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Species Richness of Avifauna in the Agusan Marsh Wildlife Sanctuary, Northeastern Mindanao, Philippines

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ABSTRACT

The Agusan Marsh Wildlife Sanctuary (AMWS) plays a crucial role in preserving bird biodiversity, with 150 species documented across 18 orders, 54 families, and 115 genera from January 2023 to August 2024 in the nine Biodiversity Monitoring System sites. This avifauna diversity includes richness in the families Ardeidae (n=6), Columbidae (n=13), Rallidae (n=9), and Scolopacidae (n=9), with a 19.05% increase in recorded species since 2014. It also supports 43 endemic species (29%), of which 13 species (9%) are unique to Mindanao. Furthermore, AMWS is a significant stopover for migratory birds, with 35 migratory species (23%) reflecting its role within the East Asian-Australasian Flyway. According to the International Union for Conservation of Nature (IUCN) and the DAO 2019-09, approximately 11% of species are threatened. Specifically, 6% were vulnerable, 2% critically endangered, 1% endangered, near threatened, and Other Threatened Species (OTS). The Caimpugan Peat Swamp Forest has the highest species richness, with 80 bird species (53%). However, areas with high anthropogenic activity have fewer species, particularly in Dinagat-Mambagongon Creek. Anthropogenic activities in AMWS include hunting, timber cutting, rattan harvesting, and agricultural expansion. Effective management strategies are essential to alleviate pressures on AMWS biodiversity and support local communities, such as deputizing park rangers known as Bantay Danao to enhance the enforcement of RA 9174 and RA 11038; imposing penalties to curtail agricultural expansion in AMWS peatlands, riparian zones, and Multiple Use Zones (MUZs); executing the Special Use Agreement in Protected Areas (SAPA) when using resources is unavoidable; exploring alternative livelihoods such as community-based forest management (CBFM) and biodiversity-friendly enterprises (BDFEs); and revising land use maps while proposing legislation with explicit wetlands management guidelines, particularly for peatlands.

Keywords: *Agusan Marsh Wildlife Sanctuary, avifauna, species richness, endemic, protected area*

1 Introduction

The Philippines is identified as one of the world's most biologically rich countries in terms of the diversity of ecosystems, species, and genetics. Avian diversity in the country is among the highest in the world, where more than 7% of the land area is declared as Important Bird Areas

(IBAs) or sites that are significant for the conservation of bird populations on a worldwide scale due to the presence of threatened, endemic, and restricted-range species (Haribon Foundation 2014, Donald et al. 2018, Jensen 2018, Waliczky et al. 2018, Paguntalan et al. 2021). Among the outstanding IBAs is the Agusan Marsh Wildlife Sanctuary (AMWS) (PH085), located in the heart of the Agusan River Basin, one of the country's most ecologically significant inland wetlands.

Agusan Marsh Wildlife Sanctuary comprises a vast complex of freshwater marshes, lakes, and water courses that collectively act as catch basins for floodwaters, which regularly inundate the Agusan Valley during monsoon season and act like a giant sponge where excess water is collected at times of high flow. AMWS has been locally, nationally, and internationally recognized through its inclusion in the ASEAN Heritage Parks Network on November 8, 2018, and its designation as Ramsar Site No. 1009, "Wetland of International Importance," on November 12, 1999 (Orella et al. 2022).

Several threatened avifauna species are known to occur only on the island of Mindanao and nowhere else in the world (Nuñeza et al. 2019, Serrano et al. 2019, Matutes & Densing 2022, Villancio et al. 2022). More than 200 avifauna species are known to spend at least part of the year in the AMWS, thus making it one of Asia's essential transit points for migratory birds (DENR n.d). Despite the high concentration of endemic and restricted-range species, ornithological expeditions were few in the AMWS. These assessments were more focused on mountainous and highland protected areas in Mindanao like Mt. Pantaron (Salolog et al. 2021), Mt. Kitanglad, Mt. Apo, Mt. Hamiguitan, and Mt. Malindang (Mohagan et al. 2015). Published articles about the avifauna of the AMWS are outdated, such as those by Michaelson (1991) during the Wetland Field Survey, Sebastian & Ibañez (2004), and Sucaldito & Nuñeza (2008, 2014). The previous survey of Sucaldito & Nuñeza was on August 2005-January 2006. These are the only available information on the avifaunal community of AMWS. Nonetheless, the Protected Area Management Office of AMWS has been monitoring the population and abundance of the avifauna species consistently in the nine (9) Biodiversity Monitoring System (BMS) sites such as Lake Mihaba, Lake Kelobidan, Lake Mambagongon, Lake Panlabuhan, Lake Tugno, Dinagat – Mambagongon Creek, Sabang Gibong-Sabang – Adgaoan River, Caimpugan Peat Swamp Forest, and Sago Forest.

Recently, the AMWS was included in the tentative lists of UNESCO World Heritage Sites under criteria 9 and 10, respectively (UNESCO n.d.). Knowledge of the current population and species richness of avifauna in the AMWS is significant since updated information, especially on endemic, migratory, and threatened species, is needed in the protected area resource profile for UNESCO application. This study presents the composition and richness of avifauna species and significant new records in the AMWS, providing essential information for identifying critical habitats and species of conservation concern and providing data that will inform effective conservation strategies and management practices for the protected area.

2 Materials and Methods

Site Description and Entry Protocol

Before conducting the surveys, PAMB Resolution No. 2024-16 and prior consent from the target Local Government Units (LGUs) in Agusan del Sur has been obtained. Nine (9) sampling sites were established following the Biodiversity Monitoring System (BMS) sites of AMWS covering the six (6) municipalities such as San Francisco, Rosario, Talacogon, La Paz, Loreto, and Bunawan (Figure 1). Geographic locations were obtained by geotagging using a handheld Global Positioning System (GPS) receiver (DENR-FMB 2013) and were transformed into a digital map using the Quantum Geographic Information System (QGIS) software v3.34.7. Sampling was done from January 2023 to August 2024. The sites were categorized into (a) Lakes (Sites 1, 2, 3, 4, and 6) with open waters; (b) Rivers and creeks (Sites 7 and 8) with a definite riparian ecosystem; and (c) Peat swamp forest (Sites 5 and 9) is determined as vegetation in a peatland area.

Site 1: Lake Mihaba, Brgy. San Marcos, Bunawan, Agusan del Sur (Figure 2A)

Lake Mihaba is characterized as a permanent freshwater lake, S-shaped and elongated. The area is 8°10'41.91"N, 125°54'55.74"E with

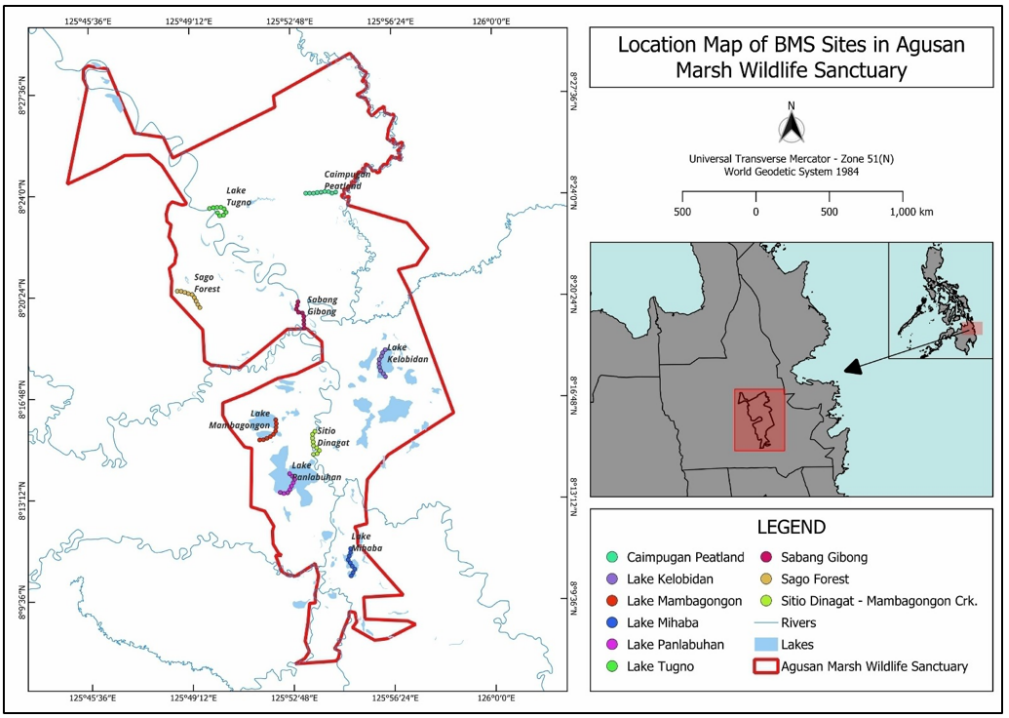

Figure 1. Map showing the BMS Sites and the sampling points within the Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines.

elevations ranging from 16-21 masl. It is 88.16 hectares with a minimum length of 520 m, a width of 500 m, and an average depth of 3 m. *Nauclea orientalis, Milletia elliptica, Mitragyna diversifolia,* and *Dillenia philippinensis* for tree species dominate its vegetation. Macrophytes observed include *Eichhornia crassipes, Phragmites australis, Ipomea aquatica, Pistia stratoites,* and *Scipiodendron gheari.* A few fish traps made with bamboo were also observed, and they were placed by the Indigenous Agusanon Manobo settling in the nearby area (approximately 1 km away). Aside from sustainable fishing, no other anthropogenic activities were inside the lake. Distance to the main population center contributed to the recede of these activities, perhaps because of logistical difficulties that are inherent therein (Gotame 2010).

Site 2: Lake Kelobidan, Brgy. Wasian and Bayugan III, Rosario, Agusan del Sur (Figure 2B)

Lake Kelobidan is characterized as a permanent freshwater lake, pear-shaped, situated at 8°16'19.8"N, 125°56'25.1"E with 21 masl approximate elevation. The lake's total area is 254 hectares and has a width of 1,100 m and a length of 2,900 m with an average depth of 2.8 m. *Nauclea orientalis, Lagerstroemia speciosa, Premna odorata*, and *Barringtonia racemosa* dominate the inundated forest on the lake shoreline, which epiphytic ferns such as *Asplenium nidus, Aglaomorpha quercifolia,* and *Stenocleana palustris* latch in. Some *Terminalia copelandii* and *Dillenia philippinensis* were observed in the outflow and inflow of the lake. *Salvinia molesta, Pistia stratoites*, and *Eichhornia crassipes* increased on the surface, covering 15% of the lake's total area. A few fishermen, Agusanon Manobo, were observed fishing using nets and modified fishing rods. The floating community of Sitio Ticgon is about 3 kilometers from the site, accessible only by a tiny pump boat or canoe. The lake water smells awful, particularly in the outflow, due to decaying plant matter mixed with oil spills from the pump boats. Prunings of naturally grown *Nauclea* and sometimes cuttings were also observed mainly on the cruise trail.

Site 3: Lake Mambagongon, Sitio Mambagongon, Brgy. Poblacion, La Paz, Agusan del Sur (Figure 2C)

Lake Mambagongon is also one of the elongated permanent freshwater lakes in AMWS.

It is situated at 8°16'36.25"N, 125°52'52.46"E, with a total area of 265.92 hectares. Elevation ranges from 16-21 masl. The length is 672 m, a width of 948 m, and an average depth of 2.51 m. Twenty-five floating households are within the lake, mainly Agusanon Manobo. *Nauclea orientalis* and *Mitragyna diversifolia* species had stunted growth near the settlement and almost no canopy. It may also be attributed to the lake's deep waters since floating houses were established in much deeper water for it to be buoyant. Several cuttings of trees were recorded in the inundated forest dominated by *Garcinia rubra, Spondias pinnata, Hibiscus tiliaceus,* and *Syzygium* sp., 1-2 km away from the settlements, indicating anthropogenic disturbance. *Lycopodium squarrosum* also dominated the epiphytes aside from *Stenochleana palustris* and *Aglaomorpha quercifolia.* Observed grasses and herbaceous plants include *Ageratum conyzoides, Scleria scrobiculata,* and *Hyptis brevipes. Pistia stratoites, Eichhornia crassipes, Ipomea aquatica,* and *Hydrilla verticillata* were some of the macrophytes observed. Several fishing boats and traditional fish traps made from bamboo called Bobo were also documented. The same is true of other lakes; they also suffer from the proliferation of Eichhornia species blocking several cruise trails.

Site 4: Lake Panlabuhan, Sitio Panlabuhan, Brgy. Poblacion, Loreto, Agusan del Sur (Figure 2D)

Lake Panlabuhan is a circular permanent freshwater lake. It is a lake system in Sitio Panlabuhan in the Loreto municipality composed of Lake Bukogon, Kanimbaylan, Kubasayon, and Dinagat (Apdohan et al. 2021). It is located within the geographic coordinates of 8°13'58.45"N, 125°52'48.30"E, with a total area of 513.3 hectares. It is approximately 34 meters above sea level. The length is 1.63 km, a width of 1.51 km, and an average depth of 4 m. The canoe is the primary transportation method because gas boats are prohibited inside the lake. Thirty-six households of Agusanon Manobo were inside the lake, adapting to life above water. They also strictly conserve the area for their cultural heritage. It is also one of the ecotourism sites of Agusan Marsh Wildlife Sanctuary for its cultural immersion in floating villages. One feature of this lake is its inundated dying forest, which woodpeckers inhabit. *Nauclea orientalis, Hibiscus tiliaceus, Mitragyna diversifolia,* and *Kleinhovia hospital* dominated the tree species. Trees do not have any or a little canopy left, and fern epiphytes such as *Aglaomorpha, Nephrolepis,* and *Stenochleana* latched on their branches. Some macrophytes observed were *Nymphaea lotus, Ipomoea aquatica, Salvinia natans, Salvina molesta,* and *Hydrillia verticillata*. The proliferation of *Salvinia*, along with *Echhornia* and *Pistia*, is also observed.

Site 5: Lake Tugno, Brgy. La Flora, Talacogon, Agusan del Sur (Figure 2E)

Lake Tugno is a horseshoe-shaped oxbow lake. It is a remnant of the bend in the Agusan River. It is also classified as Stillwater Lake because it lacks inflow or outflow and is not nourished by a stream or spring. There is no natural outlet, and it often dries up during summer. It is between 8°23'29.7"N and 125°50'15.1"E with a total area of 15.5 ha, 21 masl approximate elevation. It has a width of 92 meters, a length of 1,400 m, and an average depth of 1.15 m. The water is tea-colored, one of the characteristics of an area forming a peatland. *Nauclea orientalis* and *Mitragyna diversifolia* dominated the lake shore with minimal Ficus species. Herbaceous plants such as *Cyperus compactus, Eleocharis* sp., *Mapania sumatrana, Lepironia articulata,* and *Scleria scrobiculata* also dominated the area. It is also observed that only *Nephrolepis bisserata* is present among the ground pteridophytes, while *Stenochleana palustris* is for the fern epiphytes. Traditional fish traps were also observed mainly for mudfish. Minimal *Echhornia* is present but already dried due to the lowering of the lake's water level.

Site 6: Caimpugan Peat Swamp Forest, Brgy. Caimpugan, San Francisco, Agusan del Sur (Figure 2F)

The Caimpugan Peat Swamp Forest is the sole intact peat swamp forest in the Philippines, encompassing approximately 5,630 hectares at coordinates 8°24'53.16"N, 125°53'5.99"E, with an elevation ranging from 80 to 90 masl. It is situated between the Gibong and Agusan Rivers. This peatland is categorized into various vegetation zones based on the zonal edaphic composition of the peat and height, diameter, and growth form (Orella et al. 2022). Five (5) distinct vegetation zones are recognized: Tall-pole Forest, Short-pole Forest, Stunted Forest zone, Ferns and lycopods vegetation zone, and Sedge vegetation zone. The Tall Pole Forest can be observed around

1.2 km from the Gibong River. Stilted-rooted species characterize this zone, predominantly *Tristianopsis micrantha, Ternstroemia philippinensis, Mangifera caesia,* and *Calophyllum sclerophyllum.* The tree species in this zone reached heights up to 30 m or more (Aribal et al. 2017). The Short-pole Forest is characterized by a gradual decrease in height (5-25 m). *Tristianopsis* and other associated trees primarily dominate it, such as *Calophyllum, Fagraea, Palaquium, Ardisia,* and *Baccaurea*. The Stunded forest zone is characterized by pygmy trees at the center of the peatland, which is permanently inundated with water. The dominant species are still *Tristianopsis*, and the most common constituent trees such as *Calophyllum sclerophyllum, Ilex cymosa, Fagraea racemosa, Syzygium tenuirame,* and *Polyscias aherniana.* The forest was also open enough to allow significantly thick growth of *Pandanus* sp. and the climbing fern *Stechnochlaena palustris*. The forest is also constantly confronted with threats of degradation primarily driven by socio-economic activities and population growth, which include competing land claims, land-use conversion, timber poaching, and establishment of drainage canals. Remnants of peat fire are also recorded.

Site 7: Dinagat- Mambagongon Creek, Sitio Dinagat, Brgy. San Marcos, Bunawan, Agusan del Sur (Figure 2G)

The creek is a rivulet with minimal corn agriculture at 8°16'9"N, 125°53'37"E. Elevation ranges from 83-92 masl. Human settlements were along the creek of at least 20 households. The riparian ecosystem is dominated by *Nauclea orientalis, Ficus* sp., and *Mitragyna diversifolia f*or tree species. Grasses, such as *Apluda, Aristida*, and *Hymenachne*, dominate the ground cover. Shrubs, such as *Melastoma malabathricum, Melicope triphylla, Premna odorata,* and *Leea* sp., were also observed, as well as ground ferns such as *Diplazium esculentum, Lygodium circinnatum, Pteridium aquilinium,* and *Nephrolepis bisserata.* Human disturbance is evident in areas such as solid waste mismanagement, unsanitary disposal of livestock wastes, cutting *Nauclea* for firewood, and clearing the riparian ecosystem for corn agriculture. There are no records for *Echhornia crassipes,* but the abundance of *Salvinia molesta* and *Salvinia natans* increases on the edge of the creek where the current is slow.

Sitio 8: Sabang Gibong-Sabang Adgaoan River, Brgy. Sabang Gibong, Talacogon and Brgy. Sabang Adgawan, La Paz (Figure 2H)

The Sabang Gibong-Sabang Adgaoan River is a segment of the Agusan River, situated at coordinates 8°13'47"N, 125°53'56"E, with an approximate elevation of 18 masl. It is approximately 50-100 meters from the central barangay of Sabang Adgawan, comprising at least sixty (60) households. This segment is identified as a riparian ecosystem that was developed for corn cultivation. The cornfield measures approximately 1.5 km between the opposing riverbanks and is 5 m from the riverbank. There were remaining trees of at most 11 individuals of *Nauclea orientalis* only and no other tree species. Shrubs in the area include *Melastoma malabathricum, Allophyllus cobbe, Stachytarpheta jamaicensis,* and *Sida rhombifolia*. Along with agriculture, high-level anthropogenic disturbances were recorded, such as livestock farming of pigs, chickens, and ducks with unsanitary wastewater disposal, mismanagement of solid waste, construction of electrical posts and wire connections, and minimal oil spills from pumpboats. Due to the strong river water current, no macrophytes were recorded.

Site 9: Sago Forest, Brgy. Desamparados, Talacogon (Figure 2I)

The Sago Forest is identified as a peatland ecosystem within AMWS, encompassing approximately 1,500 hectares. It is located at 8°20'2.68"N, 125°49'31.68"E. The elevation varies from 85 to 98 masl, characterized by a waterlogged peat forest predominantly composed of sago palm (Metroxylon sagu). *Terminalia copelandii*, *Ficus* sp., and *Lagerstroemia speciosa* were observed in the nearby Sitio Bataran, the nearest community in the peatland. Grasses, such as *Hymenache amplexicaulis, Isachne globosa, Ophiuros exaltatus, Paspaslum scrobiculatum,* and *Apluda mutica*, dominated the ground cover. *Hoya myrmecopa, Hoya merrillii,* and *Hoya siariae* are also abundant in the area as epiphytes, together with pteridophytes like *Aglaomorpha quercifolia, Asplenium nidus, Asplenium polyodon, Anthrophyum reticulatum,* and *Pyrrosia piloselloides*. A few animal and fish traps were documented, and minimal tree saplings were cut, primarily in the trails inside the forest. The harvesting of sago palms, one of the food sources of Agusanon Manobo, is also noted. Agricultural

expansion for rice agriculture and drainage also disturbs the area, significantly lowering the water level and altering its hydrology.

Field Sampling and Identification of Birds

Birds were listed following the Line-Transect Survey Method, which involves recording all birds seen (flying, singing, or feeding) within 20 m of both sides of at least a 2 km line-transect established at each site (Lador & Seronay 2020). Birds seen and heard calling were recorded during the day in a prepared field datasheet using the 10 x 42 roof prism binoculars, 20 x 60-degree and 80 x 45-degree spotting scopes, and photographed using digital cameras with 800 mm telephoto lenses. The line transect was divided into nine stations at a distance of 250 m each. Geographic locations were recorded using a handheld GPS receiver and geotagging (DENR-FMB 2013). Transect cruises and walks were done early every 5:00-6:00 am when bird activity began to peak and in the late afternoon between 5:00- 6:00 pm. Observations were made for at least eight (8) minutes per station per site (Bibby et al. 2000, Lee & Marsden 2008). A total of nine (9) transects were laid around the protected area. Local guides and/or forest rangers known as Bantay Danao were considered co-researchers to capacitate local counterparts in biodiversity conservation in AWMS. These local guides were oriented on the activity's objectives while their experiences in locating and identifying birds were incorporated with the modified standard technique employed in the surveys.

Birds were identified using the photographic field guide by Kennedy et al. (2000), Strange (2015), and Allen (2020). The taxonomy and nomenclature were supported by the Handbook of Birds in the World (del Hoyo et al. 2014) and the BirdLife International Illustrated Checklist of the Birds of the World (del Hoyo & Collar 2016). Desmond Allen verified and identified the unidentified species. The conservation status and endemicity were known through DAO 2019-09 and IUCN Red List of Threatened Species version 2024-1. A Focus Group Discussion (FGD) was

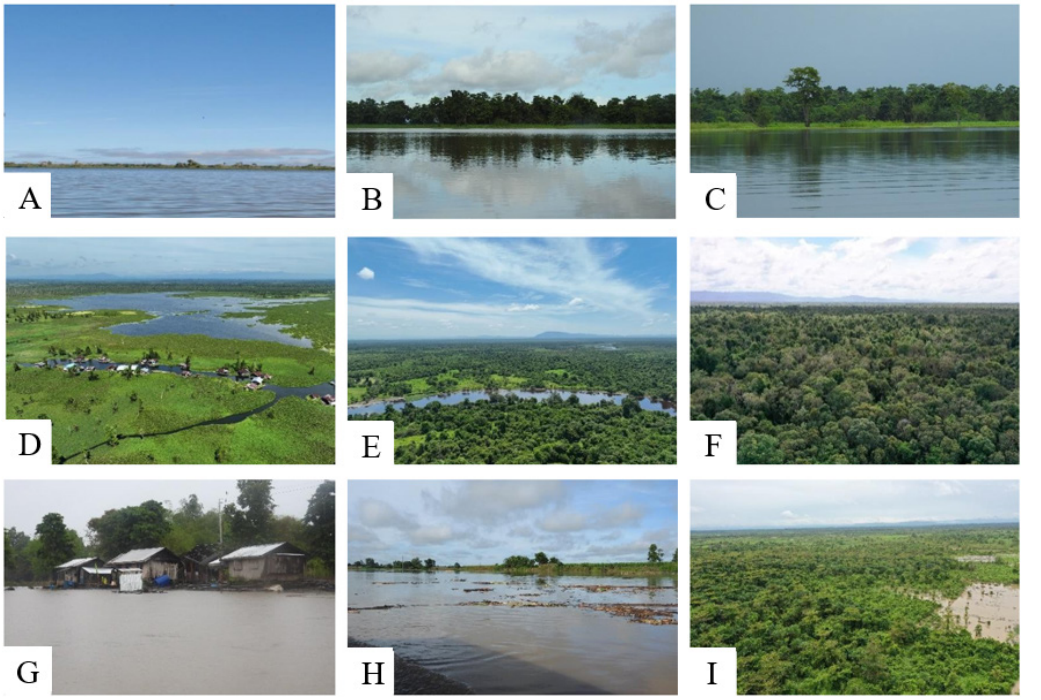

Figure 2. Landscape view of sampling sites within the Agusan Marsh Wildlife Sanctuary (AMWS), illustrating the diverse ecological features of key areas: A) Lake Mihaba, B) Lake Kelobidan, C) Lake Mambagongon, D) Lake Panlabuhan, E) Lake Tugno, F) Caimpugan Peat Swamp Forest, G) Dinagat-Mambagongon Creek, H) Sabang Gibong-Sabang Adgawan River, and I) Sago Forest.

conducted with the designated Community Monitoring Group (CMG) of AMWS, comprising 122 individuals, including Indigenous Peoples and tenured migrants. Results of FGD provided supplementary data and insights on the possible threats to biodiversity around the AMWS.

3 Results and Discussion

Composition, Richness, Conservation Status, and Endemicity

Eighteen orders, 54 families, 115 genera, and 150 avifauna species were documented in the Agusan Marsh Wildlife Sanctuary (AMWS) from January 2023 to August 2024. The family Ardeidae had the highest species richness with 16 species, followed by families Columbidae (n=13), Rallidae and Scolopacidae (n=9), and Accipitridae and Cuculidae (n=7). Conversely, the most represented genera were *Ardea* (n=4), *Diceaum* (n=4), and *Ixobrychus* (n=4), followed by *Amaurornis, Ducula, Lonchura, Phapitreron*, and *Tringa* (n=3, respectively). The number of species documented constitutes about 21.43% of the 700 identified avifauna in the Philippines (Jensen et al. 2018) (Table 1). It is more than three-fourths (76.53%) of the total 196 bird species in the Eastern Mindanao Biodiversity Corridor (EMBC). Compared to the list of Sucaldito & Nuñeza (2014), there is an increase of 19.05% in terms of species richness. Additionally, the proportion of endemic (17.84%) and threatened (9.34%) is relatively low compared to the Philippine avifauna, which can be attributed to the high number of migratory birds since wetland habitats offer abundant resources like food and resting areas that are particularly suited to migratory birds (Beatty et al. 2014). Most of the Philippine endemic birds are forest-dependent, which can be found in the highland or isolated forest ecosystems rather than in lowland wetland areas like the AMWS (Fjeldså & Bowie 2021). Table 2 shows the comprehensive list of the avifauna recorded in AMWS for the migratory and non-migratory season (2023-2024).

The total number of avifauna documented in AMWS is 54.56% greater than that of Olango Island Wildlife Sanctuary (OIWS) (n=97), a Ramsar site and one of the East Asian-Australasian Flyway (EAAF) Network in the Philippines (Xu & Xu 2018). By the East Asian-Australasian Flyway Partnership (EAAFP), specifically the criteria for membership in the EAAF Network, over 20,000 individual migratory birds have been regularly documented in OIWS, with key EAAFP species such as the Curlew sandpiper, Red knot, Great knot, Chinese crested tern, and Chinese egret being regularly observed (EAAFP n.d). Conversely, AMWS lacks a thorough enumeration of the migratory bird population in the region. If the PAMO of AMWS intends to pursue inclusion in the EAAF Network sites, they should concentrate on the criteria indicating that AMWS consistently supports over 1% of the individuals in a population of a specific migratory waterbird species or subspecies. Moreover, the Caimpugan Peat Swamp Forest has 17.91% (n=79) more bird species than the Leyte Sab-a Basin Peatland (n=67) (Matutes & Densing 2022).

The noted increase in species richness in this study may have been influenced by the survey duration, quantity of sites, and improved management of AMWS. Sulcadito & Nuñeza (2014) conducted sampling for 6 months at four sites, from August to January. This period also marks the migratory season. This duration is commendable; however, it may not encompass species that might prefer to migrate to AMWS from other wetland regions in the Philippines during February or document the early migration in July. This study's prolonged two-year survey period (2023-2024), encompassing both migratory and non-migratory seasons enables more comprehensive documentation of species that may be seasonally absent or less discernible in shorter studies.

Table 1. Comparison of bird species in the Philippines, EMBC, and Agusan Marsh Wildlife Sanctuary (AMWS). Fieldwork data in AMWS (Sumilhig et al. 2023-2024).

	Philippines (Jensen, 2018)	Eastern Mindanao Biodiversity Corridor (EMBC) (PEF, CI, & DENR, 2008)	Agusan Marsh Wildlife Sanctuary (AMWS)	
			Sucaldito & Nuneza, 2014	2024
No. of species	700	196	126	150
No. of endemic species	241	91	31	43
No. of threatened species	182	22	7	17

Table 2. Species composition and remarks of newly recorded avifauna in the Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines.

Species Name	Common Name	Local Name	Conservation Status ([a]=IUCN; [b]=DAO 2019-06)	Endemicity	Sampling Sites/ BMS Sites in Agusan Marsh Wildlife Sanctuary (AMWS)								
					Lake Mihaba	Lake Kelobidan	Lake Mambagongon	Lake Panlabuhan	Caimpugan Peat Swamp Forest	Lake Tugno	Dinagat-Mambagongon Creek	Sabang-Gibong-Sabang Adgawan	Sago Forest
Order ACCIPITRIFORMES													
Family **Accipitridae**													
Accipiter trivirgatus (↓)	Crested Goshawk	Banog	LC[a]	Scarce Resident						■			
Butastur indicus (↓)	Grey-faced Buzzard	Sawi	LC[a]	Migrant					■				
Haliaeetus leucogaster (↓)	White-bellied Sea-eagle	Mana-o	LC[a]	Resident	■								
Haliastur indus (↓)	Brahminy Kite	Banog	LC[a]	Resident	■	■	■	■	■	■	■		
Icthyophaga ichthyaetus (↓)	Grey-headed Fish-eagle	Mana-o	NT[a], VU[b]	Rare Resident		■	■	■		■			
Pernis steerei (↓)	Philippine Honey-buzzard	Banog	LC[a]	Endemic					■				
Spilornis holospilus (↓)	Philippine Serpent-eagle	Mana-o, Sikop	LC[a]	Endemic	■	■	■	■	■	■			■
Family **Pandionidae**													
Pandion haliaetus (↑)	Osprey	Agila, Banog	LC[a]	Migrant	■	■	■						
Order ANSERIFORMES													
Family **Anatidae**													
Anas acuta (↓)	Northern Pintail	Duyang	LC[a]	Migrant	■								
Anas luzonica (↓)	Philippine Duck	Kaging-king	VU[ab]	Endemic	■	■		■				■	
Aythya fuligula (—)	Tufted Duck	Pato	LC[a]	Migrant	■		■	■		■			
Dendrocygna arcuate (↓)	Wandering Whistling-duck	Gakit	LC[a]	Resident	■	■		■		■	■		
Spatula querquedula (↓)	Garganey	Paitan	LC[a]	Migrant			■						
Order BUCEROTIFORMES													
Family **Bucerotidae**													
Penelopides affinis (↓)	Mindanao Hornbill	Tariktik	LC[a], EN[b]	Endemic	■	■	■	■	■	■	■		■
Rhabdotorrhinus leucocephalus (↓)	Writhed Hornbill	Tariktik	VU[ab]	Endemic					■				
Order CAPRIMULGIFORMES													
Family **Apodidae**													
Collocalia esculenta (—)	Glossy Swiftlet	Sayaw	LC[a]	Resident		■	■						■
Family **Caprimulgidae**													
Lyncornis macrotis (—)	Great-eared Nightjar	Kanda-rapa, Tagoli-long	LC[a]	Resident		■	■						■
Family **Podargidae**													
Batrachostomus septimus (↓)	Philippine Frogmouth	Buho, Tagak	LC[a]	Endemic					■				
Order CHARADRIIFORMES													
Family **Charadriidae**													
Pluvialis squatarola (↓)	Grey Plover	Tarinting	LC[a]	Migrant				■	■				
Family **Jacanidae**													
Hydrophasianus chirurgus (?)	Pheasant-tailed Jacana	Pang-ag	LC[a]	Resident				■					

Continuation. Table 2. Species composition and remarks of newly recorded avifauna in the Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines.

Species Name	Common Name	Local Name	Conservation Status ([a]=IUCN; [b]=DAO 2019-06)	Endemicity	Sampling Sites/ BMS Sites in Agusan Marsh Wildlife Sanctuary (AMWS)								
					Lake Mihaba	Lake Kelobidan	Lake Mambagongon	Lake Panlabuhan	Caimpugan Peat Swamp Forest	Lake Tugno	Dinagat-Mambagongon Creek	Sabang-Gibong-Sabang Adgawan	Sago Forest
Order CHARADRIIFORMES													
Family **Laridae**													
Chlidonias hybrida (—)	Whiskered Tern	Buwang, Taga-dagat	LC[a]	Migrant	■	■	■	■		■	■	■	■
Sterna hirundo (?)	Common Tern	Buwang, Taga-dagat	LC[a]	Migrant		■	■	■				■	
Family **Recurvirostridae**													
Himantopus himantopus (↑)	Black-winged Stilt	Agatsona	LC[a]	Migrant	■				■				
Himantopus leucocephalus (↑)	Pied Stilt	Tiki, Tuklong	LC[a]	Migrant	■	■	■	■	■	■			
Family **Rostratulidae**													
Rostratula bengha-lensis (?)	Greater Painted-snipe	Pakubo	LC[a]	Resident	■								
Family **Scolopacidae**													
Actitis hypoleucos (↓)	Common Sandpiper	Til-aw, Tung-aw	LC[a]	Migrant					■				
Charadrius dubius (—)	Little Ringed Plover	Taringting	LC[a]	Migrant	■		■	■					
Gallinago gallinago (↓)	Common Snipe	Pat-ing	LC[a]	Migrant					■				
Gallinago megala (?)	Swinhoe's Snipe	Pat-ing	LC[a]	Migrant	■	■					■		■
Numenius phaeopus (↓)	Eurasian Whimbrel	Balang -kawitan	LC[a]	Migrant	■	■	■						
Pluvialis fulva (↓)	Pacific Golden Plover	Pulgon	LC[a]	Migrant		■		■					
Tringa glareola (—)	Wood Sandpiper	Til-aw, Tung-aw	LC[a]	Migrant	■	■	■	■	■			■	■
Tringa nebularia (—)	Common Green-shank	Til-aw	LC[a]	Migrant		■	■	■					
Tringa stagnatilis (↓)	Marsh Sandpiper	Til-aw, Tung-aw	LC[a]	Migrant	■						■		
Order COLUMBIFORMES													
Family **Columbidae**													
Chalcophaps indica (↓)	Grey-capped Emerald Dove	Agbaan, Manatad	LC[a]	Resident					■				
Columba vitiensis (—)	Metallic Pigeon	Tukmo	LC[a]	Resident					■				
Ducula aenea (↓)	Green Imperial-pigeon	Kalapati	NT[a]	Scarce Resident		■	■	■					■
Ducula pickeringii (↓)	Grey Imperial-pigeon	Kalapati	LC[a]	Near Endemic					■	■			
Ducula poliocephala (↓)	Pink-bellied Imperial-pigeon	Alimokon, Manatad	NT[a], CR[b]	Endemic	■								
Geopelia striata (—)	Zebra Dove	Alimokon, Bato- bato	LC[a]	Resident				■	■	■		■	
Macropygia tenuirostris (↓)	Philippine Cuckoo- dove	Kokok	LC[a]	Resident		■	■						
Phapitreron amethystinus (↓)	Amethyst Brown- dove	Tukmo, Alimokon	LC[a], CR[b]	Endemic	■			■	■				■
Phapitreron brevirostris (↓)	Short-billed Brown- dove	Alimokon	LC[a]	Endemic	■	■	■	■	■	■	■	■	■

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Order COLUMBIFORMES													
Family **Columbidae**													
Phapitreron leucotis (↓)	White-eared Brown Dove	Alimokon	LC[a]	Endemic		■	■	■	■				■
Ramphiculus leclancheri (↓)	Black-chinned Fruit-dove	Paloma	LC[a]	Near Endemic								■	
Spilopelia chinensis (↑)	Eastern Spotted Dove	Kalapati	LC[a]	Resident	■		■		■	■	■	■	■
Streptopelia tranquebarica (↓)	Red Turtle Dove	Tukmo, Alimokon	LC[a]	Resident	■	■		■		■		■	
Treron axillaris (↓)	Philippine Green- pigeon	Punay	LC[a], VU[b]	Endemic	■	■	■	■	■		■	■	■
Treron vernans (↓)	Pink-necked Green-pigeon	Punay	LC[a]	Resident	■	■	■	■	■	■	■	■	■
Order CORACIIFORMES													
Family **Alcedinidae**													
Alcedo atthis (↓)	Common Kingfisher	Kasay-kasay	LC[a]	Migrant	■	■				■			
Ceyx argentatus (↓)	Southern Silvery Kingfisher	Kasay-kasay, Sibit	NT[a], VU[b]	Endemic		■				■			
Ceyx mindanensis (↓)	South Philippine Dwarf-kingfisher	Tiklis, Sarig	VU[ab]	Endemic					■				
Halcyon gularis (?)	White-throated Kingfisher	Sagsag	LC[a]	Endemic		■	■	■	■	■			
Todiramphus chloris (↓)	Collared Kingfisher	Binti-binti	LC[a]	Resident	■	■	■	■	■	■	■		
Family **Meropidae**													
Merops americanus (—)	Rufous-crowned Bee eater	Tamsi-tamsi	LC[a]	Endemic					■				■
Merops philippinus (—)	Blue-tailed Bee eater	Tamsi-tamsi	LC[a]	Resident			■		■		■		
Order CUCULIFORMES													
Family **Cuculidae**													
Cacomantis merulinus (—)	Plaintive Cuckoo	Buwaw, Pook	LC[a]	Resident	■				■	■			■
Cacomantis variolosus (↓)	Brush Cuckoo	Buwaw, Pook	LC[a]	Resident				■	■	■			
Centropus melanops (↓)	Black-faced Coucal	Kokok, Ubon-ubon	LC[a]	Endemic					■	■			■
Centropus viridis (—)	Philippine Coucal	Kokok, Ubon-ubon	LC[a]	Endemic	■	■	■	■	■	■	■		■
Chalcites minutillus (—)	Little Bronze-cuckoo	Tuko-tuko, Kulikuli	LC[a]	Resident					■	■			
Eudynamys scolopaceus (—)	Western Koel	Kuh-uh, Kaw- kaw	LC[a]	Resident	■	■	■						
Surniculus velutinus (↓)	Philippine Drongo- cuckoo	Ku-ol	LC[a]	Endemic					■				

Continuation. Table 2. Species composition and remarks of newly recorded avifauna in the Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines.

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Order FALCONIFORMES													
Family **Laridae**													
Falco pere-grinus (↑)	Peregrine Falcon	Agilang-gamay	LC[a]	Migrant			■						
Order GALLIFORMES													
Family **Phasianidae**													
Gallus gallus (↓)	Red Jun-glefowl	Manok ihalas	LC[a]	Resident						■			■
Synoicus chinensis (—)	Asian Blue Quail	Suwa	LC[a]	Resident					■				
Order GRUIFORMES													
Family **Rallidae**													
Amaurornis cinerea (?)	White-browed Crake	Buwaw	LC[a]	Resident		■							■
Amaurornis olivacea (?)	Philippine Bush hen	Buwaw	LC[a]	Endemic						■	■		
Amaurornis phoenicurus (?)	White-breasted Waterhen	Unggas	LC[a]	Resident		■		■	■	■			
Gallicrex cinerea (↓)	Water-cock	Buwaw	LC[a]	Resident	■	■	■	■		■			
Gallinula chloropus (—)	Common Moorhen	Karab	LC[a]	Resident	■	■	■	■		■		■	■
Hypotaenidia philippensis (—)	Buff-banded Rail	Tikling	LC[a]	Resident					■			■	■
Hypotaenidia torquate (?)	Barred Rail	Tikling	LC[a]	Resident						■			
Porphyrio pulverulentus (?)	Philippine Swamphen	Tubtub	LC[a]	Endemic	■	■	■	■			■	■	■
Zapornia fusca (?)	Ruddy-breasted Crake	Buwaw	LC[a]	Resident				■					
Order PASSERIFORMES													
Family **Acanthizidae**													
Gerygone sulphurea (—)	Golden-bellied Gerygone	Ol-ul, Uwak-uwak	LC[a]	Resident		■							
Family **Acrocephalidae**													
Acrocephalus stentoreus (—)	Clamorous Reed-warbler	Kong-kong	LC[a]	Migrant			■	■	■	■	■		■
Family **Artamidae**													
Artamus leucoryn (—)	White-breasted Wood-swallow	It-it	LC[a]	Resident		■	■		■	■		■	■
Family **Campephagidae**													
Lalage nigra (↓)	Pied Triller	Salak	LC[a]	Resident	■	■				■		■	■
Family **Cisticolidae**													
Cisticola exilis (↑)	Golden-headed Cisticola	Pitpit Ko-gon, Dignos	LC[a]	Resident							■	■	■
Cisticola juncidis (?)	Zitting Cisticola	Pitpit, Barat	LC[a]	Resident						■			
Orthotomus frontalis (↓)	Rufous-fronted Tailorbird	Tirtir, Sing-sing	LC[a]	Endemic					■	■	■		
Orthotomus nigriceps (↓)	Black-headed Tailorbird	Tirtir, Sing-sing	LC[a]	Endemic						■			

Continuation. Table 2. Species composition and remarks of newly recorded avifauna in the Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines.

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Order PASSERIFORMES													
Family **Corvidae**													
Corvus macrorhynchos (↓)	Large-billed Crow	Uwak	LC[a]	Endemic		■	■			■			■
Family **Dicaeidae**													
Dicaeum australe (↓)	Red-keeled Flowerpecker	Tamsi	LC[a]	Endemic	■	■	■		■	■	■		■
Dicaeum hypoleucum (↓)	Buzzing Flowerpecker	Tamsi	LC[a]	Endemic					■				
Dicaeum pygmaeum (↓)	Pygmy Flowerpecker	Tamsi	LC[a]	Endemic					■	■			
Dicaeum trigonostigma (↓)	Orange-bellied Flowerpecker	Tamsi	LC[a]	Resident		■			■	■			■
Prionochilus olivaceus (↓)	Olive-backed Flowerpecker	Tamsi	LC[a]	Endemic					■				■
Family **Dicruridae**													
Dicrurus striatus (↓)	Short-tailed Drongo	Buwal	LC[a]	Endemic					■				
Family **Estrildidae**													
Lonchura atricapilla (—)	Chestnut Munia	Maya	LC[a]	Resident		■						■	
Lonchura leucogastra (—)	White-bellied Munia	Maya	LC[a]	Resident					■				
Lonchura punctulate (—)	Scaly-breasted Munia	Maya	LC[a]	Resident					■	■			
*Padda oryzivor*a (↓)	Java Sparrow	Mayang-kosta	LC[a]	Introduced					■				
Family **Hirundinidae**													
Hirundo rustica (↓)	Barn Swallow	Sibad, Layang-layang	LC[a]	Migrant				■	■	■	■		
Hirundo tahitica (?)	Pacific Swallow	Layang-layang	LC[a]	Resident						■			■
Family **Laniidae**													
Lanius cristatus (↓)	Brown Shrike	Tababaras	LC[a]	Migrant					■			■	
Family **Locustellidae**													
Cincloramphus timoriensis (—)	Tawny Grassbird	Tibsok	LC[a]	Resident							■		
Helopsaltes ochotensis (↓)	Middendorff's Grasshopper-warbler	Pang-pang	LC[a]	Migrant						■			
Megalurus palustris (?)	Straited Grassbird	Turtoriyok	LC[a]	Resident							■	■	
Family **Monarchidae**													
Hypothymis azurea (↓)	Black-naped Monarch	Pipit Asul	LC[a]	Resident					■	■			■
Terpsiphone cinnamomea (↓)	Southern Rufous Paradise-flycatcher	Suwal	LC[a]	Near Endemic					■	■			■
Family **Motacillidae**													
Motacilla cinerea (—)	Grey Wagtail	Niyotsiyot	LC[a]	Migrant	■								
Motacilla tschutschensis (↓)	Eastern Yellow Wagtai	Niyotsiyot	LC[a]	Migrant					■				

Continuation. Table 2. Species composition and remarks of newly recorded avifauna in the Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines.

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Order PASSERIFORMES														
Family **Muscicapidae**														
Copsychus mindanensis (↓)	Philippine Magpie-robin	Siloy, Dominiko	LC[a]	Endemic						■				
Cyornis rufigastra (↓)	Mangrove Blue-flycatcher	Mamal	LC[a]	Resident						■				
Muscicapa griseisticta (—)	Grey-streaked Flycatch-er	Mamal	LC[a]	Migrant	■			■	■					
Saxicola caprata (—)	Pied Bushchat	Siloy	LC[a]	Resident		■	■	■				■		
Family **Nectariniidae**														
Aethopyga bella (—)	Hand-some Sunbird	Tamsi	LC[a]	Endemic	■				■	■	■			■
Cinnyris jugularis (—)	Olive-backed Sunbird	Tamsi	LC[a]	Resident		■			■	■	■			■
Family **Oriolidae**														
Oriolus chinensis (↓)	Black-naped Oriole	Antolihao	LC[a]	Resident		■	■			■	■	■	■	■
Family **Passeridae**														
Passer montanus (↓)	Eurasian Tree Sparrow	Langgam-pari, Maya	LC[a]	Intro-duced					■	■				
Family **Phylloscopidae**														
Phylloscopus xanthodryas (—)	Japanese Leaf-warbler	Tingting, Liwliwa	LC[a]	Migrant	■									
Family **Pittidae**														
Pitta sordida (↓)	Western Hooded Pitta	Pita-pita	LC[a]	Resident					■	■				■
Family **Pycnonotidae**														
Hypsipetes philippinus (—)	Philippine Bulbul	Tagmaya	LC[a], OTS[b]	Endemic						■			■	■
Pycnonotus goiavier (↑)	Yellow-vented Bulbul	Pirok-pirok	LC[a]	Resident		■	■	■	■	■	■	■	■	■
Family **Rhipiduridae**														
Rhipidura nigritorquis (↓)	Philippine Pied Fantail	Tarerekoy	LC[a]	Endemic		■	■		■	■	■			■
Family **Sturnidae**														
Aplonis panayensis (—)	Asian Glossy Starling	Galan-syang	LC[a]	Resident				■					■	
Sarcops calvus (↓)	Coleto	Sal-ing		Endemic					■	■				■
Family **Timaliidae**														
Macronus striaticeps (↓)	Brown Tit-babbler	Mang-mang	LC[a]	Endemic	■								■	■
Order PELECANIFORMES														
Family **Ardeidae**														
Ardea alba (?)	Great White Egret	Tulabong	LC[a]	Migrant	■	■	■	■	■	■	■	■	■	■
Ardea cinerea (?)	Grey Heron	Tugak	LC[a]	Migrant				■	■	■				
Ardea intermedia (↓)	Intermediate Egret	Tulabong	LC[a]	Migrant	■	■	■	■	■	■	■	■	■	■
Ardea purpurea (↓)	Purple Heron	Tugak	LC[a]	Resident	■	■	■	■	■	■	■	■	■	■
Ardeola speciosa (?)	Javan Pond-heron	Lapay	LC[a]	Resident	■	■	■	■	■	■	■	■	■	■

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Order PELECANIFORMES													
Family **Ardeidae**													
Bubulcus ibis (↑)	Cattle Egret	Tugak	LC[a]	Resident		■	■	■				■	
Butorides striata (—)	Green-backed Heron	Lapay, Kuhaw	LC[a]	Resident		■	■			■			
Egretta garzetta (↓)	Little Egret	Tulabong, Tugak	LC[a]	Migrant	■	■	■	■	■	■	■	■	■
Egretta sacra (—)	Pacific Reef-egret	Kuro-sagi	LC[a]	Resident	■								
Ixobrychus cinnamomeus (?)	Cinnamon Bittern	Lapay	LC[a]	Resident	■	■	■	■		■	■		
Ixobrychus eurhythmus (↓)	Schrenck's Bittern	Lapay	LC[a]	Migrant				■					
Ixobrychus flavicollis (?)	Black Bittern	Lapay	LC[a]	Resident	■	■	■			■			■
Ixobrychus sinensis (?)	Yellow Bittern	Lapay	LC[a]	Resident	■	■	■	■		■		■	
Nycticorax caledonicus (—)	Rufous Night-heron	Lapay	LC[a]	Resident	■	■	■	■		■			
Nycticorax nycticorax (↓)	Black-crowned Night-heron	Lapay	LC[a]	Resident		■			■			■	
Family **Threskiornithidae**													
Plegadis falcinellus (↓)	Glossy Ibis	Tugak	LC[a]	Rare Resident					■				
Order PICIFORMES													
Family **Megalaimidae**													
Psilopogon haemacephalus (↓)	Copper-smith Barbet	Pokpok	LC[a]	Resident	■				■				
Family **Picidae**													
Chrysocolaptes lucidus (↓)	Buff-spotted Flame-back	Piko-piko	LC[a]	Endemic					■				
Dryocopus javensis (↓)	White-bellied Wood-pecker	Tugatiti, Katiktik	LC[a]	Resident					■	■			■
Mulleripicus fuliginosus (↓)	Southern Sooty Wood-pecker	Tugatiti, Katiktik	VU[a]	Endemic			■						
Picoides maculatus (↓)	Philippine Pygmy Wood-pecker	Pokpok, Balalatok	LC[a]	Endemic					■	■			■
Order PSITTACIFORMES													
Family **Psittacidae**													
Loriculus philippensis (↓)	Philippine Hanging-parrot	Kusi	LC[a], CR[b]	Endemic	■	■	■		■	■			■
Prioniturus discurus (↓)	Blue-crowned Racquet-tail	Kilit	LC[a], OTS[b]	Endemic									■
Bolbopsittacus lunulatus (↓)	Guaiabe-ro	Butitok	LC[a]	Endemic	■	■			■	■	■		
Order STRIGIDAE													
Family **Strigidae**													
Otus everetti (↓)	Mindanao Lowland Scops-owl	Kuwago, Saw- saw	LC[a]	Endemic					■				■
Ninox spilocephala (↓)	Mindanao Boobook	Kuwago	NT[a], VU[b]	Endemic			■						
Family **Tytonidae**													
Tyto longimembris (↓)	Eastern Grass-owl	Saw-saw	LC[a]	Resident					■				■

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Order SULIFORMES													
Family **Anhingidae**													
Anhinga melanogaster (↑)	Oriental Darter	Kasili-silihon	NT[a], VU[b]	Rare Resident			■						
Family **Palacrocoracidae**													
Phalacrocorax carbo (↑)	Great Cormorant	Tiong	LC[a]	Migrant		■							
Order TROGONIFORMES													
Family **Trogonidae**													
Harpactes ardens (↓)	Philippine Trogon	Ibong Adarna	LC[a]	Endemic					■				
				Total Number of Species per Site	54	64	55	51	79	68	33	34	52

Note: Areas with black ink indicate the presence of the species, while blank areas represent its absence in the area. The population trend according to the IUCN is indicated as decreasing (↓), increasing (↑), and stable (—). Conservation statuses: CR=Critically Endangered; VU=Vulnerable; EN=Endangered; NT=Near Threatened; OTS=Other Threatened Species.

This approach is particularly crucial for migratory species that inhabit the sanctuary during specific times of the year. Increasing the number of survey locations from four (across two municipalities) to nine (spanning six municipalities) inherently enhances the probability of encountering a wider array of species, particularly those that may be localized or specific to particular habitats. The expanded geographic coverage improves the representativeness of the biodiversity assessment. Magurran & McGill (2011) underscore the significance of temporal and spatial sampling strategies in precisely evaluating biodiversity, illustrating that prolonged sampling durations can effectively capture seasonal and annual fluctuations in species composition. Guillera-Arroita et al. (2014) also underscore the significance of survey duration in precisely estimating species occupancy and detectability, indicating that extended sampling periods can enhance the reliability of biodiversity assessments. Yoccoz et al. (2012) support the assertion that prolonged monitoring is essential for identifying temporal trends in species richness and comprehending ecological dynamics over time. Moreover, following the enactment of AMWS under the ENIPAS Act of 2018, improved management strategies, including rigorous enforcement of conservation regulations, habitat restoration efforts, and community involvement, could foster a more robust ecosystem, promoting increased species diversity and abundance.

Based on the recorded species, 43 (29%) are endemic to the Philippines. Of these, 13 species (9%) are Mindanao endemics (Figure 3). With about one-third of its species found only in the Philippines, the protected area plays a vital role in preserving the country's unique biodiversity. According to Ibañez (2010), the high concentration of endemic species entails the significance of an area inhabited by unique animals. A total of 35 species (23%) recorded in the area are migratory, a relatively high number compared to the nearest highland, Mt. Hilong-Hilong, which has 16 migratory species (Gracia et al. 2021). However, Xu and Xu (2018) documented 48 migratory bird species in OIWS, which is 37.14% more than in AMWS. Despite this, the findings highlight AMWS's importance as part of broader migratory routes, particularly for the East Asian-Australasian Flyway Partnership (EAAFP). Among the 67 resident species in AMWS, 41% are common residents, 2% are rare residents, and 1% are scarce residents, further emphasizing its ecological significance.

On the other hand, about 11% (n=16) of these birds fall in the threatened classification based on IUCN and DAO 2019-09 and consist

of 6% (n=9) vulnerable, 2% (n=3) critically endangered, 1% (n=2) near threatened,1% (n=1) in the endangered, and 1% (n=1) Other Threatened Species (OTS) classification (Figure 4). This data highlights the critical role of AMWS in supporting and potentially stabilizing these populations, making it a high-priority area for conservation efforts. Avifauna are valuable indicators of global patterns in biodiversity conservation due to their high sensitivity to environmental changes, and they are also used as indicator species to monitor ecosystem health (Mallari et al. 2001, Mekonen 2017) and the presence of these threatened birds in AMWS may reflect broader environmental pressures such as habitat loss, pollution, climate change, and resource scarcity (Dutta 2017). The records of threatened species are also the starting points in prioritizing management and conservation plans and strategies in this protected area.

Variations in the species composition and richness were also observed across the nine (9) BMS Sites in AMWS. Figure 5 shows that Caimpugan Peat Swamp Forest documented the highest bird species (n=80, 53%). It is followed by Lake Tugno (n=68, 45%), a peat-forming ecosystem. Species richness is also relatively high in Lake Kelobidan (n=62, 41%) and Lake Mihaba and Mambagongon (n=53, 35%). Dinagat-Mambagongon Creek recorded the least bird species (n=33, 22%), which can be attributed to the significant impact of human settlement and anthropogenic activities within the riparian ecosystem of this creek. As human development fragments the habitat, birds struggle to access the resources they need for feeding and migration (Boesing et al. 2020). The continuing degradation of the riparian vegetation can also contribute to the birds' challenges from moving to different landscapes, significantly reducing the number of species able to thrive in such fragmented habitats (Hale et al. 2014, Yurong et al. 2020). Some documented endemics, migratory, threatened, and notable resident avifauna are shown in Figures 6, 7, 8, and 9, respectively.

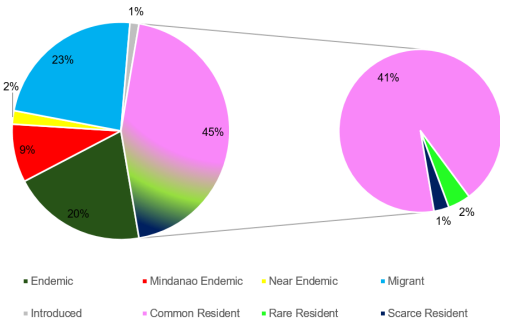

Figure 3. Geographic range description of the recorded avifauna in Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines.

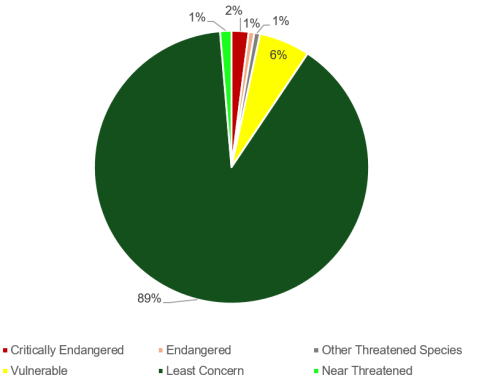

Figure 4. Conservation status of avifauna in Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines.

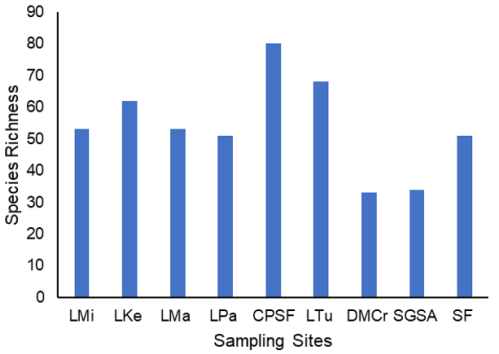

Figure 5. Species richness of avifauna in Agusan Marsh Wildlife Sanctuary (AMWS), Agusan del Sur, Caraga Region, Philippines. LMi= Lake Mihaba; LKe= Lake Kelobidan; LMa= Lake Mambagongon; LPa= Lake Panlabuhan; CPSF= Caimpugan Peat Swamp Forest; LTu= Lake Tugno; DMCr= Dinagat-Mambagongon Creek; SGSA= Sabang Gibong-Sabang Adgawan River; SF= Sago Forest.

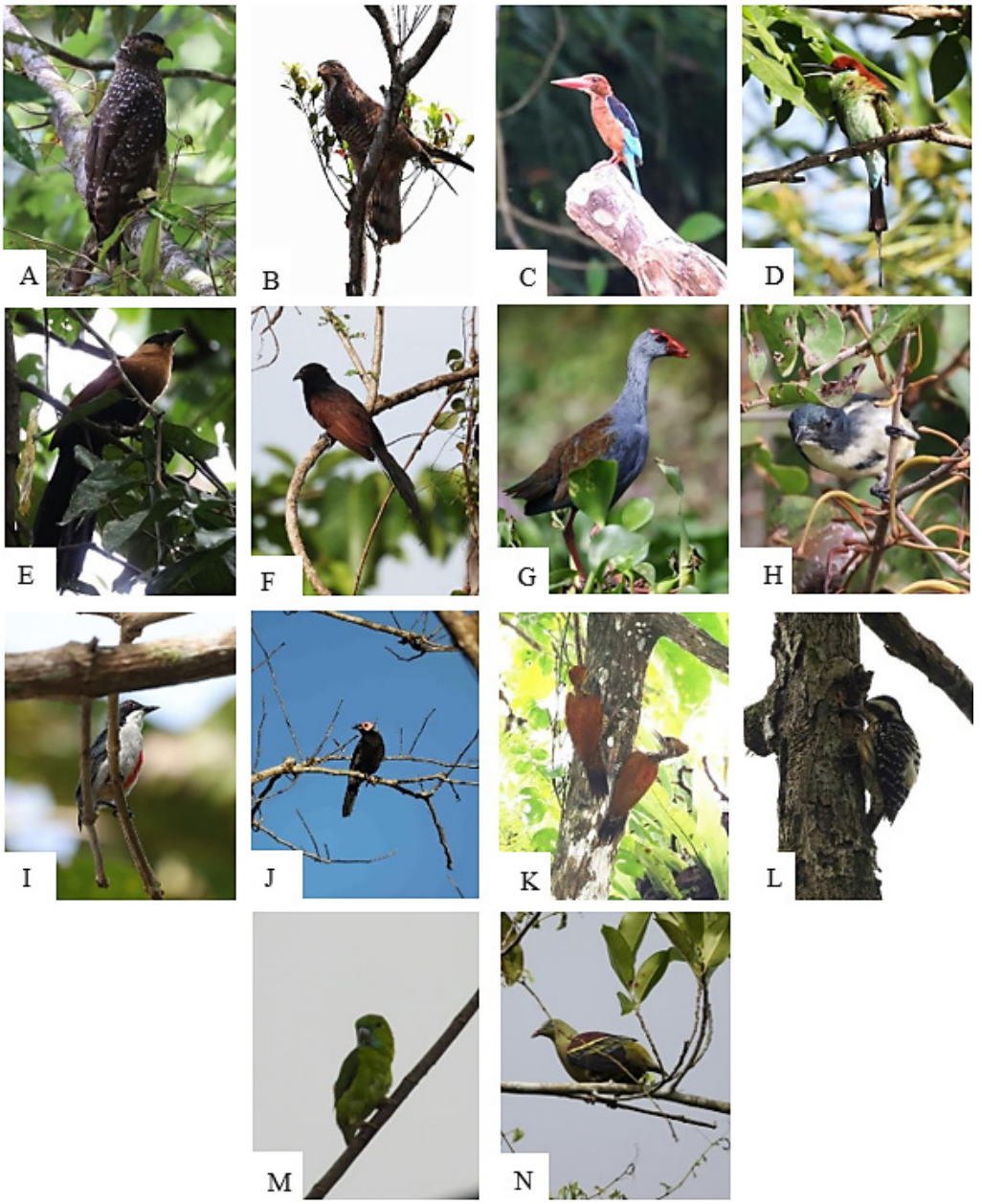

Figure 6. Some of the Philippine endemic birds recorded in Agusan Marsh Wildlife Sanctuary. A) Philippine Serpent-eagle (*Spilornis holospilus*), B) Philippine Honey-buzzard (*Pernis steerei*), C) White-throated Kingfisher (*Halcyon gularis*), D) Rufous-crowned Bee- eater (*Merops americanus*), E) Black-faced Coucal (*Centropus melanops*), F) Philippine Coucal (*Centropus viridis*), G) Philippine Swamphen (P*orphyrio pulverulentus*), H) Pygmy Flowerpecker (*Dicaeum pygmaeum*), I) Red-keeled Flowerpecker (*Dicaeum australe*), J) Coleto (*Sarcops calvus*), K) Buff-spotted Flameback (*Chrysocolaptes lucidus*), L) Philippine Pygmy Woodpecker (*Picoides maculatus*), M) Guaiabero (*Bolbopsittacus lunulatus*), and N) Philippine Green-pigeon (*Treron axillaris*).

Figure 7. Some of the migratory birds documented in Agusan Marsh Wildlife Sanctuary (AMWS). A) Grey-faced Buzzard (*Butastur indicus*), B) Osprey (*Pandion haliaetus*), C) Common Tern (*Sterna hirundo*), D) Great Cormorant (*Phalacrocorax carbo*), E) Common Sandpiper (*Actitis hypoleucos*), F) Wood Sandpiper (*Tringa glareola*), G) Pacific Golden Plover (*Pluvialis fulva*), H) Common Greenshank (*Tringa nebularia*), I) Eurasian Whimbrel (*Numenius phaeopus*), J) Common Kingfisher (*Alcedo atthis*), K) Brown Shrike (*Lanius cristatus*), L) Great White Egret (*Ardea alba*), M) Little Egret (*Egretta garzetta*), N) Grey Heron (*Ardea cinerea*), O) Intermediate Egret (*Ardea intermedia*), and P) Black-winged Stilt (*Himantopus himantopus*).

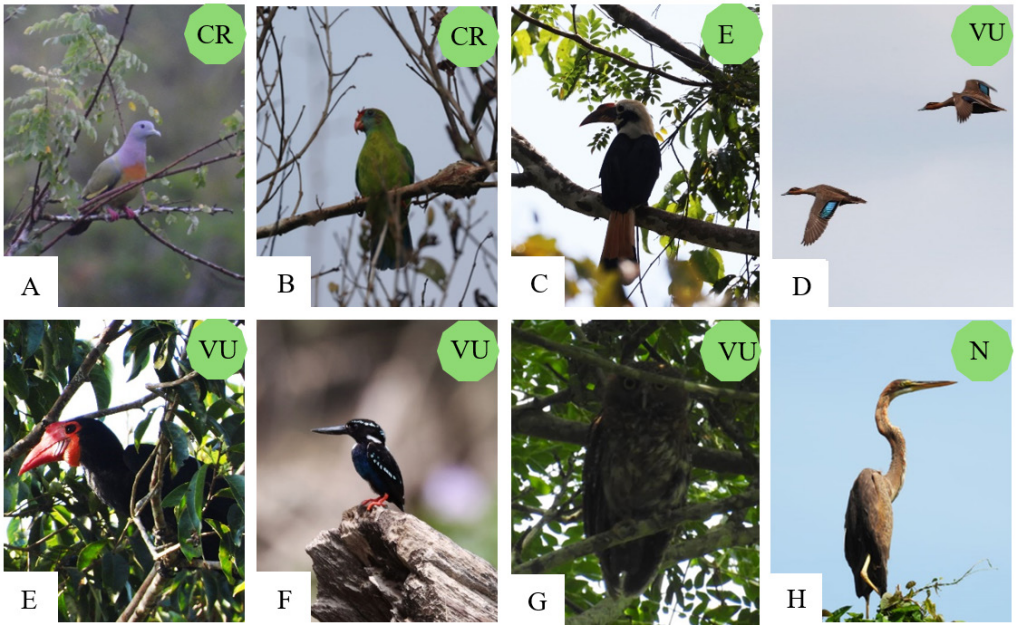

Figure 8. Some of the threatened birds documented in Agusan Marsh Wildlife Sanctuary (AMWS). A) Pink-bellied Imperial-pigeon (*Ducula poliocephala*), B) Philippine Hanging-parrot (*Loriculus philippensis*), C) Mindanao Hornbill (*Penelopides affinis*), D) Philippine Duck (*Anas luzonica*), E) Writhed Hornbill (*Rhabdotorrhinus leucocephalus*), F) Southern Silvery Kingfisher (*Ceyx argentatus*), G) Mindanao Boobook (*Ninox spilocephala*), and H) Oriental Darter (*Anhinga melanogaster*).

Threats to Biodiversity

The results of the Focus Group Discussions (FGDs) revealed that all lakes designated as BMS Sites serve as fishing grounds and primary sources of livelihood for the Agusanon Manobo. Rice and corn cultivation is typical along the riparian ecosystem in rivers and creeks within the AMWS. Wildlife hunting was prevalent across all sites, while timber cutting and harvesting other forest products, such as rattan, were common activities in the Caimpugan Peat Swamp Forest. Other concerns include the conflicting tenure around AMWS, particularly areas under the Indigenous People's claims, and the misclassification of land use, especially in peatlands. Table 3 depicts the comprehensive result of the Focus Group Discussion among the designated Community Monitoring Group (CMG) of AMWS.

Addressing the concerns and threats in AMWS is critical for protecting its biodiversity and ensuring the indigenous people's reliance on these resources for survival. Enhancing enforcement of the Wildlife Act (RA 9174) and the ENIPAS Act of 2018 (RA 11038) through the augmentation of deputized environmental law enforcement units or the deputization of park rangers known as Bantay Danao, as well as collaboration with Local Government Units (LGUs) to improve patrol systems, is a viable solution to combat illegal activities. Nonetheless, Indigenous Peoples' rights must be consistently enforced by the IPRA of 1997 (RA 8371). Sustainable fishing practices must be strictly followed by the Philippine Fisheries Code of 1998 (RA 8550) and in collaboration with the Bureau of Fisheries and Aquatic Resources (BFAR). To prevent expansion, agricultural activities in AMWS peatlands, riparian zones, and the Multiple Use Zone (MUZ) should be regulated. They can be accomplished through regular monitoring and implementing Communication, Education, and Public Awareness (CEPA) initiatives. If resource utilization is required and cannot be avoided, the Special Use Agreement for Protected Areas (SAPA) should be implemented in AMWS. Local Ordinances should also be used to enforce penalties imposed

Figure 9. Some notable resident bird species recorded in Agusan Marsh Wildlife Sanctuary (AMWS). A) Pheasant-tailed Jacana (*Hydrophasianus chirurgus*), B) Purple Heron (*Ardea purpurea*), C) Brush Cuckoo (*Cacomantis variolosus*), D) White-bellied Munia (*Lonchura leucogastra*), E) Black-naped Monarch (*Hypothymis azurea*), F) Olive-backed Sunbird (*Cinnyris jugularis*), G) Striated Grassbird (*Megalurus palustris*), H) Common Moorhen (*Gallinula chloropus*), I) Glossy Ibis (*Plegadis falcinellus*), and J) Rufous Night-heron (*Nycticorax caledonicus*).

by the LGU through the endorsement of the Protected Area Management Board (PAMB). The introduction of alternative livelihoods for the Agusanon Manobo is strongly encouraged, particularly community-based forest management (CBFM) and biodiversity-friendly enterprises (BDFEs). Engaging in dialogues to reconcile Indigenous Peoples' intellectual property rights with regulations is critical for understanding land tenure. In collaboration with the Department of Agrarian Reform (DAR) and the Department of Environment and Natural Resources (DENR), the government should prioritize revising land use maps to accurately classify wetlands and recognize peatlands, mitigating the consequences of land use misclassification. The government should also pass legislation that establishes guidelines for using and managing wetlands, particularly peatlands.

Table 3. Focus Group Discussion: Livelihood, resource use, and existing threats in Agusan Marsh Wildlife Sanctuary (AMWS).

Activity/ Concern	Description	Affected Areas	Key Stakeholders	Impact
Fishing	Source of livelihood for the Agusan Manobo	Core zones, buffer zones, designated lakes of AMWS	Agusanon Manobo, local fisher-folks, LGU	Depletion of fish stocks, overfishing concerns
Agriculture	Rice and corn cultivation along ripar-ian ecosystem; land use conversion through agricultural expansion	Waterways and Riparian Zones of AMWS	Local farmers	Soil erosion, agro-chemical pollution
Wildlife Hunting	Hunting for subsistence and economic purposes	All Biodiversity Monitoring Sites	Agusanon Manobo	Decline in wildlife population
Timber Cutting and Forest Product Harvesting	Extraction of tim-ber and non-timber products like rattan and bamboo	Caimpugan Peat Swamp Forest	Agusanon Manobo and AMWS tenured migrants	Deforestation, loss of biodiversity
Conflicting Tenure Claims	Disputes over land tenure and Indigenous People's claims	Areas under Certificate of Ancestral Domain (CADT)	Agusanon Mano-bo, DENR, DAR, NCIP	Tension between stakeholders, resource mismanagement
Land Use Misclassification	Misclassification of peatlands and oth-er critical habitats as Alieanable and Disposable land	Peatlands, Wetlands, and Riparian zones of AMWS	DAR, DENR, LGUs	Habitat degradation, improper land use
Invasive Species	Proliferation of water hyacinth	Water system and entire marsh ecosystem	DOST, DENR	Competition with native species, disruption of ecosystem

4 Conclusion and Recommendations

The Agusan Marsh Wildlife Sanctuary (AMWS) is a crucial conservation area with high species richness, serving as a key habitat for endemic, threatened, and migratory bird species. With 150 avifauna recorded, the protected area supports Philippine endemics and migratory species along the East Asian-Australasian Flyway, highlighting its national and global ecological significance. The Caimpugan Peat Swamp Forest exhibits the greatest species richness, whereas areas affected by human habitation and habitat fragmentation, like Dinagat-Mambagongon Creek, demonstrate diminished diversity. Although designated as a protected area, AMWS encounters biodiversity threats from human activities, including wildlife hunting, timber extraction, agricultural encroachment, land tenure disputes, and misclassification of land use. Efficient management strategies are essential to alleviate these pressures, maintain the biodiversity of AMWS, and promote sustainable livelihoods for local communities, particularly the Agusanon Manobo, who rely on the lakes and rivers for fishing and agriculture. Moreover, the comprehensive conservation of the nine (9) Biodiversity Monitoring System sites, particularly those with significant populations of endemic and migratory species, is essential for safeguarding avifaunal diversity. Additional ornithological research is highly recommended, mainly for concentrating on the population and diversity of migratory bird species, to create a solid basis for the designation of AMWS as part of the Philippines' East Asian-Australasian Flyway Network Site.

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Statement of Conflict of Interest

The authors declare no conflict of interest associated with the submission and publication of this manuscript.

Author Contribution

HJ Sumilhig *conceptualization and design, including data collection, formal analysis, manuscript writing*. AM Talitod *for the writing and revision process.* CY Yurong

handled data curation, formal analysis, and mapping. M Tumarao *helped gather resource materials and took bird photographs*. S Vasquez and E Ibonia *for the planning, implementation, and supervision of the study, as well as data analysis.*

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