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# EXPLORING AVIFAUNAL DIVERSITY AND DISTRIBUTION ALONG THE BICOL RIVER: A LITERATURE REVIEW

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**ABSTRACT:** *The Bicol River is a vital ecological corridor in Southern Luzon, supporting a diverse array of bird species. This review synthesizes contemporary studies (2000–2024) on avifaunal diversity, species distribution patterns, conservation status, and habitat-related threats in the riverine ecosystem. More than 150 bird species are documented along the Bicol River, including several Philippine endemics and globally threatened species. These species face growing threats from agricultural expansion, pollution, and climatic variability. The review uses a systematic literature framework to map species distributions, determine habitat requirements, and assess disturbance effects. A conceptual framework illustrates the interrelationships among species diversity, habitat quality, and conservation requirements. The results underscore the importance of habitat restoration, community-based conservation, and climate-resilient measures. This review offers valuable insights for policymakers, researchers, and local stakeholders involved in preserving the ecological integrity of the Bicol River basin. Through a thematic synthesis of 40 key studies, the review identifies urgent conservation needs in forested and wetland zones. Findings highlight the Bicol River's crucial role as a sanctuary for endemic and threatened species.*

**Keywords:** *Avifaunal diversity, Bicol River, riverine birds, habitat disturbance, conservation planning*

## INTRODUCTION

The Bicol River is one of the most important rivers in Southern Luzon and serves as an essential ecological lifeline for its exceptional avian diversity. Its dynamic wetland, forest, and floodplain system provides excellent habitat for resident and migratory birds. Avian species perform vital ecological functions, including seed dispersal, pollination, and pest control, and serve as indicators of environmental conditions (Tanalgo et al., 2015; Akhter & Sharma, 2024).

Nonetheless, urbanization, agricultural expansion, and pollution have endangered these riverine ecosystems, leading to habitat fragmentation and biodiversity loss (Danielsen et al., 2009). Deforestation and land-use changes exacerbate these threats, making the Bicol River Basin's rich avifauna a critical focus for conservation research (Brooks et al., 1997; Prabhu & Meshram, 2024). Wetland-dependent bird species, in particular, have shown significant declines due to these threats, especially from agricultural runoff and pollution from surrounding areas (Hagy et al., 2017). Aquatic birds, such as those in the Naaj River, are critical to ecosystem health, underscoring the need for further research on river ecosystems like the Bicol River (Kumar et al., 2023).

Although avian diversity in the Philippines has been well documented, many regions remain underexplored, particularly the Bicol River Basin. As in other regions in Southern Luzon, such as Kawa-Kawa Hill, which has been shown to harbor a variety of species, the Bicol River Basin's biodiversity warrants focused research to document its full avian diversity (Mape & Concepcion, 2021). Like the Nihari Tawi River in

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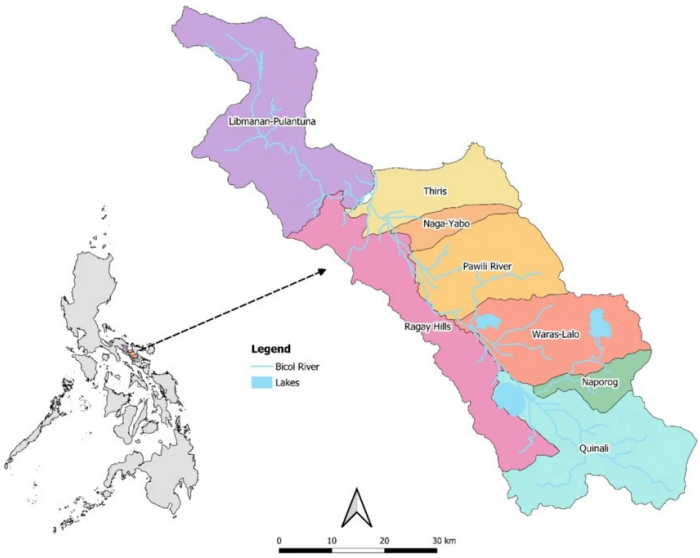
Jammu and Kashmir, the Bicol River hosts diverse avian species but lacks comprehensive monitoring to fully document its species richness (Sharma & Kumar, 2021). The lack of comprehensive research in such river ecosystems highlights the need for more focused studies (Nikam, 2022). A significant gap in the literature is the uneven allocation of research effort and persistent knowledge shortfalls regarding threatened species. Recent assessments of Philippine vertebrates illustrate that many threatened and endemic species are poorly studied and inadequately documented due to limited survey effort, particularly in non-protected or less-visited areas, resulting in underrepresentation of important taxa in global biodiversity databases (Tanalgo et al., 2025) (Dicol et al., 2024) (Baes et al., 2024). The Philippine Biodiversity Strategy and Action Plan (PBSAP, 2017) emphasize the need for focused conservation and habitat restoration in river systems such as the Bicol River Basin.

Comprehensive data on ecologically important watersheds in the Philippines are also lacking. Studies of avian diversity in other key watersheds, such as those in Mindanao and at Long-Term Ecological Research sites, have underscored the importance of long-term monitoring for documenting species richness in river ecosystems. This approach is vital for understanding avian diversity in the Bicol River Basin, where similar monitoring is lacking (Mohagan et al., 2015). The absence of in-depth studies of tributaries such as Libmanan and Naga further complicates our understanding of bird diversity across these essential habitats (Pitogo et al., 2024; Mallari et al., 2001).

Moreover, there is a pressing need for more integrative tools and improved monitoring to address gaps in avifaunal data. The integration of advanced methodologies, such as remote sensing, citizen science, and real-time biodiversity monitoring, remains underutilized in avifaunal studies in the region. If adopted, these methods could help mitigate spatial and temporal sampling biases that have limited our understanding of bird populations (Danielsen et al., 2009). Sutherland et al. (2019) emphasize the need for advanced methodologies in conservation practices, while Villamor et al. (2008) underscore the role of integrative tools in improving land use planning and biodiversity monitoring in the Philippines.

Furthermore, short-term surveys often fail to capture the full extent of species richness in the Bicol River. Many studies, including those in urban green spaces, show that limited survey periods can underestimate total species diversity. Long-term monitoring is necessary to account for seasonal fluctuations and shifts in species presence, particularly for migratory birds, whose patterns are not captured in shorter survey windows (Baes et al., 2024).

Comparing well-documented wetlands like Agusan Marsh, which recorded over 150 bird species, with less-studied river basins like the Bicol River Basin makes it clear that avifaunal research across the Philippines is geographically uneven. While some areas receive extensive research attention, regions like the Bicol River Basin remain underexplored, underscoring the need




Source: Nunag et.al 2023

Figure 1. Map of the Bicol River showing major tributaries and surrounding municipalities in Camarines Sur, Bicol Region

to prioritize studies of these under-documented river systems (Baes et al., 2024; Mallari et al., 2001; Peterson et al., 2008). The Bicol River Basin's wetland habitats, similar to those of the Rawanwadi Reservoir, provide critical habitat for aquatic bird species, reinforcing the need for their protection and conservation (Makade et al., 2024;

Apsara & Kavya, 2024).

This review synthesizes literature published from 2000 to 2024 to (a) document bird species to the lowest available taxonomic rank, (b) quantify the distribution, species richness, and conservation status of birds, and (c) examine how species richness interacts with habitat disturbance. In summary, the study provides critical information to support long-term conservation planning and ecological recovery.

## METHODOLOGY

*Study Area*. The Bicol River Basin, spanning approximately 3,770 square kilometers, is the eighth largest in the Philippines (Figure 1). Its topography features alluvial plains, volcanic slopes, and lowland agricultural areas, all sculpted by the surrounding Ragay Hills and Bicol Cordillera. Key tributaries include the Libmanan, Naga, and Sipocot Rivers, and the adjacent municipalities include Baao, Bula, Minalabac, Canaman, and Naga City. These environmental attributes create fertile, diverse habitats that support a variety of plant and animal life, including several endemic bird species (Nunag et al., 2023).

*Literature Selection and Review Process*. This review employs a thematic literature review approach, organizing findings around key ecological themes, including species richness, habitat type, and disturbance factors.

Relevant literature published between 2000 and 2024 was identified through database searches (Google Scholar, JSTOR, Scopus) and official biodiversity portals (e.g., Bird Life International, PBSAP). Keywords used were "Bicol River," "avifaunal diversity," "Philippine birds," and "habitat disturbance." Peer-reviewed publications, government reports, and biodiversity action plans were screened for inclusion. To ensure transparency in the selection process, studies were included based on the following inclusion and exclusion criteria:

Inclusion Criteria:

- Studies published between 2000 and 2024 were selected to reflect the most recent research.

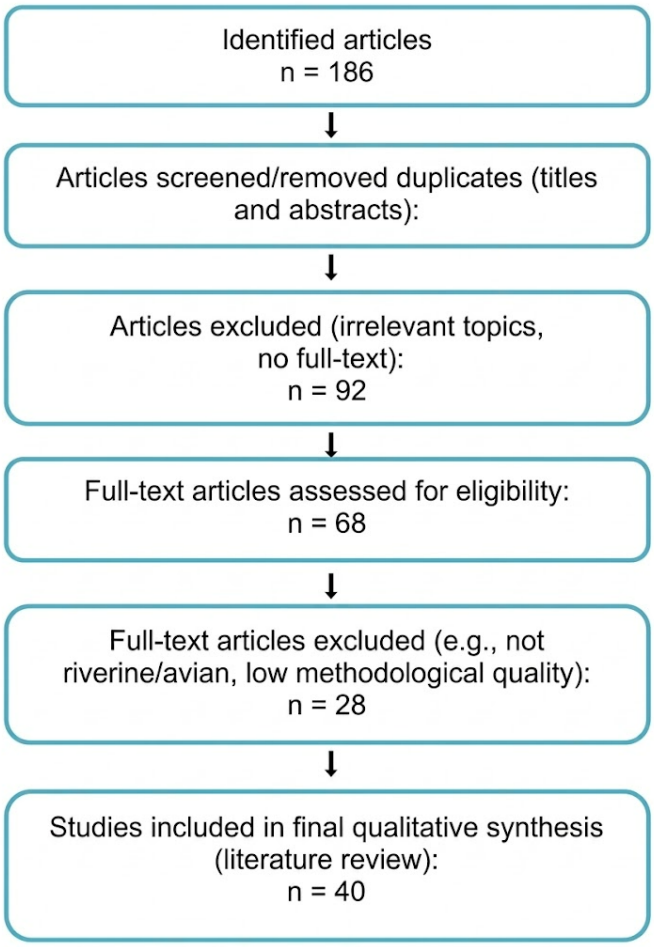



Figure 2. A PRISMA flow diagram illustrates the process of selection

- Studies focusing on avian species in the Bicol River Basin or other comparable riverine ecosystems in the Philippines were prioritized.
- Only studies that examined species richness, conservation status, habitat disturbance, or ecological impacts were included.

Exclusion Criteria:

- Studies with unclear research methodologies or inconsistent data quality were excluded.
- Non-peer-reviewed publications were excluded to maintain scientific rigor.
- Studies that focused on marine ecosystems or non-riverine habitats were excluded.

Figure 2 illustrates how studies for this

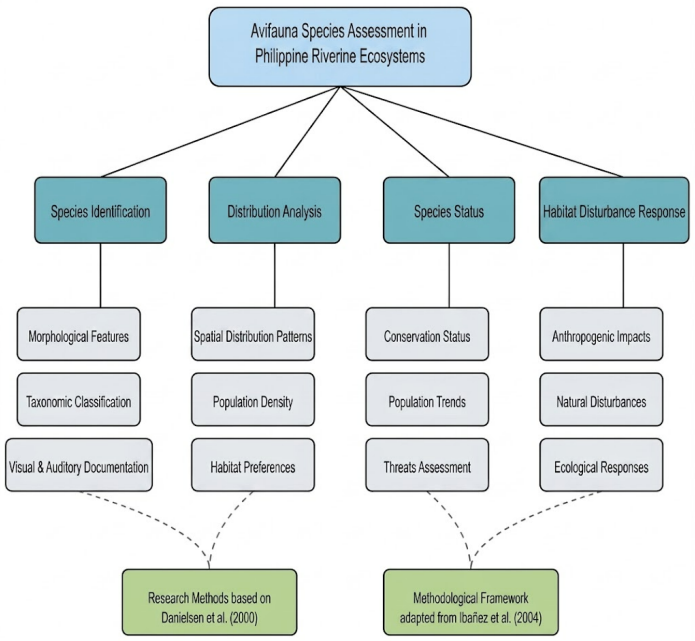



Figure 3. Conceptual framework illustrating the relationship between bird species identification, habitat preferences, levels of disturbance, and conservation outcomes.

review were selected. 186 records were initially identified from databases and online sources; duplicates and unrelated articles were removed, leaving 40 studies relevant to avifaunal diversity in the Bicol River. This process helped ensure the review focused on the most valuable and up-to-date information.

*Conceptual Framework*. The conceptual framework (Figure 3) illustrates how bird species identification and habitat preferences are affected by varying levels of disturbance, ultimately influencing conservation outcomes. Identifying bird species focuses primarily on those that are endemic or threatened, as these birds often reflect the overall health and balance of the ecosystem (BirdLife International, 2021; Mallari et al., 2001). These bird species prefer specific habitats, such as wetlands, forest patches, or agricultural land, each of which supports their survival (Serrano et al., 2019; Baes et al., 2024). However, these habitats are often modified by human actions, such as land conversion and pollution, which may negatively impact species abundance and distribution (Brooks et al., 1997; Pitogo et al., 2024). The framework helps identify which habitats should be prioritized for conservation and which species are at the highest risk.

*Data Extraction and Synthesis*. To maintain a structured approach, relevant information from each selected study was systematically collected and categorized into four main areas: (1) species name and conservation status, (2) habitat type and location, (3) identified threats or disturbances, and (4) proposed or implied conservation measures.

Each record was coded for species' habitat preference (e.g., forest, wetland, agroecosystem) and whether the study reported any environmental degradation, such as pollution, land clearing, or climate-related disturbances. For instance, Baes et al. (2024) identified *Lonchura atricapilla* and *Aplonis panayensis* as urban-adapted species, whereas Mallari et al. (2001) and Danielsen et al. (2000) highlighted that forest specialists, such as *Anas luzonica*, are highly vulnerable to habitat changes and serve as indicators of ecosystem health.

The collected data were organized into categories to identify recurring patterns, such as the correlation between habitat disturbance and species richness. Wetland-associated birds were most commonly affected by agricultural runoff, whereas forest birds were more affected by land clearing and logging pressures (Brooks et al., 1997; Pitogo et al., 2024). This process provided a clear understanding of how disturbances affect bird diversity across different habitats.

## RESULTS AND DISCUSSION

*Biodiversity Indices and Trend Interpretation*. While the methodology aligns with standard protocols for ecological literature reviews, the lack of primary field data limits the depth of quantitative analysis. Potential bias from uneven coverage across habitat types and seasons must be considered. This review primarily synthesizes qualitative information, though some studies provided quantitative measures of species diversity using ecological indices. For instance, Baes et al. (2024) and Malaki et al. (2022) used the Shannon-Wiener Diversity Index (H) to quantify diversity across habitat types. Higher diversity was recorded in forest habitats ($H > 2.5$), whereas urban and disturbed habitats had lower values ($H < 1.5$), suggesting that intact

habitats support more balanced and diverse bird communities. These findings underscore the importance of consistently using biodiversity metrics in conservation planning.

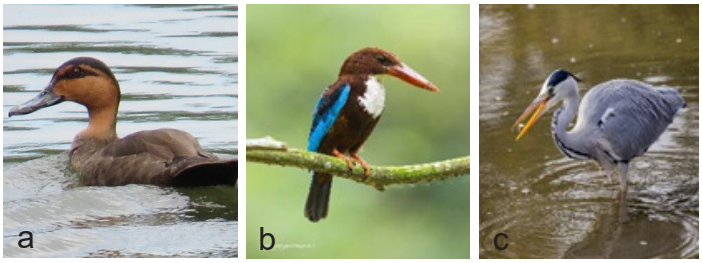



Figure 4. a. *Anas luzonica*; b. *Halcyon smyrnensis*; c. *Ardea cinerea*

*Species Richness and Habitat Identification*. The review demonstrates how habitat disturbance affects species diversity. For example, Baes et al. (2024) recorded 42 species in forest habitats, whereas heavily urbanized areas hosted only 18. Similarly, Malaki et al. (2022) reported higher Shannon-Wiener Index values in intact forests (2.68) and much lower values (1.33) in farmlands affected by agricultural practices. Disturbed habitats, such as rice paddies with pesticide runoff or riverbanks with construction disturbances, are typically dominated by generalist species such as *Passer montanus* and *Aplonis panayensis*. These trends mirror global patterns in which human-induced disturbances lead to biodiversity loss and ecological imbalance.

More than 150 bird species have been documented in the Bicol River basin, representing 43 families and 89 genera. Wetland-dependent birds, such as *Anas luzonica* (Philippine Duck) and *Ardea cinerea* (Grey Heron), were prevalent in floodplain habitats, whereas forest fragments supported species such as *Halcyon smyrnensis* (White-throated Kingfisher) and *Loriculus philippensis* (Philippine Hanging Parrot). Generalist species, such as *Passer domesticus* (House Sparrow), were more common in peri-urban and agricultural areas, suggesting a direct correlation between habitat quality and species richness (Retuerma-Dioneda & Alejandro, 2023; Malaki et al., 2022) (Figure 4).

Furthermore, taxonomic accuracy was critical for determining conservation priorities. More recent research used combined morphological and molecular methods to improve classification accuracy (Yang et al., 2022) (see Table 1).

Table 1. Sample List of Identified Bird Species in the Bicol River

| Species Name | Common Name | Habitat Type | Conservation Status |
|---|---|---|---|
| *Anas luzonica* | Philippine Duck | Wetlands | Vulnerable |
| *Halcyon smyrnensis* | White-throated Kingfisher | Riparian Forest | Least Concern |
| *Ardea cinerea* | Grey Heron | Open Water | Least Concern |

*Habitat Types and Distribution Patterns*. Birds were distributed across a range of microhabitats, including wetlands, riparian forests, rice paddies, and even urban-adjacent green spaces. Species richness was highest in forested zones and lowest in disturbed agricultural zones (Baes et al., 2024; Malaki et al., 2022) (see Table 2).

Table 2. Summary of species counts by habitat type

| Habitat Type | Number of Species |
|---|---|
| Forest Fragments | 44 |
| Wetlands | 35 |
| Agricultural Lands | 29 |
| Urban Greenspaces | 21 |

*Habitat Disturbance and Threats*. Land-use conversion, agrochemical use, and infrastructure development have significantly reduced bird diversity in affected areas. Forest- and wetland-dependent birds are the most sensitive, while generalist species have become more dominant (Mugatha et al., 2024). Furthermore, climate change effects, such as erratic rainfall patterns and prolonged droughts, have disrupted food cycles and nesting seasons for many bird species, making them more vulnerable (Pletterbauer et al., 2018; Chen et al., 2011). In response, generalist species have become increasingly dominant in areas that lose specialized habitat (Mallari et al., 2016). Research has shown that migratory birds exhibit altered arrival patterns, with some arriving earlier or shifting migration routes and

seasonal ranges due to climate-induced changes (Hussain & Khan, 2026). Invasive species such as Arctodiaptomus dorsalis, documented in the Bicol Peninsula, pose a significant threat to river ecosystems, affecting both native species and biodiversity (Rizo et al., 2015; Palmer et al., 2009).

*Management Implications*. This study suggests several management strategies, including establishing micro-reserves in riparian forests, implementing community-led wetland monitoring, and enforcing environmental regulations to limit pollution and encroachment. Community participation in biodiversity monitoring and citizen science initiatives has been shown to expand ecological data collection and support conservation decision-making. Platforms such as eBird provide large-scale, real-time bird observation data that can complement formal monitoring programs (Kelling et al., 2019; Stuber et al., 2022; Compagnone et al., 2023).

*Limitations and Future Directions*. The study is constrained by its reliance on secondary data and uneven research coverage across habitats. The lack of seasonal data and comprehensive information on the breeding habits of most species underscores the need for ongoing monitoring. Future research should prioritize establishing long-term monitoring stations and conducting phenological studies to track the effects of climate change on bird migration patterns. Long-term datasets have revealed significant shifts in migration timing and routes linked to climatic trends, underscoring the importance of sustained monitoring to understand the impacts of climate change on migratory species (Gordo & Sanz, 2005; Chen & Liu, 2025).

This review makes a significant contribution by synthesizing more than 40 studies on avifaunal diversity in the Bicol River Basin, highlighting key species, habitat types, and conservation challenges. The findings are crucial for informing local conservation strategies, particularly for riparian forest protection and habitat restoration. Additionally, these insights can be integrated into national conservation frameworks, such as the Philippine Biodiversity Strategy and Action Plan (PBSAP), to enhance policy formulation (DENR-BMB, 2017).

Furthermore, this study identifies gaps in seasonal monitoring and the underexplored role of tributaries in supporting biodiversity. Future research should prioritize long-term monitoring, using tools such as remote sensing and citizen science platforms like eBird to better track avian populations and environmental changes. These efforts will provide critical data to improve conservation planning and policy implementation for river ecosystems in the Philippines.

## CONCLUSION

The Bicol River remains a vital biodiversity hotspot, home to a rich assemblage of bird species that is increasingly vulnerable to ecological disturbances. Accurate identification, monitoring, and habitat-specific conservation planning are crucial. Immediate actions must focus on protecting riparian forests, reducing pollution, strengthening climate resilience, and supporting citizen-led monitoring.

This review demonstrates the value of integrating local and national data to develop ecologically sound, community-supported conservation frameworks for Philippine river systems.

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