4) habitat type; (5) environmental factor(s); (6) anthropogenic factor(s); (7) positive or negative relationship with the ACI; and (8) other influential factors. Environmental factors included a range of variables, including canopy density, canopy height, tree density, species richness, etc. Examples of anthropogenic factors included vehicular noise, proximity to roads/urban areas, and direct human sounds. Habitat type and other influential factors were categorised as described above. The relationship between specific factors and the ACI was reported as either positive, negative or absent (i.e. no significant correlation was found).

Results

Relationship between the ACI and species richness and/or diversity

Following a database search using specified keywords and subsequent screening of results using the inclusion/exclusion criteria, 13 papers were analysed to investigate the relationship between the ACI and species richness and/or diversity in bird assemblages. Studies were predominantly carried out in forest habitats (nine of the 13 studies) over various time periods and using different numbers of acoustic recorders. The relationship between the ACI and species richness was positive in six studies, whilst no correlation was found in seven studies (Table 1). Where a positive correlation was found five of these studies used indirect methods to calculate species richness. Nine of the studies reported other factors that may have influenced ACI scores, with eight studies reporting other biophonic sounds, including insect, amphibian and mammalian produced noise (Towsey et al. 2014; Gage et al. 2017; Raynor et al. 2017; Buxton et al. 2018; Eldridge et al. 2018; Ferreira et al. 2018; Jorge et al. 2018; Moreno-Gomez et al. 2019), three reporting geophonic sounds including wind and rain (Towsey et al. 2014; Mammides et al. 2017; Moreno-Gomez et al. 2019) and five studies highlighting the presence of anthropogenic noise including vehicular and wind turbines (Towsey et al. 2014; Gage et al. 2017; Mammides et al. 2017; Raynor et al. 2017; Jorge et al. 2018).

Relationships between the ACI, avian communities, environmental and anthropogenic factors

The database search generated 12 studies that met the inclusion criteria to investigate the relationship between the ACI, avian communities and environmental and/or anthropogenic factors. Of these studies, three investigated both environmental and anthropogenic

Table 1. A summary of 13 studies that investigate the relationship between the ACI and species richness and/or diversity in avian assemblages. For species richness and diversity, '**+**' represents a positive correlation with the ACI, "-" represents a negative correlation with the ACI and '**N**' shows that no significant correlation was found. 'P' indicates whether the study referred to other influential factors that may have impacted or skewed their results such as biophonic (other than birdsong), geophonic or anthropogenic noise.

Habitat	Length (days)	Number of recorders	Direct or Indirect	Species richness	Species diversity	Other factors	Source
Rainforest	35	3	Indirect	N		P	Moreno-Gomez et al. 2019
Rainforest	18	8	Direct	+		P	Jorge et al. 2018
Tropical dry forest	5	8	Indirect	+			Hilje et al. 2017
Temperate forest/ grassland	10	15	Indirect	+			Eldridge et al. 2018
Tropical forest/ grassland	10	15	Indirect	N		P	Eldridge et al. 2018
Forest	60	1	Indirect	N		P	Gage et al. 2017
Forest	64	19	Indirect	N			Fuller et al. 2015
Forest	6	8	Indirect	N			Atemasov and Atemasova 2019
Forest	5	1	Indirect	+		P	Towsey et al. 2014
Forest	2	1	Direct	N		P	Mammides et al. 2017
Grassland	30	8	Indirect	+		P	Raynor et al. 2017
Grassland	1	8	Both	+			Maina et al. 2016
Grassland	6	3	Indirect	N		P	Ferreira et al. 2018
Cropland	2–12	4	Indirect		+	P	Buxton et al. 2018

factors, six focused solely on environmental and three were focused solely on anthropogenic factors. Seven of the nine selected studies found a positive correlation between the ACI and an environmental factor (tree density, canopy height, canopy density, vegetation height, vegetation diversity, tree species richness and distance to forest edge), two studies found negative correlations (canopy density, forest age and distance to forest edge), whilst two reported no correlation between the ACI and environmental factors (tree density, canopy height, canopy density, vegetation diversity and tree species richness) (Table 2). Only two of the six selected studies found a relationship between the ACI and anthropogenic factors, including a negative correlation with proximity to roads and a positive correlation with proximity to mining sources (Table 3). Other influential factors were reported in seven of the 12 studies, including biophonic sounds (Duarte et al. 2015; Bobryk et al. 2016; Raynor et al. 2017; Turner et al. 2018; Myers et al. 2019; Doser et al. 2020), geophonic noise (Farina and Pieretti 2014; Turner et al. 2018) and anthropogenic noise (Farina and Pieretti 2014; Duarte et al. 2015; Bobryk et al. 2016; Turner et al. 2018).

Table 2. A summary of nine studies that investigate the relationship between the ACI in avian assemblages and environmental factors. For each environmental factor '**+**' represents a positive correlation with the ACI, "-" represents a negative correlation with the ACI and '**N**' shows that no significant correlation was found.

	Environmental factors								
Habitat	Tree density	Canopy height	Canopy density	Veg. height	Veg. diversity	Forest age	Tree species richness	Distance to forest edge	Source
Forest	N								Doser et al. 2020
Forest			-		+	-		+	Turner et al. 2018
Forest		N	N		N		N		Fuller et al. 2015
Forest		+					+		Bobryk et al. 2016
Forest	+							-	Atemasov and Atemasova 2019
Forest		+							Hilje et al. 2017
Forest			+						Farina et al. 2015
Forest			+	+	+				Farina and Pieretti 2014
Cropland				+					Myers et al. 2019

Table 3. A summary of six studies that investigate the relationship between the ACI in avian assemblages and anthropogenic factors. For each factor '**+**' represents a positive correlation with the ACI, "-" represents a negative correlation with the ACI and '**N**' shows that no significant correlation was found.

	Anthropogenic factors						
Habitat	Vehicular	Proximity to roads	Proximity to urban areas	Logging	Wind turbines	Mining	Source
Forest	N			N			Doser et al. 2020
Forest		-					Turner et al. 2018
Forest		N	N				Fuller et al. 2015
Forest		N					Khanaposhtani et al. 2019
Forest						+	Duarte et al. 2015
Grassland					N		Raynor et al. 2017

Discussion

Our systematic literature review has highlighted a scarcity in studies focused on the use of the Acoustic Complexity Index to evaluate avian species richness and diversity, and how environmental and anthropogenic factors might affect such relationship. When these relationships were evaluated in the scientific literature, results remain relatively inconclusive due to a lack of standardisation in methodology and replication.

Relationship between the ACI and species richness and/or diversity

Our review shows that the majority of studies finding a positive correlation used indirect methods (Table 1) (Towsey et al. 2014; Maina et al. 2016; Hilje et al. 2017; Raynor et al. 2017; Eldridge et al. 2018). This output from our review highlights the benefits of acoustic recordings identified in previous studies, including the removal of observer bias and a reduction in time spent in the field, which are particularly important considerations in remote, hard to access areas (Darras et al. 2018). The presence of other sounds, including those from insects, wind and rain, can influence and skew ACI scores (Shonfield and Bayne 2017; Ross et al. 2018). Eight studies reported other influential factors, including the presence of biophonic, geophonic and anthropogenically produced sounds, which may have impacted overall results (Towsey et al. 2014; Gage et al. 2017; Mammides et al. 2017; Raynor et al. 2017; Eldridge et al. 2018; Ferreira et al. 2018; Jorge et al. 2018; Moreno-Gomez et al. 2019). The high proportion of studies reporting influential factors, especially those that found no correlation (nine of the 13 studies), suggests that findings may not be guaranteed where audio files contain large proportions of geophony or other biophonic sounds that may deter and obscure avian signals (Ross et al. 2018). We recommend that audio files that are known to contain high levels of wind and rainfall should be removed from the data manually, or an energy filter can be applied to exclude small non-biophonic sounds from the analysis (Farina et al. 2021). Alternatively, the presence of these types of influential sounds may be incorporated into the analysis to investigate both the direct and indirect impacts of geophony on the soundscape, including how detectability of species alters in different weather conditions and how the presence of heavy rainfall and winds alter relationships between species richness and the ACI (Davidson et al. 2017; Mammides et al. 2017; Ross et al. 2018).

Studies predominantly occurred in forest habitats followed by grasslands, both of which are important for avian communities (Moreira et al. 2005; Hewson et al. 2011), however no clear pattern between habitat type and a correlation with the ACI was observed in the literature reviewed. This lack of correlation may reflect the difficulty to accurately measure landscape mosaics and structures where numerous factors need to be considered including vegetation structure, scale and sampling techniques (Farina and Pieretti 2014; Ross et al. 2018). However, previous findings by Eldridge et al. (2018) suggesting the ACI correlates with species richness in temperate but not tropical landscapes are not supported by our review, as positive correlations have been observed in tropical dry and rainforests (Table 1) (Hilje et al. 2017; Jorge et al. 2018). Variation in findings may result from differences in methodology across all studies, including study duration and the number of recorders used, where more recorders may better describe the landscape characteristics leading to finer scale analysis when using environmental variables (Farina et al. 2014). A standardised approach towards data collection should be utilised in the future to account for the effect of habitat type and survey effort. This should include either the removal of obscured datafiles or the application of an energy filter and the use of multiple recorders to maximise survey effort and gain insight into how the soundscape alters in different habitats with increasing complexity (Farina et al. 2014).

Within the scientific literature, a definitive relationship between the ACI and avian species richness remains absent. However, identifying the ACI as a comprehensive acoustic index will be invaluable in the future for monitoring species and habitats, identifying subtle changes in ecosystem health and setting appropriate conservation priorities for avian assemblages. Where the ACI can successfully predict avian species richness from the soundscape, in addition to understanding how this relationship alters with changes in the physical landscape, will enable the completion of overall biodiversity assessments identifying changes in ecological processes and patterns (Farina et al. 2011; Pijanowski et al. 2011b; Depraetere et al. 2012; Shonfield and Bayne 2017; Eldridge et al. 2018).

Relationships between the ACI, avian communities, environmental and anthropogenic factors

The literature search returned 12 studies that investigated correlations between the ACI, avian communities, environmental and/or anthropogenic factors. The results of these studies provided extremely mixed results, especially when environmental factors were included. For instance, Fuller et al. (2015) found no correlation between canopy height, canopy density, vegetation diversity, tree species richness and the ACI despite several other studies finding both positive and negative correlations for the same variables (Farina and Pieretti 2014; Farina et al. 2015; Bobryk et al. 2016; Hilje et al. 2017; Turner et al. 2018). The variation in the findings from the literature further reflects the lack of standardisation in the methodology (Appendix Table A1), as for instance, study duration and number of recorders were different across all studies, potentially affecting the level of description of the environment. However, our review highlights how the species composition in the different habitats also influences results. Bird species who prefer dense vegetation contribute highly to the acoustic environment, such as blackbirds (*Turdus merula*) and robins (*Erithacus rubecula*) (Farina et al. 2015), whilst the presence of migratory birds, such as the Western subalpine warbler (*Sylvia cantillans*) may influence the relationship between the ACI, avian richness and habitat type due to their preference for edges and low shrubs (Farina and Pieretti 2014). High acoustic diversity in ancient woodlands and young developing forests are also important findings reflecting species composition and the importance of different habitats for avian assemblages (Eldridge et al. 2018). Species presence, their densities and specific associations to habitats and landscape features influence the relationship between the ACI and the physical environment, by for example affecting the absolute value of the ACI. Relationships between the ACI and environmental factors vary depending on habitat type and species composition. Therefore, we caution against using results obtained in other areas with different habitat type and species composition to develop conservation guidelines to protect avian species and the habitats they inhabit, as actions should be determined on an individual site basis.

Six studies investigated the relationship between the ACI and anthropogenic factors. However, most of these studies focused solely on one factor, whilst only proximity to roads was a common factor reported in three different papers. No correlation between anthropogenic factors and ACI values was observed in most studies which is to be expected as the ACI was designed to be insensitive to anthrophony (Pieretti et al. 2011). However, the scarcity of studies investigating anthropogenic factors in addition to the variation in the methodology used makes this result inconclusive. This review also highlights that even the most common anthropogenic factor in the literature, proximity to roads, offers an inconsistent correlation to the ACI when monitoring avian vocalisations, as despite Turner et al. (2018) reporting a negative correlation, other studies found no correlation (Fuller et al. 2015; Khanaposhtani et al. 2019). A negative correlation should highlight the detrimental nature of roads to avian communities, but the lack of wider support from the literature impedes using this finding in future conservation work. These inconsistencies highlight the absence of a causal relationship between avian abundance and traffic noise where in fact proximity to roads also creates habitat edge effects that benefit some avian communities and are detrimental to others, which is reflected in the above findings (Summers et al. 2011).

As this field of study is relatively new, which was highlighted by the recent dates of papers returned in the review, there are still many areas for development. Future research should focus on incorporating a standardised methodology to obtain site-based relationships between the ACI and environmental factors, in addition to including a range of anthropogenic factors to test previous research suggesting that the ACI is unaffected by anthrophony. The inclusion of multiple factors including those relating to the wider landscape, such as tree density, habitat configuration and proximity to anthrophony, are vital to gain insight into how avian communities interact with their landscape and how this is reflected in the soundscape, with the potential to reveal subtle changes in ecosystem health. Understanding these interactions, in addition to obtaining an effective AI which highlights ecologically relevant changes in the soundscape, is necessary to improve long-term, remote monitoring of ecosystems and inform conservation priorities. Where an AI correlates with environmental factors such as canopy density, vegetation diversity and with avian species richness and/or diversity, the results can reflect alterations in avian assemblages and the health of the surrounding ecosystem, especially when faced with ecological stressors (Sueur et al. 2014; Ross et al. 2018). These relationships will be beneficial for monitoring isolated habitats along with urban areas where increasing levels of habitat loss, degradation and fragmentation are present, and gain a better understanding of the effects of these losses on birds and the wider environment.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Table A1. A summary of the methodology used in the 12 studies that investigate the relationship between the ACI in avian assemblages and environmental and/or anthropogenic factors, including study duration and number of acoustic recorders used. 'P' indicates whether the study referred to other influential factors that may have impacted or skewed their results such as biophonic (other than birdsong), geophonic or anthropogenic noise.

Year	Length (days)	No. recorder	Other factors	Source
2020	30	4	P	Doser et al. 2020
2018	6	1 (moved around)	P	Turner et al. 2018
2017	30	8	P	Raynor et al. 2017
2015	64	19		Fuller et al. 2015
2016	3	5	P	Bobryk et al. 2016
2019	1/2	22	P	Myers et al. 2019
2019	6	8		Atemasov and Atemasova 2019
2019	11	7		Khanaposhtani et al. 2019.
2017	5	8		Hilje et al. 2017
2015	28	12	P	Duarte et al. 2015
2015	7	20		Farina et al. 2015
2014	19	20	P	Farina and Pieretti 2014