COMPARATIVE ASSESSMENT AND MITIGATION STRATEGIES OF WILDLIFE HAZARD AT KEY AIRPORTS IN BICOL REGION

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ABSTRACT

The research explores the nature and characteristics of wildlife incidents and contributing factors to wildlife presence. The study will compare and evaluate the methods for mitigation used at the key airports in the Bicol region, as well as the inconsistent reporting and execution of the wildlife hazard management plan. Thus, the study emphasized the impact of external elements such surrounding residential areas and agricultural fields and sought to find important implementation gaps between knowledge and practice, particularly in vegetation removal and habitat management. The respondents must be safety officers at major airports in the Bicol Region in order to meet the study's inclusion requirements. Their legitimacy allows the study to get pertinent data and viewpoints on reducing hazards associated with wildlife. Applying a semi-structured interview guide was used as the primary research instrument for qualitative data collection. Highlighting the consistent patterns of wildlife incidents specifically the prevalence of cattle egrets and the timing of incidents during morning landings and seasonal peaks the research reinforces the need for targeted mitigation strategies during these critical periods. More significantly, the identification of implementation gaps between theoretical knowledge and actual practice underscores the importance of addressing resource constraints and shifting from reactive to proactive management approaches. The study recommends enhanced incident profiling, integrated environmental management programs, improved compliance frameworks, and adaptive management strategies tailored to the local context to strengthen aviation safety in the Bicol Region.

KEYWORDS: Wildlife Hazard Mitigation, Aviation Safety, Wildlife-Aircraft Collision, Airport Environmental Management, Wildlife Risk Reduction.

1.0 INTRODUCTION

Aviation plays a major role in today's social and economic scenarios. It offers a quick, reliable and safe way of taking people to their destinations whether it is for business reasons, holidays or family visits. Aviation provides easy access to remote areas of the globe. The industry is responsible for insurmountable economic activity and various technical jobs that entail decisive and challenging civil aviation management. The increasing number of aircraft intended for direct inter-regional transport, the trend toward liberalization, and the growing transport volumes, increase the pressure on airport management. Wildlife hazards, particularly bird strikes, pose a significant and growing threat to aviation safety worldwide. Globally, wildlife strikes cause substantial economic losses and safety risks, delays and operational disruptions. The increasing air traffic density combined with expanding airport infrastructure near natural habitats has intensified the frequency of these incidents, prompting international aviation bodies to emphasize wildlife hazard management as a critical component of aviation safety (International Civil Aviation Organization [ICAO], 2022). Analysis of wildlife hazard to aviation should be a part of the preliminary documentation for planned airports. Identification and bird strike risk assessment allows preparation of Wildlife Hazard Management plan, which includes proactive and reactive mitigation measures. (Skakuj & Łukasik, 2020). Current wildlife strike reporting requirements in aviation are inadequate for modern wildlife hazard management techniques, and using consensus building methodologies. (Parsons et al., 2025)

ASEAN region, rapid urbanization and biodiversity-rich environments create unique challenges for wildlife hazard mitigation. Countries like Indonesia, Malaysia, and the Philippines face frequent bird strike events due to their proximity to migratory bird routes and diverse ecosystems near airports (ASEAN Aviation Safety Network [AASN], 2022). ASEAN member states have been working collaboratively to adopt best practices and harmonize wildlife hazard management protocols to enhance regional aviation safety and reduce wildlife-related risks (ASEAN Secretariat, 2023).

Philippines grapples with significant wildlife hazards in its aviation sector, driven by its archipelagic nature and abundant bird populations. The Civil Aviation Authority of the Philippines (CAAP) has recognized wildlife strikes as a pressing safety concern, with over 100 reported bird strike incidents in early 2023 alone, impacting flight operations and aircraft integrity (Philippine Air Carrier Association, 2023). CAAP continues to develop and implement wildlife hazard management plans, integrating habitat modification, bird detection technologies, and pilot training to mitigate risks effectively (CAAP, 2023).

Bicol region, airports such as Bicol International Airport, Naga Airport, Virac Airport and Masbate Airport are situated near ecologically sensitive areas that attract diverse bird species, increasing the potential for wildlife strikes. The coexistence of natural habitats and aviation infrastructure necessitates tailored wildlife hazard mitigation strategies, including habitat management, community awareness, and regular wildlife monitoring (Serralde et al., 2023).

The contribution of this study is the Enhanced Wildlife Hazard Management Plan which is anchored on the findings of the study and is aligned with the aviation safety standards and

regulatory requirements of the Civil Aviation Authority of the Philippines (CAAP). It also supports the United Nations Sustainable Development Goals (UN SDGs) by promoting safe, resilient, and sustainable airport operations. In particular, the plan contributes to SDG 3 (Good Health and Well-Being) by reducing risks to passengers, flight crews, and airport personnel through improved aviation safety measures. The plan further aligns with SDG 9 (Industry, Innovation, and Infrastructure) by strengthening airport safety systems and operational practices, and SDG 11 (Sustainable Cities and Communities) by supporting the development of safe and resilient transport infrastructure. In addition, it contributes to SDG 15 (Life on Land) by promoting responsible and integrated wildlife management practices that minimize harm to wildlife while reducing human–wildlife conflict within airport environments.

Overall, the Enhanced Wildlife Hazard Management Plan translates the qualitative findings of the study into practical and context-specific strategies that enhance aviation safety while supporting environmental protection and sustainable infrastructure development in the Bicol Region.

Wildlife-aircraft collisions, commonly known as wildlife strikes, represent a significant and persistent threat to aviation safety, economic operations, and aircraft integrity worldwide. These events are characterized as low-frequency but high-impact, justifying the implementation of mandated wildlife hazard assessments and management programs at airports (Altringer et al., 2024).

Systematic profiling of wildlife incidents, including hazard reports and routine observations, is now considered a prerequisite for effective Wildlife Hazard Management Plans (WHMPs) (Andrews et al.)

Enhancing aviation safety in the Bicol Region by providing evidence-based information on wildlife hazards at key airports. The study contribution is the Enhanced Wildlife Hazard Management Plan, which translates the qualitative findings into practical, context-specific strategies aligned with aviation safety standards, regulatory requirements of the Civil Aviation Authority of the Philippines (CAAP). This plan aims to reduce risks to passengers, flight crews, and airport personnel through improved aviation safety measures, strengthen airport safety systems and operational practices, support the development of safe and resilient transport infrastructure, and promote responsible and integrated wildlife management practices that minimize harm to wildlife while reducing human–wildlife conflict within airport environments.

2.0 OBJECTIVE OF THE STUDY

To Comparatively Assess Wildlife Hazard at Key Airports in Bicol Region and propose mitigation strategies to enhance aviation safety.

2.1. Specifically it answers the following:

1. To explore the nature and characteristics of Wildlife hazard incidents at key airports in Bicol Region, Particularly in terms of:
    a. Bird Strike Incidents
    b. Other wildlife related incidents
    c. Hazard reports and observation

2. Identify and describe the factors contributing to wildlife presence at the airports, as perceived by the participants, including:
   a. environmental conditions;
   b. waste management practices;
   c. proximity to wildlife habitat and
   d. Prevailing weather patterns.

3. To examine the compliance of Wildlife Hazard Management Plan at the key Airports in terms of:
   a. Wildlife-related monitoring activities and
   b. Integrated wildlife control and management approaches.

4. To propose an enhanced wildlife hazard management plan for key airports in Bicol Region. Based on the findings of the study.

3.0 LITERATURE REVIEW

This review aims to comprehensively explore the nature and characteristics of wildlife hazard incidents, with a specific focus on bird strike incidents, other wildlife-related occurrences, and the reporting and observation of these hazards. Furthermore, it seeks to identify and describe the factors that contribute to the presence of wildlife at these airports, considering environmental conditions, waste management practices, proximity to wildlife habitats, and prevailing weather patterns. Understanding these factors is crucial for developing effective mitigation strategies and ensuring the safety of air travel.

3.1 Nature and Characteristics of Wildlife Hazard Incident

Studies comparing multiple airports in the same bioregion demonstrate that each airport develops a distinct wildlife strike profile in terms of species composition and frequency, driven by local conditions, air traffic patterns, and management intensity, supporting airport specific analyses of bird strike incidents and other wildlife events. (Steele & Weston, 2021)

Systematic profiling of wildlife incidents, including hazard reports and routine observations, is now considered a prerequisite for effective Wildlife Hazard Management Plans (WHMPs) (Andrews et al., 2022)

Global data show wildlife strikes, especially bird strikes, are increasing with air traffic growth, making wildlife hazards a major aviation safety concern worldwide. (Andrews et al., 2022; Mendonca et al., 2025)

Bird strikes, defined as collisions between flying birds and aircraft, are a long-standing and growing threat to aviation safety, imposing substantial safety, operational, and economic costs worldwide (Metz et al., 2020).

Global strike numbers have risen markedly over recent decades, driven by expansion of air traffic and increasing populations of large, hazard-prone bird species, with estimates of worldwide economic losses reaching billions of dollars annually (Metz et al., 2020; Andrews et al., 2022).

Wildlife-aircraft collisions, commonly known as wildlife strikes, represent a significant and persistent threat to aviation safety, economic operations, and aircraft integrity worldwide. These events are characterized as low-frequency but high-impact, justifying the implementation of mandated wildlife hazard assessments and management programs at airports (Altringer et al., 2024).

This research has highlighted the versatility and potential of Web-GIS in enhancing decision-making processes, promoting public engagement, and optimising resource utilisation. Daud, M., Ugliotti, F. M., & Osello, A. (2024).

Wildlife–aircraft collisions are rare in absolute terms but pose considerable safety and economic risks; risk is typically defined by frequency of strikes and severity of consequences (damage, effect on flight) (Altringer et al., 2024)

Large-scale assessments of national databases show that reported bird strikes have increased markedly over time even where aircraft movements have remained stable or declined, suggesting rising wildlife presence and/or improved reporting systems. (Andrews et al., 2022)

In U.S. assessments, large bodied birds such as red tailed hawk, Canada goose, and turkey vulture consistently rank among the highest risk species, with body mass and flocking behavior strong predictors of damage potential. (Ross et al., 2025)

Multiple studies emphasize that local environmental conditions and land use (wetlands, agricultural fields, grasslands, open water, rubbish dumps) strongly shape bird communities and thus strike risk around airports. (A, 2023)

Temporal factors are also central: seasonal shifts in species composition and behavior lead to seasonally varying strike risk even for the same species, highlighting the need for adaptive, time sensitive management strategies 110. Many damaging strikes occur during critical low altitude phases of flight—particularly approach and landing—when aircraft share airspace with birds concentrated near runways and approach paths. (Saputri et al., 2025)

Literature on wildlife hazard management shows that risk mitigation programs can substantially reduce realized strike risk and economic loss, but their evaluation is complicated by changes in reporting quality. (Altringer et al., 2024b)

Studies in Indonesia and Bangladesh argue for stronger institutional arrangements, dedicated wildlife units, and modern tools (radar, deterrent devices, habitat management) to address persisting bird strike threats. (Alfarisi & Sonhaji, 2024)

Wildlife strike risk is typically described along two dimensions: frequency of incidents and severity of outcomes (e.g., damage, flight disruption) Altringer, L., Begier, M. J., Washburn, J. E., & Shwiff, S. A. (2024d)

Studies at individual airports show that strike profiles are highly site specific, even within the same bioregion, reflecting differences in traffic, surrounding landscape, and local management. (Steele & Weston, 2021b)

Research suggests that "pulse events" like typhoons or volcanic disturbances can alter wildlife distribution patterns, forcing birds into the relatively stable, open environments of an airfield (Hernandez et al., 2024).

3.2 Other wildlife related Incidents

At many airports, non avian wildlife such as monkeys, stray dogs, cats, and small mammals regularly enter the airside area, causing runway incursions, aircraft delays, carcass related foreign object debris (FOD), and occasional collisions that are rated as moderate to high risk for operations. (Hafifa & Z, 2025).

Mammals such as deer, coyotes, and domestic animals can create hazardous situations on airport grounds. For instance, recent studies have highlighted the increasing presence of deer near airport perimeters, leading to potential collisions during takeoff or landing [USDA, 2022].

Reptiles and amphibians, while less commonly reported, continue to pose risks. Snakes on runways can cause tire damage or create distractions for pilots. In warmer regions, larger reptiles like alligators or crocodiles may pose a direct threat to personnel and aircraft [Smith et al., 2021].

Exploratory analyses at Brazil's 30 busiest airports, for example, found a 287% increase in strikes from 2020–2022, with most events occurring within the airport environment and involving medium sized animals, suggesting the importance of systematic hazard reporting and observation systems to characterize bird strikes, other wildlife incidents, and non strike hazard reports (Mendonca et al., 2025)

Assessing compliance and effectiveness of Wildlife Hazard Management Plans (WHMPs) depends on robust wildlife related monitoring and integrated control. Regulatory frameworks (e.g., CASA, FAA) require airports to conduct wildlife hazard assessments, maintain strike and observation records, identify attractants on and off airport, and implement risk based WHMPs that are periodically reviewed (Altringer et al., 2024)

The application of wildlife hazard management principles must be adapted to local conditions. Tropical airports face unique challenges, including rapid vegetation growth requiring more frequent maintenance, year-round breeding seasons reducing management windows, and high biodiversity complicating species identification (Serralde et al., 2023).

Regional ecological trends, such as documented increases in the populations of key hazard species like cattle egrets, also inform the long-term sustainability and intensity of management required (Philippine Biodiversity Conservation Foundation, 2022).

Wildlife presence at airports is strongly shaped by a combination of environmental conditions, waste management, surrounding habitats, and weather and seasonal patterns. Airfield habitat structure (e.g., grassland type and height, heathland/peatland, water bodies, drainage canals) consistently predicts which mammals and birds use the aerodrome; for example, European airfields with heathland/peatland reported higher mammal diversity, while managing water sources was rated the most successful measure for reducing mammal presence. (Ball et al., 2023)

3.3 Factors Contributing to wildlife presence

The factors contributing to wildlife presence at airports are closely linked to environmental conditions, waste management, habitat proximity, and weather patterns. Land use and habitat structure in and around airports strongly influence which species occur and how often; agricultural fields, wetlands, water bodies, grasslands, and urban areas within 8–13 km buffers can greatly increase bird richness and abundance near flight paths. (Chen et al., 2023)

Recent comprehensive guidance on airfield turf and vegetation management emphasizes that no single grass type or management approach universally deters all hazardous wildlife species, necessitating site-specific strategies tailored to geographic location and target species (National Academies Press, 2023).

Contemporary vegetation management strategies increasingly focus on selecting turf-type cultivars that minimize wildlife attraction while maintaining operational requirements for drainage and pavement protection. The Federal Aviation Administration recommends maintaining turf at heights of 6 to 12 inches to create environments that do not attract wildlife while providing adequate drainage adjacent to pavement edges (Airport Technical Assistance Program, 2021).

Modern airfield seed blends have evolved significantly, incorporating varieties that require less frequent mowing and reach maximum heights optimal for airport environments, thereby reducing insect populations that might otherwise attract avian predators (Airport Technical Assistance Program, 2021).

Ornamental landscaping practices can inadvertently create wildlife attractants when plant species selection does not account for wildlife hazard considerations. Improper landscaping attracts animals to airports when plants provide food sources such as edible fruits or shelter for potentially hazardous wildlife species, while proper landscaping using species unattractive to wildlife can actively deter animal presence (Federal Aviation Administration, 2022).

Stormwater ponds, canals, and rivers, as well as diverse vegetation, increase invertebrate and small vertebrate prey and thus draw larger hazard species. (Sarkheil et al., 2020b)

Poor control of organic waste, carcasses, or litter on or near the aerodrome similarly sustains hazardous wildlife populations (Mendonca et al., 2025)

Habitat deterrence strategies emphasize creating airport environments fundamentally incompatible with wildlife basic living needs including food, water, and shelter (Gale Associates, 2020).

Recent comparative research examining four airports in China's Lower Yangtze River Plain revealed that human-altered landscapes and habitat heterogeneity can significantly influence bird diversity patterns even among airports within the same bioregion (Chen et al., 2024, as cited in PMC 12256201).

Research conducted during the COVID-19 pandemic provided unique insights into relationships between air traffic volume and wildlife behaviour within airport environments. Analysis of the 50 largest U.S. airports during COVID-19 months of 2020 revealed that wildlife strike rates increased from May through September 2020 despite reduced absolute numbers of strikes, with increases most pronounced at airports experiencing larger relative declines in air traffic volume (Zahran et al., 2023).

Airfield structures including runway lights, taxiway signs, instrument landing system towers, and light poles can serve as roosting and nesting areas for various wildlife species (San Antonio International Airport, 2021, as cited in Wildlife Hazard Management Plan). Airport buildings, parking garages, and shade structures similarly provide shelter and nesting opportunities that attract and support wildlife populations within airport operational areas. The presence of these structures necessitates specific design modifications to prevent wildlife utilization, including installation of deterrent devices and elimination of ledges or cavities suitable for nesting.

Research examining biocenosis diversity in airport areas found that diversity in suburban airport territories is approximately 2.5 times lower compared to territories without human intervention, yet airports simultaneously create points of wildlife attraction despite associated chemical and physical pollution (Radomska et al., 2021).

Effective land use planning surrounding airports must account for agricultural activities beyond airport property boundaries. Research emphasizing sustainable land management strategies around airports demonstrates that structures such as garbage collection facilities and agricultural areas located within 13-kilometer risk zones pose significant flight safety risks by attracting birds and other wildlife (ScienceDirect, 2024).

The study of John F. Kennedy International Airport utilized dynamic mapping tools to identify and analyze structural elements within risk zones, providing framework for assessing cumulative effects of multiple land uses on wildlife hazard levels. Science Direct. (2024). Reducing flight risks through wildlife control: John F. Kennedy International Airport example.https://www.sciencedirect.com/science/article/pii/S2950338824000202

Management of insect and small rodent populations through appropriate pesticide and rodent repellent applications can minimize attraction of avian predators to airport environments (Gale Associates, 2020). Large expanses of open airport areas inherently provide habitat for insects and small mammals, which subsequently attract birds of prey including hawks, owls, and other raptors posing substantial strike hazards due to their size and flight behaviours.

Recent research on wildlife hazard management effectiveness demonstrated that realized wildlife strike risk is influenced by complex interactions of ecological and biological factors affecting wildlife presence, abundance, and behavior in proximity to airports and aircraft (Altringer et al., 2024).

Physical infrastructure characteristics also impact wildlife presence. Airports often occupy previously pristine areas outside urban zones, and the diversity of biocenosis in suburban airport areas is approximately 2.5 times lower compared to territories without human intervention (Radomska et al., 2021). These facilities simultaneously create chemical and physical pollution while offering certain benefits to wildlife, making them points of attraction despite associated hazards.

The USDA Wildlife Services program provides critical technical assistance to airports regarding landfill-related wildlife hazards. In fiscal year 2024, USDA-Wildlife Services biologists provided technical or direct management assistance resulting in estimated reduction, suppression, or prevention of hazardous conditions caused by wildlife at 777 civil airports across the United States (USDA, 2024). This assistance includes successfully initiating programs to prevent hazardous conditions from developing, such as preventing wetland mitigation, landfill expansion near airports, or planting of landscape vegetation attractive to wildlife (USDA, 2024). These interventions demonstrate the proactive role federal wildlife management agencies play in preventing creation of waste-related attractants near airports.

Gatwick Airport in the United Kingdom was the first airport to receive Zero Waste to Landfill certification from the Carbon Trust in 2018 for actively diverting non-hazardous waste from landfills (Airport World, 2022). This certification demonstrates that comprehensive waste diversion can be achieved through properly designed and operated facilities that do not create wildlife hazards. The success of such programs depends on maintaining strict separation between recyclable materials and organic wastes that would otherwise attract hazardous wildlife.

Contemporary sustainability initiatives increasingly promote composting as component of circular economy approaches at airports. Research examining waste management methods at Dutch airports within circular economy frameworks notes that applying circular economy principles in airport environments is complex due to diversity of stakeholders and numerous activities contributing to waste generation (Frontiers in Sustainability, 2024). The study emphasizes that lack of stakeholder collaboration coupled with limited awareness of roles and responsibilities represents a significant challenge negatively impacting waste management targets, including composting program effectiveness.

Contemporary airport waste management increasingly emphasizes waste minimization at source as primary strategy for reducing volumes requiring disposal. Airport sustainability initiatives in 2024 promote waste segregation, recycling programs, and composting initiatives to reduce landfill waste and promote resource recovery (Airport Information Systems, 2024).

Stakeholder collaboration represents a critical challenge in implementing sustainable waste management at airports. Research identifies that lack of stakeholder collaboration, coupled with limited awareness of roles and responsibilities, has been identified as significant challenge exerting negative impact on waste management targets (Frontiers in Sustainability, 2024).

Recent work emphasizes that WHMPs must be adaptive, combining habitat management, active dispersal and exclusion techniques, and stakeholder coordination within wider land use planning up to at least 13–20 km around airports (Robinson et al., 2021)

Runway adjacent rivers, canals, and diverse vegetation create food and shelter for insects, small mammals, and birds, increasing bird strike risk, as shown in Iran and Indonesia (Rahmawati & Sutarwati, 2025)

Land use, vegetation, water bodies, landfills, and seasonal/weather patterns drive wildlife presence and strike risk. (Robinson et al., 2021b)

Effective wildlife hazard management requires comprehensive assessment of all environmental conditions within appropriate spatial extents surrounding airports. Current recommendations specify conducting wildlife hazard assessments within 10,000 feet and 5-mile radii of airports to identify attractants and develop appropriate mitigation strategies (Denver International Airport, 2025). Denver International Airport's experience demonstrates the scope of environmental management challenges, with 53 square miles of property including agricultural practices, vegetation, structures, and drainage features requiring coordinated assessment and ongoing habitat management to minimize wildlife attractants.

Airport fence lines, while serving as mammalian exclusion barriers, can inadvertently create wildlife habitat when abundant vegetation grows along fenceline corridors. Herbicide applications are recommended for controlling vegetation at fence lines, as unchecked plant growth provides refuge for wildlife and can damage fencing infrastructure itself (Airport Technical Assistance Program, 2021).

Large scale circulation modes such as the El Niño–Southern Oscillation (ENSO), the Indian Ocean Dipole and the North Atlantic Oscillation (NAO) organize regional weather patterns by modulating storm tracks, pressure fields and moisture transport, thereby influencing temperature and precipitation anomalies over vast areas. (Howard et al., 2021)

Classification of these circulation states into "weather patterns" or "weather regimes" using techniques such as empirical orthogonal functions and k means clustering has become central for linking synoptic scale flow to local impacts. For example, optimized sets of weather patterns over India and Southeast Asia, derived from low level winds and pressure, successfully separate monsoon phases, cold surges, tropical cyclones and other modes, and explain a substantial fraction of the spatial variability in heavy precipitation. (Howard et al., 2021b)

Weather and seasonal patterns also shape hazard levels, affecting migration, flocking, and daily activity; several studies highlight seasonal peaks in strike indices and the need to model risk dynamically in response to changing environmental conditions (Andrews et al., 2022e)

Weather radar-based estimates of bird migration intensity can accurately predict bird strike probability, with 80% of variation in bird strikes across the year explained by average amounts of migratory movements captured on weather radar (Nilsson et al., 2021). This finding demonstrates the powerful predictive capacity of meteorological data for understanding temporal patterns in strike risk, particularly during migration periods when bird densities increase substantially.

Seasonal weather patterns drive migration timing and intensity, creating predictable periods of elevated strike risk. Bird collisions demonstrate seasonal and latitudinal trends, with strikes occurring more frequently during late-summer and autumn seasons corresponding to migration periods (Vaishnav et al., 2024). Airport wildlife management personnel utilize these patterns to predict peak bird presence by time of day for each month or season, integrating predictions into flight planning activities.

3.4 Compliance of wildlife hazard management

Regulatory frameworks (e.g., ICAO Annex 14, national civil aviation regulations) require airports to conduct wildlife hazard assessments (WHAs) and implement Wildlife Hazard Management Plans (WHMPs) that are data driven, site specific, and periodically reviewed. (Skakuj & Łukasik, 2020b)

Integrated wildlife control and management approaches. Effective WHMPs combine proactive habitat management (e.g., grass management, drainage and storm water design, reducing standing water and prey availability, vegetation control, perimeter fencing) with reactive measures (hazing, trapping, immediate pilot warnings, temporary operational restrictions) (Mendonca et al., 2025b)

All public airports receiving federal grants-in-aid are obligated to conduct wildlife hazard assessments and develop Wildlife Hazard Management Plans as directed by the FAA, regardless of grant amount (Reed-Joseph, 2020). This compliance requirement extends beyond Part 139 certificated airports to include general aviation facilities obtaining FAA Airport Improvement Project grants, which must conduct wildlife hazard assessments as part of grant assurances (Environmental Science Associates, 2024).

The importance of implementing these management plans extends to airports not federally mandated to develop them, as integrated, functioning, and dynamic Wildlife Hazard Management Plans provide essential safety provisions tailored to individual airport environments, operational tempos, and budgetary considerations (Reed-Joseph, 2020).

Administrative procedures necessary for regulatory compliance include comprehensive record keeping, reporting of strikes, trending analysis, and ensuring adherence to federal, state, and local regulations and guidelines (Reed-Joseph, 2020). These administrative functions represent extensions of overall safety management systems already employed by airports to ensure passenger and aircrew safety while reducing economic damages to equipment and cargo. The Wildlife Hazard

Management Plan serves as a critical documentation and implementation tool for these safety programs across airports of all sizes.

The European Aviation Safety Agency has similarly emphasized the importance of competent personnel conducting wildlife hazard assessments using structured approaches that identify how wildlife management risks may have changed, particularly during periods of reduced operations such as those experienced during the COVID-19 pandemic (EASA, 2021). This guidance recommends establishing means and procedures to minimize collision risks between wildlife and aircraft, encompassing areas approximately 13 kilometers from the aerodrome reference point.

Tampa International Airport's Wildlife Hazard Management Plan exemplifies comprehensive implementation of regulatory requirements and best practices. The plan underwent annual reviews following its initial FAA approval, with a 12-month Wildlife Hazard Assessment completed in 2020 and submitted to the FAA in February 2022, receiving approval on June 15, 2022 (Tampa International Airport, 2022). Annual reviews occur every 12 consecutive calendar months at minimum, with actions including tabulation and summarization of wildlife hazard information from daily inspection logs, review of effectiveness of wildlife control procedures, evaluation of impacts from off-airport projects, and review of future airport projects and land-use changes affecting wildlife patterns (Tampa International Airport, 2022).

San Antonio International Airport's Wildlife Hazard Management Plan demonstrates the multi-departmental coordination required for effective implementation. Several divisions within the airport have outlined responsibilities incorporated into operational programs, with clear communication among airport personnel identified as essential for plan success (San Antonio International Airport, 2021). Personnel working at airports must communicate resource needs, recommendations, and progress to designated Qualified Wildlife Biologists, who obtain FAA approval of plans and review amendments for compliance with federal, state, and local laws and regulations (San Antonio International Airport, 2021).

The USDA Wildlife Services provides ongoing monitoring assistance at airports nationwide. In 2023, USDA provided assistance with wildlife hazards at 777 civil airports across the United States, demonstrating the extensive scope of federal support for airport wildlife management programs (Denver International Airport, 2025). USDA personnel monitor wildlife activity continuously, allowing immediate threat detection and mitigation actions when hazardous conditions develop within airport operational areas.

Communication systems represent critical components of effective monitoring programs. Airport staff, Air Traffic Services providers, and pilots are all well-situated to observe and monitor wildlife hazards, and when effective communication and reporting systems are in place, reports of wildlife activity can be relayed to airport wildlife control officers for action to disperse wildlife before collisions occur (FOD Control Corporation, 2024). Air Traffic Services providers often have ideal vantage points to observe wildlife from towers, while pilots see bird activity in areas not visible to other personnel.

This study employs Tableau and R to create a web-based system for early wildlife hazard alerts at airports. The result shows specific time, season, altitude, size, and frequency related to wildlife reports in the United Stated. A user-friendly risk assessment tool, utilizing the Shiny platform, offers airport stakeholders color-coded risk levels by analyzing wildlife hazard report frequencies and sizes. Lu, C.- tsung, Fu, H., Cheng, M., & Wei, M. (2024).

Between 1990 and 2023, approximately 292,000 wildlife strikes with civil aircraft were reported in the United States, with about 19,700 strikes occurring at 780 U.S. airports in 2023 alone (FAA, 2024). The number of reported strikes increased significantly in 2024, with 22,372 strikes reported representing a 14 percent increase from 2023, disproportionate to the respective 4 and 3 percent increases in aircraft movements at Part 139 and general aviation airports (GlobalAir, 2025). This substantial increase highlights the importance of comprehensive reporting systems for documenting actual strike occurrence rates.

In 2024, approximately 74 percent of reported strikes were filed using electronic versions of FAA Form 5200-7, Bird/Other Wildlife Strike Report, while 9 percent were submitted through the Air Traffic Organization Mandatory Occurrence Reporting system (GlobalAir, 2025). Memoranda of Understanding and Agreement between federal agencies provide frameworks for coordinated wildlife hazard management. The Memorandum of Understanding between the U.S. Department of Transportation Federal Aviation Administration and U.S. Department of Agriculture Animal and Plant Health Inspection Service Wildlife Services, established in June 2005, formalizes cooperation between agencies responsible for aviation safety and wildlife management (FAA, 2024). Additional memoranda involving the U.S. Air Force, U.S. Army, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service address aircraft-wildlife collision prevention across civil and military aviation sectors.

Geographic Information System technologies have become standard tools for monitoring wildlife activity and analyzing historical trends. USDA personnel monitor wildlife activity and collect data through GIS technology, which illustrates historical trends similar to radar systems while providing spatial analysis capabilities for understanding wildlife movement patterns and habitat associations (Denver International Airport, 2025).

Computer software has changed the way data are collected and analyzed in airport wildlife management, with some systems automatically collecting data when deterrents are activated (Flight Safety Foundation, 2020). While software has not fundamentally changed operational wildlife management techniques, enhanced data capture and analysis capabilities enable more sophisticated evaluation of management effectiveness, identification of temporal and spatial patterns in wildlife activity, and documentation of compliance with regulatory requirements.

Wildlife Hazard Management Plans must be monitored, adapted, and modified by federal, state, and local aviation authorities for compliance and efficacy (Reed-Joseph, 2020). This iterative process ensures that management strategies remain responsive to evolving wildlife populations, habitat conditions, and operational requirements. Annual review cycles required by regulation provide

formal mechanisms for systematic evaluation and plan modification based on accumulated experience and data.

The COVID-19 pandemic provided unique insights into relationships between air traffic volume and wildlife behavior, demonstrating the importance of adaptive management during unusual operational conditions. Analysis of 50 largest U.S. airports during COVID-19 months of 2020 revealed that wildlife strike rates increased from May through September 2020 despite reduced absolute numbers of strikes, with increases most pronounced at airports experiencing larger relative declines in air traffic volume (Zahran et al., 2023). This research concluded that observed increases resulted at least partially from risk-enhancing changes in wildlife abundance and behaviour, demonstrating that reduced human activity allows wildlife to become more abundant and active within airport environments. Such findings emphasize the necessity for adaptive management responses to changing operational conditions.

3.5 Integrated Wildlife control and management approaches

The ultimate goal of data collection is to inform proactive decision-making. Advanced data utilization, such as predictive modeling that integrates historical strike data, weather patterns, and seasonal variables, has demonstrated the ability to forecast high-risk periods with 78% accuracy up to 48 hours in advance, enabling targeted mitigation (Varnousfaderani & Shihab, 2025).

Analyses of national strike databases show that risk is typically conceptualized as the product of strike frequency and severity; large-bodied birds such as Canada geese, turkey vultures, and raptors consistently rank among the highest-risk species because they are more likely to cause aircraft damage or affect flight when collisions occur (DeVault et al., 2018; Ross et al., 2025). However, hazard is not uniform in space or time. Most strikes occur at low altitudes during take-off, climb, approach, and landing, yet a rising proportion of damaging events now happens outside the immediate airport boundary, highlighting limitations of measures that focus only on the airfield (Dolbeer, 2019; DeVault et al., 2016; Metz et al., 2021).

In response, research has shifted from static hazard rankings toward dynamic, risk-based tools, including probabilistic economic risk models, land-use-based attraction indices, data-driven collision-likelihood models, and operational concepts that combine avian radar with advisory systems for controllers and pilots (DeVault et al., 2018; Coccon et al., 2015 as cited in Shao et al., 2020; Andrews et al., 2022; Metz et al., 2021). Evidence from program evaluations indicates that well-implemented wildlife hazard management can reduce realized strike damage and yield economic benefits far exceeding program costs, but also that improved reporting and adaptive, seasonally informed strategies are essential to accurately assess and further reduce bird-strike risk (Altringer et al., 2024; Ross et al., 2025).

Evidence suggests that robust WHMPs can significantly reduce realized strike risk and economic damages, although they may initially increase reported strike numbers as reporting improves. (Altringer et al., 2024e)

Airports lacking structured wildlife units or formalized procedures often show reactive, ad hoc handling and gaps in hazard reporting and monitoring. (Martadinata et al., 2023b)

Airports with dedicated wildlife control units experience fewer strikes and faster response times compared to those relying on general operations staff (Rifqi et al., 2023). Furthermore, specialized training for personnel significantly improves species identification accuracy, understanding of effective tactics, and reporting completeness (Martadinata et al., 2023).

WHMPs should institutionalize systematic monitoring through trained wildlife control units, standardized reporting forms, and regular bird and mammal surveys, including small mammal monitoring to inform management of predators that pose strike risk (Shiels et al., 2025)

Integrating risk based tools and technology can strengthen decision making: dynamic risk models that combine wildlife observations with environmental and weather data; radar or sensor fusion systems using thermal and visual cameras for real time runway surveillance; and, where feasible, unmanned aircraft systems (UAS) to map habitats and hard to access attractants such as wetlands. (Dziak et al., 2022)

Studies emphasize that successful programs link WHMPs to an airport wide Safety Management System (SMS), use formal risk matrices, and embed training and communication so that operational staff, air navigation services, and external stakeholders (e.g., local governments, protected area managers) coordinate habitat and land use decisions around the airport. (Rahmawati & Sutarwati, 2025)
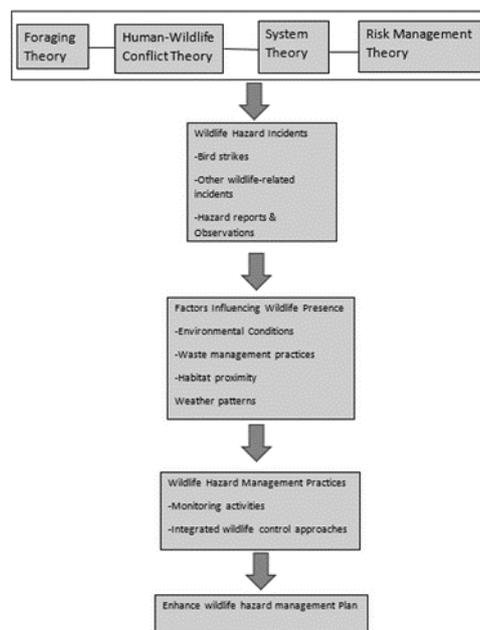
4.0 THEORETICAL FRAMEWORK

Figure 1. Theoretical Framework

This qualitative study draws on several complementary theories and an integrated framework to explain why wildlife occur in and around airports, how airport practices influence these patterns,

and which strategies can reduce wildlife strike risk at key airports in the Bicol Region. Together, these perspectives guide the analysis of wildlife hazard incidents and underpin the development of an enhanced Wildlife Hazard Management Plan tailored to local conditions.

Foraging theory explains animal behavior in terms of optimizing energy intake and minimizing risks related to food acquisition (Pyke, 2022). Animals choose habitats and feeding sites based on resource availability, competition, and predation risk, which can lead them into conflict with humans when seeking resources in human-dominated landscapes.

Human-wildlife conflict theory examines the interactions between humans and wildlife, focusing on the negative impacts on both parties when their needs and behaviors clash (Manfredo & Dayer, 2020). This conflict is often rooted in competition for resources, habitat loss, and differing values, leading to economic damage, injury, or loss of life for both humans and animals. Understanding the social and ecological dimensions of HWC is crucial for developing effective mitigation strategies.

Systems theory provides a holistic approach by viewing HWC as a complex system of interconnected components, including ecological, social, economic, and political factors (De Brabandere, 2023). This perspective emphasizes the interdependence of these components and how changes in one area can cascade through the entire system. Systems theory helps in understanding feedback loops, emergent properties, and the overall dynamics of HWC, enabling more comprehensive and sustainable solutions.

Risk management theory offers tools and strategies for assessing, mitigating, and monitoring the risks associated with HWC (Hubbard, 2020). This involves identifying potential hazards, evaluating the likelihood and severity of negative outcomes, and implementing measures to reduce these risks. Risk management approaches can help prioritize resources and develop proactive strategies to minimize the impacts of HWC on both human communities and wildlife populations.

By integrating these theories, a more complete understanding of HWC can be achieved, leading to the development of more effective and sustainable management strategies. This integrated approach acknowledges the complexity of HWC and promotes solutions that address the ecological needs of wildlife, the socio-economic needs of human communities, and the importance of proactive risk management.

5.0 METHODOLOGY

5.1 Research Design

The study adopts qualitative research design. This study employed a purposive sampling technique to select four safety officers from the key airports in the Bicol Region—Masbate Airport, Virac Airport, Naga Airport, and Bicol International Airport. These individuals were chosen based on their direct involvement in wildlife hazard management, ensuring that the data collected would be both relevant and credible. Their professional roles and firsthand experiences with wildlife-related incidents positioned them as information-rich informants, consistent with qualitative research standards (Patton, 2002). While the sample size is limited to four, this is deemed methodologically sufficient for a qualitative inquiry focused on depth rather than breadth. The study achieved data

saturation, as recurring themes and patterns emerged across interviews, with no significant new insights arising from subsequent responses. This aligns with recommendations in qualitative research literature, which emphasize that small, focused samples are appropriate when participants are experts in the phenomenon under study (Guest, Bunce, & Johnson, 2006). Furthermore, the inclusion criteria ensured that only personnel actively engaged in wildlife hazard documentation, mitigation, and reporting were involved. This exclusion of non-involved staff helped maintain the integrity and manageability of the data, allowing for a focused and rigorous thematic analysis.

5.2 Research Instrument

To achieve the objectives of the study, a semi-structured interview guide was used as the primary research instrument for qualitative data collection. The interview guide was developed by the researcher based on related literature, established aviation safety standards, and the Civil Aviation Authority of the Philippines (CAAP) guidelines on wildlife hazard management.

The instrument was designed to elicit in-depth insights from key informants while allowing flexibility for probing and follow-up questions, thereby ensuring consistency across interviews without limiting the depth of responses. Prior to data collection, the interview guide was reviewed to ensure clarity, relevance, and alignment with the study objectives.

To ensure the validity and credibility of the research instrument, the semi-structured interview guide underwent expert review prior to data collection. Subject matter experts in aviation safety and research methodology evaluated the clarity, relevance, and alignment of the interview questions with the study objectives. Their feedback and recommendations were incorporated to refine the content and structure of the instrument, ensuring that it was appropriate for eliciting in-depth qualitative data.

All ethical considerations were strictly observed. Participants were informed of the purpose of the study, and their participation was voluntary. Confidentiality and anonymity of responses were assured in accordance with the Data Privacy Act of 2012 (Republic Act No. 10173). Informed consent was obtained from all participants prior to the conduct of the interviews.

5.3 Data Gathering Procedure

The researcher obtains the necessary permissions from Civil Aviation Authority Philippines Area Center V management prior to data collection. Qualitative data will be collected through semi-structured interviews with airport safety personnel to gain deeper insights into current mitigation practices and challenges. The researcher personally introduced the study to potential respondents and key informants. The objective of the study, research procedures, expected duration of participation, potential risks and benefits, and the voluntary nature of involvement were clearly explained. Written informed consent was obtained from all participants in accordance with the Data Privacy Act. Of 2012 (Republic Act No. 10173) and established ethical principles governing research involving human participants, including respect for persons, voluntariness, confidentiality and the right to withdraw at any stage without penalty. Consent was documented through signed informed consent forms and participants were assured that all information provided would be anonymized and treated with strict confidentiality.

5.4 Participants of the Study

For this study, the inclusion criteria are that the respondents chosen who are safety officers in key airports in Bicol Region. Their credibility suits the study to extract relevant information and perspectives regarding mitigating wildlife-related risks. Also, they must be willing to share their experiences regarding the study. This inclusion criterion ensures that it will reflect the data sets and their experiences, allowing for an accurate and manageable data collection and analysis. While other personnel is excluded from this study due to its non involvement in the data collection, processing and review of reports regarding wildlife hazard.

Table 1: Participant Profile

Participant	Airport	Position
Participant 1	Masbate Airport	Safety Officer
Participant 2	Virac Airport	Safety Officer
Participant 3	Naga Airport	Safety Officer
Participant 4	Bicol International Airport	Safety Officer

5.5 Sampling Technique

The study will employ a purposive sampling technique to select participants who are directly involved in wildlife hazard management and airport operations at key airports in Bicol Region. This method will ensure that only individuals with relevant knowledge and experience—such as safety officers will be included in the qualitative interviews. This sampling approach will allow the researcher to obtain comprehensive and in-depth data necessary to meet the study objectives.

5.6 Study Site

The Bicol region, located in the southeastern part of the Philippines, is served by several airports that provide vital connections to the rest of the country. Bicol International Airport (RPLK), located in Alobo Daraga, Albay, is the primary gateway to the region, offering domestic flights. It is especially popular among tourists visiting the stunning Mayon Volcano and other attractions in Albay. Naga Airport (WNP), in Pili, Camarines Sur, is another key hub, linking the Bicol region to major cities like Manila. Virac Airport (VRC), situated in Catanduanes, serves as a regional airport connecting the island province to Manila and other nearby areas. Additionally, Masbate Airport (MBT), located in the city of Masbate, provides domestic flights to and from Manila, facilitating travel to this island province known for its rich cultural heritage and beautiful beaches. Together, these airports are essential for tourism, business, and overall connectivity within the Bicol region, offering convenient access to the area's natural wonders and vibrant local culture.

5.7 Data Analysis

The study employed a qualitative data analysis approach to systematically examine the information gathered from semi-structured interviews, document review, and field observations. Data analysis was conducted using thematic analysis, which allowed the researcher to identify, analyze, and interpret patterns and themes emerging from the participants' responses in relation to the study objectives (Braun & Clarke, 2006). Audio-recorded interviews were transcribed verbatim to ensure accuracy and completeness of the data. The transcripts were read repeatedly to achieve data familiarization. Initial codes were then generated by identifying significant statements, phrases, and

ideas related to wildlife hazard incidents, factors contributing to wildlife presence, and wildlife hazard management practices at the airports.

Thematic analysis was used to systematically code and interpret interview data, allowing patterns related to wildlife hazards and management practices to emerge. The coded data were subsequently organized into categories and themes through constant comparison. Similar codes were grouped together to form broader themes that reflected recurring patterns and shared meanings across participants. These themes were reviewed and refined to ensure internal consistency and clear distinction between themes.

The final themes were interpreted and discussed in relation to the specific objectives of the study and relevant literature on wildlife hazard management and aviation safety. This process enabled the researcher to develop an in-depth understanding of wildlife hazards, the factors influencing wildlife presence at airports, and the implementation of wildlife hazard management plans. The findings served as the basis for proposing an enhanced wildlife hazard management plan for key airports in the Bicol Region. To ensure rigor and trustworthiness of the analysis, the researcher maintained an audit trail consisting of interview transcripts, coding notes, and thematic summaries. Direct quotations from participants were used to support the identified themes and to preserve the authenticity of participants' perspectives. The proposed strategies are aligned with CAAP Wildlife Hazard Management requirements, particularly on hazard identification, habitat control, integrated wildlife management, training, and continuous improvement under the safety management system.

6.0 RESULT AND DISCUSSION

This qualitative study provides comprehensive insights into wildlife hazard management practices across four key airports in the Bicol Region: Bicol International Airport (BIA), Naga Airport, Virac Airport, and Masbate Airport. Through thematic analysis of semi-structured interviews with airport personnel, the study reveals both consistent patterns and unique challenges in wildlife hazard management across these facilities. The findings illuminate the complex interplay between environmental factors, operational practices, and management effectiveness in addressing aviation safety risks posed by wildlife encounters.

The thematic analysis identified four major themes that characterize wildlife hazard management in Bicol Region airports. Wildlife Presence and Incident Patterns emerged as the foundational theme, revealing that while bird strikes occur infrequently across all airports, they follow predictable temporal, spatial, and species-specific patterns.

6.1 Nature and characteristics of Wildlife Hazard incidents at key Airport in Bicol Region

Each airport has established documentation processes for recording wildlife sightings and strike incidents, though the specific approaches vary. This reveals a dual system forced by technical limitations. Clear reporting structures exist across airports, with safety officers playing a central role. Airports demonstrate different patterns in how frequently they compile and submit wildlife hazard reports to higher authorities. The study highlights the importance of reliable and user-friendly reporting systems. Uniform data gathering system must be implemented. For easy comparison of reports regarding wildlife strikes incidents.

These results are supported by recent studies emphasizing administrative procedures necessary for regulatory compliance include comprehensive record keeping, reporting of strikes, trending analysis, and ensuring adherence to federal, state, and local regulations and guidelines (Reed-Joseph, 2020). These administrative functions represent extensions of overall safety management systems already employed by airports to ensure passenger and aircrew safety while reducing economic damages to equipment and cargo. The Wildlife Hazard Management Plan serves as a critical documentation and implementation tool for these safety programs across airports of all sizes. Moreover, the European Aviation Safety Agency has similarly emphasized the importance of competent personnel conducting wildlife hazard assessments using structured approaches that identify how wildlife management risks may have changed, particularly during periods of reduced operations such as those experienced during the COVID-19 pandemic (EASA, 2021). This guidance recommends establishing means and procedures to minimize collision risks between wildlife and aircraft, encompassing areas approximately 13 kilometers from the aerodrome reference point.

6.2 Factors contributing to wildlife presence

The weather patterns reflect known bird behavior. Many species alter their habitat use based on whether to optimize foraging, regulate body temperature, or avoid adverse conditions. Rain increases invertebrate activity and creates temporary water bodies, attracting water birds and insectivores. Hot, dry conditions concentrate birds around remaining water sources and create good conditions for aerial insect feeders. Storms displace birds from usual areas and create temporary concentrations as they seek shelter. These findings suggest that weather-related patterns mean that wildlife hazard risk is not constant but varies predictably with weather conditions. This allows airports to anticipate high-risk periods and intensify monitoring and dispersal efforts accordingly. It also suggests that weather forecasting should be integrated into wildlife hazard management planning.

Weather conditions emerged as a significant factor influencing wildlife presence and behaviour at airports. Participants identified specific weather patterns that correlate with increased wildlife activity.

These results are supported by recent studies with weather and seasonal patterns also shape hazard levels, affecting migration, flocking, and daily activity; several studies highlight seasonal peaks in strike indices and the need to model risk dynamically in response to changing environmental conditions (Andrews et al., 2022e). Southeast Asia, derived from low level winds and pressure, successfully separate monsoon phases, cold surges, tropical cyclones and other modes, and explain a substantial fraction of the spatial variability in heavy precipitation. (Howard et al., 2021b). Moreover, Seasonal weather patterns drive migration timing and intensity, creating predictable periods of elevated strike risk. Bird collisions demonstrate seasonal and latitudinal trends, with strikes occurring more frequently during late-summer and autumn seasons corresponding to migration periods (Vaishnav et al., 2024). Airport wildlife management personnel utilize these patterns to predict peak bird presence by time of day for each month or season, integrating predictions into flight planning activities.

6.3 Compliance of Wildlife Hazard Management Plan

These findings suggest that grass cutting emerged as the primary habitat management tool used by airports to reduce wildlife attractiveness. However, achieving consistent grass management requires significant resources. Several airports employ active wildlife dispersal techniques to drive wildlife away from operational areas, particularly around aircraft movements. The pattern shows that while grass management is universally recognized and implemented, its effectiveness is limited by resource constraints. The results are supported by recent research emphasizing the positive trends despite resource limitations support Rifqi et al.'s (2023) argument that management effectiveness depends more on systematic implementation than equipment sophistication. Evidence suggests that robust WHMPs can significantly reduce realized strike risk and economic damages, although they may initially increase reported strike numbers as reporting improves. (Altringer et al., 2024e). Airports lacking structured wildlife units or formalized procedures often show reactive, ad hoc handling and gaps in hazard reporting and monitoring. (Martadinata et al., 2023b). Moreover, airports with dedicated wildlife control units experience fewer strikes and faster response times compared to those relying on general operations staff (Rifqi et al., 2023). Furthermore, specialized training for personnel significantly improves species identification accuracy, understanding of effective tactics, and reporting completeness (Martadinata et al., 2023). WHMPs should institutionalize systematic monitoring through trained wildlife control units, standardized reporting forms, and regular bird and mammal surveys, including small mammal monitoring to inform management of predators that pose strike risk (Shiels et al., 2025)

7.0 CONCLUSION

This qualitative research examined wildlife hazard management across four airports in the Bicol Region through interviews with airport personnel. The study revealed consistent patterns across locations, incidents occurring predominantly during morning hours and landing phases, with seasonal peaks from August to December. Cattle egrets emerged as the most common hazard species, while dogs posed occasional severe threats.

The findings of this qualitative study have several important practical implications for wildlife hazard management at key airports in Bicol region, particularly those in regions with similar ecological and resource contexts. By highlighting the consistent patterns of wildlife incidents—specifically the prevalence of cattle egrets and the timing of incidents during morning landings and seasonal peaks the research reinforces the need for targeted mitigation strategies during these critical periods. More significantly, the identification of implementation gaps between theoretical knowledge and actual practice underscores the importance of addressing resource constraints and shifting from reactive to proactive management approaches. While regular grass cutting is beneficial, a more holistic strategy that includes managing other attractants like trees, shrubs, and water features is essential. The study also emphasizes the need for airports to collaborate with surrounding communities to mitigate external factors contributing to wildlife hazards. Furthermore, the documented decline in wildlife incidents, despite resource limitations, demonstrates the potential for meaningful progress through consistent application of basic management principles. By systematically analyzing collected data, airports can refine their strategies, optimize resource allocation, and ultimately enhance the safety and efficiency of airport operations. This research

contributes valuable insights to the field by providing a nuanced understanding of the challenges and opportunities for effective wildlife hazard management in resource-constrained environments.

8.0 RECOMMENDATION

1. Incident Profiling System Implement standardized species identification, temporal risk mapping, and spatial hazard analysis. Focus on peak risk periods (morning hours) and primary hazard species (cattle egrets). This data-driven approach enables strategic resource deployment rather than uniform vigilance.
2. Integrated Environmental Management Address root causes of wildlife attraction through systematic vegetation management (7-14 inch grass height), community engagement for off-airport attractants (residential pigeon-keeping, waste disposal), and weather-responsive protocols. Aims for 58% strike reduction through habitat management.
3. Enhanced Compliance Framework Establish dedicated wildlife control units, systematic monitoring protocols (daily observations, monthly trend analysis, semi-annual reviews), and coordinated management approaches. Transitions airports from reactive to proactive management.
4. Comprehensive Locally-Adapted Strategies Develop enhanced Wildlife Hazard Management Plans incorporating adaptive management, reliable technology integration with backup systems, and regional coordination among Bicol airports. Prioritizes phased deployment of high-impact, low-cost interventions that match local capacity and resources.

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