Sains Malaysiana 43(4)(2014): 513–520

Diversity and Temporal Distribution of Birds in Rice-Growing Landscape, Northern Peninsular Malaysia

(Kepelbagaian dan Taburan Temporal Burung di Landskap Pertumbuhan Padi, Utara Semenanjung Malaysia)

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ABSTRACT

Rice fields are traditional landscape in Malaysia that sustains various species of birds. Waterbirds, raptors, Passeriformes and Columbiformes were observed and counted using point count method at rice fields in Bandar Baharu, Kedah from March 2009 to February 2010. The current status of birds in the rice fields of Malaysia has not been widely researched. The objective of this study was to document the bird species richness and diversity and temporal bird distribution during the annual rice growing cycle. There were 5120 birds representing 67 species belonging to 29 families being recorded. The diversity index (Shannon-Wiener) varied monthly between 2.154 and 3.321. The most abundant bird family observed was Ardeidae (29.09%), followed by Sturnidae (10.15%) and Hirundinidae (7.86%). Rice growing seasons involve three main stages; direct seedling/transplanting, growing and harvesting. Each stage attracts different bird species to exist in the rice field and surrounding areas. Statistical analysis showed the alternative hypothesis that states abundance of bird species is different monthly was accepted ($F_{11,24} = 3.033$, $p < 0.05$). Farming activities and rice growing seasons regularly influenced birds' presence in the rice fields and attracted different bird species. Reclamation and urban development on the rice fields is a major concern. Conservation efforts and strict regulation of pesticide use should be implemented to develop sustainable agriculture practices that are beneficial to human and wildlife communities.

Keywords: Bird species; human activities; rice fields; rice growing season

ABSTRAK

Sawah padi merupakan landskap tradisi di Malaysia yang menampung pelbagai spesies burung. Burung air, burung pemangsa, Passerines dan Columbiformes telah diperhatikan dan dikira dengan menggunakan kaedah bilang titik di sawah padi, Bandar Baharu, Kedah dari Mac 2009 hingga Februari 2010. Status terkini burung di sawah padi Malaysia masih tidak meluas dikaji. Objektif kajian ini ialah untuk mendokumentasi kekayaan dan kepelbagaian spesies burung dan taburan temporal burung semasa kitaran pertumbuhan padi tahunan. Terdapat 5120 individu mewakili 67 spesies dan 29 famili telah direkodkan. Indeks kepelbagaian (Shannon-Weiner) berubah pada setiap bulan antara 2.154 hingga 3.321. Kelimpahan famili burung tertinggi yang diperhatikan adalah Ardeidae (29.09%), diikuti oleh Sturnidae (10.15%) dan Hirundinidae (7.86%). Musim pertumbuhan padi melibatkan tiga peringkat utama; tabur terus/pemindahan anak benih, tumbesaran dan menuai. Setiap peringkat menarik spesies burung berlainan di sawah padi dan kawasan-kawasan sekitarnya. Analisis statistik menunjukkan hipotesis alternatif yang menyatakan kelimpahan spesies burung berbeza mengikut bulan diterima ($F_{11,24} = 3.033$, $p<0.05$). Aktiviti pertanian dan musim pertumbuhan padi sentiasa mempengaruhi kehadiran burung di sawah padi dan menarik spesies burung yang berbeza. Penambakan dan pembangunan bandar terhadap sawah padi merupakan kebimbangan utama. Usaha pemuliharaan dan peraturan ketat terhadap penggunaan racun perosak perlu dikuatkuasakan bagi membentuk amalan pertanian lestari yang berfaedah kepada manusia dan komuniti haiwan liar.

Kata kunci: Aktiviti manusia; musim pertumbuhan padi; sawah padi; spesies burung

Introduction

Rice (*Oryza sativa*) is one of the most important crops in the world. Malaysia's agricultural traditional landscape is characterised by swathes of rice fields with a total area of 673 745 ha (Ministry of Agriculture 2010). Four states in northern Peninsular Malaysia (Kedah, Perak, Perlis and Penang) are top producers of rice in the country. Kedah, or popularly known as *negeri jelapang padi* (literally means 'rice bowl state'), has the largest area of rice fields (210644 ha) while Penang has the smallest area of rice fields (25630 ha) (Ministry of Agriculture 2010). The awareness of rice fields as unique wetland landscapes for many waterbirds, raptors, sparrows and other species has increased. These wetland landscapes are widely studied by many ornithologists and conservationists in countries such as Korea, Japan, India and Indonesia and continents

like the Americas (Acosta et al. 2010; Amano et al. 2010; Fujioka et al. 2010; Sundar & Subramanya 2010). The large flocks of waterbirds such as egrets, herons, storks, snipes, sandpipers and lapwings are found frequently in many rice field areas around the world (Kelly et al. 2008). Rice fields environment is influenced by human activities (Stafford et al. 2010) including ploughing, seasonal flooding and planting. Each of these activities attracts different bird groups for foraging (Stafford et al. 2010) and breeding (Fasola et al. 2004). Not only the landscape features of rice fields influence birds diversity, but also their different surrounding areas. Malaysia's traditional rice field agriculture, or locally known as s*awah padi*, is surrounded by several habitat types including secondary forest, shrub land, ponds and streams (Shah et al. 2008). The connectivity among these habitats allows various organisms including birds to use rice fields to obtain food (Katoh et al. 2009) and shelter. Moreover, irrigation ditches and small ponds in the rice field landscape serve as breeding places for water-dependent fauna such as fish, tadpoles and aquatic insects as their main food sources for birds in rice field (Fernando 1993). Another important influence on bird diversity and abundance in rice fields is migratory season, since bird migration only occurs from September to March every year (Wells 1999, 2007).

The current status of birds in the rice fields of Malaysia has not been widely researched with the exception of few isolated studies that have been carried out (Shah et al. 2008). Plenty of baseline data have been collected over the years by Malaysian Nature Society (MNS) about distribution and diversity of birds. However, there has been a lack of rigorous scientific studies on the current status of birds in the rice fields. The objective of this study was to document the bird species richness and diversity and temporal bird distribution during the annual rice growing cycle in one of the rice field areas in Malaysia.

Materials and Methods

Study Area

Bird surveys were conducted in the rice fields located at the lower reaches of Kerian River Basin (KRB), Bandar Baharu, Kedah, Malaysia (5°5'41.64"N, 100°31'50.52"E; Figure 1). The study site covered 20 ha with more than 10 rice plots and is located 50 to 100 m from the banks of the Kerian River. The rice fields are surrounded by several habitat types such as oil palm plantation, forest patches and mangroves.

Sample Collection and Analysis

Birds in the rice fields were monitored for three consecutive days in every month during the survey period using the point count method (Zakaria & Rajpar 2010). Birds heard or seen were counted at 15 points of 200 m intervals (Gregory et al. 2004). Birds in flight were not recorded except for family Accipitridae, Apodidae, and Hirundinae since they were rarely found perching on trees (Amano et al. 2010) and care was taken to avoid recounting the same individual at a point. The observer walked along the footpath between rice plots from 0700 and 1000 h and from 1700 to 1900 h. Bird observations were made using 8×42 binoculars (Omicron Savvy) and bird identification follows the Field Guide to the Birds of South-East Asia (Robson 2008). The Shannon-Wiener index, H' was used to measure bird diversity for every sampling month (Krebs 1999). One-way analysis of variance (ANOVA) was used to test the significant differences of bird abundance between months. In this study, the alternative hypothesis stated there is a significant difference in bird abundance between months of sampling periods.

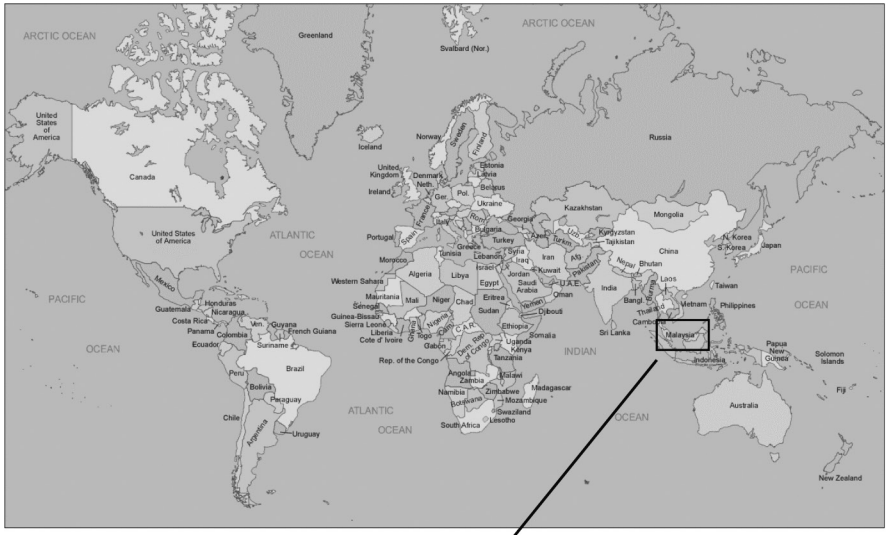
Results and Discussion

Richness, Diversity and Temporal Bird Ditribution

Throughout a year of sampling, 5120 individual birds were recorded in the rice field. There were 67 bird species from 29 families (Table 1) were recorded in the rice field during the survey period. The family with the highest abundance observed was Ardeidae (29.09%), followed by Sturnidae (10.15%) and Hirundinidae (7.86%). Ardeidae, as exemplified by Purple Heron *Ardea purpurea*, Little Heron *Butorides striata* and Great Egret *Ardea alba* mainly fed on various aquatic animals, such as small fishes, invertebrates, amphibians and crustaceans. Sturnidae such as Asian Glossy Starling *Aplonis panayensis* and Common Myna *Acridotheres tristis* were frequently observed visiting fruiting trees mostly in the more open habitats. The five largest bird families were Ardeidae (11 species), Accipitridae (five species), Scolapacidae, Sturnidae and Estrildidae (each has four species).

Rice growing seasons involve three main stages; direct seedling/transplanting, growing and harvesting. First observation (March 2009) was made when the paddy was about 70 days old (in the middle of first phase growing season) and rice plots were inundated with water. Carnivorous birds such as Eastern Cattle Egret *Bubulcus coromandus* and Little Egret *Egretta garzetta* were among the main species observed in large numbers with the highest record of 21 individuals for each species. Eurasian Tree-sparrow *Passer montanus* and White-rumped Munia *Lonchura striata* were also observed abundantly in the rice fields with the highest record of 38 individuals and 27 individuals, respectively.

In April-May 2009, just before harvesting, paddy ripened at about 100 days. Great Egret and Little Egret were the most abundant carnivorous species found during this stage with the highest record of 136 individuals and 81 individuals, respectively. Granivorous birds such as Eurasian Tree-sparrow (49 individuals) and Baya Weaver *Ploceus philippinus* (27 individuals) were observed increasingly in number. Similarly, during the harvesting season that occurred in June 2009, Great Egret (54



(a)

(b)

(c)

FIGURE 1. (a) World Map; the location of Peninsular Malaysia is shown in black box (b) map of Peninsular Malaysia; the study site of rice field is shown in black box and (c) location of study site in Bandar Baharu, Kedah (5.0949° N, 100.5307° E). This area of rice fields is located in the lower part of Kerian River Basin

TABLE 1. Bird species observed in the rice fields of Bandar Baharu, Kedah, north Peninsular Malaysia

Family	Scientific name	Habitat, protection and conservation status	Incidence of occurrence
Ardeidae	*Ardea purpurea*	IS, R&M, C, TP	11
	Butorides striata	IS/MG/MF, R&M, A, TP	9
	Ardeola baccus	IS/MG, M, RA, NP	7
	Ardeola speciosa	IS/MG, M, RA, NP	7
	Bubulcus coromandus	OC, M, C, TP	10
	Ardea alba	MF/MG, R&M, A, TP	7
	Mesophoyx intermedia	IS/MF/MG, M, U, TP	4
	Egretta garzetta	IS/MF/MG, M, C, TP	12
	Nycticorax nycticorax	IS/MG, R, C, TP	1
	Ixobrychus sinensis	IS, R&M,C, TP	1
	Ixobrychus cinnamomeus	IS, R, C, TP	4
Accipitridae	*Pernis ptilorhynchus**	OC/LF/LMF, R&M, C, TP	3
	*Elanus caeruleus**	OC, R, C, TP	9
	*Haliastur indus**	MG, R, A, TP	11
	*Spilornis cheela**	MG/LF/LMF/UMF, R, C, TP	7
	*Circus melanoleucos**	OC/IS, M, G, TP	1
Rallidae	*Amaurornis phoenicurus**	IS, R&M, A, GB	11
	Gallicrex cinerea	IS, R&M, C, GB	2
Vanellidae	*Vanellus cinereus*	OC, M, RA, GB	4
	*Pluvialis fulva**	OC/MF, C, GB	1
Scolopacidae	*Tringa stagnatilis**	MF, M, C, GB	3
	Tringa glareola	IS/MF, M, C, GB	3
	Actitis hypoleucos	OC/IS/MF, M, C, GB	2
	Gallinago gallinago	OC, M, U, GB	4
Columbidae	*Columba liva**	GP, I, C, NP	2
	Streptopelia chinensis	GP/OC, R, C, NP	12
	Geopelia striata	GP/OC, R, C, NP	12
Cuculidae	*Eudynamys scolopaceus**	MG/OC, R&M, C, TP	6
	*Centropus sinensis**	OC/LF, R, C, TP	6
	*Centropus bengalensis**	OC,R, C, TP	4
Tytonidae	*Tyto alba*	GP/OC, R, C, TP	3
Halcyonidae	*Pelargopsis capensis**	IS/MG/LF, R, C, TP	9
	Halcyon smyrnensis	GP/OC, R, C, TP	12
Meropidae	*Merops philippinus**	OC, R, C, TP	10
	*Merops viridis**	OC, R, C, TP	1
Coraciidae	*Eurystomus orientalis**	OC, R&M, C, TP	1
Megalaimidae	*Megalaima haemacephala**	GP/OC/MG, R, C, TP	1
Picidae	*Dinopium javanense**	GP/OC/MG/LF, R, C, TP	1
Hirundinidae	*Hirundo rustica**	OC, M, A, TP	7
	*Hirundo tahitica**	OC, R, C, TP	11
Aegithinidae	*Lalage nigra**	GP/OC, R, C, TP	7
	*Aegithina tiphia**	GP/OC/MG, R, C, TP	4
Pycnonotidae	*Pycnonotus goaivier**	GP/OC, R, A, NP	12
Oriolidae	*Oriolus chinensis**	GP/OC, R&M, C, TP	11
Corvidae	*Corvus splendens**	GP/OC/LF/LMF, R, C, NP	10
	*Corvus macrorhynchos**	GP/OC/LF/LMF, R, C, NP	3
Cisticolidae	*Orthotomus sutorius**	GP/OC/MG/LF/LMF, R, C, TP	5
	*Orthotomus atrogularis**	GP/MG/LF/LMF, R, C, TP	2
	*Prinia flaviventris**	OC, R, C, TP	7
Muscicapidae	*Copsychus saularis**	LF, R, C, OPB	10
Rhipiduridae	*Rhipidura javanica**	MG/LF/LMF, R&M, C, TP	4
	*Anthus rufulus**	R&M	2

(Continued)

TABLE 1. *(Continued)*

Family	Scientific name	Habitat, protection and conservation status	Incidence of occurrence
Laniidae	*Lanius cristatus**	GP/OC, M, C, TP	8
Sturnidae	*Aplonis panayensis**	GP/OC, R, A, NP	11
	*Acridotheres tristis**	GP/OC, R, A, NP	11
	*Acridotheres fuscus**	OC, R, U, NP	10
	Acridotheres cristatellus	GP/OC, I, U, TP	1
Nectariniidae	*Anthreptes malaccensis**	GP/OC/MG, R, C, TP	4
	*Cinnyris jugularis**	GP/OC/MG, R, C, TP	9
Dicaeidae	*Dicaeum cruentatum**	GP/OC/MG/LF, R, C, TP	10
Passeridae	*Passer montanus**	GP/OC, R, A, NP	12
Ploceidae	*Ploceus philippinus**	OC, R, C, NP	10
Estrildidae	*Lonchura striata**	OC/LF/LMF, R, U, NP	11
	*Lonchura punctulata**	GP/OC, R, C, NP	8
	Lonchura atricapilla	OC, R, C, NP	4
	Lonchura maja	OC, R, C, NP	3
Phylloscopidae	*Cisticola juncidis*	OC, R, C, TP	10

Abbreviation: (HABITAT) GP- Gardens and parks (including wooded suburban areas), OC- Open country (open grassy areas, scrub and tin mines), IS- Inland freshwater swamps (mining pools, lakes and paddy fields), MG- Mangroves, LF- Lowland rainforest (including secondary forest and forest edge), LMF- Lower montane rainforest (including secondary forest and forest edge), (STATUS) R- Resident, M- Passage migrant/winter visitor, V- Vagrant, I- Introduced, (INCIDENCE OF OCCURANCE) C- Common, U- Uncommon, RA- Rare, (PROTECTION BY LAW IN PENINSULAR MALAYSIA) TP- Totally protected (may not be hunted or reared in captivity), GB- Game birds (may be hunted under licence), OPB- Other protected birds (may be reared in captivity under licence) and NP- Not protected. * May not inhabit paddy field but used paddy field as their foraging ground

individuals) also dominated the rice fields. However, Little Egret was absent and replaced with Eastern Cattle Egret (52 individuals). Other species such as Baya Weaver was commonly seen during the harvesting season with 44 individuals recorded. Harvesting is the last stage in rice growing seasons. Burning and ploughing activities took place before transplanting began for the next season.

In July 2009, burning activity was used to remove the rice straw, which created open fields for Jungle Myna *Acridotheres fiscus*. This species occurred up to 82 individuals in a single flock. After one month (August 2009), ploughing activity was started to prepare the rice plots for the next phase of rice growing season. Ploughing using heavy machines began after rice plots were flooded with a water level of 5-10 cm. A large flock of Eastern Cattle Egret, estimated between 60 individuals, was seen following the machine. Jungle Myna was also seen in large flocks during ploughing activity with the highest record of 123 individuals.

Planting activity began in September to October 2009 with two methods of planting; transplanting and direct seedling. Rice plots were inundated to a water level of 5-10 cm. In September, Eastern Cattle Egret dominated the fields with the highest record of 324 individuals, meanwhile in October, Little Egret dominated the fields with the highest record of 23 individuals. In November 2009, the paddy was about 60 days old and rice plots were still inundated with water. Black-shouldered Kite *Elanus caeruleus* was commonly seen preying on rodents. At the end of December 2009, just before harvesting, the paddy ripened in about 100 days. White-rumped Munia and Zitting Cisticola *Cisticola juncidis* were observed as the two most abundant species with 46 and 37 individuals recorded, respectively. In January and February 2010, the paddy was harvested for the second round of rice growing seasons. Eastern Cattle Egret (122 individuals) and Commom Myna (31 individuals) were the two most common bird species at this stage.

Throughout the one-year observation, rice field and surrounding areas were identified as ideal habitats for several bird species including species of Baya Weaver, Greater Coucal *Centropus sinensis* and Blue-throated Bee-eater *Merops viridis*. Baya Weaver was seen actively collecting nest materials from paddy leaves to make a long down-hanging nest. Their nests were observed located mainly at bamboos that grew near the rice field and houses. Two individuals of juvenile Greater Coucal were found sitting silently in the tall grass vegetation near the ditch and growing paddy areas. In addition, juvenile Brahminy Kite *Haliastur indus* was also found soaring above the rice fields.

By the end of one-year sampling period, no additional species were recorded in the rice fields. The aggregate total of species recorded remained constant at 67 species (Figure 2). Figure 3 shows the temporal variation of bird's abundance and richness in rice fields between March 2009 and February 2010. Distinct variation in abundance and richness of birds can be seen in the rice fields. The birds' occurrence was highly affected by migratory seasons and paddy growing season. During migratory seasons more bird species can be observed due to the presence of migrant bird. Statistical analysis showed the number of individual species was significantly different across the months ($F_{11, 24} = 3.033$, $p < 0.05$). Post-hoc test showed

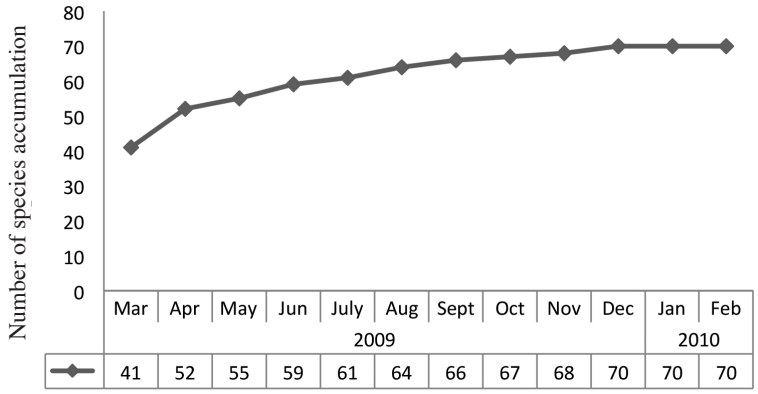


FIGURE 2. Species accumulative curve for the study site between March 2009 and February 2010

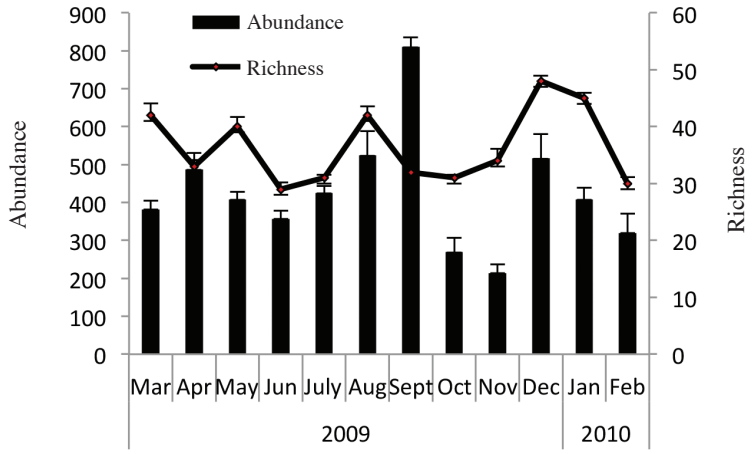


FIGURE 3. Bird abundance and species-richness recorded at the study site between March 2009 and February 2010 *March 2009: Paddy 70 days (Phase 1), April-May 2009: Rice ripens, June 2009: Harvesting season, July 2009: Burning activity, August 2009: Ploughing activity, September-October 2009: Transplanting/ Direct seedling (Phase 2), November 2009: Paddy 70 days, December 2009: Just before harvesting season, January-February 2010: Harvesting season

that the mean bird abundance between September and October 2009 was significantly different ($p< 0.05$).

Temporal observation shows high abundance of birds (810 individuals) was recorded in September 2009. Eastern Cattle Egret (324 individuals) was the most dominant bird species in this month where transplanting/direct seedling (phase 2) is in progress. Eastern Cattle Egret is a migratory bird species where they migrate to Malaysia starting from September (Southward migration) every year. Therefore, high abundance of Eastern Cattle Egret was recorded visiting the rice field areas in September. In November 2009, low abundance of birds (214 individuals) was recorded. None of Eastern Cattle Egret was observed, presumably they migrate more southward of Peninsular Malaysia. High species richness (48 species) was recorded during just before harvesting season (phase 2) in December 2009. At this stage, rice fields were dominated by migratory species from family Ardeidae (9 species) except Cinnamon Bittern *Ixobrychus cinnamomeus*. These migratory birds were on their way of migration and stopped at rice fields for feeding before continuing their journey. Low species richness (24 species) was recorded during harvesting season (phase 1, June 2009) because dominated only by resident bird species.

Past studies suggested that rice fields provided suitable habitat for foraging, breeding activities and shelter for various kind of birds (Takahashi & Ohkawara 2007; Wood et al. 2010). These include migratory species that utilise rice fields located along their migratory routes (Masero et al. 2006). Farming activities, rice growing seasons and rice field landscape features were the main factors that influenced bird use and bird occurrence (Ibáñez et al. 2010; King et al. 2010). The result from statistical analysis confirmed that all farming activities and rice growing seasons influenced bird occurrences in the rice plots at Bandar Baharu, Kedah.

During ploughing activity, a large flock of Eastern Cattle Egret was seen following the machine, presumably

because many invertebrates were exposed and easily available to the birds. In the second stage, planting and transplanting activities took place followed by manual weeding of the fields throughout the growing season. Pesticides and fungicides were actively used to eliminate rodents, weeds and fungus. Some of these chemicals were believed to be highly toxic to birds and could cause increased in mortality rate and negative reproductive effect (Parsons et al. 2010). However, the effect of pesticide used on bird communities in Bandar Baharu was not studied.

Rice fields were flooded during the growing season, creating a temporary wetland environment. This period attracted a variety of birds consisting of migrants and residents that requires wet areas to feed on various aquatic animals including fish, amphibians, crustaceans and invertebrates. Little Egret, Javan Pond Heron *Ardeola speciosa* and Eastern Cattle Egret were seen in breeding plumage and use wet areas as their foraging habitat. Prior to harvesting season, the rice ripened and attracted numbers of granivorous species such as White-rumped Munia and Scaly-breasted Munia *Lonchura punctulata*. In the last stage, the rice fields were drained and the rice crop was harvested. The remaining grains left after harvesting were utilised on by the granivorous species. Large predators such as Brahminy Kite and Black-shouldered Kite were observed in the harvested areas and responded quickly to the intentional burning of stubble. This presumably because both circumstances caused rodents to emerge from their hiding places, to feed on the split grain, or to avoid the burning fields, enabling the raptors to locate their prey easily. Similar observations were made in a study undertaken in southern Florida where large raptors were found at recently harvested fields (Pearlstine et al. 2006). Most of the resident raptors observed in the study were believed to inhabit nearby forest patches, mangrove and oil palm plantations.

According to King et al. (2010), rice fields in many countries support large number of migratory waterbirds. The reason for the abundance may be due to large amount of food supplies such as polychaetes, crustaceans and mollusks in rice plots during migratory season (Stafford et al. 2010). Based on personal observation, waterbirds frequently moved from one plot to another plot by selecting available quality and quantity of habitat in order to take advantage from the exposed prey resources and to maximise foraging efficiency.

The rice fields in Bandar Baharu and many other traditional agricultural landscapes in Malaysia are gradually being encroached by rapid development of surrounding areas and reclamation for other type of land uses. For example, between 2007 and 2010, 1000 ha of rice fields in Kedah and Perlis have been converted into residential areas (Ministry of Agriculture 2010). The loss of rice fields has caused the shrinking of temporary wetlands areas. Attention from authorities, naturalists and local people are needed to highlight the importance of rice fields as potential habitat that supports various birds species. Birds such as Yellow Bittern *Ixobrychus sinensis* and Oriental Honey Buzzard *Pernis ptilorhynchus* are listed as totally protected wild birds by Malaysia's Wildlife Act 2010. Therefore, awareness campaigns, conservation efforts and strict regulation for pesticides use need to be implemented to develop sustainable ecosystem that is beneficial to both humans and wildlife communities.

Conservation works in rice fields can be started through bird surveys in various rice field areas such as the Kerian River Basin. This is important to provide latest information on bird status and population estimates. A collaborative conservation effort between Kedah Department of Wildlife and National Parks and non-governmental organisations (NGOs) is also important for an effective on-going monitoring programme. All data from surveys and monitoring should be used to develop sustainable management and conservation strategies within the Kerian River Basin. Another approach is to establish links between research universities and conservation projects, which could be beneficial for biodiversity conservation in the rice fields. According to Kobori and Primack (2003), research development by universities can be achieved by using rice field areas as sites to teach students about conducting research related to rice field ecology, management and restoration.

The purpose of all conservation actions as stated above is to maintain the quality of rice fields as an important habitat for a great diversity of waterbirds. This implementation needs strong support and commitment from the public, conservation organisations (including NGOs), government and scientists in order to achieve successful conservation programmes. Such programmes will result in Malaysian citizens with increased conservation awareness and concern for birds and wildlife presence in their surrounding environments. Thus, human-wildlife conflict can be reduced, which would eventually be beneficial to both human and wildlife.

ACKNOWLEDGEMENTS

We thank the staff of Biological School (USM) for the field assistance. This study was funded by Universiti Sains Malaysia (USM) Research Grant, USM/RU/815075 and 811191 and transportation was provided by the School of Biological Sciences, USM. The first author was supported by the Graduate Fellowship Scheme from Institute for Post Graduate Studies, USM.

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Received: 9 October 2012
Accepted: 15 July 2013