



ISSN Print: 2664-9926  
 ISSN Online: 2664-9934  
 NAAS Rating: 4.82  
 IJBS 2025; 7(2): 109-115  
[www.biologyjournal.net](http://www.biologyjournal.net)  
 Received: 15-12-2024  
 Accepted: 18-01-2025

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## Passive acoustic monitoring of Red-wattled Lapwing (*Vanellus indicus*) and house crow (*Corvus splendens*) during breeding season in agricultural landscape of Punjab

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**DOI:** <https://www.doi.org/10.33545/26649926.2025.v7.i2b.311>

### Abstract

Bioacoustic technology has shown immense potential for understanding the biological soundscape of our surroundings leading to better understanding of animal behaviors. It helps in assessing the current state of ecosystems as well as in creating a bio-acoustic archive. Bird calls have always been the choice of ornithologists to identify and study the birds. The present study deals with the study and analysis of acoustic signals of Red-wattled Lapwing (*Vanellus indicus*) and House Crow (*Corvus splendens*) during breeding season. Calls of the species were recorded by using Recforge II mobile app and were then analyzed in Raven Pro 1.5 software of Cornell University, New York. Red-wattled Lapwing was found to be vocally more active whereas House Crow was observed to be vocally less active during the breeding season. A total of six types of acoustic signaling were observed in case of Red-wattled Lapwing out of which five calls were during the breeding season where as in case of House Crow a total of five types of acoustic signaling were observed out of which only one type of call was recorded specifically while performing incubation activity and rest of the time House crow was mostly observed silent near the nests during the breeding season. Hence it is concluded that the analysis of acoustic signaling of avian species plays an important role in study the behavior of avian species during breeding seasons which will help in better understanding the behavioral complexities of these flying wonders.

**Keywords:** Red-wattled Lapwing, house crow, bioacoustic signals, Raven pro, breeding season

### Introduction

Bioacoustic technology has shown immense potential for understanding the biological soundscape of our surroundings leading to better understanding of animal behaviors. It helps in assessing the current state of ecosystems as well as in creating a bio-acoustic archive. Birds occupy a significant role in our ecosystem as well as in agriculture and play dual role in agriculture (Ali 2008; Sekercioglu 2006; AL-Taai, 2022) <sup>P</sup>. India is reported to have 12.13% (1358 sps.) of the world's 11,188 bird species and among these 423 species of birds are found in Punjab (Gupta 2008; Maheswaran and Alam 2024) <sup>[12, 18]</sup>. Acoustic emissions of animals serve communicative purposes and most often contain species-specific and individual information exploitable to listeners, rendering bioacoustics predestined for biodiversity monitoring in visually inaccessible habitats (Bradbury and Vehrencamp 2011; Aide *et al* 2013, Marques *et al* 2013, Stowell and Plumbley 2014, Heinicke *et al* 2015, Mutalib *et al.* 2025) <sup>[6, 1, 19, 27, 13, 22]</sup>. Acoustic signals given by birds are the means of their communication (Catchpole and Slater 1995) <sup>[8]</sup>. Usually birds give call signals to inform about the food, predator, and to identify family members etc. (Patterson *et al* 1994; Larsen and Goller 2002; Lima and Hofling 2006; Vallet *et al* 2006; Araya-Salas and Smith-Vidaurre 2017) <sup>[24, 16, 17, 28, 4]</sup>. Recording bioacoustic signals allows reproducible identification and documentation of species' occurrences, but it also requires technical prerequisites and behavioral precautions for better understanding of the species under investigation (Merchant *et al* 2015) <sup>[21]</sup>. For bioacoustic monitoring the efficient time is at dawn and dusk and the field surveys usually depend on both visual and auditory identification of the selected species (Bibby *et al* 2000) <sup>[5]</sup>.

The Red-wattled Lapwing (*Vanellus indicus*) and House Crow (*Corvus splendens*) were the most common bird species observed in the agricultural landscapes of Punjab. Red-wattled Lapwing is a ground forager and mainly feed on insects, grains, snails and other invertebrates picked from the ground and is ground nester whereas House Crow is omnivorous and feed on grains, vegetables, fruits, berries, small invertebrates & vertebrates, dead animal's carcasses, as well as other anthropogenic waste available in the surroundings and is an open nester on trees (Wells 2007; Akram *et al* 2013; Fraser *et al* 2015; Merchant *et al* 2015; Medina-Garcia *et al* 2015; Keighley *et al* 2016; Araya-Salas and Smith-Vidaurre 2017) [34, 2, 9, 21, 20, 15, 4].

Red-wattled Lapwing is characterized by their loud alarm calls. It lay eggs on the ground. It is difficult to find their nests as the eggs laid are cryptically colored and camouflages with the ground. Breeding season is between March and August. After the hatching of eggs both the parents become alert and protect the chicks from predators. They remain active at all hours and even during midnight to rescue from predators (Vyas 1997) [30]. It belongs to family Charadriidae and are distributed throughout East Pakistan, India, Nepal and Bangladesh. It is commonly known as 'Titeeri' and it mostly observed in ploughed fields, grazing patches, open country side and dry beds of water bodies (Ali 2008) [1]. Red-wattled Lapwing is about 35cm long with long yellow legs, black-tipped red bill and light brown wings with purple sheen (Vyas 1997) [30]. Lapwings usually have loud pitch noisy sound calling did-he-do-it or pity-do-it, more frequent at night (Jerdon 1984) [14]. These birds lay their eggs on ground depressions. Clutch size normally obtained is 3-4 (Vyas 1997) [30].

House Crows being ubiquitous, belonging to family Corvidae and order Passeriformes, are found in most climatic zones. House Crow is about 40 cm in length and morphologically deeply glossed black forehead, crown, throat and upper breast with distinctly light grey colored neck (Ali 2008) [1]. It is gregarious commensal bird, highly adaptable to changing environments, and a pest of great concern due to its destroying influences on livestock,

agricultural and horticultural crops, indigenous fauna as well as a fecal contaminator of human environments and water resources (Gill 1995; Parr 1997; Brook *et al* 2003; Sen 2011; Akram *et al* 2013; Fraser *et al* 2015) [11, 23, 7, 26, 2, 9]. Males are found to be larger than females and are reported as pair-bonded even during non-breeding season (Ali 2008) [1]. The study of bio-acoustic signals of Red-wattled Lapwing and House Crow during breeding seasons will help in better understanding their behavior during breeding.

### Materials and Methods

The study of acoustic breeding calls of Red-wattled Lapwing and House Crow were conducted at two selected locations from May 2018 to July 2019 and data was collected pertaining to the acoustic signaling of bird species under study.

**Location I: Punjab Agricultural University, Ludhiana:** Situated at latitude of, the university is situated towards west in the outskirts of Ludhiana city (75.79° E, 30.90° N; 189 m above the mean sea level). The campus covering an area of 1600 acres is surrounded by residential area on the eastern side and area consists of various lawns, hedges and ornamental trees; the campus also has a large expanse of agricultural field area comprised of seasonal crops such as wheat, rice, maize, cotton etc. along with vegetables, fodder and orchards. The experimental areas consisted of well active nests of Red-wattled Lapwing and data was taken during breeding and non-breeding activities involving roosting, foraging, nesting, incubation, hatching, mobbing and parental care up to fledging of chicks.

**Location II: Ahmedgarh, district Sangrur:** Ahmedgarh is a town in Sangrur district of Punjab situated at 26 km from Ludhiana having area of 6 km<sup>2</sup> (75.82° E, 30.68° N; 232 m above the mean sea level). This location comprises of both agricultural fields and residential area including schools, markets, parks, grain market etc. The field area comprised of seasonal crops including rice, wheat and maize.



**Fig 1:** Sites under study at location I & II

**Recording and analysis of acoustic signals:** Recordings of Red-wattled Lapwing were done by using Recforge II mobile app and all the recordings were edited in Audacity software to reduce the background noise of vehicles, other bird species, machinery and humans etc. This software also provided the facility of amplifying the recorded calls in addition to the background noise reduction. Then the edited

recordings were played & analyzed in Raven Pro 1.5 software (Cornell Laboratory of Ornithology, Ithaca, New York, U.S.A.). The software provided various features such as playing a section, correlating the calls, coloring features, wave form and spectrogram analysis etc. Software provides such spectrograms which can either be captured colored or black and white according to requirement. Spectrograms

disclose some features including fast frequency or amplitude variations, that are not heard by humans even if it come in their hearing frequency of 30 Hz-16 kHz. The spectrograph thus formed are used to analyse sounds and convert them into a graphical representation. Usually the x axis on a spectrogram represents the time, y axis represents the frequency and the scale of grays or the scale of colors represents the amplitude of signals.

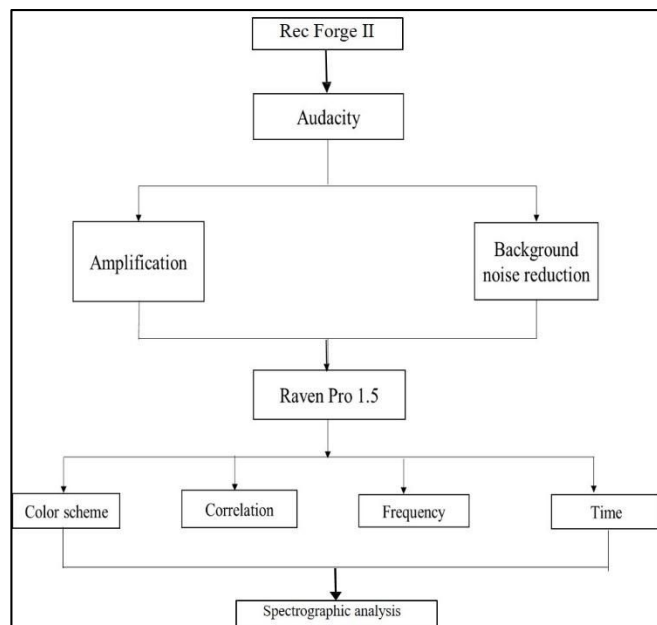


**Fig 2:** Flow chart representing process of audio recording and analysis

## Results and Discussion

During the present study it was observed that during the breeding season, Red-wattled Lapwing was vocally more active as compared to House Crow (AL-Taai, 2022) <sup>[29]</sup>. Breeding period included acoustic signaling (calls) during different activities such as nesting, egg laying, incubation, hatching, mobbing and parental care. A total of six types of calls were observed in case of Red-wattled Lapwing out of which five calls were during the breeding season where as in case of House Crow a total of five types of calls were observed out of which only one type of call was recorded specifically while performing incubation activity and rest of the time House crow was mostly observed to be silent near the nests during the breeding season.

### Vocalizations of Red-wattled Lapwing

These birds breed from March to August laying their eggs on ground depressions. A total of 10 nests were observed during the study. Clutch size ranges from 3-4 with cryptically colored eggs. A total of six types of vocalization calls were observed and analyzed out of which five calls were during the breeding season.

**1. Flying calls of lapwing over its territory:** At time of breeding season lapwings were vocally active while flying over their territories in order to protect the territories from entering another male or predators. Same call was heard after time interval of 1-2 seconds. It was observed that same segment of call of 11-13 seconds was repeated after pause of 5 seconds. The highest frequency observed was 11 kHz although fluctuation in the frequency was more during whole call length (Fig. 3).

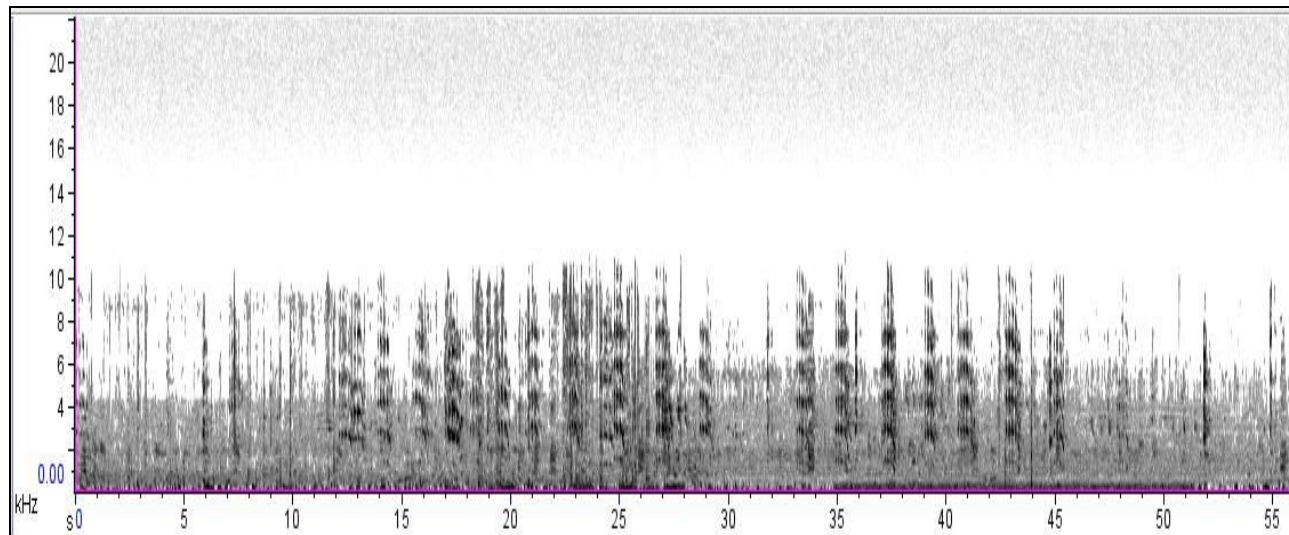


**Fig 3:** Spectrogram of Flying calls of lapwing over its territory during breeding season

Similar observation were also reported by Walters (1982) <sup>[31]</sup> that at time of breeding season lapwings were vocally active while flying over their territories in order to protect the territories from entering another male or predators.

### Calls of Red-wattled Lapwing during incubation of eggs

As observed from spectrogram the calls were continuous at the time of incubation. The intensity of calls were more as

the predator approaches the eggs and declined after the departure of predator. In the beginning for 1-3 seconds of total call period, calls were heard after constant pause while from 4-5 seconds of time period calls were intensified with no pause in between. This pattern of both intensified and non-intensified calls was repeated up to 15 seconds of call length (Fig 4).

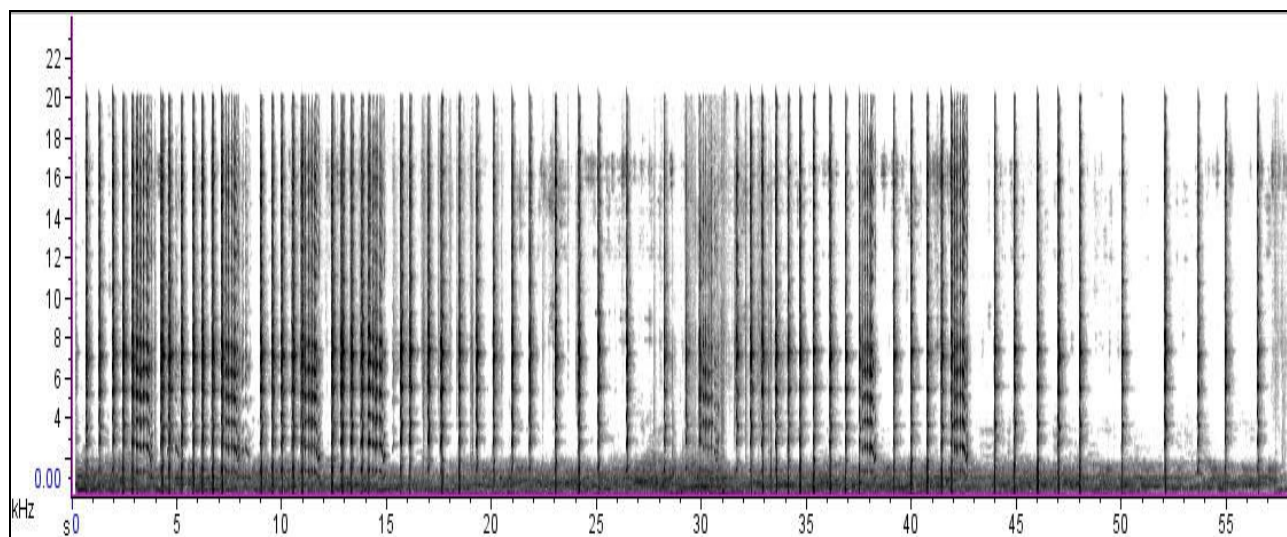


**Fig 4:** Spectrogram of calls of Red-wattled Lapwing during incubation of eggs

After 15 seconds of time interval calls were observed with more pause up to 30 seconds of time. In this pattern call segments were repeated during whole call length showing more gap between the calls in the end as the predator left away. The frequency remained constant up to 20 kHz. Large repertoire of danger response behaviors were shown by adults taking care of their young. These include alarm calls such as (a) alerting call and vigilant posturing for distant threats; (b) alarm call, swooping attack, injury-feigning, and mobbing against non-reptilian predators (Walters 1990) <sup>[33]</sup> Alarm calls provoked crouching behavior in young. These seemed to grade into the alerting call, the notes being longer, louder, and more frequent than those characterizing the alerting call. During breeding season territorial defense behavior also get intensified. Less loafing, preening or sitting was observed in Southern Lapwing during breeding season as compared to non-breeding period (Walters 1982

and Walters 1984) <sup>[31, 32]</sup>. We observed similar results in Red-wattled Lapwing. On comparing with non-breeding season adults spend less time foraging in breeding period after the hatching of eggs. Hence, hard work invested in parental care increases (Walters 1982) <sup>[31]</sup>.

It is clear from the spectrogram above that frequency of the complete call length remained constant showing that birds were much alert and active during breeding season and were continuously protecting their eggs from predation. The degree of difficulty in sighting eggs on an open ground obviously helped in dodging the prying eyes of predator.

**Alarm calls of Red-wattled Lapwing in response to predator coming close to the nest:** For the first 1 minute of call period calls were more intense with frequency ranging from 7-11 kHz. After that calls observed were less intensified with highest frequency of 11 kHz (Fig. 5).

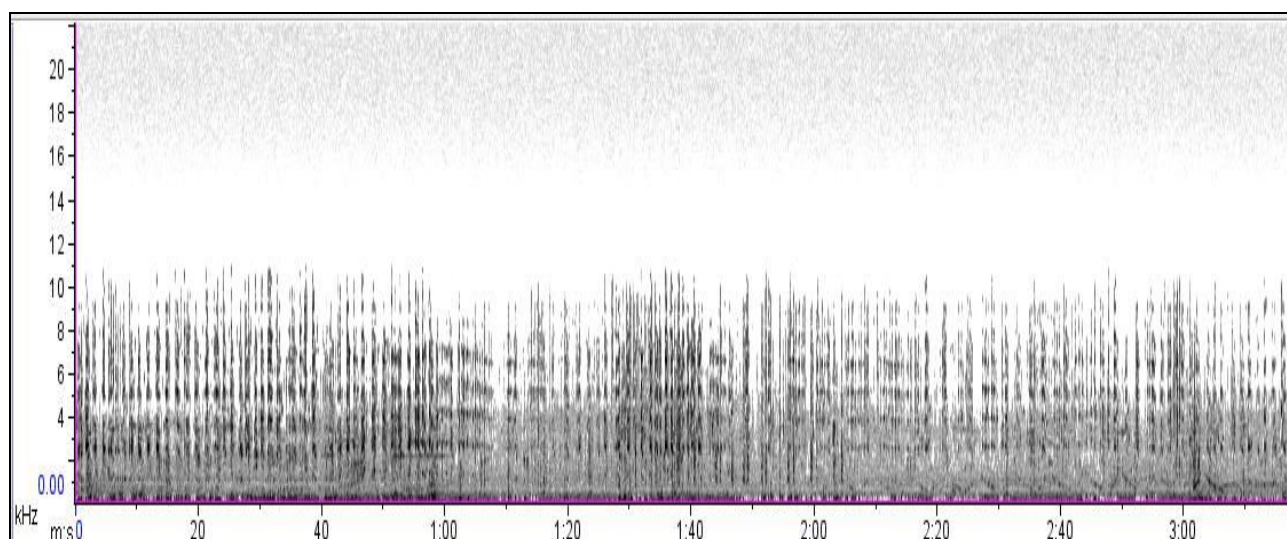


**Fig 5:** Spectrogram of calls of Red-wattled Lapwing in response to predator coming close to the nest

Alarm calls given close to the nest were continuous with fluctuation in the frequency of calls. Alarm calls helped in protecting the chicks from predators (Walters 1990) <sup>[33]</sup>.

**Calls of Red-wattled Lapwing to their chicks after the departure of predator:** It was observed that after the

predator left the site chicks were given signal to come out by the low tit-tit call of parents. Until this call was not given by the parents, the chicks remained silent and immobile. Such type of call was found to be continuous but with low intensity (Fig. 6).

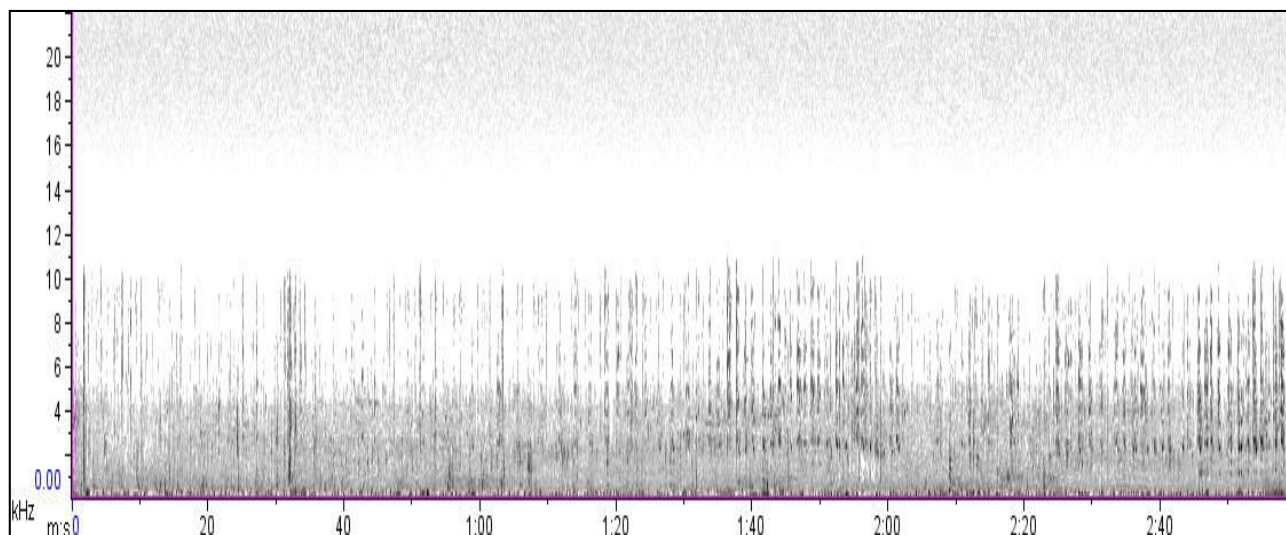


**Fig 6:** Spectrogram of calls of Red-wattled Lapwing to their chicks after the departure of predator

The graph show large variation in the frequency of call. Maximum frequency of call was found to be 11 kHz. This behavior of chicks responding to the signal of parents is necessary for the success rate to increase the species population (Walters 1984) <sup>[32]</sup>.

**Mobbing calls of Red-wattled Lapwing:** Mobbing calls increased in intensity and frequency with the closest approach of predators. It was that calls given were continuous, loud and sharp (Fig. 7).

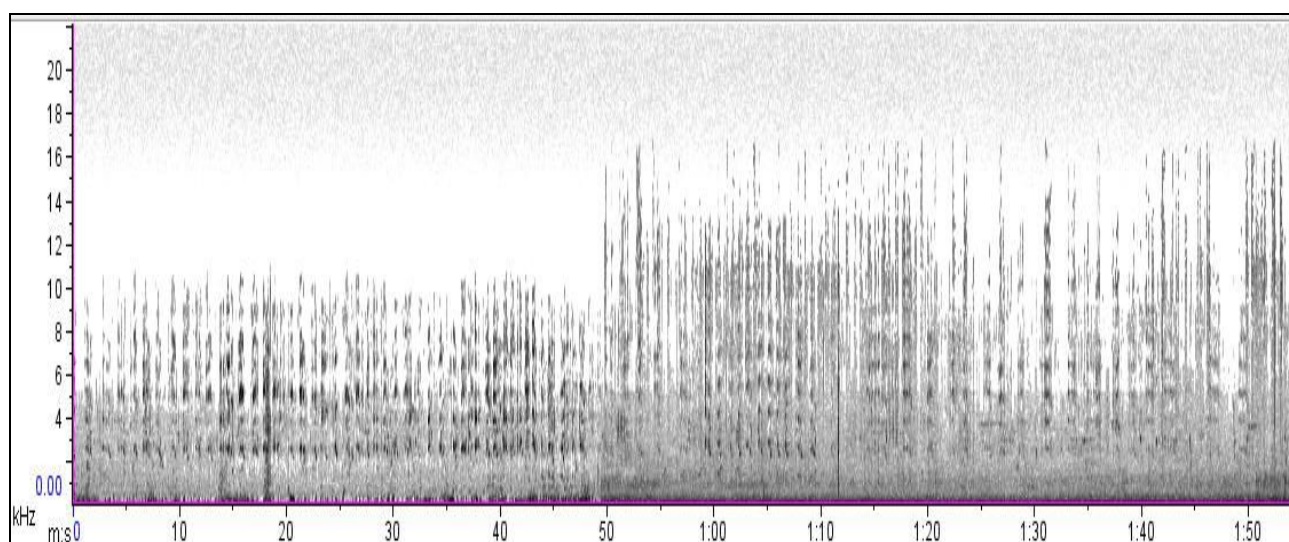


**Fig 7:** Spectrogram of calls of Mobbing calls of Red-wattled Lapwing:

The fluctuation in the frequency of call was high as in the beginning the frequency range was about 11 kHz while after the 50 seconds of total call length observed, the frequency was seemed to reach 18 kHz (Fig. 7). Further the fluctuation in the frequency is clear from the line graph shown below. Beside this parental care, aggression towards interspecific non-predatory birds entering the territories was shown by adult lapwings with downy chicks (Walters 1982) <sup>[31]</sup>.

#### **Vocalizations of House Crow:**

Breeding season of House Crow starts in early spring mainly from April to June, extending up to March to August

depending on the locality with an average of 3-5 eggs per clutch. The growth and development of House Crow nestlings with fledging period of 27-35 days was reported (Fry *et al* 2000) <sup>[10]</sup>. During the present study nesting was observed from early April-September at the selected locations.

**Calls of House Crow during incubation period:** House Crow was found to be vocally less active during breeding season with few call segments after large gap interval. Usually calls were given by males as female was busy in incubating the eggs.

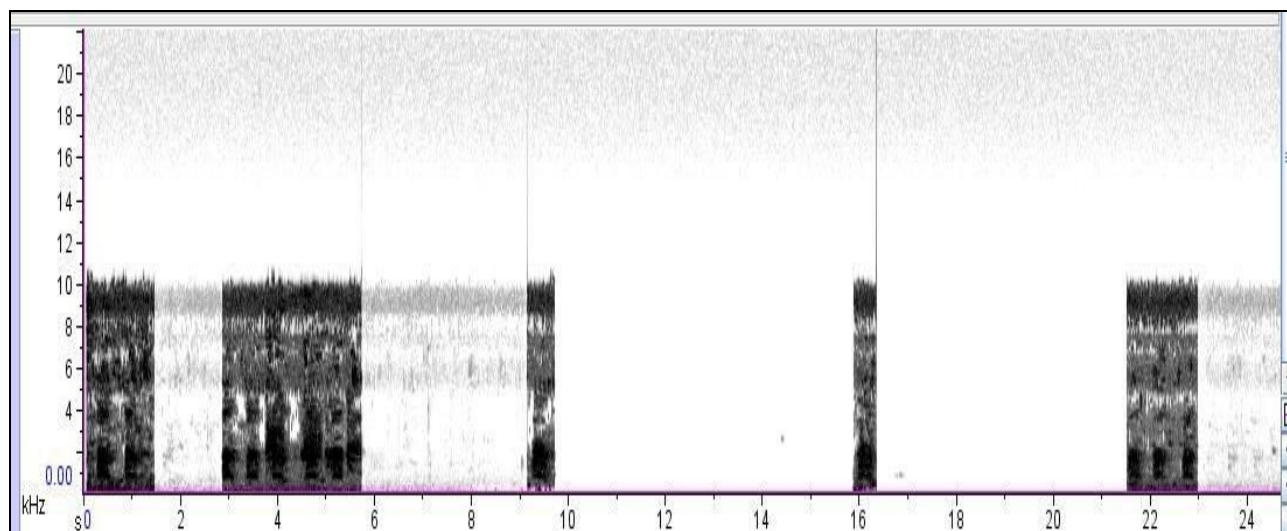


**Fig 8:** Spectrogram of calls of House Crow during incubation period

Calls were also given to protect the territories and the House Crows did not mind nesting of other group members nearby. It was observed that they defend their nests in groups as being socio-active. Nests were observed at selected location on *Eucalyptus tereticornis* and *Populus deltoids* trees. Calls observed were few with large gap intervals and frequency reached up to 10.5 kHz. Calls were observed total 5 times during the whole call length of 24 seconds. Fluctuation in the frequency of calls was found to be less. For the first 1 second of call period combined calls were heard while at 3-6 seconds of time period the intensity of calls increased even more. After that single call pattern was observed after 3 seconds of time gap. Then the call was observed after large pause of 6 seconds at 16 seconds of call period. Then again the call segment was observed after gap of 5.5 seconds. Hence, it shows crow was vocally less active during the breeding period.

### Conclusion

To sum up we can say that the acoustic signaling study of avian species plays an important role in understanding their behavior. It was concluded in the present study that Red-wattled Lapwing was vocally more active as compared to House Crow during the breeding season. In case of Red-wattled Lapwing a total of five types of calls were recorded during breeding season where as in case of House Crow only one type of call was recorded specifically while performing incubation activity and rest of the time House crow was mostly observed to be silent performing different breeding activities during the breeding season. Further in the light of these findings detailed future research is the need of the hour for better understanding the avian soundscape of agricultural ecosystem.

### Acknowledgment

Authors are grateful to Head, Department of Zoology, Punjab Agricultural University, Ludhiana and AINP on VPM (Agricultural Ornithology) and ICAR, New Delhi for providing required facilities for research work. Also, we are thankful to Cornell University, Ithaca, New York for providing Raven Pro 1.5 software for analysing the recorded calls.

### Competing Interests

Nil

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