EFFECT OF ROAD TO AVIAN DIVERSITY, ABUNDANCE AND RICHNESS IN SELECTED RICE FIELDS ALONG LAGUNA NATIONAL HIGHWAY, PHILIPPINES

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Abstract: With the destruction of our natural wetlands, rice fields are man-made ecosystems which serve as an important alternative wetland habitat for birds. In this study, two selected ricefields along Laguna National Highway were sampled to determine the species of both landbirds and waterbirds in ricefield ecosystems during the summer season using transect and opportunistic sampling. A transect was placed perpendicular to the road to assess the effect of the distance from the road to the avian diversity, abundance and richness in rice fields. A total of 1259 individual birds were observed from 43 bird species belonging to 22 families mainly dominated by *Passer montanus* (22.64%) and *Cisticola juncidis* (20.18%). Among all the families, Ardeidae had the highest species richness (18.18%) dominated by *Bubulcus coromandus* (10.88%). Furthermore, lower diversity of waterbirds was detected compared to the landbirds. It was also observed that the rice field ecosystem was dominated by insectivorous and carnivorous birds. Statistically, there were no significant effects of distance from the road to both bird abundance (Kruskal-Wallis, $p = 0.08$) and richness (Kruskal-Wallis, $p = 0.07$); however, both were observed to be higher in the more distant part. Additionally, species diversity was also highest in the most distant part on the ricefields. It was also observed that different species could exhibit different responses to the road. The results of the study may imply that the road could affect the community and population of birds in ricefield ecosystems.

Keywords: abundance, diversity, ricefield birds, richness, road effect, Philippines

Introduction:

Earliest researches about rice field birds were focused on species that were said to be crop pests (Elphick 2010) but it turns out that only a small number of rice field birds are rice pests. In the Philippines, only six species of birds eat rice grains namely: *Passer montanus, Lonchura atricapilla, Lonchura oryzivora, Lonchura leucogastra, Lonchura punctulata* and *Gallicrex cinerea* (Bourdin et al. 2015). Rice field birds are significant and important species as they control the population of invertebrates that causes detrimental effects on the rice plants. They could also serve as indicator species on paddy

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fields according to Kirinde et al. (2015) in their study in a minor irrigation system in Awlegama Agrarian Service area in Wariyapola Divisional Secretariat. It is therefore important to study rice field birds and the factors that could affect its diversity richness and abundance, which could further be used for their conservation.

Nearly a third of all birds species use agricultural habitats (Sekercioglu 2012) such as rice fields. Rice fields act as a major migration corridor for water birds (Remsen et al. 1991; Elphick and Oring 1998; Blanco et al. 2006). These artificial wetlands follow different stages such as ploughing, seasonal flooding and planting (Munira et al. 2014) that could affect the species composition and the diversity of both resident and migrant birds (Lourenço and Piersma 2009). These variations of the area's characteristics attract different kinds of birds for feeding and breeding. The bird species composition and distribution are also influenced by the different growing stages of rice on the area. Nachuha and Muchai (2008) found out that plough rice and stage 1 rice fields comprised more diverse species compared to stage 2 and harvested rice fields. Field size, abundance of suitable habitats, and depth of water on the rice fields also affect the waterbirds diversity.

Disturbances inflicted by humans also affect the abundance of animals in a particular area. It was suggested that traffic could affect breeding birds possibly by the emission of traffic matters and energy, such as pollution, visual stimuli and noise (Reijnen et al. 1997). Another example is the effect of traffic noise, argued as the main stressor produced by road, which could greatly affect the abundance of songbirds as it interferes with their vocal communication. A contrasting scenario could also be observed where bird species are not affected by the noise from the road or are attracted by the road (Fahrig and Rytwinski 2009). Another possible contributors of lower abundance in rice field birds are the use of pesticides. These pesticides could either indirectly affect the abundance of birds by reducing food abundance (Vickery et al. 2001) and/or directly because of toxic poisoning from the chemicals (Isenring 2010).

Distance from potentially unfavorable landscape features (e.g. roads) are important to consider (King et al. 2010) and understanding these would enhance our ability to assess the effects of these landscapes to birds in agricultural environments (Fujioka et al. 2001). In the Philippines, monitoring the abundance, species richness and diversity of rice field birds focuses mainly on the effect of rice stages (Tanalgo et al. 2015) but the anthropogenic effects, specially the road, were never been appreciated. In this study, the avian species, diversity, abundance and species richness from the two randomly selected rice fields, beside a national road, during summer season were determined. The feeding guilds, conservational and residential status of the birds were also checked. Moreover, the effect of road to the diversity, abundance and species richness of rice field birds were assessed.

Materials and methods:

Study area

The sampling areas were randomly selected along the Laguna National Highway where 2160 vehicles per hour were observed. Two rice fields were selected which are characterized by its scare vegetation of trees and herbs, and the presence of houses along the road. The first rice field is located in Brgy. Hanggan 1, Calauan, Laguna (14°10'37.84"N - 121°18'16.35"E) while the second field is in Brgy. Sto. Domingo, Bay, Laguna (transect from 14°10'33.36"N - 121°16'01.41"E), with 4,041 m away from each other. Transect length across both sites were 500 meters, sampled vice versa. Selection of rice fields was influenced by the presence of straight soil levees perpendicular to the road, presence of relatively similar vegetation type, and other factors that could affect the safety of the researchers. Because the study was conducted during summer season, only matured and harvested stages of rice fields were sampled.

Sampling method

Transect lines in a straight soil levees perpendicular to the main road were used. Transects were placed along an irrigation canal to increase the probability of finding water birds. No sampling was done during rainy days. The birds were census using the standardized speed along the transect line (2km/h) by only 1 observer without disturbing the birds. Distance from the road was recorded for each observed birds and care was observed to avoid double-counting. Point counts were also placed for every 100 m interval from the road (Helldin and Seiler 2003). The samplings were performed during the summer season of the month of March, April and May. Furthermore, each site was sampled twice a day between 5:30 - 7:00 in the morning, and 16:30 - 18:00 in the afternoon. A total of 19 visits were done in the rice field in both sites. The distance of each observed bird from the road was recorded, but birds flying overhead were not (Nachuha and Muchai 2008). Transects' length was limited by the characteristics of the rice fields, such as the absence of a paddy straight soil.

Opportunistic sampling was also performed after each transect sampling to sample shy and rare birds and to observe and count the birds on the area not sampled during the transect sampling. Additionally, soil levees parallel to the road were also monitored and counting to a particular point was also done. Birds were identified *in situ* with the aid of a field guide for Philippine rice field birds (Bourdin et al. 2015). Food preference, and status of the observed birds were also based on the same field guide. Conservational status for each bird species was checked in the IUCN (2015). All observations were made using an 8 x 42 Bushnell binocular.

Species diversity and Statistical Analysis

The relative abundance (%) of each species and family were computed using the equation N/n, where N is the number of individuals observed for a particular species or family and n is the total number of birds observed. The species richness for each bird family was computed using the equation: number of species of the family/the number of all species observed. Shannon diversity (H) index was used to compute the diversity of the two sites and for the comparison of the diversity with distance from the road with 100 m interval using PAST version 1.68. Shapiro-Wilk was used to test the normality of the data in order to determine the appropriate analysis to be used for comparing means. Kruskal Wallis was used to compare the avian abundance and species richness with distance from the road with 100 m interval using SPSS 24 Free Trial version. Regression Analysis was also used to determine the trend of the abundance of selected birds with increasing road distance. Moreover, Sigma Plot 10.0 was used to generate all the figures in this study.

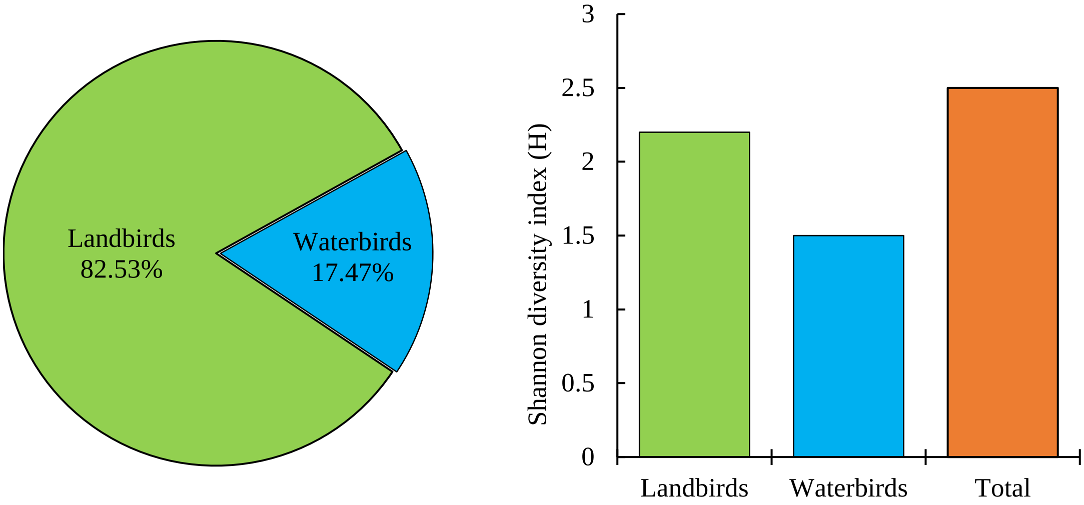
Results and discussion:

Bird abundance, richness, composition and diversity

A total of 1259 birds of 43 species belonging to 22 families were observed from the two rice fields along the Laguna National Highway during the whole duration of the study (Tab. 1, Annexes). It was observed that the family Passeridae (22.64%) was the most abundant followed by Cisticolidae (20.18%). The lowest of which, in terms of individual sightings, are the Halcyonidae (0.08%) and Alaudidae (0.08%). Among the species observed, *Passer montanus* (22.64%) featured the highest individual sightings followed by *Cisticola juncidis* (20.18%). This was already expected as the rice fields in the month of March, April and May are usually characterized by mature and harvested stages of rice. This attracts rice eating birds such as *P. montanus*. This fact was also noticed by Maeda (2001) where *P. montanus* displayed the highest occurrence during the cultivation season. Furthermore, because the sites are adjacent to the road, *P. montanus* has the advantage because it is already very adapted to urban areas, which is also a possible reason why it got the highest abundance value. Similarly, insects were abundant during the time of study, thus attracting the insect eating birds such as *C. juncidis* which, together with *P. montanus*, are among the most common residents on the area (Bourdin et al. 2015).

Furthermore, it was observed that the diversity and species composition of waterbirds was very low compared to that of landbirds (Fig. 1). This is because during mature and harvested stage of rice fields, waterbirds are very much affected as reported by Nachuha and Muchai (2008).

Figure no. 1 Left: Showing the relative abundance of waterbirds to landbirds. Right: Comparison of diversity indices of waterbirds and landbirds



Among the waterbirds, Ardeidae was observed to have the highest species richness (18.61%) among all the bird families sighted in this study (Tab. 2). The species are *Egretta alba* (0.16%), *Egretta garzetta* (1.35%), *Egretta intermedia* (0.17%), *Bubulcus coromandus* (10.88%), *Dupetor flavicollis* (0.08%), *Ixobrychus chinensis* (0.59%), *Ixobrychus eurhythmus* (0.16%) and *Ixobrychus cinnamomeus* (1.43%). This was followed by Rallide (9.30%), a waterbird family. The species observed under this family were *Amaurornis phoenicurus* (0.16%), *Amaurornis olivacea* (0.16%), *Gallinula chloropus* (0.24%) and *Porzana cinerea* (0.24%). However, the species pertaining to both families, except *B. coromandus*, were not abundant, and might be because during the last part of mature stage and during the harvested stage of rice, the water was drained resulting in lower abundance of invertebrate food supply (Nachuha and Muchai 2008). Another possible reason for relatively lower abundance and diversity of waterbirds is the relatively dense vegetation during the mature stage which lessen the probability of encounter, and people shoo the birds to avoid loss of their yield. However, it could be predicted that during ploughing and phase 1 stage on the study areas, more waterbirds could be observed because of flooding (Maeda 2001; Nachuha and Muchai 2008).

Most of the birds observed in this study were mixed feeders. Insectivorous birds were observed to have the highest species among the feeding guilds (see Tab. 1, Annexes) dominated by *Cisticola juncidis, Colocalia esculenta* and *Megalurus palustris.* Insectivores as the dominant feeding guild was also observed by Tanalgo et al. (2015) in their study about bird diversity in rice fields in Central Mindanao, Philippines. This was followed by carnivorous birds which are mainly contributed by water birds. Carnivorous birds were also detected by Tanalgo et al. (2015) as the second highest guild in terms of number of species. In this study, the carnivorous guild was dominated *by Bubulcus coromandus*. It could be the presence of polychaetes, crustacians and mollusks (Stafford et al. 2010) which contribute to the high abundance of *B. coromandus*, however other carnivorous bird species were lower in abundance. Granivores in this study was the third species rich guild, dominated by *P. montanus* and *L. atricapilla*. These birds are considered as pests by farmers. Moreover, if high diversity of granivores is detected, the habitat could be disturbed (Gray et al. 2007). Lastly, frugivores appeared the lowest species detected in this study. This could be expected as lesser fruit bearing trees were observed from rice fields. However, more frugivore species could be observed in agroforests as more fruiting plants could be observed which could contribute to high diversity of fruit eating birds (Moegenburg and Levey 2003).

Table no. 2 Bird families and their abundance and richness

Family	Abundance	Abundance (%)	Richness	Richness (%)
Acrocephalidae	10	0.79	1	2.33
Alaudidae	1	0.08	1	2.33
Apodidae	79	6.28	2	4.65
Ardeidae	195	15.49	8	18.61
Artamidae	5	0.40	1	2.33
Cisticolidae	254	20.18	1	2.33
Columbidae	9	0.72	2	4.65
Corvidae	4	0.32	1	2.33
Estrildidae	212	16.84	3	6.98
Halcyonidae	1	0.08	1	2.33
Hirundinidae	57	4.53	3	6.98
Laniidae	19	1.51	2	4.65
Locustellidae	41	3.26	2	4.65
Meropidae	16	1.27	1	2.33
Motacillidae	25	1.99	3	6.98
Passeridae	285	22.64	1	2.33
Pycnonotidae	15	1.19	1	2.33
Rallidae	10	0.72	4	9.30
Rostratulidae	5	0.40	1	2.33
Scolopacidae	2	0.16	1	2.33
Sternidae	7	0.56	2	4.65
Sturnidae	7	0.56	1	2.33
Total	1259		43	

Effect of Road to the Avian Abundance, Species Richness and Diversity

In this section, the species number and abundance of the two sites were combined. The data derived from the opportunistic sampling was used but excluding the birds seen 500 m away from the road for the reason of making the distance of the two sites the same.

There were no conclusive trends detected for both species richness (N = 19, df = 4, p = 0.07) and abundance (N = 19, df = 4, p = 0.08) but it was observed that the avian diversity was higher in 410 - 500 m distance from the road (Figs. 2, 3 and 4). It could be observed that 310 - 400 m reached the highest value for both species richness and abundance. However, this does not show any conclusive effect of the road to the bird abundance and species richness because the first 100 m from the road were higher than that of 110 - 200, 210 - 300 and 410 - 500 m.

Figure no. 2 Comparison of the mean bird species richness (p = 0.07) of increasing distance from the road with 100 m intervals

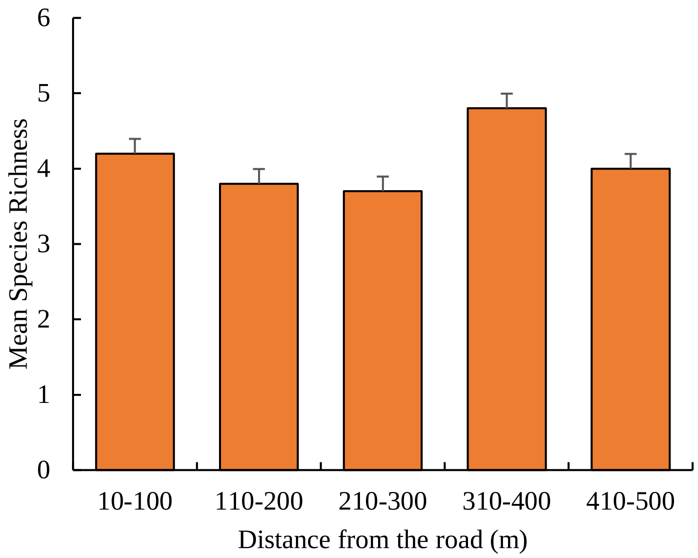


Figure no. 3 Comparison of the mean bird abundance (p = 0.08) of increasing distance from the road with 100 m intervals

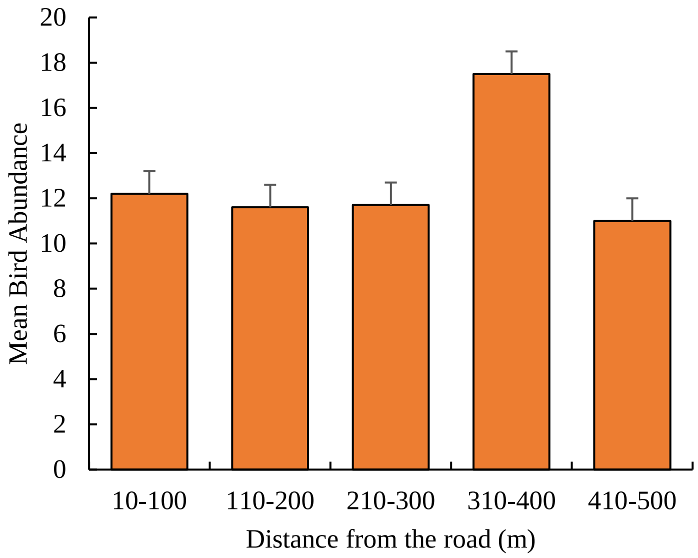
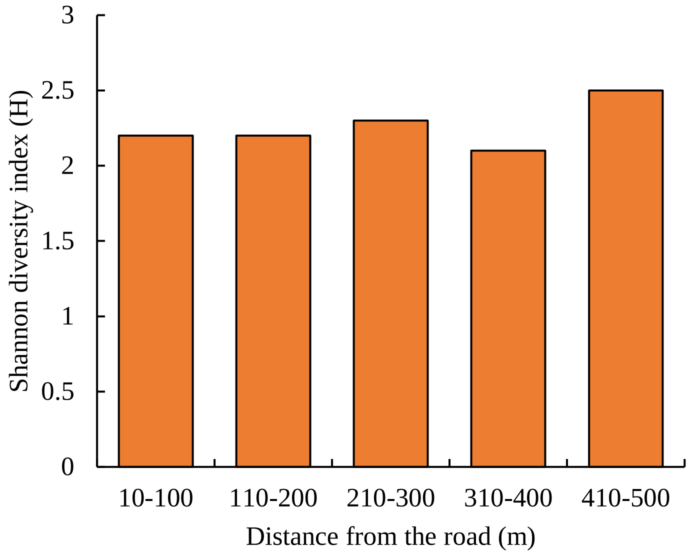


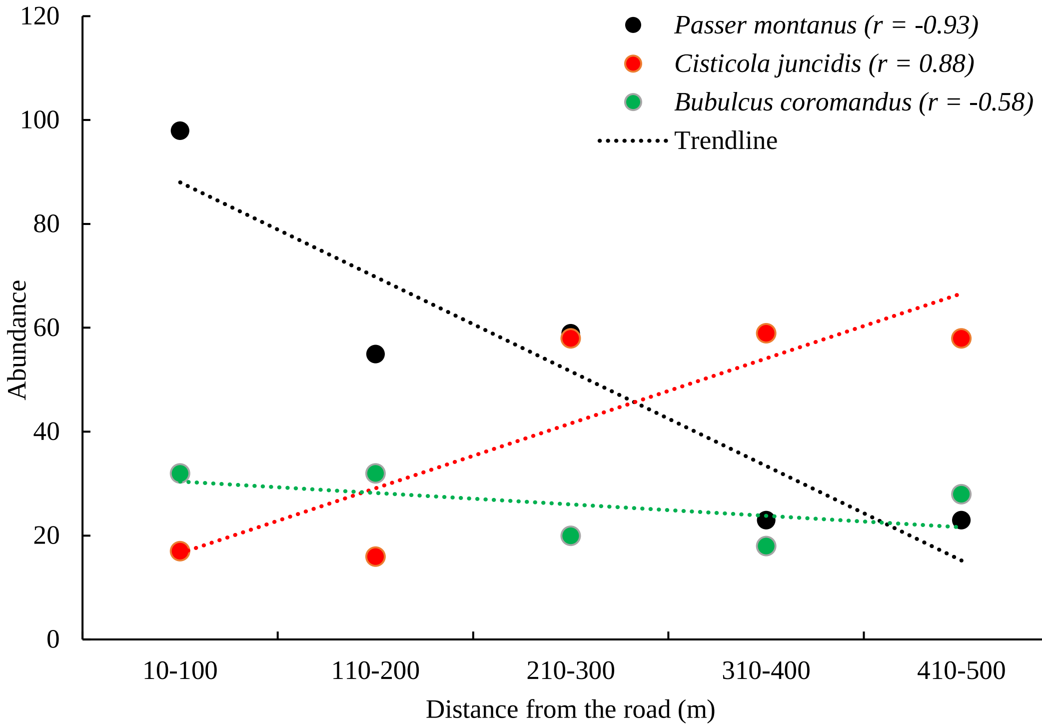
Figure no. 4 Comparison of bird diversity of increasing distance from the road with 100 m interval



This result was also observed in the study of Helldin and Seiler (2003) where they did not detect a significant difference of both species richness and abundance in farmland and forest regarding distances from the road. However, they have observed that in farmlands, species abundance and richness of the birds were lowest in the area adjacent to the road, contrasting to the present study. The lack of road effect on the birds may be due of its ability to efficiently escape moving vehicles, thus lower mortality could be observed in birds compared to reptiles and small mammals. Furthermore, road could result to predatory release (Rytwinski and Fahrig 2007). Because the birds observed in this study could be preyed upon by snakes or other animals, these species could be attracted by the road, as predators such as snakes are negatively affected. Other studies considering other ecosystems, detected negative effect of road to bird species richness (Findlay et al. 2000) and density (Reijnen et al. 1996), and neutral effect on birds' abundance (Warner 1992).

Although there was no conclusive evidence that the abundance and richness were positively or negatively affected by the road, it could be observed that the highest species diversity was observed in the most distant area while the first 4 distances were relatively the same (see Fig. 4). This could be argued that at this distance from the road, bird diversity is higher because of lower road stresses such as noise, lights and humans in settlements. Furthermore, the possibility of detecting a road effect trend in the community level would be lower because different birds have different responses to the road as can be seen in the examples in Figure 5 showing the 3 possible trends. Based on this study, positive road effect was detected in *P. montanus*, negative effect on *C. juncidis* and relatively neutral effect on *B. coromandus*. Other studies concerning road effect in birds also detected positive effect in *Ficedula hypoleuca* (Kuitunen et al. 2003), neutral in *Dolichonyx oryzivorus* (Forman et al. 2002) and positive in *Miliaria calandra* (Peris and Pescador 2004). According to the review of Fahrig and Rytwinski (2009) most birds are negatively or neutrally affected by roads and only some birds are positively affected.

Figure no. 5 Effect of the road on the abundance of *Passer montanus*, *Cisticola juncidis* and *Bubulcus coromandus*



Conclusions:

According to the result of the present study, both rice fields have slightly diverse species of birds during summer season. Forty-three species under 22 bird families were observed, dominated mainly by *Passer montanus* and *Cisticola juncidis*. Furthermore, among the bird families, Ardeidae has the highest species richness observed, however, all species except *B. coromandus*, under the family has lower abundance. This is also true to all species of waterbirds observed in this study where a lower diversity was detected compared to the landbirds. It was also noted that during summer, insectivorous birds have dominated the ricefields followed by carnivorous birds. Granivores and frugivores featured the lower species richness in feeding guilds. All of the results suggests that rice fields could still be considered as an important agroecosytem for waterbirds and landbirds. Although all the species are considered as least concerns under IUCN Red List, while some are data deficient (IUCN 2015), rice fields are still needed by both migrating and resident birds. Moreover, the result also shows that most of the rice field birds are relatively helpful to the farmers as more pests (insects and mollusks) eating birds were observed compared to seed eating birds.

It was also observed that there were no significant differences of both abundance and richness of birds with increasing distance from the road. However, both abundance and species richness were relatively higher in the more distant part of the ricefields. Moreover, species diversity was highest in the most distant parts of the ricefields. It was also observed that in the population level, some birds could be positively and negatively affected or not affected by the presence of the road. These data could imply that species diversity, abundance and richness could be affected by the road negatively. Although, it could be argued that the effect was relatively weak in this study, still a strong effect on the behavior of the birds towards the road could be observed in the population level.

Rezumat:

EFECTUL TRAFICULUI ASUPRA DIVERSITĂȚII, ABUNDENȚEI ȘI BOGĂȚIEI PĂSĂRILOR DIN CÂMPURILE DE OREZ SELECTATE DE-A LUNGUL AUTOSTRĂZII NAȚIONALE LAGUNA, FILIPINE

Odată cu distrugerea zonelor umede naturale, câmpurile de orez sunt ecosisteme făcute de om care servesc ca un important habitat umed pentru păsări. În acest studiu au fost selectate două câmpuri de orez de-a lungul autostrăzii naționale Laguna, pentru a determina atât speciile de păsări terestre, cât și acvatice prezente în acest tip de ecosistem în timpul sezonului de vară, utilizând metoda eșantioanelor și a transectelor. Un transect a fost plasat perpendicular pe drum, pentru a evalua efectul distanței față de drum asupra diversității, abundenței și bogăției păsărilor în câmpurile de orez. Un total de 1259 exemplare au fost observate, aparținând la 43 de specii de păsări și 22 de familii, în care *Passer montanus* (22.64%) și *Cisticola juncidis* (20.18%) au fost dominante. Dintre toate familiile, Ardeidae a avut cea mai mare bogăție de specii (18.18%), dominantă fiind *Bubulcus coromandus* (10.88%). Pe de altă parte, a fost semnalată o diversitate mai mică a păsărilor de apă în comparație cu păsările terestre. De asemenea, s-a observat că în orezăriile selectate păsările insectivore și carnivore sunt dominante. Din punct de vedere statistic, nu au existat efecte semnificative în ceea ce privește distanța față de drum și abundența (Kruskal-Wallis, p = 0.08) și bogăția păsărilor (Kruskal-Wallis, p = 0.07); totuși, valori mai ridicate au fost înregistrate în partea mai îndepărtată față de drum. De asemenea, diversitatea speciilor a fost mai mare tot în zonele îndepărtate ale orezăriilor. S-a observat că speciile de păsări pot prezenta răspunsuri diferite față de drum. Potrivit cu rezultatele studiului, putem presupune că drumul ar putea afecta comunitatea și populația de păsări în ecosistemele de tip orezării.

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References:

BLANCO D.E., LÓPEZ-LANÚS B., DIAS R.A., AZPÌROZ A., RILLA F. (2006) (on line), Use of rice fields by migratory shorebirds in southern South America: implications for conservation and management, *Wetlands International*, Buenos Aires, Argentina.

BOURDIN P., PARIS T., SERRANO F., SMEDLEY R., HETTEL G. (2015), *Guide to the birds of Philippine rice fields*, International Rice Research Institute.

ELPHICK C.S. (2010), Why study birds in rice fields?, BioOne, *Waterbirds 33 (Special Publication 1): 1-7*.

ELPHICK C.S., ORING L.W. (1998), Winter management of Californian rice fields for waterbirds, *Journal of Applied Ecology 35 (1): 95-108*.

FAHRIG L., RYTWINSKI T. (2009), Effects of roads on animal abundance: an empirical review and synthesis, *Ecology and society 14 (1): 21*.

FINDLAY T., SCOT C., BOURDAGES J. (2000), Response time of wetland biodiversity to road construction on adjacent lands, *Conservation Biology 14 (1): 86-94*.

FORMAN R.T., REINEKING B., HERSPERGER A.M. (2002), Road traffic and nearby grassland bird patterns in a suburbanizing landscape, *Environmental management 29 (6): 782-800*.

FUJIOKA M., JAMES JR. W.A., YOSHIDA H., MAEDA T. (2001), Value of fallow farmlands as summer habitats for waterbirds in a Japanese rural area, *Ecological Research 16 (3): 555-567*.

GRAY M.A., BALDAUF S.L., MAYHEW P.J., HILL J.K. (2007), The response of avian feeding guilds to tropical forest disturbance, *Conservation Biology 21 (1): 133-141*.

HELLDIN J.O., SEILER A. (2003), Effects of roads on the abundance of birds in Swedish forest and farmland, *Wildlife Biology 6: 111-120*.

ISENRING R. (2010), Pesticides and the loss of biodiversity. *How intensive pesticide use affects wildlife population and species diversity*, Pesticide Action Network, Europe.

IUCN (2015), *The IUCN Red List of Threatened Species.* Version 2015-4. <http://www.iucnredlist.org>. Retrieved on 22 May, 2016.

KING S., ELPHICK C.S., GUADAGNIN D., TAFT O., AMANO T. (2010), Effects of landscape features on waterbird use of rice fields, *Waterbirds 33 (Special Publication 1): 151-159*.

KIRINDE G.W.R.W.M.R.M.W.K., MOWJOOD M.I.M., DAYAWANSA N.D.K. (2015), Biodiversity Assessment of Paddy Field Ecosystem using Birds as a Biodiversity Indicator, In: *Proceedings of International Forestry and Environment Symposium (Vol. 20)*.

KUITUNEN M.T., VILJANEN J., ROSSI E., STENROOS A. (2003), Impact of busy roads on breeding success in pied flycatchers *Ficedula hypoleuca*, *Environmental Management 31 (1): 0079-0085*.

LOURENÇO P.M., PIERSMA T. (2009), Waterbird densities in South European rice fields as a function of rice management, *Ibis 151 (1): 196-199*.

MAEDA T. (2001), Patterns of bird abundance and habitat use in rice fields of the Kanto Plain, central Japan, *Ecological Research 16 (3): 569-585*.

MOEGENBURG S.M., LEVEY D.J. (2003), Do frugivores respond to fruit harvest? An experimental study of short-term responses, *Ecology 84 (10): 2600-2612*.

MUNIRA A., SALMI A.N., ANUAR M.S., MUIN M.M.A. (2014), Diversity and temporal distribution of birds in rice-growing landscape, Northern Peninsular Malaysia, *Sains Malaysiana 43 (4): 513-520*.

NACHUHA S., MUCHAI M. (2008), Is waterbird distribution within rice paddies of Eastern Uganda affected by the different stages of rice growing?, In: *Proceedings of the 12th Pan-African Ornithological Congress*, pp. 44-49.

PERIS S.J., PESCADOR M. (2004), Effects of traffic noise on paserine populations in Mediterranean wooded pastures, *Applied Acoustics 65 (4): 357-366*.

REIJNEN R., FOPPEN R., MEEUWSEN H. (1996), The effects of traffic on the density of breeding birds in Dutch agricultural grasslands, *Biological conservation 75 (3): 255-260*.

REIJNEN R., FOPPEN R., VEENBAAS G. (1997), Disturbance by traffic of breeding birds: evaluation of the effect and considerations in planning and managing road corridors, *Biodiversity & Conservation 6 (4): 567-581*.

REMSEN J.V., SWAN M.M., CARDIFF S.W., ROSENBERG K.V. (1991), The importance of the rice-growing region of south-central Louisiana to winter populations of shorebirds, raptors, waders, and other birds, *Journal of Louisiana Ornithology 1 (2): 35-47*.

RYTWINSKI T., FAHRIG L. (2007), Effect of road density on abundance of white-footed mice, *Landscape Ecology 22 (10): 1501-1512*.

SEKERCIOGLU C.H. (2012), Bird functional diversity and ecosystem services in tropical forests, agroforests and agricultural areas, *Journal of Ornithology 153 (1): 153-161*.

STAFFORD J.D., KAMINSKI R.M., REINECKE K.J. (2010), Avian foods, foraging and habitat conservation in world rice fields, *Waterbirds 33 (Special Publication 1): 133-150*.

TANALGO K.C., PINEDA J.A.F., AGRAVANTE M.E., AMEROL Z.M. (2015), Bird Diversity and Structure in Different Land-use Types in Lowland South-Central Mindanao, Philippines, *Tropical life sciences research 26 (2): 85-103*.

VICKERY J.A., TALLOWIN J.R., FEBER R.E., ASTERAKI E.J., ATKINSON P.W., FULLER R.J., BROWN V.K. (2001), The management of lowland neutral grasslands in Britain: effects of agricultural practices on birds and their food resources, *Journal of Applied Ecology 38 (3): 647-664*.

WARNER R.E. (1992), Nest ecology of grassland passerines on road rights-of-way in central Illinois, *Biological Conservation 59 (1): 1-7*.

Annexes:

Table no. 1 Summary of the observed species of birds and their residential status, conservational status, diet and abundance

Family	Scientific name	Status	CS	Diet	Total Ab	Ab (%)
Acrocephalidae	*Acrocephalus stentoreus*	CR	LC	I	10	0.79
Alaudidae	*Alauda gulgula*	CR	LC	I, G	1	0.08
Apodidae	*Collocalia esculenta*	CR	LC	I	72	5.72
	Cypsiurus balasiensis	CR	LC	I	7	0.56
Ardeidae	*Egretta alba*	M	LC	C, I	2	0.16
	Egretta garzetta	CR	LC	C, I	17	1.35
	Egretta intermedia	M	NE	C, I	11	0.87
	Bubulcus coromandus	CR	NE	C, I	137	10.88
	Dupetor flavicollis	SR	LC	C, I	1	0.08
	Ixobrychus chinensis	CR	LC	C, I	7	0.56
	Ixobrychus eurhythmus	M	LC	C, I	2	0.16
	Ixobrychus cinnamomeus	CR	LC	C, I	18	1.43
Artamidae	*Artamus leucorynchus*	CR	LC	I	5	0.40
Cisticolidae	*Cisticola juncidis*	CR	LC	I	254	20.18
Columbidae	*Geopelia striata*	CR	LC	F, G	8	0.64
	Streptopelia tranquebarica	R	LC	F, G	1	0.08
Corvidae	*Corvus macrorhynchos*	CR	LC	C	4	0.32
Estrildidae	*Lonchura atricapilla*	CR	LC	G	175	13.9
	Lonchura punctulata	CR	LC	G	20	1.59
	Lonchura leucogastra	SR	LC	G	17	1.35
Halcyonidae	*Todiramphus chloris*	CR	LC	C, I	1	0.08
Hirundinidae	*Hirundo rustica*	M	LC	I	51	4.05
	Hirundo tahitica	CR	LC	I	4	0.32
	Cecropis striolata	FCR	LC	I	2	0.16
Laniidae	*Lanius cristatus*	CWV	LC	C, I	17	1.35
	Lanius schach	CR	LC	C, I	2	0.16
Locustellidae	*Megalurus palustris*	CR	LC	I	40	3.18
	Megalurus timoriensis	UR	LC	I	1	0.08
Meropidae	*Merops philippinus*	CSV	LC	I	16	1.27
Motacillidae	*Anthus rufulus*	CR	LC	I	16	1.27
	Motacilla cinerea	M, WV	LC	I	5	0.40
	Motacilla tschutschensis	M, WV	NE	I	4	0.32
Passeridae	*Passer montanus*	AR	LC	G, I	285	22.64
Pycnonotidae	*Pycnonotus goiavier*	R	LC	I, F	15	1.19
Rallidae	*Amaurornis phoenicurus*	CR	LC	C, I	2	0.16
	Amaurornis olivacea	PE	LC	G, I, C	2	0.16
	Gallinula chloropus	R	LC	C	3	0.24
	Porzana cinerea	CR	LC	G, C, I	3	0.24
Rostratulidae	*Rostratula benghalensis*	CR	LC	G, C	5	0.40
Scolopacidae	*Galinago* sp.	M, WV	LC	I, C	2	0.16
Sternidae	*Chlidonias hybrida*	M, WV	LC	C, I	6	0.48
	Chlidonias leucopterus	M	LC	C, I	1	0.08
Sturnidae	*Acridotheres cristatellus*	R, I	LC	I, F	7	0.56
Total					1259	

Note: Status: CR-common resident, R-resident, AR-abundant resident, I-introduced, M-migrant, WV-winter visitor, PE-Philippine endemic, CSV-common summer visitor, CWV-common winter visitor, UR-uncommon resident, FCR-fairly common resident, SR-scarce resident; CS-conservational status: LC-least concerned, NE-not evaluated; Diet: I-insectivores, G-granivores, F-frugivores, C-carnivores; Ab-abundance.