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A Review On Vocalization Of Birds For Identification, Associated Behavior, And Database Development.

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Abstract

Birds play a crucial role in ecosystems by occupying almost every habitat and serving at multiple trophic levels, making them reliable indicators of environmental health. Birds communicate with each other by producing sounds. This bird's vocalization is associated with different behaviors, making it a useful tool for monitoring populations and measuring the biodiversity. Birds have a special organ for the vocalization. Both male and female songbirds use vocalizations to deliver specific information to the receiver. The bird vocalization is classified into calls and songs. Calls have a large functionality and 10 different call categories such as alarm, flight, feeding, etc. A spectrogram is a visualization of sounds and can be used to visualize the frequencies over time. The point–count method is one of the most popular techniques for surveying birds based on vocalization. Autonomous recording units (ARUs) are a new technology for studying and monitoring animals' vocalizations. A review paper presents the review of the vocalization of birds for identification, associated behavior, and database development.

Keywords: Bird Vocalization, Bird Identification, Bird Acoustic, Vocal Behavior of Birds

NTRODUCTION:

Vocalizations are a significant mode of avian communication and play an important role in various aspects such as reproduction, partner selection, social interactions, and foraging, all of which are vital for survival. These vocal signals have long been utilized in scientific research to investigate inquiries concerning animal behavior, ecology, evolutionary processes, and neurobiology. They have also been pivotal in identifying numerous previously unknown bird species (Alstrom and Ranft, 2003). Birds employ vocalizations for diverse functions, typically categorized into songs and calls (Krebs and Kroodsma, 1980). Calls, which are brief sounds, serve immediate purposes like signaling alarms and threats, whereas songs are more intricate and are characteristic of male birds.

In general, the vocalizations of songbirds exhibit greater complexity and a wider range compared to non-songbirds due to enhanced control over vocalization production (Gaunt, 1983). Birdsong, akin to human speech, serves to convey information. While less emphasis has been placed on the study of song perception compared to production, research on mechanisms involved in song detection and recognition is crucial for comprehending avian vocal behavior. In various species, both adult and juvenile birds of both genders have displayed the ability to differentiate between different song types based on acoustic and temporal features (Searcy *et al.,* 1997; Riebel, 2009; Rodríguez-Saltos, 2017). The syrinx, found at the confluence of the primary bronchi and trachea, or entirely within the trachea or bronchi, is the avian organ responsible for sound production. Functionally akin to human vocal cords, the syrinx exhibits a distinct structure (Nowicki, 1987). Birds contribute significantly to ecosystem services and regulation, making research on avian

conservation paramount. Given the aerial nature of birds and dense environments like tropical forests, auditory identification of birds may be more effective than visual methods (Ramashini *et al.,* 2022).
Songbirds, such as Mockingbirds, were discovered to possess remarkably intricate and vibrant songs compared to most species (Derrickson, 1987; Kershenbaum and Garland, 2015). Mockingbirds exhibit a diverse array of song components and are subjects of extensive research on the acquisition and production of complex learned songs by humans (Catchpole and Slater, 2003). Initial studies utilizing Autonomous Recording Units (ARUs) relied on human observers for the identification of birdsongs and calls within the recordings (Haselmayer and Quinn, 2000). Autonomous Recording Unit (ARU) is the alternative method for the field survey and monitoring of wildlife and different research areas (Sugai *et al.,* 2019). Passive acoustic monitoring requires the placement of autonomous recording units (ARUs) in the field, programmed to record and followed up by an interpretation of the recordings.
The identification of bird species through vocalizations necessitates a labor-intensive process involving equipment setup, sound recording, and data annotation (Conway and Gibbs, 2001). Another tool is available for the identification of birds in the field, a joint effort between the Cornell Lab of Ornithology and Chemnitz University of Technology resulted in BirdNET, a freely available classifier that is a tool for identifying large groups of bird species in small segments within longer audio recording files by using convolutional neural network algorithm (Kahl *et al.,* 2021). An alternative method for correcting biases in acoustic surveys is to measure the sound pressure level (SPL) of bird songs, which is a measure, usually in decibels, of the energy of a sound signal (Pérez-Granados and Traba, 2021). This study shows that there will be scope for making a database of the vocalization of birds so that future generations can use the information for the conservation and management of birds.

INTERNATIONAL STATUS:
Baxter *et al.,* (1999) observed the interspecific distress call. They evaluate existing distress call recordings in various species to determine the effect of the current call that could disperse foreign species in the region of Hong Kong and the UK. Gentner and Hulse (2000) observed a female European starling, *Sturnus vulgaris*, who attends to variation among the songs of conspecific males when making mate-choice decisions. Stein (2002) observed the female Great Snipe mating behavior, he suggested that female calls are responsible for indirect or direct mate choice. Thierry *et al.,* (2004) observed the song of a white-browed warbler and suggested how a simple and stereotyped acoustic signal transmits individual information of *Besileuterus leucoblepharus.*

Podos & Moseley (2017) studied vocal communication in birds. This research suggested the role of vocalization in species recognition and sexual selection birds show response towards song parameter-related vocal performance. Tobias *et al.,* (2010) observed Amazonian birds and suggested that the song divergence by sensory drive. Dowling *et al.,* (2012) studied bird songs and suggested the comparative effects of urban development and anthropogenic noise. Osmun and Mennill (2011) observed male and female tropical Wrens, they suggested that acoustic monitoring reveals congruent patterns of territorial singing behavior. Lopes *et al.,* (2011) focused on the automatic identification of bird species from their audio-recorded song. Foote *et al.,* (2013) observed songs of *Eastern Phoebe* and suggested that the sub-oscine songbirds are individually distinctive but do not vary geographically.
Moss (2003) focused on the study of bird behavior. The direct field survey methodology was used for observations and identification of birds. He suggested the importance of bird behavior like breeding, feeding, navigation, migration life and death in concern with bird identification. Brumm and Ritschard (2011) observed male receivers in Chaffinches and suggested that the song amplitude affects the territorial aggression of birds. In most songbirds' social aggression by territorial males can easily be elicited with playback experiments. Neal *et al.,* (2011) studied on noisy acoustic environment; they suggested the time-frequency segmentation of bird songs. He proposed a supervised time-frequency audio segmentation method, using a random forest classifier. Thompson *et al.,* (2013) observed the songbird's auditory cortex and suggested that local inhalation modulates learning-dependent song encoding. Tsai *et al.,* (2014) observed the timbre and pitch features of different bird species' vocalization patterns, for identification of them. They developed a two-stage bird identification system. In the first performed a call/song classification if an unknown sound clip is classified as a call, then it is handed by call identifier, in the second stage is handed by a song identifier and learning. Wilson *et al.,* (2014) analyses the vocal performance constraints using uneven sampling for the evolution of mating displays.

Keen *et al.,* (2013) observed cooperatively breeding birds and suggested that the birds living in utilize flight calls to signal groups. Stowell and Plumbley (2014) studied large-scale analysis of frequency modulation in

the bird song database and observed that bird songs contain a large amount of rapid frequency modulation. Digby *et al.,* (2014) focused on temporal and environmental influences on the vocal behavior of a nocturnal bird. They observed little spotted kiwi, *apteryx owenii,* and vocal behavior over 3 years to find influences on vocal activity in male and female birds. Fanioudakis and Potamitis (2017) observed deep networks tag the location of bird vocalizations on audio spectrograms. They focused on reliable detection and segmentation of bird vocalizations as recorded in the open field. Acoustic detection of avian sounds can be used for the automatized monitoring of multiple bird taxa and querying in long-term recordings for species of interest. Odom and Benedict (2018) focused on the significance of bird songs in diverse biological fields like neurobiology and conservational biology. They highlighted documenting female bird songs.

Halfwerk *et al.,* (2018) worked on the effect of man-made sounds on birds and their songs. They investigated how ambient noise influences birds' behavior and physiology, particularly in songs. The study suggested that birds modify their songs in response to elevated noise by human activities, such as birds singing longer, higher, and louder. Zhang *et al.,* (2022) worked on an efficient time-domain end-to-end single-channel bird sound separation network. They proposed that networks may contribute to discriminating individual birds and studying the interaction between individual birds, as well as to realize the automatic identification of bird species in various mobile and edge computing devices. Marck *et al.,* (2022) studied the white spectacled bulbul (*Psynonotus xanthopygos*) as a model for the identification and analysis of the characterization of a base unit of vocal communication by using syllables of bulbul to capture divers' pattern of variation in vocalization.

NATIONAL STATUS:
Katti (2001) observed migrant warblers and suggested vocal communication and territoriality during the non-breeding season. They performed playback experiments by using recorded calls suggesting that individuals respond equally and aggressively to territorial instructions. Sotthibandhu (2003) observed the red-whiskered bulbul in a semi-wild habitat of the bird farm she suggesting that territorial defense of *Pycnonotus jocose* species. Sivakumaran and Thiyagesan (2003) observed the Indian roller and suggested the population, diurnal activity patterns, and feeding ecology of the Indian roller, *Coracias benghalensis* species. Asokan and Ali (2010) observed the Indian roller and suggested a preliminary investigation on the diet and breeding biology of *Coracias benghalensis* species in a portion of the Cauvery Delta, Tamil Nadu, India. Kumar (2011) studied Indian Robin and suggested the physical characteristics, categories, and functions of the song in *Saxicoloides fulicate* species. Kamtaeja *et al.,* (2012) Studied six sympatric bulbuls (genus- *Pycnonotus*) in Southeast Asia, and suggested the species' distinctiveness in the vocal behavior. *Pycnonotus* include many highly vocal species which are capable of a produced large variety of sounds. They investigate the acoustical features of the songs of six sympatric *P. bulbul* species.
Kumar (2012) studied the songs and calls of Indian birds and suggested implications for behavioral studies, systematic and conservation. Bhatt *et al.,* (2014) focused on some notes on the breeding behavior of the Oriental magpie-robin from Uttarakhand India. They observed the behavior of the 27 pairs of Magpie robins. The male magpie robin delivered complex songs mainly during the down through the breeding season. The male produced a song continuously in the presence of the female. Tyagi *et al.,* (2006) Introduced the novel automatic voice recognition method called Spectral Ensemble Average Voice Print (SEAV). This technique is used for the identification of bird calls. This technique computes the ensemble average FTT spectrum for identification of the bird calls.
Aparna (2015) focused on the automatic recognition of birds through audio spectral analysis. They produced an automatic bird identification system and analyzed the unknown sounds of bird species. Chakraborty *et al.,* (2016) investigated bird call identification using dynamic kernel-based support vector machines and neural networks. They used speech and audio processing techniques for bird vocalization and bird classification of birds from the lower Himalayas region. Narayana *et al.,* (2017) observed the parenthood of red-vented bulbul (*Pycnonotus cafer*). They recorded and observed the behavioral activities of red-vented bulbul such as begging, calling, flying, and guarding by the parental care provided to the chicks. Divyapriya and Pramod (2019) investigated the Spectral analysis of common Iora and suggested that Common Iora males produced 14 syllable types more commonly and females produced one syllable type during the study period. Males used high-frequency, short-duration syllables to communicate with their proximate partners.

Pahuja and Kumar (2021) investigated the sound spectrogram of bird species. This method was based on the automatic sound recognition of bird species by using an MLP classifier complexity. Yambem *et al.,* (2021) studied the functional and structural complexity of the jungle babbler, they found various vocal repertoires and the Jungle babbler produced 15 different types of calls. This call is for the coordination of various social

behaviors including aggression, group activity, foraging and vigilance. Saxena *et al.,* (2022) worked on the analysis of object detection techniques for bird species identification. They use object detection techniques such as Faster R-CNN and YOLOv5 to identify birds in images from Peninsular India and Maharashtra.

CONCLUSION:

Bird vocalization is a powerful tool for understanding avian behaviour, species identification, and ecosystem monitoring. The unique acoustic features of bird calls and songs reflect their ecological roles, territorial communication, mate attraction, and alarm signalling. These vocalizations also serve as a non-invasive method for identifying bird species, especially in diverse and remote habitats. The development of comprehensive vocalization databases has revolutionized ornithology by facilitating automated identification using bioacoustics tools. Advanced technologies, including machine learning and signal processing algorithms, have enhanced the accuracy and scalability of these systems. Such databases are not only vital for species conservation but also for studying behavioural ecology and the effects of environmental changes on bird populations. This review underscores the critical role of bird vocalization in advancing avian research and highlights the importance of continued efforts in database development and behavior analysis for ecological sustainability.

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REFERENCES:

1. Alström, P., & Ranft, R. (2003). The use of sounds in avian systematics and the importance of bird sound archives. *Bull. BOC*, *123*, 114-135.
2. Aparna, P. C. (2015). Automatic recognition of birds through audio spectral analysis. In *2015 Fifth International Conference on Advances in Computing and Communications (ICACC)* (pp. 395-398). IEEE.
3. Asokan, S., & Ali, A. M. S. (2010). Time-activity budget of white-breasted kingfisher Halcyon smyrnensis in Cauvery Delta Region, Tamil Nadu, India. *Advances in Biological Research*, *4*(6), 288-291.
4. Baxter, A. T.; Bell, J. C.; Allan, J. R.; and Fairclough, J. (1999). "The Interspecificity of Distress Calls". *1999 Bird Strike Committee-USA/Canada, First Joint Annual Meeting.*
5. Bhatt, D., Sethi, V. K., Kumar, A., & Singh, A. (2014). Some notes on the breeding behaviour of the oriental magpie robin (Copsychus saularis) from Uttarakhand, India. *Journal of Sustainability Science and Management,* 9(1), 112-119.
6. Brumm, H., & Ritschard, M. (2011). Song amplitude affects territorial aggression of male receivers in chaffinches. *Behavioral Ecology*, *22*(2), 310-316.
7. Catchpole, C. K., & Slater, P. J. (2003). *Bird song: biological themes and variations*. Cambridge university press.
8. Chakraborty, D., Mukker, P., Rajan, P., & Dileep, A. D. (2016). Bird call identification using dynamic kernel-based support vector machines and deep neural networks. In *2016 15th IEEE International Conference on Machine Learning and Applications (ICMLA)* (pp. 280-285). IEEE.
9. Conway, C. J., & Gibbs, J. P. (2001). Factors influencing detection probability and the benefits of call broadcast surveys for monitoring marsh birds. *Progress report to USGS-BRD for USDA project*, *5004789*.
10. Derrickson, K. C. (1987). Yearly and situational changes in the estimate of repertoire size in northern mockingbirds (Mimus polyglottos). *The Auk*, 104(2), 198-207.
11. Digby, A., Towsey, M., Bell, B. D., & Teal, P. D. (2014). Temporal and environmental influences on the vocal behaviour of a nocturnal bird. *Journal of Avian Biology*, *45*(6), 591-599.
12. Divyapriya, C., & Pramod, P. (2019). Spectral characteristics of Common Iora Aegithina tiphia vocalizations and their context-specific preferences. *Current Science*, *117*(11), 1863-1871.
13. Dowling, J. L., Luther, D. A., & Marra, P. P. (2012). Comparative effects of urban development and anthropogenic noise on bird songs. *Behavioral Ecology*, *23*(1), 201-209.
14. Fanioudakis, L., & Potamitis, I. (2017). Deep networks tag the location of bird vocalisation on audio spectrograms. *arXiv preprint arXiv:1711.04347*.
15. Foote, J. R., Palazzi, E., & Mennill, D. J. (2013). Songs of the Eastern Phoebe, a suboscine songbird, are individually distinctive but do not vary geographically. *Bioacoustics*, *22*(2), 137-151.

16. Gaunt, A. S. (1983). An hypothesis concerning the relationship of syringeal structure to vocal abilities. *The Auk*, *100*(4), 853-862.
17. Halfwerk, W., Lohr, B., & Slabbekoorn, H. (2018). Impact of man-made sound on birds and their songs. *Effects of anthropogenic noise on animals*, 209-242.
18. Haselmayer, J., & Quinn, J. S. (2000). A comparison of point counts and sound recording as bird survey methods in Amazonian southeast Peru. *The Condor*, *102*(4), 887-893.
19. Tobias, J. A., Aben, J., Brumfield, R. T., Derryberry, E. P., Halfwerk, W., Slabbekoorn, H., & Seddon, N. (2010). Song divergence by sensory drive in Amazonian birds. *Evolution*, *64*(10), 2820-2839.
20. Kahl, S., Wood, C. M., Eibl, M., & Klinck, H. (2021). BirdNET: A deep learning solution for avian diversity monitoring. *Ecological Informatics*, *61*, 101236.
21. Kamtaeja, S., Sitasuwan, N., Chomdej, S., Jatisatienr, A., & Mennill, D. J. (2012). Species-distinctiveness in the vocal behaviour of six sympatric bulbuls (genus Pycnonotus) in South-East Asia. *Emu-Austral Ornithology*, *112*(3), 199-208.
22. Katti, M. (2001). Vocal communication and territoriality during the non-breeding season in a migrant warbler. *Current Science*, 419-423.
23. Keen, S. C., Meliza, C. D., & Rubenstein, D. R. (2013). Flight calls signal group and individual identity but not kinship in a cooperatively breeding bird. *Behavioral Ecology*, *24*(6), 1279-1285.
24. Kershenbaum, A., & Garland, E. C. (2015). Quantifying similarity in animal vocal sequences: which metric performs best? *Methods in Ecology and Evolution*, *6*(12), 1452-1461.
25. Krebs, J. R., & Kroodsma, D. E. (1980). Repertoires and geographical variation in bird song. In *Advances in the Study of Behavior* (Vol. 11, pp. 143-177). Academic Press.
26. Kumar, A. (2011). Physical characteristics, categories and functions of song in the Indian Robin Saxicoloides fulicata (Aves: Muscicapidae). *Journal of Threatened Taxa*, *3*(7), 1909-1918.
27. Kumar, A. (2012). Songs and Calls of Indian Birds: Implications for Behavioural Studies, Systematics and Conservation. *Journal of the Bombay Natural History Society (JBNHS)*, *109*(1&2), 60-71.
28. Lopes, M. T., Gioppo, L. L., Higushi, T. T., Kaestner, C. A., Silla Jr, C. N., & Koerich, A. L. (2011, December). Automatic bird species identification for large number of species. In *2011 IEEE International Symposium on Multimedia* (pp. 117-122). IEEE.
29. Marck, A., Vortman, Y., Kolodny, O., & Lavner, Y. (2022). Identification, analysis and characterization of base units of bird vocal communication: The white spectacled bulbul (Pycnonotus xanthopygos) as a case study. *Frontiers in Behavioral Neuroscience*, *15*, 812939.
30. Moss, S. (2003). *The garden bird handbook: how to attract, identify and watch the birds in your garden*. New Holland.
31. Narayana, B. L., Swamy, K., Surender, G., & Rao, V. V. (2017). An Observation on Parenthood of Red-vented Bulbul. *Ambient Science*, Vol. 4(2); 40-41 DOI:10.21276/ambi.2017.04.2.nn03
32. Neal, L., Briggs, F., Raich, R., & Fern, X. Z. (2011). Time-frequency segmentation of bird song in noisy acoustic environments. In *2011 ieee international conference on acoustics, speech and signal processing (icassp)* (pp. 2012-2015). IEEE.
33. Nowicki, S. (1987). Vocal tract resonances in oscine bird sound production: evidence from birdsongs in a helium atmosphere. *Nature*, *325*(6099), 53-55.
34. Odom, K. J., & Benedict, L. (2018). A call to document female bird songs: Applications for diverse fields. *The Auk: Ornithological Advances*, *135*(2), 314-325.
35. Osmun, A. E., & Mennill, D. J. (2011). Acoustic monitoring reveals congruent patterns of territorial singing behaviour in male and female tropical wrens. *Ethology*, *117*(5), 385-394.
36. Pahuja, R., & Kumar, A. (2021). Sound-spectrogram based automatic bird species recognition using MLP classifier. *Applied Acoustics*, *180*, 108077.
37. Pérez-Granados, C. & Traba, J. (2021) Estimating bird density using passive acoustic monitoring: a review of methods and suggestions for further research. *Ibis*, *163*(3), 765-783.
38. Podos, J., Moseley, D.L., 2017. Vocal communication in birds. In: *Reference Module in Neuroscience and Biobehavioral Psychology. Elsevier Inc*, pp. 389–396.
39. Ramashini, M., Abas, P. E., Mohanchandra, K., & De Silva, L. C. (2022). Robust cepstral feature for bird sound classification. *International Journal of Electrical and Computer Engineering*, *12*(2), 1477.
40. Riebel, K. (2009). Song and female mate choice in zebra finches: a review. *Advances in the Study of Behavior*, *40*, 197-238.
41. Rodríguez-Saltos, C. A. (2017). To become senders, songbirds must be receivers first. *Integrative and Comparative Biology*, *57*(4), 910-919.

42. Saxena, S., Thorat, S., Jain, P., Mohanty, R., & Baraskar, T. (2022). Analysis of object detection techniques for bird species identification. In *Journal of Physics: Conference Series* (Vol. 2325, No. 1, p. 012054). IOP Publishing.
43. Searcy, W. A., Nowicki, S., & Hughes, M. (1997). The response of male and female song sparrows to geographic variation in song. *The Condor*, *99*(3), 651-657.
44. Sivakumaran, N., & Thiyagesan, K. (2003). Population, diurnal activity patterns and feeding ecology of the Indian Roller Coracias benghalensis (Linnaeus, 1758). *ZOOS'PRINT JOURNAL*, *18*(5), 1091-1095.
45. Sotthibandhu, S. (2003). Territorial defense of the red-whiskered bulbul, Pycnonotus jocosus (Pycnonotidae), in a semi-wild habitat of the bird farm. *Songklanakarin J. Sci. Technol*, *25*(5), 553-563.
46. Stein Are Saether (2002) "Female calls in lek-mating birds: indirect mate choice, female competition for mates, or direct mate choice" Department of zoology, Norwegian university of science and technology, N-7491 Trondheim, Norway, *Behavioral Ecology* Vol. 13 No. 3: 344-352.
47. Stowell, D., & Plumbley, M. D. (2014). Large-scale analysis of frequency modulation in birdsong data bases. *Methods in Ecology and Evolution*, *5*(9), 901-912.
48. Sugai, L. S. M., Silva, T. S. F., Ribeiro Jr, J. W., & Llusia, D. (2019). Terrestrial passive acoustic monitoring: review and perspectives. *BioScience*, *69*(1), 15-25.
49. Thierry Aubin, Nicolas Mathevon, Maria Lusia Da Silva, Jacques M. E. Vielliaed and Fredric Sebe (2004). "How a simple and stereotyped acoustic signal transmits individual information: the song of the White-browed Warbler *Basileuterus leucoblepharus". Anais da Academia Brasileia de Ciencias*, 76(2): 335-334 (Annals of the Brazilian Academy of Sciences).
50. Thompson, J. V., Jeanne, J. M., & Gentner, T. Q. (2013). Local inhibition modulates learning-dependent song encoding in the songbird auditory cortex. *Journal of neurophysiology*, *109*(3), 721-733.
51. Gentner, T. Q., & Hulse, S. H. (2000). Female European starling preference and choice for variation in conspecific male song. *Animal behaviour*, *59*(2), 443-458.
52. Tsai, W. H., Xu, Y. Y., & Lin, W. C. (2014). Bird Species Identification Based on Timbre and Pitch Features of Their Vocalization. *J. Inf. Sci. Eng.*, *30*(6), 1927-1944.
53. Tyagi, H., Hegde, R. M., Murthy, H. A., & Prabhakar, A. (2006). Automatic identification of bird calls using spectral ensemble average voice prints. In *2006 14th European Signal Processing Conference* (pp. 1-5). IEEE.
54. Yambem, S. D., Chorol, S., & Jain, M. (2021). More than just babble: functional and structural complexity of vocalizations of Jungle Babbler. *Behavioral Ecology and Sociobiology*, *75*(8), 118.
55. Zhang, C., Chen, Y., Hao, Z., & Gao, X. (2022). An Efficient Time-Domain End-to-End Single-Channel Bird Sound Separation Network. *Animals*, *12*(22), 3117.