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Avifauna assessment in and around the hydraulic mining area of Brgy, Tumpagon, Cagayan de Oro City, Philippines

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Abstract: Birds are good indicators as it responds fast to threats and changing environmental conditions. Assessment of bird's diversity was conducted in and around the mining area of Brgy. Tumpagon, Cagayan de Oro during the dry and wet season. Line transect, point count and mist netting method were used to survey the birds in the study area. Four 2-km transect lines were established in each key mine site (two 2-km transects within mine areas and another two 2-km transects outside mine areas with at least 5 km distance). Diversity indices were calculated to determine the diversity of birds in the two sampling sites. Results revealed that a total of 58 species under 31 different families were identified in the study area. Species composition and diversity of birds differ between seasons and between sampling sites. Species richness and abundance of bird are higher during the wet season and at the outside mining area. More endemic bird species are also found outside the mining area. Conservation or rehabilitation strategies must be implemented inside the mining area for the protection and conservation of bird species.

Key words: Birds; Surface mining; Species diversity; Endemism

1. Introduction

The Philippine archipelago, being the world's second largest archipelago after Indonesia, is one of the countries in the world considered as both a hotspot and a mega diversity country placing it as one of the top priority hotspots for global conservation (International, 2013). There are about 572 species of birds known to occur within the 7,100 islands that comprise the Philippines and nearly 172 species are not found anywhere else in the world (Kennedy et al., 2000). Birds, like other taxa, also exhibit a strong pattern of regional endemism (International, 2013). Birdlife International has identified 10 Endemic Bird Areas (EBA) in the Philippines which include Batanes and Babuyan Island, Mindoro, Luzon, Negros and Panay, Tablas, Romblon and Sibuyan, Cebu, Mindanao and the Eastern Visayas, the Sulu archipelago, and Palawan (Birdlife International, 2011).

Birds provide several ecological functions such as pest control, pollination, seed dispersal and plant reproduction in thousands of economically and culturally important plant species through its consumption of various terrestrial, aquatic and aerial resources (Whelan et al., 2015). Foraging ecology of birds contribute regulating services such as scavenging carcasses and nutrient cycling (Whelan et al., 2008). Bird communities also provide a reliable ecological indicator of forest condition (Canterburry et al., 2000) due to their sensitivity to environmental perturbations, relevance to ecosystem functioning (e.g., in pollination and seed dispersal), and relative ease in sampling (Brown, 1991). Moreover, birds are associated with singular habitats, they are short-lived species so any change in composition may manifest shortly after a disturbance. Hence, they can be used to develop habitat associations which are predictors of relative human disturbance levels and may be affected by some tourist activities (Higginbottom et al., 2003; Newsome et al., 2004). The bird population is an indication of environmental changes as they respond fast to threats and changing environment conditions (Barov, 2011).

As significant as being one of the mega diverse countries, the Philippines is also considered as the 5th most mineral-rich country in the world, with the third largest reserves of gold, the fourth largest copper and the fifth largest nickel reserve (Philippines: Mining Laws and Regulations Handbook, 2013). Mining and mineral processing have the potential to be important sources of income and driving forces behind broader economic development (Eggert, 2001). With this, the country is faced with a great challenge in utilizing the rich

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available mineral resources for economic growth and development without compromising its ecological integrity and species diversity. In this study, the species richness, abundance and diversity of birds as well as their endemism and conservation status in and around the small scale gold mining area of Barangay Tumpagon, Cagayan de Oro, Philippines were assessed to determine the impacts of surface mining in bird diversity. Information that will be generated can be used as basis for possible bird conservation strategies while pursuing economic development.

2. Materials and method

The Study Area: Tumpagon, as shown in Fig. 1, is among the hinterland barangays of Cagayan de Oro City located at 8°19'19"N and 124°28'49"E and has a total area of 11,926,596 ha. It is bounded by Iponan river on the north and westside; Province of Lanao on the south and barangay Pigsag-an on the east. Tumpagon has abundant supply of sand and gravel as well as gold. The gold mining activity in Tumpagon, Cagayan de Oro started during the 1950's up to the present. The method is surface mining through hydraulic technique which utilizes highly pressurized water to dislodge the surface soils to extract the gold nuggets from the area.

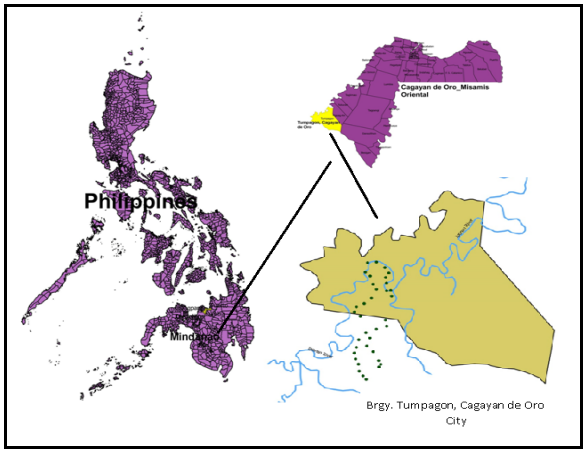

Fig. 1: Map showing the location of the study area in Brgy. Tumpagon, Cagayan de Oro City, Philippines.

As per record, the City Local Environment and Natural Resources Office through the City Mining Regulatory Board confirmed no existing mining concessions for gold, copper, or any other minerals. As such, any mining activity in the area are all considered illegal (Source: Interview; Engr. Rodante B. Felima, OIC-Mining Environment and Safety Division, DENR-MGB 10; CLENRO, CDO City).

Collection of Samples and Environmental Data: Line transect, point count and mist netting method were used to survey the birds in the study area. Four 2-km transect lines were established in each key mine site (two 2-km transects within mine areas and another two 2-km transects outside mine areas with at least 5 km distance). Each line was divided into nine sampling points placed every 250 m ensuring that the two 2-km or sampling stations were parallel from each other and had a distance of at least 2 km. There were 36 sampling points established in each of the selected key mine sites which covered various habitat types. Eight-minute fixed-radius point counts were used in each study area between 5am to 8am when the bird activity is assumed to be highest. Each survey was carried out under similar weather conditions i.e. no strong winds and no heavy rain (Venegas, 2000). At every sampling point, all birds encountered (either seen or heard) within 30-m radius were recorded by two observers. Upon arrival at the sampling point, an additional minute was allotted for resting before commencing the count. Each point was surveyed twice whereby counts were repeated the following day in reverse order, starting from the farthest end of the line at dawn to minimize bias associated with time of day. Bird species were recorded and the abundance of birds at each sampling point from the two surveys was summed.

Identification and Processing of Samples: Birds encountered during the transect walk were identified through the bird's call with the help of a bird expert. Captured specimens, on the other hand, were identified with the use of photographic guides and taxonomic literature on Philippine birds. Morphometric measurements such as forearm length (FA), ear length (E), hind foot length (HF), tail length (T), tibia length (Tb), tragus length (Tr) and total length (TL) were obtained using vernier caliper while the body weight was determined using Pesola spring balance. All identified bird species were released back to the field. Captured specimens were tagged prior to the released to avoid recounting of the same individual. Two voucher specimens especially those unidentified species were preserved following the standard procedure for taxidermy.

Analysis of Data: Diversity indices including dominance, evenness, Simpson Index and Shannon Index were calculated using the PAST software version 2.14 to determine the species diversity of birds within and outside the mining area of Brgy. Tumpagon, Cagayan de Oro City.

3. Results and discussion

The study was able to assess a total of 58 bird species. Information pertaining to the taxonomy as well as the distribution and conservation status of each bird species is shown in Table 1.

The 58 species of birds collected and observed were classified under 31 different families of which, family Columbidae is the most common. There are 13 bird species that are endemic to the Philippines; 2 species are migratory and the rest are known resident species. On the basis of their conservation status, all species are categorized under the least concern status according to the IUCN Red List of Threatened Species.

Table 1: Species profile of birds found outside and inside the mining area of Brgy. Tumpagon, Cagayan de Oro, Philippines

Family	Scientific Name	Common Name	Distribution Status	Conservation Status
Accipitridae	Haliastur indus	Brahminy Kite	Resident	Least Concern
Alcedinidae	Halcyon smyrnensis	White-throated Kingfisher	Resident	Least Concern
Alcedinidae	Todiramphus chloris	White-collared Kingfisher	Resident	Least Concern
Apodidae	Collocalia esculenta	Glossy Swiftlet	Resident	Least Concern
Apodidae	Collocalia troglodytes	Pygmy Swiftlet	Resident	Least Concern
Apodidae	Collocalia vanikorensis	Island Swiftlet	Resident	Least Concern
Ardeidae	Egretta garzetta	Little Egret	Resident	Least Concern
Artamidae	Artamus leucorhynchus	White-breasted Woodswallow	Resident	Least Concern
Campephagidae	Lalage nigra	Pied Triller	Resident	Least Concern
Caprimulgidae	Caprimulgus manillensis	Philippine Nightjar	Resident	Least Concern
Caprimulgidae	Eurostopodus macrotis	Great Eared Nighjar	Resident	Least Concern
Columbidae	Chalcophaps indica	Common Emerald Dove	Resident	Least Concern
Columbidae	Geopelia striata	Zebra dove	Resident	Least Concern
Columbidae	Macropygia amboinensis	Slender-billed Cuckoo-Dove	Resident	Least Concern
Columbidae	Papitreron amythystina	Amythyst Brown-Dove	Endemic	Least Concern
Columbidae	Phapitreron leucotis	White-eared Brown Dove	Endemic	Least Concern
Columbidae	Streptopelia chinensis	Spotted Dove	Resident	Least Concern
Columbidae	Treron vernans	Pink-necked Green Pigeon	Resident	Least Concern
Corvidae	Corvus macrorhynchos	Large-billed Crow	Resident	Least Concern
Cuculidae	Cacomantis merulinus	Plaintive Cuckoo	Resident	Least Concern
Cuculidae	Centropus melanops	Black-faced Coucal	Endemic	Least Concern
Cuculidae	Centropus viridis	Philippine Coucal	Endemic	Least Concern
Cysticolidae	Cisticola juncidis	Zitting Cisticola	Resident	Least Concern
Dicaeidae	Dicaeum australe	Red-keeled Flowerpecker	Endemic	Least Concern
Dicaeidae	Dicaeum hypoleucum	Buzzing Flowerpecker	Endemic	Least Concern
Dicaeidae	Dicaeum trigonostigma	Orange-Bellied Flowerpecker	Resident	Least Concern
Estrildidae	Lonchura leucogastra	White-Bellied Munia	Resident	Least Concern
Estrildidae	Lonchura atricapilla	Black-headed Munia	Resident	Least Concern
Hirundinidae	Hirundo tahitica	Pacific Swallow	Resident	Least Concern
Laniidae	Lanius cristatus	Brown Shrike	Migratory	Least Concern
Laniidae	Lanius schach	Long-tailed Shrike	Resident	Least Concern
Megalaimidae	Psilopogon haemacephala	Coppersmith Barbet	Resident	Least Concern
Meropidae	Merops philippinus	Blue-Tailed Bee-eater	Resident	Least Concern
Meropidae	Merops viridis	Blue-throated Bee-eater	Resident	Least Concern
Motacillidae	Motacilla flava	Yellow Wagtail	Migratory	Least Concern
Muscicapidae	Copsychus saularis	Oriental Magpie-Robin	Resident	Least Concern
Muscicapidae	Culicicapa helianthea	Cetrine Canary Flycatcher	Resident	Least Concern
Muscicapidae	Cyornis rufigastra	Mangrove Blue-Flycatcher	Resident	Least Concern
Muscicapidae	Saxicola caprata	Pied Bushchat	Resident	Least Concern
Nectariinidae	Nectarinia jugularis	Olive-backed Sunbird	Resident	Least Concern
Nectariniidae	Anthreptes malacensis	Plain-throated Sunbird	Resident	Least Concern
Nectariniidae	Arachnothera longirostra	Little Spiderhunter	Resident	Least Concern
Oriolidae	Oriolus chinensis	Black-nape Oriole	Resident	Least Concern
Passeridae	Passer montanus	Eurassian Tree Sparrow	Resident	Least Concern
Psittacidae	Bolbopsittacus lunulatus	Guaiabero	Endemic	Least Concern
Psittacidae	Loriculus philippensis	Colasisi	Endemic	Least Concern
Pycnonotidae	Ixos philippinus	Philippine Bulbul	Endemic	Least Concern
Pycnonotidae	Pycnonotus goiavier	Yellow-vented Bulbul	Resident	Least Concern
Rallidae	Amaurornis phoenicurus	White-Breasted Waterhen	Resident	Least Concern
Rallidae	Gallirallus torquatus	Barred Rail	Resident	Least Concern
Rhipiduridae	Rhipidura javanica	Pied Fantail	Resident	Least Concern
Sturnidae	Aplonis panayensis	Asian Glossy Starling	Resident	Least Concern
Sturnidae	Sarcops calvus	Coleto	Endemic	Least Concern
Sylviidae	Megalurus palustris	Striated Grassbird	Resident	Least Concern
Sylviidae	Megalurus timoriensis	Tawny Grassbird	Resident	Least Concern
Timaliidae	Macronous striaticeps	Brown Tit-Babbler	Endemic	Least Concern
Trogonidae	Harpactes ardens	Philippine Trogon	Endemic	Least Concern

In Table 2, the species composition of birds varied between seasons and between sampling sites. There are 37 species that were found in both seasons while 9 species and 12 species were found separately during the dry and wet season respectively. A. leucorhynchus, C. juncidis and C. rufigastra are some of those only found during the dry season while A. panayensis, H. tahitica and E. garzetta are some of the species that were found only during the wet season. On the other hand, there

are also species that were found to be site specific. There are 7 species and 10 species were found exclusively inside and outside the mining area respectively while there are 41 species common to both sampling sites. A. leucorhynchus, C. juncidis and M. viridis are some of those which were only found inside the mining area; while A. longirostra, S. calvus and D. trigonostigma are some species which were only found outside the mining area (Fig. 2).

Fig. 2: Examples of the bird species found inside and outside the mining area of Brgy. Tumpagon, Cagayan de Oro City. Legend: a= C. troglodytes, b= I. philippinus, c= B. septimus, d= P. leucotis, e= A. panayensis, f= G. striata, g= L. schach, h= L. philippensis, i= S. caprata, j= A. malacensis, k= C. merulinus, l= M. philippinus, m= B. lunulatus, n= N. jugularis, o= A. phoenicurus, p= C. manillensis, q= C. indica, r= D. trigonostigma, s= C. saularis, t= P. goiavier.

Table 2: Abundance of bird species found outside and inside the mining area of Brgy. Tumpagon, Cagayan de Oro, Philippines during Dry and Wet Season

Bird Species	Inside Mining Area			Outside Mining Area			Overall
	Dry Season	Wet Season	Total	Dry Season	Wet Season	Total	
A. phoenicurus	6	4	10	23	10	33	43
A. malacensis	0	0	0	0	2	2	2
A. panayensis	0	26	26	0	59	59	85
A. longirostra	0	0	0	3	3	6	6
A. leucorhynchus	18	0	18	0	0	0	18
B. septimus	0	0	0	1	1	2	2
B. lunulatus	1	0	1	2	10	12	13
C. merulinus	2	4	6	4	8	12	18
C. manillensis	2	0	2	0	0	0	2
C. melanops	9	13	22	7	32	39	61
C. viridis	2	1	3	1	0	1	4
C. indica	0	0	0	0	1	1	1
C. juncidis	5	0	5	0	0	0	5
C. esculenta	18	87	105	11	136	147	252
C. troglodytes	2	60	62	5	53	58	120
C. vanikorensis	1	25	26	21	52	73	99
C. saularis	0	13	13	1	32	33	46
C. macrorhynchos	2	8	10	0	11	11	21
C. helianthea	0	0	0	1	0	1	1
C. rufigastra	1	0	1	2	0	2	3
D. australe	9	89	98	132	131	263	361
D. hypoleucum	1	0	1	1	0	1	2
D. trigonostigma	0	0	0	2	1	3	3
E. garzetta	0	17	17	0	16	16	33
E. macrotis	0	0	0	0	1	1	1
G. torquatus	1	7	8	7	5	12	20
G. striata	7	49	56	4	66	70	126
H. smyrnensis	7	0	7	2	3	5	12
H. indus	7	2	9	3	5	8	17
H. ardens	0	0	0	0	1	1	1
H. tahitica	0	17	17	0	52	52	69
I. philippinus	7	0	7	122	3	125	132
L. nigra	7	5	12	8	9	17	29
L. cristatus	0	7	7	0	23	23	30
L. schach	7	3	10	3	2	5	15
L. leucogastra	1	0	1	0	0	0	1
L. malacca	7	35	42	1	56	57	99
L. philippensis	7	15	22	2	8	10	32
M. striaticeps	0	0	0	2	0	2	2
M. amboinensis	0	1	1	0	0	0	1
M. haemacephala	7	13	20	1	40	41	61
M. palustris	7	12	19	2	17	19	38
M. timoriensis	7	2	9	2	1	3	12
M. philippinus	7	7	14	6	14	20	34
M. viridis	2	0	2	0	0	0	2
M. flava	0	14	14	0	8	8	22
N. jugularis	7	87	94	118	85	203	297
O. chinensis	7	4	11	7	16	23	34
P. montanus	7	24	31	1	3	4	35
P. amethystina	7	1	8	2	0	2	10
P. leucotis	7	59	66	56	103	159	225
P. goiavier	7	148	155	228	230	458	613
R. javanica	7	100	107	68	126	194	301
S. calvus	0	0	0	0	6	6	6
S. caprata	7	2	9	6	0	6	15
S. chinensis	7	45	52	3	27	30	82
T. chloris	7	93	100	38	105	143	243
T. vernans	0	1	1	0	0	0	1
TOTAL	237	1100	1337	909	1573	2482	3819

In Table 3, the number of bird species and the total number of individuals that were captured and observed is higher during the wet season than in the dry season. Between sampling sites on the other hand, a higher species richness and abundance was observed outside than inside the mining area. Overall, P. goiavier is the most abundant species in both seasons and in both sampling sites. Based on the Shannon's index of diversity, birds are more diverse during the wet season and between the two sampling sites, bird's diversity is higher outside the mining area. Among the 13 endemic species found in the study area, 4 species of which namely: B. septimus, H. ardens, M. striaticeps and S. calvus were found only outside the mining area. No endemic species were found exclusively inside the mining area. Although found in both sampling areas, there are some endemic species which were found extensively more abundant outside the mining area than the inside mining area. These species includes D. australe, I. philippinus and P. leucotis

Table 3: Diversity indices of bird species found outside and inside the mining area of Brgy. Tumpagon, Cagayan de Oro, Philippines

	Dry Season	Wet Season	Inside Mining Area	Outside Mining Area
Taxa_S	46	49	48	51
Individuals	1146	2673	1337	2482
Dominance_D	0.0942	0.0641	0.0545	0.0769
Simpson _1-D	0.9058	0.9359	0.9455	0.9232
Shannon _H	2.868	3.064	2.995	3.238
Evenness	0.3825	0.4371	0.531	0.3919

According to Rahayuninagsih et al., (2007), the structures of bird community were known to be affected by several factors. Differences in the species composition and abundance of birds between seasons might be attributed to availability of food, breeding season of the bird species and habitat condition (Aynalem and Bekele, 2008). Seasonal variation in the abundance of resources and distinct seasonality of rainfall results in seasonal changes in the abundance of bird species (Gasto et al., 2000). In this study, the species richness and abundance of birds is higher during the wet season as compared to the dry season. This variation might be attributed to the seasonal variation in the structure and type of plant communities that forms the major component in its habitat. As the habitat changes, a particular bird species may appear, increase or decrease, and disappear (Lee and Rotenberry, 2005). Moreover, higher density of birds during the wet season could be a result of seasonal variations in food sources which occur when woody and other plant species bloom during the wet and short rainy season (Mengesha et al., 2011).

Variation in the species richness and abundance of birds was also observed between the sampling sites. This might be caused by the disturbances brought about by the existence of small scale mining activity in the area. Birds are more diverse and abundant outside as compared inside the mining area. Fragmentation is harmful to wildlife especially birds and humans intensify it (Marzluff and Ewing, 2001). Human activities threaten the existence of many birds by destroying their habitat or directly affecting their survival and reproductive success (Green and Hirons, 1991). Deforestation and disturbances have negative effects on birds including declines in diversity and abundance (Hamer et al., 1997) changes in species assemblages (Hamer et al., 2003) and extinction (Brook et al., 2003).

Mining and its related activities are regarded as one of the causes of habitat destruction for wildlife (Kennedy et al., 2010; Gajera et al., 2013). Vegetation, which constitutes the primary aspect of the habitat, is significant for birds as it provides food, protection and nesting ground. Destruction or clearing of vegetation inside the mining area due to surface mining might be the reason for the lower diversity and abundance of birds in the area. This agrees with the statement of Naeem et al. (1999) that vegetation clearance of forest reserves due to mining activities is also one of the most important reasons of biodiversity decline. Mining has a direct impact on the existing vegetation particularly surface mining which displaces or remove the existing plant cover since the topsoil are totally taken away (Lloyd et al., 2002).

In the Philippines, a large proportion of endemics are dependent on forested habitats (Dickinson et al., 1991). But due to their sensitivity to environmental distresses, many of the endemic bird species are endangered as the result of high levels of habitat destruction in the Philippine forest (Kennedy et al., 2000). Habitat destruction might be the reason for the lower number of endemic bird species found inside the mining area. A study by Hahn et al. (2010) revealed that endemic species selects native forest and declines in population in perturbed habitat and endemic birds specifically act as habitat specialists. Disturbed habitats may act as barrier for endemic bird species decreasing the connectivity between native patches of habitat (Hahn et al., 2010). Endemic taxa were found to be higher in population in a closed forest or habitats with lower detection probabilities (Catry et al., 2000).

4. Conclusion

There exist a seasonal variation in the species composition and diversity of birds in Brgy. Tumpagon,

Cagayan de Oro. The surface mining activity occurring in the area has negatively affected the endemicity, richness and abundance of bird species. Destruction and clearing of vegetation is the main identified factor that contributed to the variation in species diversity between sampling sites.

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