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A Review on the Interpretation of Avian Distress Calls in Fowl (Gallus gallus) and Egret (Ardea alba)

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Abstract
This review examines the significance of distress calls in birds, focusing on two species: the domestic chicken (Gallus gallus) and the great egret (Ardea alba). Distress calls are vital vocalizations produced in response to immediate threats such as predators, environmental disturbances, or social conflict. These calls serve to alert conspecifics and facilitate survival by either startling predators or eliciting mobbing behaviors. The review explores the physiological and acoustic characteristics of distress calls, highlighting their complexity in domestic chickens, where calls are influenced by multiple stimuli, and the simpler, predator-related calls of great egrets. Additionally, the review addresses the evolutionary significance of these calls, their role in social dynamics, and their seasonal and environmental variability. The impact of habitat types on distress call characteristics is discussed, with birds in urban environments adapting their calls to higher frequencies to avoid masking by ambient noise. Moreover, the paper explores the use of distress calls in conservation strategies, particularly in monitoring bird populations and detecting environmental stressors. Distress calls can serve as early warning signals of ecosystem health and offer a non-invasive method to assess avian welfare. Finally, the review identifies gaps in current research, including the need for better standardization in methods and further investigation into the neurological and hormonal responses triggered by distress calls. The integration of advanced technologies like bioacoustic monitoring and machine learning is recommended to enhance the study of avian vocalizations, ultimately contributing to improved wildlife management and conservation efforts.
Keywords: *Distress Calls, Avian Communication, Gallus gallus, Ardea alba, Conservation Strategies*

1. INTRODUCTION

1.1 Overview of Avian Communication

Avian communication is a highly developed and diverse system that plays an essential role in the survival and social dynamics of birds. It involves the use of vocalizations, visual cues, and sometimes even chemical signals. Among these, vocal communication stands out as particularly complex, with birds using songs and calls for various functions such as mate attraction, territory defense, social bonding, and the warning of potential dangers. The structure and purpose of these vocalizations are heavily influenced by evolutionary pressures, social needs, and environmental conditions (Catchpole, 1981; Marler, 2004).

Vocalizations in birds can generally be classified into two main categories: songs and calls. Songs are typically longer, more complex, and serve primary functions related to sexual attraction and territorial defense (Marler, 2004). Calls, on the other hand, are shorter and simpler, serving a broader range of functions such as signaling food availability, maintaining group cohesion, and coordinating movements (Naguib, 2005). Among these calls, distress calls are unique in their urgent nature, often emitted in response to immediate threats, such as predation, and are critical in anti-predator behavior.

Distress calls are often characterized by loud, harsh, and explosive sounds designed to attract attention and communicate urgency. These calls can travel over long distances and serve to startle predators or alert conspecifics to the danger. The acoustic structure of distress calls can include a wide range of frequencies and nonlinear features, reflecting their evolutionary adaptation to maximize their effectiveness in predatory contexts (Miller et al., 2022). Unlike songs or other calls used for social purposes, distress calls are produced in high-stress situations and are primarily functional in nature, aimed at enhancing the survival of the caller and its group members.

1.2 Importance of Distress Calls in Bird Behavior

Distress calls are critical to avian behavior, particularly in the context of predator-prey interactions. These vocalizations are typically emitted when a bird is threatened by a predator or in a situation of intense stress, such as being handled by humans (Neudorf & Sealy, 2002). The primary function of distress calls is to alert others to the presence of danger, either by startling the predator or by alerting conspecifics and even heterospecifics. The effectiveness of these calls depends on their acoustic structure and the response of other birds to the calls.

In many cases, distress calls can attract secondary predators to the scene, creating a distraction that may allow the caller to escape (Koenig et al., 1991). Moreover, distress calls can elicit mobbing behavior from conspecifics and heterospecifics, further disrupting the predator's attack. This mobbing behavior is particularly significant in species that live in groups, as it increases the likelihood of deterring predators and protecting vulnerable individuals, such as nestlings (Rohwer et al., 1976). Additionally, the distress calls often convey information about the health and quality of the caller, with harsher calls indicating better physical condition and ability to escape, thus influencing the predator's foraging decisions (Laiolo et al., 2004).

1.3 Objective and Scope of the Review

The objective of this review is to explore the function, structure, and significance of distress calls in birds, with a particular focus on the species *Gallus gallus* (domestic chicken) and *Ardea alba* (great egret). By synthesizing recent research, this review aims to provide a comprehensive understanding of how distress calls are utilized in avian communication, their evolutionary significance, and their role in survival strategies.

This paper will examine the physiological and acoustic properties of distress calls, the environmental and social contexts in which these calls are produced, and the responses of conspecifics and predators to such calls. Additionally, this review will explore the role of distress calls in conservation and wildlife management, emphasizing their potential applications in monitoring bird populations and mitigating human-wildlife conflicts.

2. Background on Avian Distress Calls

2.1 Definition and Characteristics of Distress Calls

Distress calls in birds are typically high-intensity, loud vocalizations produced during moments of extreme stress, such as during predation or handling. These calls are designed to serve as a form of alarm communication, signaling the presence of danger to other members of the species or even other species in the vicinity. Unlike songs and other calls used for territorial or social purposes, distress calls are produced as a last resort to mitigate immediate threats (Santana et al., 2013; Sierro et al., 2024).

The acoustic structure of distress calls is characterized by a wide frequency range, often incorporating both high-pitched and low-pitched elements. This broad frequency range is designed to increase the likelihood that the call will be heard by others, including both conspecifics and potential predators (Miller et al., 2022). Distress calls may also exhibit nonlinear characteristics, such as rapid changes in pitch or intensity, which make them stand out in the environment and increase their effectiveness in alarming other birds (Jurisevic & Sanderson, 1998).

Distress calls can vary depending on factors such as the age, sex, and physiological condition of the bird. For example, distress calls in younger birds may differ in frequency and duration from those in adults, reflecting differences in size and acoustic capabilities. Additionally, some birds, such as the red-necked nightjar, produce distress calls that mimic the vocalizations of larger animals, potentially deterring predators by creating the illusion of a more formidable threat (Sierro et al., 2024).

2.2 Evolutionary Significance of Distress Calls in Birds

The evolutionary significance of distress calls lies in their role as a critical survival mechanism. Distress calls likely evolved as an adaptive response to predation, providing birds with a means of alerting others to the presence of danger. These calls have been shaped by selective pressures to maximize their effectiveness in predator avoidance, including traits such as loudness, frequency range, and the ability to travel long distances (Neudorf & Sealy, 2002). In some species, distress calls may also serve a dual purpose by attracting secondary predators to the scene, which can interfere with the initial predator’s attack. This strategy, known as the "predator distraction hypothesis," is particularly evident in species like the acorn woodpecker, where distress calls help draw in additional predators that may distract the primary threat and increase the caller’s chances of escape (Koenig et al., 1991). In other species, distress calls may signal the health and quality of the caller to potential predators, influencing the predator's decision to pursue the prey (Laiolo et al., 2004).

2.3 The Role of Distress Calls in Survival and Social Dynamics

Distress calls are integral to both individual and group survival in birds. At an individual level, distress calls may help the calling bird evade predation by startling the predator or attracting secondary predators. At a group level, distress calls can enhance survival by eliciting mobbing behavior from conspecifics and heterospecifics. This collective response to danger increases the likelihood that the predator will be overwhelmed or deterred by the group's combined efforts (Rohwer et al., 1976; Conover, 1994).

In group-living species, the response to distress calls can also facilitate social bonding and cooperation. For example, distress calls may signal the need for social support, such as assistance in defending a nest or avoiding predators. In some species, distress calls are linked to kin selection, where individuals are more likely to respond to calls from close relatives, thereby enhancing the survival of their kin (Rohwer et al., 1976).

3. Species Overview: Fowl (*Gallus gallus*) and Egret (*Ardea alba*)

3.1 Habitat, Distribution, and Ecological Roles

The Red Junglefowl (*Gallus gallus*) is native to the forests of Southeast Asia and serves as the wild ancestor of the domestic chicken. This species prefers mixed forests, often avoiding heavily disturbed or human-modified habitats (Javed & Rahmani, 2000). *Gallus gallus* plays an important ecological role as a prey species for various predators, and its vocalizations are essential for communication within its habitat.

The Great Egret (*Ardea alba*), on the other hand, is typically associated with wetlands, marshes, and other aquatic habitats. As a predator, it plays a significant role in controlling populations of fish, amphibians, and invertebrates. Its distress calls, although less studied, are likely adapted for signaling the presence of predators in these often open, vulnerable habitats (Rong et al., 2023).

3.2 Behavioral Ecology of Fowl

In domestic chickens, distress calls play a significant role in their social structure, particularly during early life stages. Chicks use distress calls to signal hunger, discomfort, or danger, and these calls are crucial in influencing maternal behavior. Female chickens (hens) also use distress calls strategically to manipulate the behavior of males, especially in terms of copulation and mate choice (Pizzari, 2001). The distress calls of chickens are also associated with welfare indicators, with higher frequencies and more intense calls being linked to poor health or stress. Studies have shown that these vocalizations can predict health outcomes, such as weight gain and mortality, in commercial poultry settings (Herborn et al., 2020).

3.3 Behavioral Ecology of Egret

The Great Egret exhibits complex behavioral responses to disturbances, including increased vigilance and flight when threatened. These birds often communicate distress through vocalizations, although their calls are relatively simple compared to those of songbirds. In their colonial nesting sites, distress calls may serve to coordinate group responses to predators, enhancing group vigilance (Brzorad et al., 2015). In mixed-species environments, such as wetlands, egrets' distress calls can also attract heterospecifics to mob a predator, highlighting the role of interspecific communication in predator defense (Magrath et al., 2007).

4. Physiological and Acoustic Characteristics of Distress Calls

4.1 Spectrographic Analysis of Distress Calls in Fowl

Distress calls in *Gallus gallus* (domestic chickens) are characterized by descending frequencies, in contrast to ascending frequencies found in pleasure calls (Collias &Joos, 1953). These calls feature complex harmonic structures and slow frequency changes, which are crucial for identifying distress (Aubin, 1987). Spectral entropy, negatively correlated with manual distress call counts (-0.88), has proven effective for monitoring chicken welfare, predicting outcomes such as weight gain and mortality (Herborn et al., 2020). Deep learning models like light-VGG11 are used to automate distress call identification, enhancing welfare monitoring in large flocks (Mao et al., 2022). Additionally, natural language processing helps to analyze the emotional states of chickens, contributing to improved farm management (Manikandan & Neethirajan, 2024).

4.2 Spectrographic Analysis of Distress Calls in Egret

Distress calls in larger birds, such as *Ardea alba* (great egret), are louder and longer, with lower frequencies compared to smaller species like the domestic chicken (Jurisevic & Sanderson, 1998). Both species exhibit frequency modulation, which is essential for eliciting distress responses (Aubin, 1987). While the frequency range and modulation properties differ between species, larger birds generally produce calls that can travel over long distances. In egrets, these calls are likely to have lower frequencies to adapt to open habitats (Brémond & Aubin, 1992). The Gabor transform is a useful tool for analyzing such vocalizations, differentiating distress calls from ambient sounds (Connor et al., 2012).

4.3 Acoustic Variability and Seasonal Influence

Seasonal changes significantly affect the acoustic characteristics of distress calls. For example, the Striped Cuckoo's vocalizations vary during breeding seasons, with certain calls peaking during early breeding. Similarly, temperature and rainfall influence calling patterns in birds like the Undulated Tinamou (Pérez-Granados & Schuchmann, 2021). Distress calls also vary seasonally due to environmental conditions and physiological factors, such as hormonal changes (Vidas-Guscic et al., 2023). These seasonal patterns suggest that distress calls serve adaptive functions linked to the birds' environment and breeding cycles (Greig-Smith, 1984). Additionally, health conditions like poxvirus infections can alter distress call characteristics (Laiolo et al., 2007).

5. Interpretation and Response to Distress Calls

5.1 Fowl's Response to Distress Calls

Fowl exhibit significant physiological and behavioral responses to distress calls, indicating the importance of these calls in their emotional and social lives. Distress calls are associated with increased metabolic rates and oxygen consumption, even independent of body mass (Jurisevic et al., 1999). This stress response is linked to the activation of the hypothalamo-pituitary-adrenal axis, leading to the release of corticosterone, a hormone that varies with individual bird personalities (Cockrem, 2007). In terms of behavior, domestic hens show increased alertness, reduced preening, and elevated heart rates when exposed to distress calls. Additionally, maternal hens respond empathetically by vocalizing in response to their chicks' distress calls (Edgar et al., 2011). Similarly, cockatiels demonstrate heightened attentiveness and activity, particularly when distress calls are from affiliated partners, showing emotional contagion influenced by social bonds (Liévin-Bazin et al., 2018). For young birds like Peking ducklings, distress calls from siblings inhibit their own distress vocalizations, maintaining social cohesion and sibling bonds (Gaioni et al., 1983). Distress calls in chicks also correlate with negative affective states, which can predict welfare outcomes such as weight gain and mortality in commercial settings (Herborn et al., 2020). These findings underscore the complexity of fowl responses, suggesting that distress calls are integral to their social dynamics and emotional states (Jiang et al., 2022).

5.2 Egret's Response to Distress Calls

Egrets, such as *Ardea alba* (great egret), likely exhibit responses to distress calls similar to those of other bird species, particularly when disturbed by anthropogenic factors. While direct studies on egrets' responses to distress calls are scarce, research on other bird species offers insights. Birds typically respond strongly to conspecific distress calls by approaching the sound source to gather information about potential threats (Baxter et al., 1999; Conover, 1994). Egrets, when exposed to significant disturbances such as construction noise or military jets, exhibit heightened vigilance or take flight, which suggests that they respond similarly to distress calls by becoming more alert or altering their behavior (Novčić, 2022). The general principle that birds respond more to conspecific distress calls than to those of other species may imply that egrets are more responsive to calls from their own species, although further studies are needed (Baxter et al., 1999). This heightened vigilance in response to both distress calls and environmental disturbances reflects the complex ways egrets process threats and maintain safety in their environments (Novčić, 2022; Baxter et al., 1999).

6. Environmental and Seasonal Factors Affecting Distress Calls

6.1 Influence of Habitat on Distress Call Characteristics

The characteristics of bird distress calls are strongly influenced by habitat type, as these calls are adapted to the environmental challenges and acoustic properties of different habitats. In forested areas, such as the neotropical cloud forest, distress calls are often loud and harsh, serving to startle predators or attract additional predators to distract the original captor. Larger bird species produce calls with greater amplitude, which travel further, allowing for effective communication over long distances (Neudorf & Sealy, 2002). In contrast, urban environments, characterized by high levels of ambient noise, require adaptations in vocal frequency to avoid masking by low-frequency noise. Urban birds often vocalize at higher frequencies, which are less affected by urban noise, indicating that these species are preadapted to noisy environments (Hu & Cardoso, 2009; Hao et al., 2024). For example, the gray catbird increases the frequency of its calls to counteract the masking effects of urban noise, enhancing signal transmission (Rhodes et al., 2023). In more natural habitats like wetlands or undisturbed forests, birds do not need to adjust their calls as much, allowing for a wider range of vocalizations (Battisti et al., 2017). These findings illustrate the complex interplay between habitat type, environmental challenges, and the evolution of bird communication strategies.

6.2 Seasonal Variations in Distress Call Intensity

Distress call intensity among birds varies seasonally, with some species exhibiting higher rates of calling during certain times of the year. In woodland birds, winter distress calls are correlated with the number of conspecifics likely to hear the call, supporting the idea that distress calls in winter are often directed toward potential helpers rather than predators, reflecting kin selection (Greig-Smith, 1984; Rohwer et al., 1976). Seasonal stressors such as temperature fluctuations and resource scarcity can also affect the frequency and intensity of distress calls, particularly during the energetically demanding winter months (Borniger et al., 2017). In addition, environmental changes like heat stress have been shown to impact stress responses in birds, as demonstrated in studies on zebra finches (Udino et al., 2024). These seasonal variations in distress call intensity are influenced not only by immediate environmental conditions but also by broader ecological and social factors, including the presence of conspecifics and the physiological stress of seasonal changes.

6.3 Environmental Stress and Its Impact on Vocalization Patterns

Environmental stressors, such as habitat degradation and climate change, have profound effects on bird vocalizations, including distress calls. Climate change, particularly aridity in grassland and desert habitats, has reduced sound propagation distances, leading to a breakdown of avian soundscapes and a loss of vocal culture in some species (Pandit et al., 2022). Noise pollution, such as snowmobile noise, disrupts avian vocalizations, reducing the frequency of bird songs during critical periods for foraging and mating. However, some species show resilience and can recover their vocalization patterns after noise events (Cretois et al., 2023). Furthermore, birds are adapting to anthropogenic noise by modifying their songs, such as increasing the volume or shifting to higher frequencies to avoid masking by urban sounds (Halfwerk et al., 2018). Changes in song post heights in response to climate change, as well as environmental factors such as tree cover and elevation, also influence vocalization patterns, affecting communication, mating success, and predator-prey interactions (Møller, 2011; Kirschel et al., 2009). These adaptations highlight the complex relationship between environmental stressors and avian vocalization patterns, underscoring the importance of further research into how these changes impact bird populations and ecosystems.

7. Applications of Distress Call Research

7.1 Implications for Conservation Strategies

Understanding avian distress calls has significant potential for enhancing bird conservation strategies by offering insights into bird behavior and communication. Distress calls serve to startle predators and attract other birds to assess the threat, making them potentially useful in conservation efforts when paired with predator models to reinforce fear and delay habituation (Conover, 1994). Furthermore, avian vocalizations, including distress calls, can be vital for monitoring bird populations and biodiversity. They provide valuable baseline data for understanding population dynamics, individual behaviors, and environmental stressors, which are crucial for conservation planning (Lewis et al., 2021). For example, the transmission of vocalizations like the "chick-a-dee" mobbing call emphasizes the importance of maintaining connectivity between bird populations to prevent cultural breakdowns that could exacerbate declines in isolated populations (Saborse, 2011). Additionally, the impact of anthropogenic noise on bird vocalizations highlights the necessity of measures to preserve the effectiveness of distress calls in territory defense and mate attraction (Slabbekoorn & Ripmeester, 2008). Integrating this understanding into conservation strategies can improve the management and protection of species, as demonstrated in successful programs such as the Adjutant Stork conservation project in India (Sault, 2020). Therefore, research into avian distress calls can inform targeted conservation actions, ensuring the preservation of avian biodiversity.

7.2 Use in Predator Deterrence and Wildlife Management

Distress calls are powerful tools for predator deterrence, as they provide predators with honest signals regarding the prey's condition and fighting capabilities, influencing predator behavior. For example, distress calls in the lacertid lizard, *Psammodromus algirus*, signal the lizard's body size and fighting ability, potentially deterring predators from attacking (Baeckens et al., 2019). Similarly, in birds like the lesser short-toed lark, distress calls correlate with the bird's health and immunocompetence, which might lead predators to opt for weaker, easier prey (Laiolo et al., 2004). This phenomenon is also used in agricultural settings, where distress calls have been broadcasted to reduce the presence of pests like crows and night herons, effectively lowering damage to crops and fish ponds (Delwiche et al., 2007; Spanier, 1980). However, the effectiveness of distress calls can diminish over time due to predator habituation (Wise et al., 1999). To overcome this, artificial predators, such as the RobotFalcon, have shown superior deterrence capabilities by scaring bird flocks without the issue of habituation (Storms et al., 2022). Distress calls are also used in non-lethal wildlife management strategies, such as in reducing deer activity and damage in treated areas using bioacoustic devices (Hygnstrom et al., 2013). Thus, distress calls offer a versatile approach for predator deterrence and wildlife management, influencing predator behavior and reducing conflicts with humans.

7.3 Practical Considerations in Urban Bird Conservation

Studying distress calls in urban birds offers valuable insights into how these birds cope with urban stressors and how conservation strategies can be tailored to these environments. Urban great tits exhibit more distress calling and aggressive behaviors compared to their rural counterparts, suggesting a proactive coping strategy that could be beneficial in urban settings (Senar et al., 2017). This behavior can be leveraged in conservation efforts by identifying and supporting species better adapted to urban environments. Distress calls can also serve as tools for managing bird populations in urban areas, as demonstrated by their effective use in repelling night herons from fish ponds, reducing economic losses without causing habituation (Spanier, 1980). Additionally, distress calls play a crucial role in bird safety by attracting other birds to assess predator threats, which can inform urban space design to enhance bird safety and reduce stress (Conover, 1994). The use of bioacoustics, including distress calls, has also proven effective in monitoring bird community patterns and biodiversity in urban environments. For instance, acoustic recorders used in post-industrial cities have been instrumental in assessing bird diversity (Dennison et al., 2024). This approach can guide urban planning, ensuring environments that support diverse bird populations. Furthermore, urban birds in tropical cities exhibit increased distress during breeding seasons, indicating the need for species-specific management strategies (Hinchcliffe et al., 2022). By integrating distress call research into urban bird conservation, we can develop more effective management practices that support both biodiversity and human interests.

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Table 1: Characteristics and Functions of Distress Calls in Fowl (*Gallus gallus*) and Egret (*Ardea alba*)

Species	Distress Call Features	Function of Distress Calls	Environmental Influence	Reference
Gallus gallus **(Fowl)**	High-energy, harsh vocalizations Descending frequencies Complex harmonics Variations based on age/sex	Startles predators Signals danger Attracts conspecifics Influences social behavior	• Adaptations to urban stressors • Modifications due to noise pollution (Lombard Effect) • Responses to temperature changes	Collias & Joos (1953); Neudorf & Sealy (2002); Herborn et al. (2020)
Ardea alba **(Egret)**	Simple, loud, low Frequency calls Limited frequency modulation	Alerts conspecifics to danger Promotes group vigilance Deterrence of predators	• Increased vigilance due to anthropogenic disturbances (e.g., construction, military jets) • Responses to habitat degradation	Novčić, (2022); Baxter et al. (1999)

Table 2: Acoustic and Physiological Characteristics of Distress Calls in Birds

Species	Acoustic Characteristics	Physiological Responses to Distress Calls	Social and Behavioral Impact	Reference
Gallus gallus (Fowl)	• Broad frequency range • Harsh and loud calls • Vary based on age and sex	Increased metabolic rate Rise in oxygen consumption Increased heart rate Maternal vocalizations	• Affects social dynamics • Strengthens maternal bonds • Influences social hierarchy	Jurisevic et al. (1999); Herborn et al. (2020); Pizzari (2001)
Ardea alba (Egret)	• Low-frequency, harsh vocalizations • Simple and less modulated	Heightened vigilance Increased flight behavior during disturbances	• Enhanced group cohesion • Promotes predator deterrence in colonies	Boesman (2017); Baxter et al. (1999); Caldwell (2014)

8. Challenges and Gaps in Current Research

8.1 Limitations of Existing Studies

The primary challenge in avian distress call research lies in obtaining consistent and reliable data, often hindered by the artificial environments used in many studies. These environments fail to replicate the complexities and unpredictability of natural habitats, which limits the ecological validity of findings. Additionally, the vast diversity of avian species, each potentially exhibiting unique distress call patterns, creates a significant barrier to generalizing results across different species. Most studies focus on a small number of species, meaning the findings cannot easily be applied to the broader avian population. Furthermore, the lack of standardized methods for recording and analyzing distress calls leads to inconsistencies between studies, making cross-comparisons difficult and impeding the synthesis of comprehensive conclusions. Field research also presents substantial challenges. Collecting distress call data from wild populations is logistically complex, as distress calls often occur unpredictably in response to rare events, making it hard to gather enough data for solid conclusions. Environmental factors, such as weather and human interference, often distort recorded calls, complicating analysis further. These limitations highlight the need for innovative methodologies that can better capture the nuances of distress calls in their natural context.

8.2 Unexplored Areas in Avian Distress Call Research

Several critical gaps remain in the understanding of avian distress calls. First, while some species like the domestic chicken and great egret have been studied, there is a lack of in-depth research on species-specific differences in distress call behavior. The functional significance of these calls in different ecological and social contexts remains underexplored. For example, how do environmental stressors like habitat destruction or climate change affect the production and interpretation of distress calls? These questions remain largely unanswered, and research in this area is urgently needed. Additionally, while distress calls are known to trigger physiological responses, the neurological and hormonal mechanisms behind these reactions remain poorly understood. Little research has been conducted to explore how distress calls influence hormone levels like cortisol or adrenaline in birds. Understanding these responses could offer valuable insights into how distress calls affect bird behavior and social structures, and how these physiological changes impact survival.

8.3 Future Directions for Research

Future research must adopt interdisciplinary approaches that integrate behavioral ecology, neurobiology, and evolutionary biology. Studying how distress calls evolve in response to ecological pressures will deepen our understanding of their adaptive significance. Furthermore, investigating how social dynamics influence the variation in distress call responses, particularly in species with complex social structures, could reveal important insights into avian communication and survival strategies. Technological advancements, particularly machine learning and bioacoustic monitoring, offer promising avenues for future research. Machine learning algorithms can automate the analysis of large datasets, detecting subtle patterns in distress calls that may not be perceptible to human listeners. This would allow researchers to analyze vocalizations on a much larger scale, improving the efficiency and accuracy of studies. Bioacoustic monitoring tools, such as remote audio sensors, can provide continuous real-time data on distress call frequency and context, offering a more accurate representation of how these calls function in natural settings.

Moreover, combining machine learning with bioacoustic monitoring could lead to real-time bird population tracking systems, providing early warnings about changes in bird behavior or environmental stressors. This would enable more proactive conservation efforts, improving the management of bird populations and their habitats. Further, while current research on avian distress calls has laid the groundwork, many gaps remain. The field would benefit from a more comprehensive approach that considers a broader range of species, investigates physiological responses, and uses advanced technologies to capture data more accurately. Addressing these challenges will enhance our understanding of avian communication and improve conservation strategies, ensuring the long-term health of bird populations.

9. Key Findings

The review underscores the significant role of distress calls in birds, emphasizing their function as urgent signals that communicate immediate threats, eliciting behavioral and physiological responses. These calls are essential for survival, acting as a communication mechanism not only for the individual emitting the call but also for those within its social environment. Distress calls may be triggered by a variety of stressors—predator presence, environmental disturbances, or social conflicts—and serve to facilitate survival and social cohesion within avian communities.

The study of two species, *Gallus gallus* (domestic chicken) and *Ardea alba* (great egret), reveals key differences in their distress call behaviors. Domestic chickens exhibit more complex distress calls due to the multifaceted stimuli present in their environments, such as human interference and threats from other animals. On the other hand, great egrets tend to produce simpler distress calls related to direct predator threats in more solitary settings. These differences reflect the species' varied evolutionary histories, habitat types, and social structures, highlighting the adaptability of vocalizations in response to specific environmental pressures.

REFERENCES:

1. Aubin, T. (1987). Respective parts of the carrier and of the frequency modulation in the semantics of distress calls: an experimental study on Sturnus vulgaris by mean of digital synthesis methods. *Behaviour*, 123-133.
2. Baeckens, S., Llusia, D., García-Roa, R., & Martín, J. (2019). Lizard calls convey honest information on body size and bite performance: a role in predator deterrence?. *Behavioral Ecology and Sociobiology*, *73*, 1-11.
3. Battisti, C., Fanelli, G., Pavel, D., Redolfi De Zan, L., Rossi de Gasperis, S., & Caneva, G. (2017). Assessing habitat-related disturbance in bird communities: Applying hemeroby and generalism as indicators. *Community Ecology*, *18*(2), 215-223.
4. Baxter, A. T., Bell, J. C., Allan, J. R., & Fairclough, J. (1999). The interspecificity of distress calls.
5. Boesman, P. (2017). *Notes on the vocalizations of Great Egret (Ardea alba)*. HBW Alive Ornithological Note 453. In: Handbook of the birds of the world Alive. Barcelona.
6. Borniger, C. J., Cisse, Y. M., Nelson, R. J., & Martin, L. B. (2017). Seasonal variation in stress response. *Stress: neuroendocrinology and neurobiology. Handbook of stress series*, *2*, 411-419.
7. Brémond, J. C., & Aubin, T. (1992). The role of amplitude modulation in distress-call. *Ethology ecology & evolution*, *4*(2), 187-191.
8. Brzorad, J. N., Maccarone, A. D., & Stone, H. M. (2015). A telemetry-based study of Great Egret (Ardea alba) nest-attendance patterns, food-provisioning rates, and foraging activity in Kansas, USA. *Waterbirds*, *38*(2), 162-172.
9. Caldwell, C. J. (2014). Foraging interactions of the Great Egret in upland habitats. *Western Birds*, *45*, 71-80.
10. Catchpole, C. K. (1981). Vocal Communication in Birds a personal view of the evolution of song in passerines. *Japanese Journal of Ornithology*, *30*(2-3), 87-89.
11. Cockrem, J. F. (2007). Stress, corticosterone responses and avian personalities. *Journal of Ornithology*, *148*(Suppl 2), 169-178.
12. Connor, E. F., Li, S., & Li, S. (2012). Automating identification of avian vocalizations using time–frequency information extracted from the Gabor transform. *The Journal of the Acoustical Society of America*, *132*(1), 507-517.
13. Conover, M. R. (1994). How birds interpret distress calls: implications for applied uses of distress call playbacks. In *Proceedings of the Vertebrate Pest Conference* (Vol. 16, No. 16).
14. Cretois, B., Bick, I. A., Balantic, C., Gelderblom, F. B., Pávon-Jordán, D., Wiel, J., ... & Reinen, T. A. (2024). Snowmobile noise alters bird vocalization patterns during winter and pre-breeding season. *Journal of Applied Ecology*, *61*(2), 340-350.
15. Delwiche, M. J., Houk, A., Gorenzel, W. P., & Salmon, T. P. (2007). Control of crows in almonds by broadcast distress calls. *Transactions of the ASABE*, *50*(2), 675-682.
16. Dennison, C., Buxton, R. T., Brown, K., & Pearson, A. L. (2024). Using bioacoustics to determine bird community patterns in a post-industrial city. *The Journal of the Acoustical Society of America*, *155*(3_Supplement), A182-A182.
17. Edgar, J. L., Lowe, J. C., Paul, E. S., & Nicol, C. J. (2011). Avian maternal response to chick distress. *Proceedings of the Royal Society B: Biological Sciences*, *278*(1721), 3129-3134.
18. Gaioni, S. J., Applebaum, S., & Goldsmith, J. (1983). The response of young peking duklings to sibling distress calls. Developmental Psychobiology: The Journal of the International Society for Developmental Psychobiology, 16(5), 423-437.
19. Greig-Smith, P. W. (1984). Distress calling by woodland birds: seasonal patterns, individual consistency and the presence of conspecifics. *Zeitschrift für Tierpsychologie*, *66*(1), 1-10.
20. 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.
21. Hao, Z., Zhang, C., Li, L., Gao, B., Wu, R., Pei, N., & Liu, Y. (2024). Anthropogenic noise and habitat structure shaping dominant frequency of bird sounds along urban gradients. *Iscience*, *27*(2).

22. Herborn, K. A., McElligott, A. G., Mitchell, M. A., Sandilands, V., Bradshaw, B., & Asher, L. (2020). Spectral entropy of early-life distress calls as an iceberg indicator of chicken welfare. *Journal of the Royal Society Interface*, *17*(167), 20200086.
23. Hinchcliffe, D. L., Young, R. J., & Teixeira, C. P. (2022). Callout analysis in relation to wild birds in a tropical city: implications for urban species management. *Urban Ecosystems*, *25*(6), 1643-1652.
24. Hu, Y., & Cardoso, G. C. (2009). Are bird species that vocalize at higher frequencies preadapted to inhabit noisy urban areas?. *Behavioral Ecology*, *20*(6), 1268-1273.
25. Hygnstrom, S., Hildreth, A. M., & VerCauteren, K. C. (2013). Deer-activated bio-acoustic frightening device deters white-tailed deer.
26. Javed, S. Á. L. I. M., & Rahmani, A. R. (2000). Flocking and habitat use pattern of the Red Junglefowl Gallus gallus in Dudwa National Park, India. *Tropical Ecology*, *41*(1), 11-16..
27. Jiang, Y., Han, J., Zhang, Z., Chen, X., & Yang, C. (2022). Parent–offspring and inter-offspring responses to conspecific versus heterospecific distress calls in 2 sympatric birds. *Current Zoology*, *68*(6), 700-707.
28. Collias, N., & Joos, M. (1953). The spectrographic analysis of sound signals of the domestic fowl. *Behaviour*, 175-188.
29. Jurisevic, M. A., & Sanderson, K. J. (1998). A comparative analysis of distress call structure in Australian passerine and non-passerine species: influence of size and phylogeny. *Journal of Avian Biology*, 61-71.
30. Jurisevic, M. A., Sanderson, K. J., & Baudinette, R. V. (1999). Metabolic rates associated with distress and begging calls in birds. *Physiological and Biochemical Zoology*, *72*(1), 38-43.
31. Kirschel, A. N., Blumstein, D. T., Cohen, R. E., Buermann, W., Smith, T. B., & Slabbekoorn, H. (2009). Birdsong tuned to the environment: green hylia song varies with elevation, tree cover, and noise. *Behavioral Ecology*, *20*(5), 1089-1095.
32. Wise, K., Conover, M., & Knowlton, F. (1999). Response of coyotes to avian distress calls: testing the startle-predator and predator-attraction hypotheses. *Behaviour*, *136*(8), 935-949.
33. Laiolo, P., Serrano, D., Tella, J. L., Carrete, M., López, G., & Navarro, C. (2007). Distress calls reflect poxvirus infection in lesser short-toed lark Calandrella rufescens. Behavioral Ecology. https://doi.org/10.1093/BEHECO/ARM008
34. Laiolo, P., Tella, J. L., Carrete, M., Serrano, D., & Lopez, G. (2004). Distress calls may honestly signal bird quality to predators. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *271*(suppl_6), S513-S515.
35. Lewis, R. N., Williams, L. J., & Gilman, R. T. (2021). The uses and implications of avian vocalizations for conservation planning. *Conservation Biology*, *35*(1), 50-63.
36. Liévin-Bazin, A., Pineaux, M., Clerc, O., Gahr, M., von Bayern, A. M. P., & Bovet, D. (2018). Emotional responses to conspecific distress calls are modulated by affiliation in cockatiels (Nymphicus hollandicus). PLOS One, 13(10), Article e0205314. https://doi.org/10.1371/JOURNAL.PONE.0205314
37. Magrath, R. D., Pitcher, B. J., & Gardner, J. L. (2007). A mutual understanding? Interspecific responses by birds to each other's aerial alarm calls. *Behavioral Ecology*, *18*(5), 944-951.
38. Manikandan, V., & Neethirajan, S. (2024). Decoding Poultry Vocalizations-Natural Language Processing and Transformer Models for Semantic and Emotional Analysis. *bioRxiv*, 2024-12.
39. Mao, A., Giraudet, C. S., Liu, K., De Almeida Nolasco, I., Xie, Z., Xie, Z., ... & McElligott, A. G. (2022). Automated identification of chicken distress vocalizations using deep learning models. *Journal of the Royal Society Interface*, *19*(191), 20210921.
40. Marler, P. (2004). Bird calls: their potential for behavioral neurobiology. *Annals of the New York Academy of Sciences*, *1016*(1), 31-44.
41. Miller, E. H., Kostoglou, K. N., Wilson, D. R., & Weston, M. A. (2022). Anatomy of avian distress calls: structure, variation, and complexity in two species of shorebird (Aves: Charadrii). *Behaviour*, *159*(8-9), 699-733.
42. Møller, A. P. (2011). When climate change affects where birds sing. *Behavioral Ecology*, *22*(1), 212-217.
43. Naguib, M. (2005). Singing interactions in songbirds: implications for social relations and territorial settlement. *Animal communication networks*, 300-319.
44. Novčić, I. (2022). Behavioural responses of grey herons Ardea cinerea and great egrets Ardea alba to human-caused disturbance. *Journal of Vertebrate Biology*, *71*(22026), 22026-1.
45. Pandit, M. M., Bridge, E. S., & Ross, J. D. (2022). Environmental conditions lead to shifts in individual communication, which can cause cascading effects on soundscape composition. *Ecology and Evolution*, *12*(10), e9359.
46. Pérez-Granados, C. (2022). Diel and seasonal variation of Striped Cuckoo (Tapera naevia) vocalizations revealed using automated signal recognition. Ibis. https://doi.org/10.1111/ibi.13129
47. Pizzari, T. (2001). Indirect partner choice through manipulation of male behaviour by female fowl, Gallus gallus domesticus. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, *268*(1463), 181-186.
48. Rhodes, M. L., Ryder, T. B., Evans, B. S., To, J. C., Neslund, E., Will, C., ... & Moseley, D. L. (2023). The effects of anthropogenic noise and urban habitats on song structure in a vocal mimic; the gray catbird (Dumetella carolinensis) sings higher frequencies in noisier habitats. *Frontiers in Ecology and Evolution*, *11*, 1252632.
49. Rong, A., Besra, S., Chatterjee, L., Samanta, T., Mazumdar, S., Hazra, D., ... & Roy, A. B. (2023). A Comprehensive Study on Diversity and Land Use of the Bird Species around Eco Park Area, Kolkata, West Bengal.
50. Saborse, J. A. (2011). *Cultural Breakdown of Learned Avian Alarm Calls: Implications to Management and Conservation* (Master's thesis, Youngstown State University).
51. Santana, D. J., Orrico, V. G., São-Pedro, V. D. A., & Feio, R. N. (2013). Distress call of Hypsiboas leucocheilus (Caramaschi and Niemeyer, 2003)(Anura, Hylidae). *Herpetology Notes*, *6*(1), 289-293.

52. Sault, N. (2020). Avian Voices, Avian Silences. *Ethnobiology Letters*, *11*(2), 1-4.

53. Senar, J. C., Garamszegi, L. Z., Tilgar, V., Biard, C., Moreno-Rueda, G., Salmón, P., ... & Isaksson, C. (2017). Urban great tits (Parus major) show higher distress calling and pecking rates than rural birds across Europe. *Frontiers in Ecology and Evolution*, *5*, 163.

54. Sierro, J., Gil, D., Sáez-Gómez, P., Hidalgo-Rodríguez, P., Rabadán-González, J., & Camacho, C. (2024). Call for Your Life: Acoustic Structure and Age-Sex Differences in Distress Calls of Red-Necked Nightjars. Ethology, 130(12), e13513.

55. Slabbekoorn, H., & RIPMEESTER, E. A. P. (2008). Birdsong and anthropogenic noise: implications and applications for conservation. *Molecular ecology*, *17*(1), 72-83.

56. Spanier, E. (1980). The use of distress calls to repel night herons (Nycticorax nycticorax) from fish ponds. *Journal of Applied Ecology*, 287-294.

57. Storms, R. F., Carere, C., Musters, R., Van Gasteren, H., Verhulst, S., & Hemelrijk, C. K. (2022). Deterrence of birds with an artificial predator, the RobotFalcon. *Journal of the Royal Society Interface*, *19*(195), 20220497.

58. Udino, E., Oscos-Snowball, M. A., Buchanan, K. L., & Mariette, M. M. (2024). A prenatal acoustic signal of heat reduces a biomarker of chronic stress at adulthood across seasons. *Frontiers in Physiology*, *15*, 1348993.

59. Vidas-Guscic, N. D., Jonckers, E., Van Audekerke, J., Orije, J., Hamaide, J., Majumdar, G., ... & Van der Linden, A. (2023). Season-dependent processing of innate conspecific vocalizations in the male and female European starling (Sturnus vulgaris). *bioRxiv*, 2023-07.