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Significant records of birds in Agusan Marsh, Philippines with notes on the conservation importance of the area

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Abstract. Agusan marsh is one of the most ecologically significant wetland ecosystems in the Philippines. Sago, terminalia, mixed swamp, and peat swamp forests in Agusan Marsh were surveyed from August 2005 to January 2006 using a combination of mist netting (3,337 net days) and transect walk methods to determine the distribution, endemicity, and conservation of birds in Agusan marsh. One hundred twenty-four species of birds were identified with low endemism of 25%. The mixed swamp forest had the highest species richness (S = 92) while sago forest had the least (S = 70). Peat swamp forest had the highest number of migratory birds (S = 26). Highest endemicity was recorded in the terminalia forest (21%). Migratory birds were recorded at the start of sampling in August and considerably increased thereafter reaching its peak in November. A sudden decline in the number of endemic species was observed in November. Forty-six species of birds which include six migratory species were reported to be of socio-economic importance. Changes in the structural and floristic composition brought about by forest degradation such as conversion of forest into agriculture, timber poaching and hunting were seen as threats to the birds in Agusan marsh. Conservation of the different habitats in the marsh is necessary for the retention of the broadest avifaunal diversity.
Key Words: distribution, endemicity, migratory, peat swamp, wetland.

Introduction. The Philippines has 576 birds species, 195 of which are endemic and 74 (12.8%) of which are threatened with global extinction (Gomez et al 2009). The latest report is a higher count of more than 600 bird species (Birdwatch.ph 2012). Birds are considered the most important indicator of changes in ecosystem balance in nature because of their highly specific habitat requirements (Prakash & Manasvini 2013).

The Agusan Marsh is a protected area, officially called the Agusan Marsh Wildlife Sanctuary (AMWS). It stores more than 15% of the freshwater resources in the Philippines (Almeria & Nuñeza 2013). Mallari et al (2001) reported that several threatened species have been recorded in or near Agusan Marsh in the past, mainly forest birds, but it is unclear whether they have significant populations in the remaining forests. However, *Alcedo argentata* (Silvery Kingfisher) was recently recorded in the marsh itself. The marsh is also home for the rare Oriental Darter (*Anhinga melanogaster*), Purple Swamp Hen (*Porphyrio porphyrio*), the threatened Philippine Hawk-Eagle (*Spizaetus philippensis*), Spotted Imperial Pigeon (*Ducula carola*) and Rufous-lored Kingfisher (*Todiramphus winchelli*) (UNESCO 2006).

The Philippine archipelago holds a high species diversity of flora and fauna and endemism of global importance (Peterson et al 2013). However, human activities such as deforestation and thinning of the forest which are very pervasive and increasingly high are just few of the things that affect wildlife and their habitat (Steidl & Powell 2006). The Philippines is one of the countries which is high on the list of priority for wildlife conservation because of its remarkable biological diversity with huge and large number of endemic animal and plant species, inadequate wildlife protection measures, and high rate of deforestation and habitat loss (Maala 2001).

Many studies on birds were done in forest ecosystems but relatively very few researches had been conducted on birds in the swamp forests of the Philippines. In Mindanao, particularly the Agusan Marsh in Agusan del Sur, little scientific exploration has been undertaken. The latest published study on vertebrates of the marsh was that of Almeria and Nuñeza (2013) who reported on amphibian diversity and endemism. Cagod & Nuñeza (2012) recorded 88 bird species in oil palm plantations in the same province where Agusan Marsh is located.

More information is required about the migratory birds like their presence on particular months of the year, their arrival, and departure.

Monitoring is required to determine whether Agusan Marsh is a regular wintering site for the migratory species. Surveys are urgently needed of the vast Agusan Marsh to investigate the extent and quality of the remaining habitats and the current status of the threatened, restricted-range birds, and congregatory waterbirds (Mallari et al 2001). In this study, the distribution of birds was assessed and significant records noted in the four sampling sites in Agusan Marsh, Agusan del Sur, Philippines. Specifically, this study generated a list of species of birds found in the swamp forest. It monitored the distribution of the bird fauna by determining the migratory birds' presence, number of endemic, non-endemic, threatened bird species and percent endemism. Moreover, it determined the socio-economic importance, resource utilization, existing threats, and conservation status of the avifauna.

Material and Method

Sampling sites. Sampling was done in the swamp forest of Agusan Marsh, Agusan Del Sur (Figure 1) from August 2005 to January 2006 in four different vegetation types. Four sampling sites were established in the swamp forest of Agusan Marsh (Figure 2). The swamp forest which is the major habitat type within the marsh is estimated to cover 39.4% of the total land area of the proposed boundary of Agusan Marsh Wildlife Sanctuary. During minimum water level, open water habitat type accounts for only 3% of the area (Arreza 1999).

Figure 1. Map of the Philippines and Mindanao (A) (en.wikipedia.org) showing the location of Agusan Del Sur (B) (caraga.neda.gov.ph).

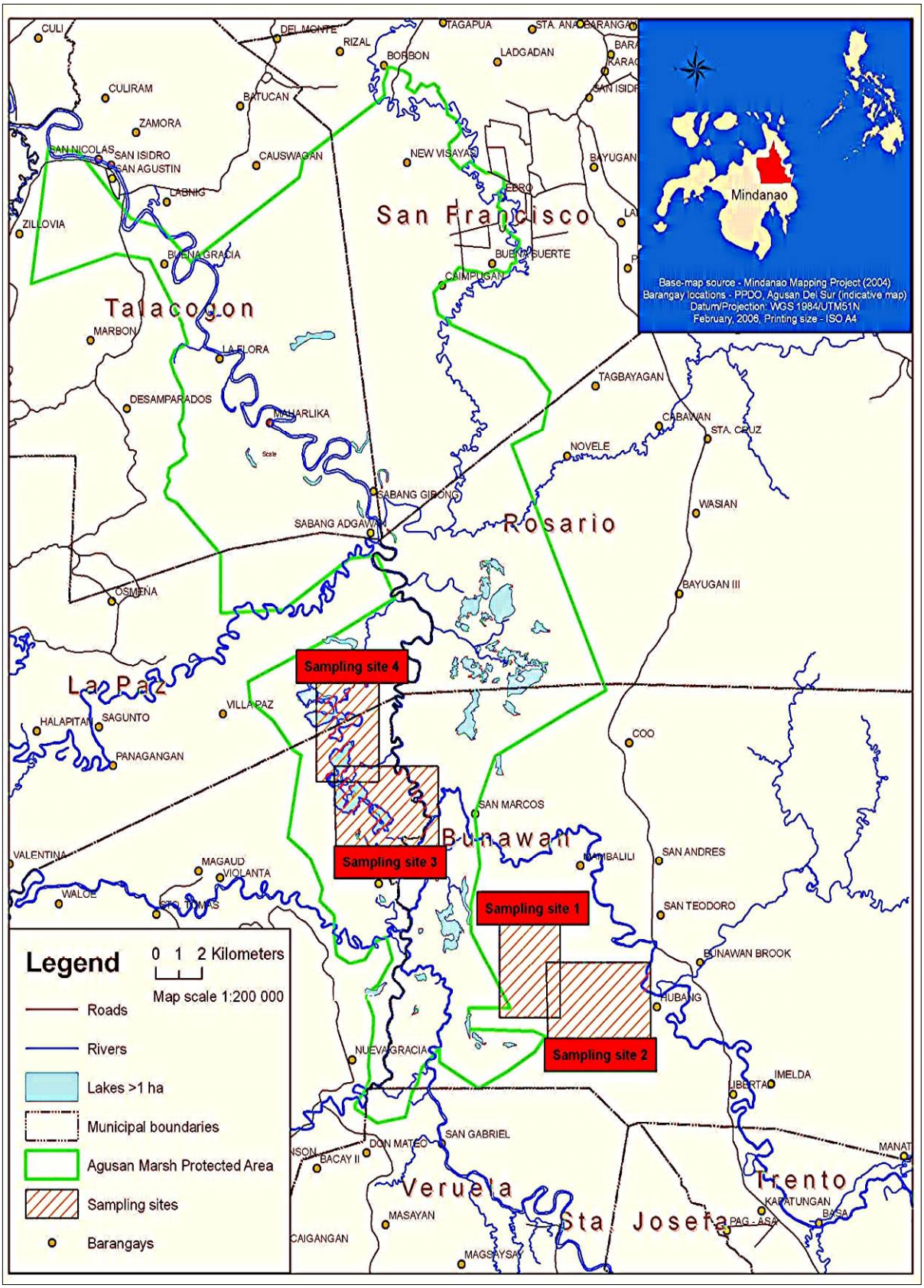

Figure 2. Locator map of Agusan Marsh, Agusan Del Sur showing the four sampling sites (essc, 2011).

Sampling site 1 - Sago Forest is found in Sitio Kaliluan, Poblacion, Bunawan situated at 08°10.016' N, 125°57.671' E. It is considered as secondary vegetation with an estimated land area of about 100 hectares in which sago (*Metroxylon sagu*) dominates the area. Sago forest is the rarest swamp forest type in the marsh. This sampling site is 50 meters from a creek system.

Sampling site 2 - Terminalia Forest is found in Sitio Kaliluan, Poblacion, Bunawan situated at 08°09.438' N, 125°58.044' E. *Terminalia* forest is found in several locations in the marshland containing pure stands of *Terminalia copelandii,* locally known as "lanipao" among the Manobos (the indigenous people in the area). This forest is considered primary vegetation. The estimated land area of the *Terminalia* forest of where sampling site 2 was established is about 300 hectares. The creek is the only water system that was observed with a distance of 20 meters from the sampling area. On-site disturbances include kaingin. These kaingin areas were eventually developed to agricultural farming such as rice and corn farming. Hunting and human settlement at a distance of 20-50 m from the sampling site were the other disturbances observed.

Sampling site 3 - Mixed Swamp Forest is found in Sitio Panlabuhan, Poblacion, Loreto at 8°14.264' N, 125°52.630' E. It is considered primary vegetation where *Barringtonia* and *Nauclea* dominate the area. The surrounding lakes which include Lake Dinagat, Lake Kaningbaylan, Lake Bukugon, and Lake Kubasayon are about 300-1000 meters away from the sampling area. Corn plantation, fishing, and hunting were the major on-site disturbances observed. Human settlement and migration of local people from other municipalities were also seen as contributing factors to the disturbance of the swamp forest.

Sampling site 4 - Peat Swamp Forest is found in Sitio Panlabuhan, Poblacion, Loreto situated at 8°14.263' N, 125°52.252' E. The peat swamp forest covers a rather small area in the marsh where stands of vegetation are considered as primary vegetation. Lakes, river and creeks were observed in this sampling site. The observed anthropogenic disturbances were the clearing of the area, cornfield, fishing, and human settlement.

Sampling techniques. Collection was done using 6-12 m long mist nets. Mist nets were placed along and across waterways, forest edges and clearings, within or near forest canopies, flyways, and vicinities of feeding trees. The nets were left open during day and night to catch both diurnal and nocturnal birds. Mist nets were checked at least every 1-2 hours during daytime and twice during nighttime so as not to overly subject the captured birds to stress. A total of 3,337 net days were spent to sample bird fauna with 816 net days in site 1 (sago forest), 897 net days in site 2 (terminalia forest), 826 net days in site 3 (mixed swamp forest) and 798 net days in site 4 (peat swamp forest).

Birds that were captured were processed immediately to prevent mortality and damage to their body parts. Specimens were identified using Fisher & Hicks (2000), Kennedy et al (2000) and Robson (2000). Two to three specimens of each species captured were collected as voucher materials (as per stipulated conditions in the gratuitous permit) while others were released. Threatened species were likewise released. Voucher specimens were deposited at the Natural Science Museum of Mindanao State University – Iligan Institute of Technology.

Nomenclature and taxonomic listing followed Kennedy et al (2000) and conservation status of the avifauna was determined based on the IUCN Red List of Threatened Species (2013).

To supplement capture results, the line transect method was done. Prior to the transect walk, a standard two kilometer transect line was first established along the man-made trail in the sampling area. Using colored plastic markers, the line was divided into 80 transect points with an interval of 25 meters per point and eight reference points. Data such as the locality, elevation, location, date, weather, habitat type, species, number of times the bird was observed during the walk, stratum or the location of the bird during observation, how the bird was observed, the transect point where it was

observed and remarks, were all written down. Transect walks were done early in the morning at 05:30 hours and in the afternoon at 15:00 hours. Other field efforts like listening to bird calls/songs and key informant interviews were also done.

Monthly monitoring of the avifauna was done to account for the presence of migratory birds. Documentation was by way of photographs, video, audio tape recording, and field notes.

Socio-economic importance, resource utilization by people in the area, and present and possible threats to the bird fauna were determined by direct observations, capture results and key informant interviews of the local residents of Agusan marsh. The local conservation status of the avifauna was based on actual observations and capture results.

Results and Discussion. One hundred twenty-four bird species in 46 families and 104 genera were recorded in Agusan Marsh, of which 64 species were mist-netted (Table 1). Twenty-five migrants, 68 residents and 31 endemics were documented.

Table 1

List of captured birds in the swamp forest of Agusan Marsh. Nomenclature follows Kennedy et al (2000)

No.	*Family*	*Species*	*Site 1*	*Site 2*	*Site 3*	*Site 4*	*Total*
1	Accipitridae	*Accipiter gularis*			2	1	**3**
2		*Spilornis cheela*		1			**1**
3	Acrocephalidae	*Acrocephalus orientalis*			4	1	**5**
4		*Acrocephalus stentoreus*				7	**7**
5	Alcedinidae	*Alcedo argentata*	1	4	2	1	**8**
6		*Alcedo atthis*			5	1	**6**
7		*Halcyon chloris*	2	1	13	9	**25**
8		*Halcyon coromanda*	4	11			**15**
9		*Halcyon smyrnensis*	4	3	8		**15**
10	Ardeidae	*Ardea purpurea*			5		**5**
11		*Ardeola speciosa*	1				**1**
12		*Bubulcus ibis*				2	**2**
13		*Egretta garzetta*				1	**1**
14		*Ixobrychus cinnamomeus*		2	11	4	**17**
15		*Ixobrychus sinensis*			3	10	**13**
16		*Nycticorax nycticorax*	1				**1**
17	Artamidae	*Artamus leucorynchus*		1	3		**4**
18	Bucerotidae	*Penelopides affinis*		1			**1**
19	Columbidae	*Ducula carola*	1				**1**
20		*Geopelia striata*			1	1	**2**
21		*Phapitreron leucotis*		1	1	1	**3**
22		*Treron pompadora*			2		**2**
23		*Treron vernans*			9	3	**12**
24	Cuculidae	*Cacomantis merulinus*			1	13	**14**
25		*Centropus melanops*		2			**2**
26		*Centropus viridis*			1	1	**2**
27		*Cuculus fugax*		1			**1**
28	Dicaeidae	*Dicaeum australe*	1	1			**2**
29		*Dicaeum trigonostigma*		1			**1**
30	Dicruridae	*Dicrurus hottentottus*		3			**3**
31	Estrildidae	*Lonchura leucogastra*		8			**8**
32	Estrildidae	*Lonchura malacca*		1			**1**
33	Eurylaimidae	*Eurylaimus steerii*		2			**2**
34	Hirundinidae	*Hirundo rustica*				2	**2**

35		*Hirundo tahitica*			1	3	**4**
36	Laniidae	*Lanius cristatus*		7	3	8	**18**
37	Locustellidae	*Locustella ochotensis*	4	2	8	7	**21**
38	Monarchidae	*Hypothymis azurea*				2	**2**
39	Muscicapidae	*Copsychus saularis*			3	1	**4**
40		*Cyornis rufigastra*			3	1	**4**
41		*Luscinia calliope*				1	**1**
42	Nectariniidae	*Arachnothera longirostra*		2			**2**
43	Nectariniidae	*Nectarinia jugularis*	1			1	**2**
44	Oriolidae	*Oriolus chinensis*			2	1	**3**
45	Picidae	*Chrysocolaptes lucidus*		2			**2**
46		*Mulleripicus funebris*			2		**2**
47	Pittidae	*Pitta erythrogaster*		2			**2**
48		*Pitta sordida*		4	2	1	**7**
49	Podargidae	*Batrachostomus septimus*		2			**2**
50	Psittacidae	*Bolbopsittacus lunulatus*		3			**3**
51	Pycnonotidae	*Hypsipetes philippinus*		5			**5**
52		*Pycnonotus goiavier*	1		17	4	**22**
53	Rallidae	*Amaurornis olivaceus*			1	2	**3**
54		*Amaurornis phoenicurus*		1		1	**2**
55		*Gallicrex cinerea*	1	1			**2**
56		*Gallinago megala*				2	**2**
57		*Gallinula chloropus*			1	1	**2**
58		*Gallirallus torquatus*	2	1			**3**
59		*Rallina fasciata*		1			**1**
60	Rhipiduridae	*Rhipidura javanica*			4		**4**
61	Scolopacidae	*Actitis hypoleucos*			1		**1**
62	Strigidae	*Otus megalotis*	2	1	1		**4**
63	Sturnidae	*Aplonis panayensis*	2	1			**3**
64	Timaliidae	*Macronous striaticeps*	17	22	9	1	**49**
		TOTAL	**45**	**101**	**129**	**95**	**370**
		Net Days	**816**	**897**	**826**	**798**	**3,337**

More species were documented through direct observations and the transect walk method (Table 2).

Table 2

List of bird species in the swamp forest of Agusan Marsh obtained through transect walk and general observations. Nomenclature follows Kennedy et al (2000)

No.	*Family*	*Species*	*Site 1*	*Site 2*	*Site 3*	*Site 4*	*Total*
1	Accipitridae	*Accipiter soloensis*	3	3	4	4	**14**
2		*Accipiter virgatus*	0	4	4	2	**10**
3		*Circus melanoleucos*	0	0	1	2	**3**
4		*Haliaeetus leucogaster*	0	0	3	0	**3**
5		*Hieraaetus kienerii*	1	0	2	0	**3**
6		*Ichthyophaga ichthyaetus*	0	0	0	4	**4**
7		*Spilornis cheela*	7	3	0	0	**10**
8		*Spizaetus cirrhatus*	4	6	0	0	**10**
9		*Spizaetus philippensis*	0	0	1	0	**1**
10	Acrocephalidae	*Acrocephalus orientalis*	0	0	1	1	**2**
11	Alcedinidae	*Alcedo argentata*	2	2	4	0	**8**
12		*Alcedo atthis*	0	0	12	13	**25**
13		*Ceyx melanurus*	0	0	1	0	**1**
14		*Halcyon chloris*	4	24	23	22	**73**

15		*Halcyon coromanda*	4	9	0	1	**14**
16		*Halcyon smyrnensis*	22	34	26	14	**96**
17	Anatidae	*Anas luzonica*	12	4	57	42	**115**
18		*Dendrocygna arcuata*	0	4	244	621	**869**
19	Apodidae	*Collocalia esculenta*	2	0	0	2	**4**
20		*Cypsiurus balasiensis*	0	5	137	0	**142**
21	Ardeidae	*Ardea cinerea*	0	0	1	3	**4**
22		*Ardea purpurea*	4	3	15	85	**107**
23		*Ardeola speciosa*	1	11	149	180	**341**
24		*Bubulcus ibis*	0	3	339	2715	**3057**
25		*Dupetor flavicollis*	0	0	1	13	**14**
26		*Egretta alba*	0	0	49	150	**199**
27		*Egretta garzetta*	0	0	67	196	**263**
28		*Egretta intermedia*	0	0	19	44	**63**
29		*Ixobrychus cinnamomeus*	3	5	22	38	**68**
30		*Ixobrychus eurythmus*	0	0	0	11	**11**
31		*Ixobrychus sinensis*	0	0	12	36	**48**
32		*Nycticorax caledonicus*	7	0	0	0	**7**
33		*Nycticorax nycticorax*	1	0	2	4	**7**
34	Artamidae	*Artamus leucorynchus*	14	21	29	45	**109**
35	Bucerotidae	*Penelopides affinis*	4	5	18	5	**32**
36	Campephagidae	*Coracina striata*	0	0	2	0	**2**
37		*Lalage nigra*	7	13	8	19	**47**
38	Caprimulgidae	*Eurostopodus macrotis*	4	6	4	3	**17**
39	Cisticolidae	*Cisticola juncidis*	0	1	1	9	**11**
40		*Orthotomus nigriceps*	1	26	1	0	**28**
41	Columbidae	*Chalcophaps indica*	0	1	0	0	**1**
42		*Columba vitiensis*	0	0	0	1	**1**
43		*Ducula aenea*	0	2	0	0	**2**
44		*Ducula carola*	1	1	0	0	**2**
45		*Geopelia striata*	9	35	20	18	**82**
46		*Macropygia phasianella*	0	3	2	1	**6**
47		*Phapitreron amethystina*	1	5	0	0	**6**
48		*Phapitreron leucotis*	9	42	17	7	**75**
49		*Ptilinopus melanospilus*	0	0	0	1	**1**
50		*Streptopelia chinensis*	22	51	62	56	**191**
51		*Treron pompadora*	7	0	14	20	**41**
52		*Treron vernans*	10	2	169	185	**366**
53	Corvidae	*Corvus macrorhynchos*	8	1	3	0	**12**
54	Cuculidae	*Cacomantis merulinus*	0	1	4	9	**14**
55		*Centropus melanops*	13	36	8	5	**62**
56		*Centropus viridis*	46	46	62	87	**241**
57		*Cuculus fugax*	0	3	0	0	**3**
58		*Eudynamys scolopacea*	0	0	4	0	**4**
59		*Surniculus lugubris*	0	4	1	0	**5**
60	Dicaeidae	*Dicaeum australe*	20	31	16	0	**67**
61		*Dicaeum trigonostigma*	13	5	4	7	**29**
62		*Prionochilus olivaceus*	4	2	4	0	**10**
63	Dicruridae	*Dicrurus hottentottus*	20	51	13	11	**95**
64	Estrildidae	*Lonchura leucogastra*	0	100	40	386	**526**
65		*Lonchura punctulata*	5	25	32	112	**174**
66	Eurylaimidae	*Eurylaimus steerii*	2	5	0	0	**7**
67	Falconidae	*Microhierax erythrogenys*	8	14	8	4	**34**
68	Hirundinidae	*Hirundo rustica*	0	0	0	3	**3**
69		*Hirundo tahitica*	72	20	332	1007	**1431**
70	Laniidae	*Lanius cristatus*	32	37	52	107	**228**
71	Laridae	*Gelochelidon nilotica*	0	0	0	1	**1**
72		*Sterna hirundo*	0	0	13	126	**139**
73	Locustellidae	*Locustella ochotensis*	13	24	52	37	**126**

74	Megalaimidae	*Megalaima haemacephala*	13	24	11	6	**54**
75	Meropidae	*Merops philippinus*	0	10	8	0	**18**
76	Monarchidae	*Hypothymis azurea*	4	11	11	2	**28**
77	Motacillidae	*Motacilla flava*	0	0	55	13	**68**
78	Muscicapidae	*Copsychus saularis*	2	6	9	3	**20**
79		*Cyornis rufigastra*	0	0	3	0	**3**
80	Nectariniidae	*Aethopyga shelleyi*	0	6	0	0	**6**
81		*Anthreptes malacensis*	0	4	25	9	**38**
82		*Arachnothera longirostra*	3	7	0	0	**10**
83		*Nectarinia jugularis*	1	3	5	4	**13**
84	Oriolidae	*Oriolus chinensis*	46	50	84	112	**292**
85	Passeridae	*Passer montanus*	11	51	42	43	**147**
86	Phasianidae	*Gallus gallus*	4	0	0	0	**4**
87	Picidae	*Chrysocolaptes lucidus*	6	10	11	5	**32**
88		*Dendrocopos maculatus*	0	0	6	0	**6**
89		*Dryocopus javensis*	6	3	5	3	**17**
90		*Mulleripicus funebris*	5	3	18	0	**26**
91	Pittidae	*Pitta sordida*	0	2	0	3	**5**
92	Podargidae	*Batrachostomus septimus*	0	4	1	1	**6**
93	Psittacidae	*Bolbopsittacus lunulatus*	45	86	15	9	**155**
94		*Loriculus philippensis*	5	4	0	0	**9**
95		*Prioniturus discurus*	52	29	6	1	**88**
96	Pycnonotidae	*Hypsipetes philippinus*	66	86	31	8	**191**
97		*Pycnonotus goiavier*	61	180	379	476	**1096**
98	Rallidae	*Amaurornis olivaceus*	11	37	17	17	**82**
99		*Amaurornis phoenicurus*	9	18	38	57	**122**
100		*Gallicrex cinerea*	1	1	4	2	**8**
101		*Gallinago megala*	0	0	11	14	**25**
102		*Gallinula chloropus*	0	0	12	84	**96**
103		*Gallirallus torquatus*	21	15	12	14	**62**
104		*Porphyrio porphyrio*	0	0	7	51	**58**
105		*Porzana cinerea*	3	2	8	14	**27**
106	Recurvirostridae	*Himantopus himantopus*	0	0	0	7	**7**
107	Rhipiduridae	*Rhipidura javanica*	7	18	15	22	**62**
108		*Rhipidura superciliaris*	7	10	11	11	**39**
109	Rostratulidae	*Rostratula benghalensis*	12	11	0	10	**33**
110	Scolopacidae	*Actitis hypoleucos*	0	1	26	28	**55**
111		*Charadrius dubius*	2	0	0	3	**5**
112		*Pluvialis fulva*	0	0	0	57	**57**
113	Stenostiridae	*Culicicapa helianthea*	0	4	0	1	**5**
114	Strigidae	*Mimizuku gurneyi*	1	0	1	0	**2**
115		*Otus megalotis*	2	1	1	0	**4**
116	Sturnidae	*Aplonis panayensis*	441	25	56	174	**696**
117		*Sarcops calvus*	16	24	14	1	**55**
118	Timaliidae	*Macronous striaticeps*	45	59	39	25	**168**
	TOTAL NUMBER OF INDIVIDUALS		**1330**	**1544**	**3188**	**7765**	**13827**
	TOTAL NUMBER OF SPECIES		**70**	**82**	**92**	**86**	**118**
	TOTAL NUMBER OF FAMILIES		**39**	**41**	**40**	**41**	**46**
	TOTAL NUMBER OF GENERA		**61**	**71**	**78**	**73**	**98**
	OBSERVATION DAYS		**11**	**11**	**11**	**11**	**44**

The one hundred twenty-four species documented in this study represent about 20% of the bird species in the Philippines indicating the conservation importance of the marsh.

Of the 15 endemic species that were captured in the Agusan marsh, three were evaluated as vulnerable (IUCN 2013). *Ducula carola* was captured only in the sago forest, *Eurylaimus steerii* only in the terminalia forest while Silvery Kingfisher *Alcedo argentata* was captured in all sampling sites. *A. argentata* had a large number of individuals in the marsh as observed during the sampling period. Individuals were seen along riverbanks

where they feed on fishes, on canopies and grasses in all vegetation types. *A. argentata* was formerly widespread and locally common but because its population is suspected to be undergoing a rapid decline as a result of the loss and decline in quality of its forested lowland stream habitats, is now considered vulnerable (BirdLife International 2012).

Threatened and restricted-range species reported by Mallari et al (2001) were found in the present study. These are the *A. argentata*, of restricted-range and vulnerable status and Philippine duck (*Anas luzonica*), another species under the vulnerable category. The present results are very encouraging since in spite of the habitat degradation occurring in the marsh it is still able to serve as refuge to some of the endemic, threatened, and restricted-range species.

Most of the migratory species captured were recorded in Mindanao except for Siberian Rubythroat *Luscinia calliope* which was recorded in Luzon Faunal Region as accounted by Kennedy et al (2000). We mist-netted this species in the peat swamp forest of Agusan marsh. The capture of this species in the marsh indicates that this bird is not only confined to Luzon but could also be found in other areas of the Philippines. *L. calliope* was also noted on Mt. Kitanglad, Bukidnon, Philippines along with two other migratory species, *Turdus chrysolaus* and *Motacilla alba* (Peterson et al 2008). This species needs high rate of discovery to determine the status regarding the distribution in the Philippines. The highest species richness was recorded in the month of December (Figure 3).

Figure 4 shows some of the migratory bird species documented in the marsh.

Figure 3. Endemic, migratory and resident birds monitored monthly in the four sampling sites of Agusan Marsh.

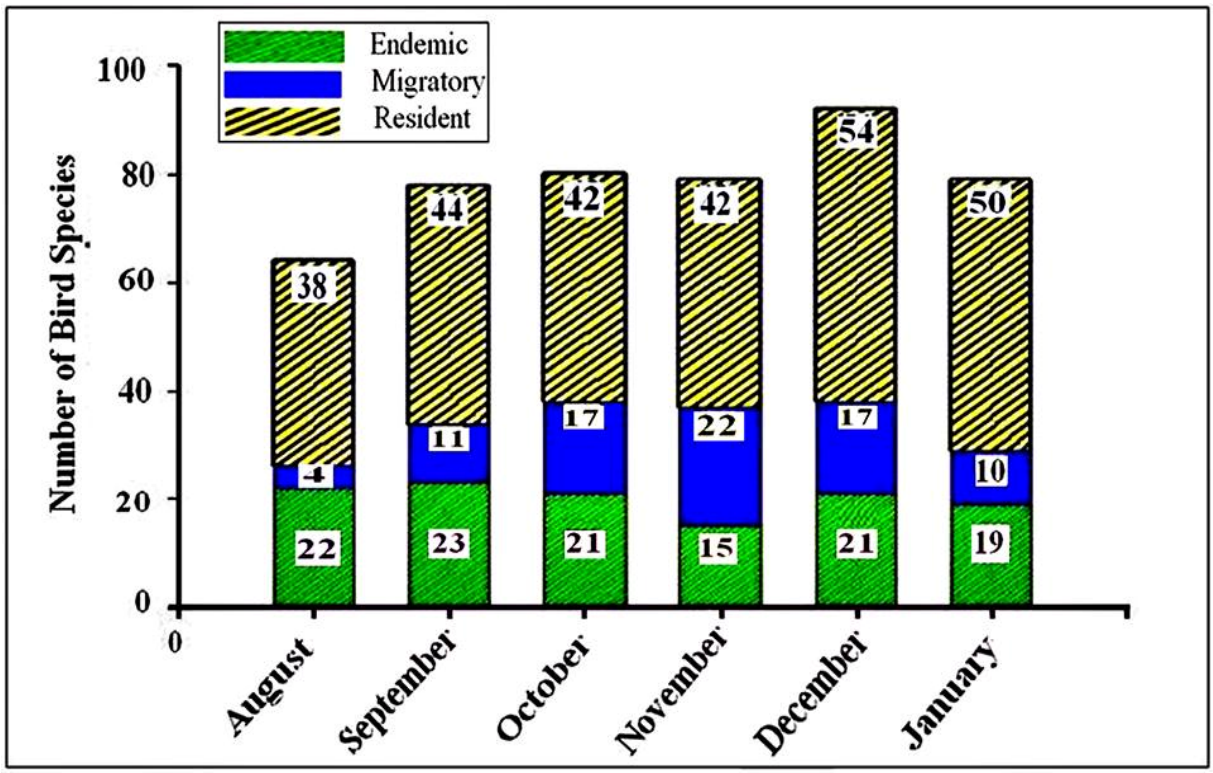

Figure 4. Some of the migratory bird species recorded in Agusan Marsh.

Higher species richness and endemism were recorded in the terminalia forest and these were attributed to its highly heterogeneous plant composition in the area (Figure 5). Martin (1980) stated that aside from the diversity of plant species or isolation of the islands, area must also be considered in determining abundance and number of species. The capture and observed results coincided with the observation of 85% of the key informants who said that birds are found in greater number in the terminalia forest. Also, the number of species differed among the four sites which is associated with the different vegetation types. This unevenness in bird species richness can be partly attributed to differences in the habitat type and quality (Paguntalan & Jakosalem 2008). Bird species richness also has positive relation with habitat complexity (Herzog & Kattan 2009).

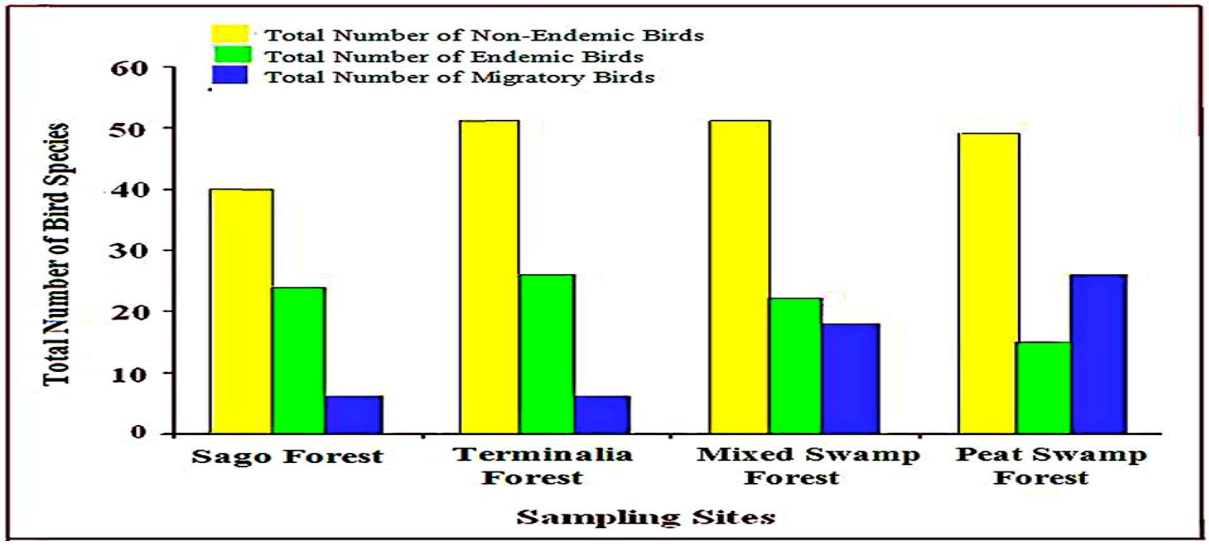

Figure 5. Total number of non-endemic (resident), endemic and migratory birds recorded in the four sampling sites of Agusan Marsh.

Endemic forms - taxa with geographic regions - are potentially most sensitive to habitat perturbation and thereby especially vulnerable to extinction. These forms are generally considered critical in indicating areas of special importance for conservation action (Townsend & Watson 1998). The presence of endemic and vulnerable bird species in the marsh indicates the importance of conserving the habitats in the marsh. Figure 6 shows some of the endemic bird species recorded in the marsh.

Figure 6. Some of the endemic bird species recorded in Agusan Marsh.

The most resident bird species were found in the mixed swamp forest. Seed–eaters and some insectivorous birds were observed feeding in the corn farms. In addition, the peat swamp forest which has an open canopy had the most number of migratory bird species

which is related to the numerous water systems such as lakes, creeks and rivers in this site. The high occurrence of these species may be attributed to the presence of shade crops which is an important habitat for a wide diversity of migratory and resident bird species (Van Bael et al 2007b). Diversity and abundance of wintering migratory birds appears to be affected more by habitat heterogeneity and preponderance of submerged aquatic vegetation (Datta 2011). It was observed that the number of endemic species tends to decrease as migrants increase in number or that endemism tends to decrease with the influx of migrants. The month of November had the most number of migrants recorded and the least number of endemics. This result, however, is inconclusive. A longer sampling period could yield more conclusive results.

Capturing wild birds for food resources, raising as pets, or for commercial purposes which lead to loss of habitat, have been the main causes of population reductions among many species (Fernandes-Ferreira et al 2012). Predation was seen as another factor affecting the distribution of bird population in the area. Predators can affect individual fitness, population and community processes (Cresswell 2008). Some birds like the non-endemic Crested serpent eagle (*Spilornis cheela*), Brown shrike (*Lanius cristatus*), and Large-billed crow (*Corvus macrorhynchos*) prey on bird eggs and the young of birds. Birds of prey fly higher, search and prey on small birds like pigeons and doves. Alcala (1976) reported that big reptiles like the monitor lizard (*Varanus* sp.), and the reticulated python (*Python reticulatus*) feed on the eggs of young and adult birds. Rats may also eat bird eggs and hatchlings. Hunting was also observed to be widespread at the buffer zones of the marsh. Lesser anthropogenic disturbance was observed in the mixed swamp and peat swamp forests since these sites are in the center of the Agusan marsh wildlife sanctuary affording protection to the species therein. Prakash & Manasvini (2013) reported that anthropogenic pressures are still a burden on the survival of bird diversity.

Pigeons, bitterns, doves, and egrets possess large bodies with tasty, soft and desirable meat. They are good sources of protein and are hunted for food. One respondent said that all birds are edible but it takes patience to cook small birds, thus the large ones are hunted for consumption. The meat of Purple swamp hen is used as bait for fishing by hook and line and gill netting. The white meat of this species is very attractive to the fishes. Small birds like the Psittacidae which include *Bolbopsittacus lunulatus*, *Prioniturus discurus* and *Loriculus philippensis* were commonly hunted and traded. Airguns are commonly used in hunting while fish cages and animal traps are used in trapping live birds.

Predators like *Ichthyophaga ichthyaetus*, *Haliaeetus leucogaster, Spilornis cheela*, *Hieraaetus kienerii*, and *Spizaetus cirrhatus* are hunted for food. *Gallicrex cinerea*, *Gallirallus torquatus*, *Amaurornis phoenicurus*, *Amaurornis olivaceus*, *Porphyrio porphyrio* and *Gallinula chloropus* of order Gruiformes are not exempted from hunting and trapping for food. *A. phoenicurus* and *G. chloropus* are commonly trapped in the fish cages of the fishermen. Sometimes if fishing is bad, the fishermen opt to trap birds for food. The two species *Sterna hirundo* and *Gelochelidon nilotica* are seen as competitors to fishermen since these species feed mainly on fishes. During migration time in the months of November to January, when these species are in great number, the fishermen have less fish captured in nets.

Birds that feed on insects, rats, and other organisms that destroy the farmer's crops include *Cuculus fugax*, *Cacomantis merulinus*, *Centropus melanops* and *Centropus viridis* of family Cuculidae. Insectivorous birds are also considered economically important. Bird predation is a potential ecosystem service that benefits farmers by limiting pests (Van Bael et al 2007a). However, birds such as *Lonchura malacca* and *Lonchura leucogastra* are the two most hated birds in the area since they are considered as pests to rice farms.

Respondents were asked which among the bird species are seen as the most abundant. Majority said that egrets which include *Egretta alba*, *Egretta intermedia*, *Egretta garzetta*, *Bubulcus ibis*, *Ardeola speciosa* are very abundant especially during the migration period. Results of this study confirmed their observations.

Key informant interviews showed that birds serve as food for humans and bait for fishes, source of income as in the pet trade, serve as pets, have medicinal value, and significant in seed dispersal. Birds of family Ardeidae which include *E. alba*, *E. intermedia, E. garzetta*, *A. speciosa*, *B. ibis*, *Ixobrychus sinensis* and *Ixobrychus cinnamomeus* were found to be utilized as medicine. The down feathers of these birds were found effective for wounds. *Ardea purpurea* serves as food to the indigenous people in the area. Fish cages were seen as threat to the birds in the marsh. During the field sampling, *E. garzetta* and *B. ibis* were seen accidentally trapped in fish cages.

Some species considered stable by IUCN (2013) were seen as locally threatened as gleaned from local interviews. Hunting for food and the pet trade made these species locally threatened. Commonly hunted for the pet trade using airguns were *Phapitreron leucotis*, *Bolbopsittacus lunulatus*, and *Loriculus philippensis.* Smaller birds were hunted using sling shots.

The major threat to the avifauna of Agusan Marsh is the conversion of forestland to agriculture (Figure 7). Local residents converted portions of the area to agriculture such as corn and rice farms. Habitat loss and degradation, timber extraction, selective logging, and harvesting (hunting/gathering) of birds for food, increasing population migration to the marsh, and illegal cutting of the trees in the sanctuary were some of the threats to the avifauna in the marsh.

Figure 7. Conversion of forest land to agricultural farming.

Significant records

Threatened endemic species:

- Spotted Imperial Pigeon (*Ducula carola*): this species is a Philippine endemic confined to Islands of Luzon and Mindanao. It is the smallest Imperial pigeon in the Philippines (Kennedy et al 2000). It has light grey head, grey breast band and dark chestnut belly. It prefers habitats that are on degraded secondary forest and scrub. This nomadic species has a small population, which is inferred to be declining rapidly owing to forest loss throughout its range, compounded by widespread hunting, qualifying it as vulnerable (IUCN 2013). One individual was mist-netted in sago forest.

- Silvery Kingfisher (*Alcedo argentata*): endemic to the southern islands of the Philippines; found in Basilan, Dinagat, Siargao, Bohol, and Mindanao. This species qualifies as vulnerable because it has a small population that is undergoing a rapid decline as a result of the loss and decline in quality of its forested lowland stream habitats (IUCN 2013). This species was commonly seen along river banks on our way to Agusan marsh. Eight individuals were mist netted and were present in the four sampling sites.

- Mindanao broadbill (*Eurylaimus steerii*): this broadbill is endemic to the Mindanao Faunal Region of the Philippines. It is found in lowland primary and secondary forests of

Basilan, Bohol, Leyte, Samar, Dinagat, and Mindanao except Zamboanga Peninsula. This species is uncommon and local in forest understory below 1000 m. This species qualifies as vulnerable because it has a small, seriously fragmented population and is declining rapidly as a result of lowland deforestation (IUCN 2013). Only two individuals were mist netted in the terminalia forest in the months of August and September 2005.

Philippine endemic species:

- Philippine Scops-Owl (*Otus megalotis*): it is endemic and fairly common throughout the Philippines. This owl is strictly nocturnal and difficult to locate owing to its very infrequent calls, which consist of two or three descending growling notes. Four individuals were mist netted in sago, terminalia and mixed swamp forests. We also heard calls in the sampling sites during night time.

- Philippine Frogmouth (*Batrachostomus septimus*): this nocturnal bird species is endemic to the Philippines and uncommon. Nocturnal in forest edge up to about 2500 m; it is more often heard than seen. This species was captured in the terminalia forest during the months of August and September 2005. The global population size and trends have not been quantified, but the species is not believed to approach the threshold for the population size and decline criterion of the IUCN Red List even though the species is described as uncommon in at least parts of its range and for these, this species is evaluated as Least Concern (IUCN 2013).

- Mindanao Hornbill (*Penelopides affinis*): this hornbill is endemic to the Philippines found in Bucas, Dinagat, Mindanao and Siargao. The male is generally dirty yellow or rufous, the wings and back are brown to black glossed green, and the tail is black with broad rufous band. The female is all grayish brown to black. This species prefers primary forest. One individual was caught in the terminalia forest in the September 2005 sampling.

Resident birds:

- Purple Heron (*Ardea purpurea*): this species is fairly common in all types of wetlands from coastal marshes to rice fields and feeds on anything it can catch. It flies slowly and heavily with head held back (Fisher & Hicks 2000). More than 500 individuals were observed in Lake Dinagat near sampling site 4 (peat swamp forest) on December 2005. Although we have accounted 107 individuals encountered during the whole duration of the study, only five individuals were caught.

- Javan Pond-Heron (*Ardeola speciosa*): this heron is a recent colonist of the Philippines found singly or in flocks in rice fields and marshes. It is a small heron which has all white wings and the sexes are alike. We captured Javan Pond-Heron in the sago forest. It was non-breeding; was streaked with buff and pale olive brown on head and neck, and back has scapulars pale olive brown and the remaining parts were white. Three hundred-seventy one individuals were observed in the four sites but were commonly seen in mixed swamp and peat swamp forests in September 2005 to January 2006.

Migratory species: flocks of white egrets were very common in the wetlands of Agusan marsh. There were four egrets encountered in the marsh. These include *Egretta alba*, *Egretta intermedia*, *Egretta garzetta*, and *Bubulcus ibis*.

- Little Egret (*Egretta garzetta*): this egret is considered as medium in size. It forages by posing or actively pursuing fish in most wetlands from rice fields and marshes to tidal flats. It eats a wide variety of preys from fish, mollusks and worms to insects and even small mammals and birds. It is the liveliest hunter among herons and egrets, with a wide variety of techniques. Generally, this species moves around silently. This species spends winter in Southeast Asia, migrating in large dispersal flocks, arriving mainly in September-October. Like other egrets with beautiful breeding plumes, Little Egrets are threatened by hunting for their feathers. They are more threatened by habitat destruction and pollution. This species is evaluated as Least Concern (IUCN 2013).

- Cattle Egret *Bubulcus ibis* (Linnaeus, 1758): this species is most often found near farmland and livestock but also in and near marshes or lakes and wetlands and often associated with large domestic animals like cattle or carabao. About 3,057 individuals were observed for the whole duration of the sampling. This species has Least Concern conservation status (IUCN 2013).

- Japanese Sparrowhawk (*Accipiter gularis*): three individuals of this migrant species were captured through mist netting in mixed swamp and peat swamp forests of Agusan Marsh.

- Swinhoe's Snipe (*Gallinago megala*): it is the most common snipe in the Philippines where it winters in marshy areas and ricefields at all elevations from 29 Aug (Luzon) to 27 May (Batan) (Kennedy et al 2000). Only one individual was caught in the peat swamp forest of Agusan marsh on September, 2005.

- Oriental Reed-Warbler (*Acrocephalus orientalis*): it is a large warbler distinguished from other Acrocephalus warblers by its long bill, long wings and faint streaks on chest. This species is a widespread and common passage migrant and winter visitor. It breeds in East Asia and stays during winters in Southeast Asia. Five individuals were mist netted in mixed swamp and peat swamp forests of Agusan marsh.

- Middendorff's Grasshopper-Warbler (*Locustella ochotensis*): this species is migrant and uncommon to the Philippines. It skulks on or near the ground in reeds, thickets, and tall grass usually near water. This species is difficult to see. It has faint breast band, grey edge to outer primary feathers, and graduated tail with white tips to outer feathers. Call is an almost continuous insect-like, racheting staccato of *trat-at-at-at-at* interspersed with *trat* (Kennedy et al 2000). This species was present in the four sampling sites of Agusan marsh. Twenty-one individuals were mist netted.

New record for Agusan marsh, Mindanao:
- Siberian Rubythroat (*Luscinia calliope*): this terrestrial robin is a common winter visitor to the Philippines, particularly Luzon, breeding in north-eastern Asia and migrating south in winter. According to Kennedy et al (2000) this bird was recorded only in Batan, Calayan, Luzon, Mindoro, Negros, Panay, Masbate, Catanduanes, Sibuyan and Marinduque in the Philippines during the migratory season. A male individual with prominent white eyebrows, moustachial stripes and a startling red throat was mist netted in the peat swamp forest of Agusan marsh. This bird inhabits marshlands and open country with long grass, skulking in thick tangled vegetation where it feeds on insects, but sometimes coming out onto tracks in the early morning. This species is evaluated as Least Concern since this species is not believed to approach the threshold for the population decline criterion of the IUCN Red List.

Conclusions and Recommendations. The additional 54 species found in this study and the discovery of *L. calliope* as new record for Agusan Marsh, Mindanao are significant records for the birds in Agusan Marsh. More species could be discovered with more intense sampling efforts and surveys in other areas of the marsh. The presence of endemic, vulnerable, migratory, and restricted-range species shows that Agusan marsh is a key conservation site. A high number of endemic species was recorded in Sites 1 and 2 which are outside the Agusan Marsh Wildlife Sanctuary. Within the protection zone are sites 3 and 4 which have high number of migratory bird species. It is recommended that these sites be given conservation priority action. However, conservation issues like resource utilization and conversion of forests for agricultural purposes and the livelihood of the people need to be taken into account in the formulation of conservation and management plan for the marsh. Since the study was conducted mostly within the migratory season, it is recommended that longer sampling within and outside the migratory season be done to show clearer evidence of temporal variation.

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Annex

Ecological Knowledge Questionnaire

DATE: _____

Name of Respondent: _____
Age: _____ Sex: [ ] M [ ] F
Residency:
Locality: _____
Municipality / Province: _____
Sources of Income: _____

Ecological Knowledge of Birds

1. What are the different kinds of birds that you know that are present here in Agusan Marsh?
2. Where do you usually find them?
3. Are they observed singly or in groups?
4. Which among the bird species has the greatest or least number at present?
5. What particular habitats do you see greater and lesser number of birds?
6. Is the number of birds, better off, worse off or about the same as it has been over the past 5 years? 10 years?
7. What do you think are the common threats to birds in your area?
8. Do you think birds play an important role in the ecosystem?
   If yes, why?
   If no, why?
9. What do you want to do with the birds today?
10. What are the socio-economic importances of birds?
11. Are there any birds that you have eaten, sold or used as medicine?
    A. Eaten [ ] Yes [ ] No
       a. What are those?
       b. Are they eaten raw or cooked?
       c. What parts are eaten?

    B. Sold [ ] Yes [ ] No
       a. What are those?
       b. How were they sold? Per piece or per kilo?
       What is the selling price of these birds?

    C. Used as medicines [ ] Yes [ ] No
       a. What are those?
       b. What parts are being used?
       c. What is the mode of application?

What do you think are the helpful ways of maintaining the healthy population of birds at present and in the years to come?