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SEASONAL AND HABITAT DISTRIBUTION OF BIRDS IN THE CENTRAL PLAIN: A SURVEY AT SALAYA, NAKHON PATHOM, THAILAND

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ABSTRACT

A survey of birds and their habitats was carried out on the Salaya campus of Mahidol University, Nakhon Pathom Province, during 1987-1990. A total of 99 species was seen, the most common being Red Turtle-Dove, Streak-eared Bulbul, Lesser Whistling Duck, Plain Prinia and Common Myna. Little Grebe was the most common waterbird, but Yellow Bittern, White-breasted Waterhen and Bronze-Winged Jacana were also common in ponds and canals. The natural grassland habitat had the greatest number of species (56), with planted tree habitats second (with 47) and lawns and garden third (41). The filling in and development of land in the southern part of the plain is causing the relatively diverse grass-marsh fauna to be replaced by one typical of secondary scrub and woods habitat.

INTRODUCTION

The vegetation of the Central Plain of Thailand is varied and changing. Behind the shoreline, which is growing seaward due to deposition of sediments from currents and floods, lie (or did lie) mangrove forests, behind which once probably occurred fresh-water swamp forest. How much swamp forest covered the plain and when is problematical, as the deep alluvial soil has long supported one of the richest rice growing areas of the world. Cleared areas not planted in rice rapidly succeed to reeds, grasses or cat-tails. Canals have their own biological communities, probably reminiscent of the original meandering streams and ox-bow ponds. Dykes and filled areas if left unmanaged develop into secondary shrub and woodland of "weedy" species. Many such areas (including the Salaya Campus) are planted in wide variety of hardy local and exotic species. These artificial woodlands are not devoid of birds—they support many species.

It is of great interest, however, to compare the composition of the bird community in such artificial woodlands with that in the natural swamp forest (though there is virtually no freshwater swamp forest left in the Central Plain) and more upland deciduous and evergreen forest. The main goal of this survey was to evaluate the species diversity (species richness) and uniqueness of species in several common habitats of the Central Plain as lie on the out-of-town campus of Mahidol University. We encountered no great surprises or rare species but did document some interesting trends. It is not widely

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appreciated how land use changes in the Central Plain are changing the avifauna.

The bird survey was carried out during 1987–1990. The objectives of the survey of birds and habitats were as follows:

(1) Enumerate the total number of birds on the campus and their seasonal distribution;
(2) Evaluate the distribution of each species by habitat;
(3) Determine the total bird species richness of each major habitat type;
(4) Evaluate the species richness of each major section of the campus; and produce recommendations about conservation of habitats on the campus;
(5) To try to draw some conclusions about how human development and alteration of habitats is changing the diversity and composition of bird communities in the Central Plain.

STUDY AREA

The Salaya campus has a total area of 1,240 rai (1 rai = 1,600 m^2), or approximately 200 ha. It is located about 20 km west of Bangkok of the north side of the Pinklao-Nakhonchaisri Road, across from Puthamonthon Religious Center (latitude 13° 45'N). The original (precampus) habitat consisted mostly of grassy fields which were flooded in the rainy season. Rice was planted over much of area, and is still planted in parts of the surrounding area. Old irrigation canals, or *khlongs,* surround most of the campus and extend through it. About 23 ha of the property lie outside the encircling khlong and this area was excluded from the survey. There are six ponds on the campus ranging in size from 0.12 to 4.0 ha, plus four contiguous waste treatment settling ponds on the west side totaling about 4.5 ha in area.

Preliminary visits were made to the campus in early 1987 to devise a system of habitat classification. The habitats included both "natural" or unmanaged types of vegetation and heavily modified habitats. The classification included six major types of habitats (field, woodland, planted trees, lawn, khlong (canal), pond) and several minor types. The major types were subdivided into subtypes, and each was given a 2-letter code. The habitats are listed and described in Table 1, and illustrated in Figures 1–12. In the final analysis, some habitats were combined or disregarded because there were too few observations of birds in them to permit meaningful analysis, or because the birds present were not distinct from those in related habitats.

Many trees have been planted on the campus adjacent to buildings and lawns, which are now 5–10 m tall. The species and the number planted are as follows:

Pterocarpus macrocarpus Kurz	ต้นประดู่	4,000
Terminalia catappa L.	ต้นหูกวาง	800
Lagerstroemia speciosa (L.) Pers.	ต้นอินทนินน้ำ	1,500
Cassia fistula L.	ต้นราชพฤกษ์	400
Peltophorum pterocarpum (DC.) Back. ex k. Heyne	ต้นนนทรี	300
Cocos nucifera L.	ต้นมะพร้าว	350
Casuarina equisetifolia J.R. & G. Forst.	ต้นสนทะเล	5,000
Casuarina junghuhniana Miq.	ต้นสนปฏิพัตร	10,000
Acacia auriculiformis A. Cunn. ex Bth.	ต้นกฐินณรงค์	-

Polyalthia longifolia (Sonn.) Thw.	ต้นอโศกอินเดีย	1,800
Erythrina variegata L.	ต้นทองหลางด่าง	500
Mimosops elengi L.	ต้นพิกุล	400
Swietenia macrophylla King	ต้นมะฮอกกานี	2,000
Gliricidia sepium (Jacq.) Walp.	ต้นแคฝรั่ง	700
Thevetia peruviana (Pers.) k. Sch.	ต้นรำเพย	400
Samanea saman (Jacq.) Merr.	ต้นจามจุรีสีทอง	350
Leucaena leucocephala (Lmk.) De Wit	ต้นกระถินยักษ์	6,000
Roystonea regia (H.B.k.) Cook	ต้นปาล์มขวด	200

Of these species, only about the first seven are native to central Thailand; five others are native to other parts of Asia or Pacific, and the last six are native to America only.

At the time of survey, approximately 54 ha of the campus was covered with fields, 20 ha was occupied by buildings and surrounding lawns, and 15 ha was planted in trees (excluding roadsides). There were 6.3 km of paved roads and 7.3 km of khlongs.

METHODS

Each month observers walked through the campus on a set route (Fig. 13) which was selected to cover all habitat types and cross all areas of the campus. Areas of the campus nos. 1–5 are defined in Fig. 13; two additional areas, 6 and 7, were defined on the north-west and west sides of the campus, respectively. Area 7 includes the four rectangular settling ponds near the waste-treatment plant. Areas 1, 3, 5 and 6 still had, at the time of survey, undeveloped expanses of grassy fields with wild shrubs.

At least two observers with 7X or 8X binoculars walked the route each time beginning 0600-0700 h and finishing about 1100 h. Usually the route was split between two parties. For every species observed they noted down numbers, area and habitat code. Bird names follow LEKAGUL & ROUND (1991). The survey was started in August of 1987 and was concluded in June 1988. March and April were missed due to other commitments; a March survey was done in 1990. It was felt that a survey in July would not reveal anything different and was therefore not needed.

Analysis

The compilation of results was carried out on SPSS for PC and the analysis on Microsoft Excell software.

Table 1. List of habitats and codes on Salaya Campus.

Habitat	Subtype	Description
Field (F)	FG	Wild grasses, sedges
	FS	Grasses/shrubs (mostly *Ageratum conyzoides* L.)
	FM	Marshy field
Woodland	WO	Patches of woods in swampy areas (mostly *Combretum quadrangulare* Kurz trees) or on banks of khlongs (usually *Casuarina equisetifolia* J.R. & G. Forst).
Lawn (L)	LG	Mowed lawn with planted shrubs
	LT	Mowed lawn with planted trees
Garden	GN	Planted experimental garden
Dirt fill	DF	Freshly filled land
Tree plantation	TP	Small groves of planted trees of several species in scattered areas
Roadside (R)	RS	On road, sidewalks or shrubbery planted between
	RT	In trees planted in row along road
Building	BU	On buildings
Wires	WI	On electric wires or poles
Khlong (K)	KL	Open water of khlong (water canal about 5 m wide)
	KC	In cat-tails bordering khlong
	KV	Canal covered with floating vegetation: *Eichornia crassipes, Salvinia cucullata* or *Pistia stratoites*
Pond	PO	Open water of pond at least 30 m across
	PC	Cat-tails *(Typha angustifolia)* bordering pond
Airborne	AB	Flying in air over campus; not flushed

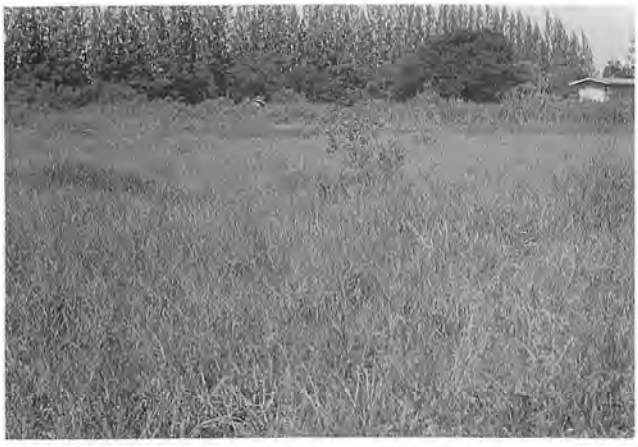


Figure 1. Grassy field (FG).

Figure 2. Field with shrubs (FS).

Figure 3. Marshy field (FM).

Figure 4. Roadside (RS, RT).

Figure 5. Lawn with planted trees (LT).

Figure 6. Lawn with planted shrubs (LG).

Figure 7. Tree plantation (TP).

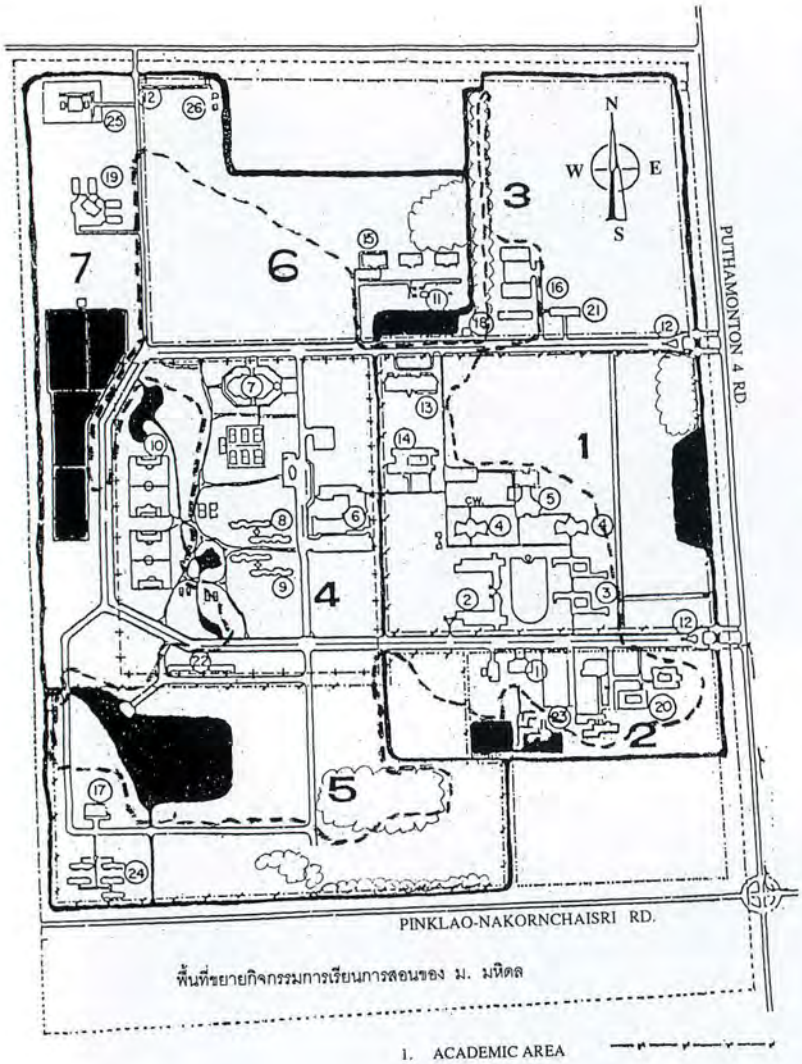
Figure 8. Woodland (WO).

Figure 9. Khlong with cattail edges (KL, KC).

Figure 10. Khlong with floating vegetation (KV).

Figure 11. Pond in area 7 (PO).

Figure 12. Pond in area 5 (PO), disturbed by humans.



1. Administration
2. Faculty of Sciences
3. Faculty of Social Sciences-Humanities
4. Lecture
5. Library
6. Union-Food Service
7. Gymnasium
8. Dormitory, Women
9. Dormitory, Men
10. Out-Door Sports
11. Water Tank
12. Guard Station
13. Institute of Nutrition
14. Institute of Environment

Cw. Covered Way

15. Maintenance
16. Research and Development
17. Medical Herbs & Botanical Garden
18. Nursery Plants
19. National Laboratory Animal Center
20. Asean Training Center for Primary Health Care Development
21. Center for Vaccine Development
22. Dormitory
23. Research Center of Southeast Asian Cultures
24. Employee Housing Units
25. Morgue & Crematorium
26. Special Intergrated Development for The Outreached Rural Areas

Figure 13. Map of the Salaya Campus. Black areas are ponds and canals; observation route shown with thick dashed line.

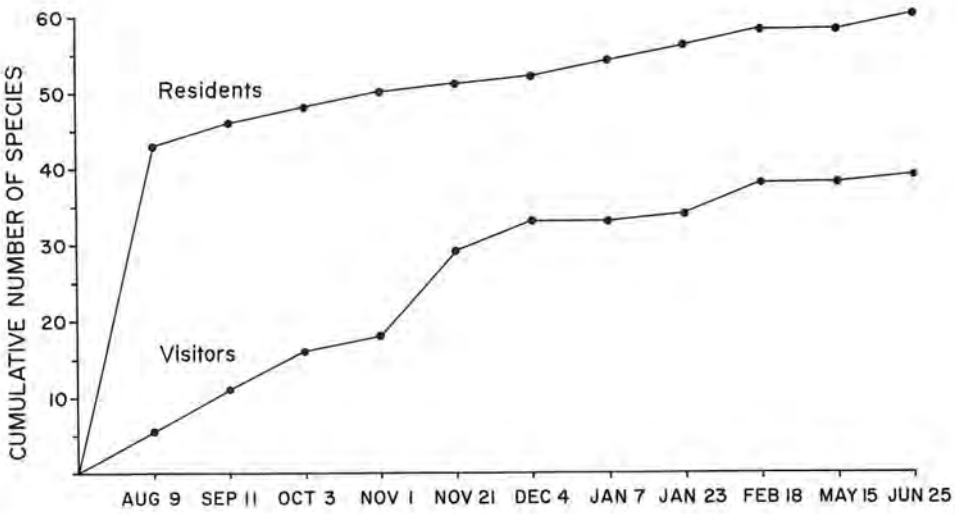


Figure 14. Cumulative numbers of birds seen in relation to number of visits to campus, for resident species and migrant visitors.

RESULTS

Species and Dates

The number of individuals of each species seen on each visit is listed in Table 2. The total number of species seen was 99; the number seen per survey did not very much over the year and averaged 46 (range 35–57). Most species on the campus are permanent residents, but individual species varied in abundance between summer and winter. January to May are probably the best months for birding because aquatic species are more concentrated on permanent water bodies and warblers, especially grassland species, are more active and visible. There are also more migrants present during this time.

Which are the most common species? Red Turtle Dove was seen in greatest numbers, but this species is seen almost entirely on wires and should be regarded as the most visible rather than the most abundant on campus (Table 3). Streak-eared Bulbul and Plain Prinia probably deserve most common status as they are abundant in shrub and grassland habitats everywhere. Common Myna has perhaps the widest habitat distribution of all species and is also highly visible. Little Grebe is a regular resident on the settling ponds of area 7, and is found only in small numbers on other ponds.

More than 100 species are expected to occur on the central lowland plain, but all are not expected on the campus. In order to obtain an idea of the completeness of the survey we have plotted discovery curves, which show the cumulative number of species seen in relation to number of visits (Fig. 14). Residents and winter visitors are shown separately. The curves continue to increase at the rate of about 1.4 resident and 1.2 visitor species per visit, or a total of 2.6 species per visit. This suggests that another year of census could bring the total to somewhere around 125 species.

Table 2. Numbers of birds seen on Salaya campus during 12 survey visits, 1987–90.

Species (*major*, minor habitats)	JAN 7	JAN 23	FEB 18	MAR 18	MAY 15	JUN 25	AUG 9	SEP 11	OCT 3	NOV 1	NOV 21	DEC 4
Little Grebe *(PO)* *Tachybaptus ruficollis*	20	43	64		34	22	35	6			1	1
Little Cormorant *(PO)* *Phalacrocorax niger*	2	1	2	6		2						
Chinese Pond-Heron *(PO, F)* *Ardeola bacchus*	6		3	7						1		
Javan Pond-Heron *(PO, F)* *Ardeola speciosa*	25	25	17		6	4	1	40	17	14	7	31
Cattle Egret *(AB)* *Bulbulcus ibis*					1			1			6	
Intermediate Egret *(AB)* *Egretta intermedia*	4	1								2		
Little Egret *(AB, TP, F, PO)* *Egretta garzetta*	4		1	2	1		1	1	1			2
Little Heron *(PO, L)* *Butorides striatus*			1	2								
Black Bittern (F,WO) *Dupetor flavicollis*							1	1	1	3		
Black-crowned Night-Heron *(WO, K, PO)* *Nycticorax nycticorax*		5	3		13	2	20	1				
Yellow Bittern *(K, PO, F, RT)* *Ixobrychus sinensis*	3		6	2	4	3	6	2	1	1	1	
Cinnamon Bittern *(F, PO)* *Ixobrychus cinnamomeus*		1				1	2					1
Garganey *(PO)* *Anas querquedula*		14										
Lesser Whistling-Duck *(PO, AB)* *Dendrocygna javanica*		70	64	4	252	15	55	3	1			
Black-shouldered Kite *(AB, F, WI)* *Elanus caeruleus*	1		1			1	1		1			1
Shikra *(AB)* *Accipiter badius*				1					1			
Ruddy-breasted Crake *(K, PO)* *Porzana fusca*				1					1			
White-breasted Waterhen *(K, PO, WO)* *Amaurornis phoenicurus*	3	2	2	1	6	2	4	7	4	3	3	
Watercock *(PO)* *Gallicrex cinerea*				1				1			1	

Species (*major*, minor habitats)	JAN 7	JAN 23	FEB 18	MAR 18	MAY 15	JUN 25	AUG 9	SEP 11	OCT 3	NOV 1	NOV 21	DEC 4
Common Moorhen (*PO*, K) *Gallinula chloropus*	8	27	7	22	12					2		6
Bronze-winged Jacana (*PO, K*, FM) *Metopidius indicus*	4	7		4	3	1	2	5	2	2	1	10
Red-wattled Lapwing (*L, F*, AB) *Vanellus indicus*		2		3	2				2			
Pacific Golden Plover *(L)* *Pluvialis fulva*					3							
Little Ringed Plover *(L)* *Charadrius dubius*			41	5								
Wood Sandpiper (*FM*, L) *Tringa glareola*			6	2								
Pintail Snipe *(F)* *Gallinago stenura*								1	4			
Common Snipe (*E*, K, PO) *Gallinago gallinago*	1		3	2					1	4		1
White-winged Tern *(AB)* *Chlidonias leucopterus*												3
Whiskered Tern *(AB)* *Chlidonias hybridus*											1	
Rock Pigeon (*BU*, AB) *Columbia livia*	29	5		5	12	34	2	11	4	3	83	54
Red Turtle-Dove (*WI*, AB) *Streptopelia tranquebarica*	74	14	18	17	9	27	15	39	10	271	469	63
Spotted Dove (*WI, F*, L, TP) *Streptopelia chinensis*	29	5	13	14	17	21	27	17	51	?	18	16
Zebra Dove (*RS*, F) *Geopelia striata*				3		2	1	1	2		1	
Large Hawk-Cuckoo (*WO*, F) *Cuculus sparverioides*	1	1										1
Plaintive Cuckoo (*TP, F*, L) *Cacomantis merulinus*			1	2	1	1	1					
Common Koel (*FS, TP, WO*, L) *Eudynamys scolopacea*	11	11	4	6	8	3	1	4	6	6	9	4
Green-billed Malkoha *(TP)* *Phaenicophaeus tristis*		2		1								
Greater Coucal (*F*, L, WO, TP) *Centropus sinensis*	2	3	4	5		2	1	2	2	1	9	

Species (*major*, minor habitats)	JAN 7	JAN 23	FEB 18	MAR 18	MAY 15	JUN 25	AUG 9	SEP 11	OCT 3	NOV 1	NOV 21	DEC 4
Lesser Coucal (*F*, WO, TP, L) *Centropus bengalensis*	1		7	1	4	4	1				3	1
Common Kingfisher (*PO, TP*, F, K) *Alcedo atthis*		3						4	2		7	
White-throated Kingfisher (PO, F, WI, WO, TP, K) *Halcyon smyrnensis*		1		1	1	3	2	1	4	1	2	2
Black-capped Kingfisher (*TP, F*, L, WI, K) *Halcyon pileata*	1	1		2					3	2	1	
Collared Kingfisher (*TP*, WO, PO, WI) *Halcyon chloris*				4		5					1	
Chestnut-headed Bee-eater *(WO) Merops leschenaulti*												4
Blue-tailed Bee-eater (*F*, WI, WO) *Merops philippinus*	4	12	3						2	1	24	11
Green Bee-eater *(TP) Merops orientalis*			16									
Indian Roller (BU, WI, L, TP, F) *Coracias benghalensis*	4	3	3	2	3	1	4	2	8	3	3	5
Rufous Woodpecker *(TP) Celeus brachyurus*		1			1							
Fulvous-breasted Woodpecker (*TP, L*, WO, F) *Picoides macei*			1	2	1	3	1	2		1		
Himalayan Swiftlet *(AB) Aerodramus brevirostris*						50						
Asian Palm-Swift *(AB) Cypsiurus balasiensis*	20	14	8		3	25	12	68	21	8	11	4
Sand Martin *(AB) Riparia riparia*											1	
Barn Swallow (*AB, PO*, WI) *Hirundo rustica*	12	22	5		77		3	17	1		32	35
Richard's Pipit (*F*, L) *Anthus novaeseelandiae*			1				2				2	I
Grey Wagtail *(AB) Motacilla cinerea*								3				
Yellow Wagtail *(AB) Motacilla flava*								3				
Common Iora (*TP, F*, WO, L) *Aegithina tiphia*		5		1			4	5			1	

Species (*major*, minor habitats)	JAN 7	JAN 23	FEB 18	MAR 18	MAY 15	JUN 25	AUG 9	SEP 11	OCT 3	NOV 1	NOV 21	DEC 4
Black-headed Bulbul *(TP)* *Pycnonotus atriceps*	1											
Black-crested Bulbul *(TP)* *Pycnonotus melanicterus*			1									
Sooty-headed Bulbul *(TP)* *Pycnonotus aurigaster*					1							
Yellow-vented Bulbul (*TP*, F) *Pycnonotus goiavier*	2			1								
Streak-eared Bulbul (*F*, *TP*, L, WO) *Pycnonotus blanfordi*	36	45	61	57	72	63	46	39	38	37	41	52
Black Drongo (*TP*, L) *Dicrurus macrocercus*	34	34	29	14	33	8	2	1	2	4	22	34
Black-naped Oriole (*TP*, AB) *Oriolus chinensis*											2	
Large-billed Crow (*F*, R, AB) *Corvus macrorhynchos*	1										2	4
Dusky Warbler (*WO*, F, L, PO) *Phylloscopus fuscatus*		8	1	2					1		2	
Arctic Warbler *(WI)* *Phylloscopus borealis*								1				
Greenish Warbler *Phylloscopus trochiloides*											2	
Eastern Crowned Warbler (*TP*, *F*, WO) *Phylloscopus coronatus*	2							3	1			
Inornate Warbler (*AB*, L, WO, TP) *Phylloscopus inornatus*		1	1	1							11	2
Thick-billed Warbler (*F*, PO, WO) *Acrocephalus aedon*		6	1							3	2	
Great Reed-Warbler (*F*, K, PO) *Acrocephalus arundinaceus*	7	16	6	11	2				2	9	18	6
Black-browed Reed-Warbler (*F*,*K*, *PO*, TP) *Acrocephalus bistrigiceps*		9	5									1
Pallas's Grasshopper-Warbler *(F, TP)* *Locustella certhiola*	1	1			1						1	
Lanceolated Warbler *(F)* *Locustella lanceolata*		11	4	1							5	1
Zitting Cisticola (*F*, K) *Cisticola juncidis*							1	1			2	

Species (*major*, minor habitats)	JAN 7	JAN 23	FEB 18	MAR 18	MAY 15	JUN 25	AUG 9	SEP 11	OCT 3	NOV 1	NOV 21	DEC 4
Plain Prinia (*F*, K, L, PO) *Prinia inornata*	26	36	35	10	62	69	38	31	29	25	39	12
Common Tailorbird (*F*, *LT*, TP, WO) *Orthotomus sutorius*	5	11	7	10	12	24	13	24	8	5	19	3
Siberian Rubythroat *(F)* *Luscinia calliope*		1									5	
Oriental Magpie-Robin (*LT*, *TP*, F, WO) *Copsychus saularis*	8	16	22	6	8	13	14	11	10	2	3	2
Stonechat (*F*, PO) *Saxicola torquata*	3	6	4								5	9
Red-throated Flycatcher (*L*, *WO*, TP, F) *Ficedula parva*	2	1		2						5	2	
Pied Fantail (*WO*, *TP*, LT, FS) *Rhipidura javanica*	4	5	5	1		7	14	12	6	6	2	
Black-naped Monarch (*WO*, *TP*) *Hypothymis azurea*	2	2								1		
Brown Shrike (*FS*, LS, WO, WI) *Lanius cristatus*	4	10	3		19			9	12	3	10	5
Long-tailed Shrike (*F*, LT, TP) *Lanius schach*	5	1	5	2	5	13	8	3	5		4	3
Asian Pied Starling (*L*, *AB*, WI, TP) *Sturnus contra*	3	2	1			3	5	2	3			44
Black-collared Starling (*AB*, *L*, RT, F) *Sturnus nigricollis*	2	1		3	2		3				3	
Common Myna (*L*, *F*, AB, TP) *Acridotheres tristis*	39	25	17	11	16	49	11	31	19	25	20	22
White-vented Myna (*AB*, BU) *Acridotheres javanicus*	10	6		8		2	1		13	6		2
Brown-throated Sunbird (LT, TP, WO, WI) *Anthreptes malacensis*		2	2	3		4	5		6		2	
Olive-backed Sunbird (*TP*, *LT*, FS) *Nectarinia jugularis*	8	17	1	10		29	13	33	10	9	11	14

Species (*major*, minor habitats)	JAN 7	JAN 23	FEB 18	MAR 18	MAY 15	JUN 25	AUG 9	SEP 11	OCT 3	NOV 1	NOV 21	DEC 4
Scarlet-backed Flowerpecker (*LT*, TP, PO, KC) *Dicaeum cruentatum*	1		1		1	1	4	6	3	5	1	1
Eurasian Tree-Sparrow (*R, WI*, BU, L) *Passer montanus*		1	1	2		18	13	50	20	5	3	4
Plain-backed Sparrow (*L, BU*, TP, WI) *Passer flaveolus*	5		3			13	2					2
Baya Weaver *(TP)* *Ploceus philippinus*						1						
Asian Golden Weaver *(WI)* *Ploceus hypoxanthus*							2					
White-rumped Munia (*TP, AB*, L, F) *Lonchura striata*					1	13	6	1			7	
Scaly-breasted Munia (*FS, AB*, LT) *Lonchura punctulata*		6			2	1	2	6	2		10	

Table 3. Number and habitats of the 10 most frequently observed species on the Salaya campus.

Species	Total no.	Status[1]	Habitat[2]
Red Turtle-Dove	1026	R	WI, AB, LA
Streak-eared Bulbul	587	R	FI, TP, LA, WO
Lesser Whistling-Duck	464	R,V	PO, AB
Plain Prinia	413	R	FI, KL, LA, PO
Common Myna	285	R	LA, FI, AB, TP, WI, BU
Little Grebe	253	R	PO
Rock Pigeon	242	R	BU, AB
Spotted Dove	228	R	WI, FI, LA, AB, TP
Black Drongo	217	R,V	TP, AB, LA, WI
Barn Swallow	204	V	AB, PO, WI

[1]R = resident; R,V = population partly resident and partly visiting in winter; V=visitor only.
[2]only habitats each having more than 5% of individuals observed.

Habitat Distribution

Table 4 shows the total observations of birds seen by habitat. (An "observation" is a sighting of one or more individuals or a flock of one species.) Areas 1 and 2 had numerous buildings, lawns, and also some field and pond habitat. The pond on the east side of area 1 was not visited; subsequent visits showed it to contain abundant typical canal species such as White-breasted Waterhen, Bronze-winged Jacana, bitterns and crakes. Area 3 was mostly field but had a long walkway through a *Casuarina* plantation along a khlong. Area 5 had a large pond on which flocks of Lesser Whistling-Duck sometimes landed in spring and summer, and also a large amount of field area. Area 5 had the largest number of bird observations and had all habitat types. Area 6 was mostly field habitat. Area 7 is noted most for the artificial ponds. These ponds had more observations then any of the others visited. They appear to be rich in vegetative cover and aquatic life, but the large numbers of grebes and waders in them is due mostly to the fact that they are surrounded by elevated banks which hide birds from view from the road. Birds on all other ponds visited are easily disturbed by people walking past.

Table 4. Frequency of bird observations in different habitats on Salaya campus.

	Habitat	No. observations		Percent
FG	Field, grass	99		
FS	Field, shrubs	233	346 (Fields)	31.1
FM	Field, marsh	14		
GN	Garden	13		
LA	Lawn, grass	63	225 (Lawns)	20.1
LS	Lawn, shrubs	18		
LT	Lawn, trees	131		
RS	Roadside, ground	27		
RT	Roadside, trees	77	268 (Planted trees)	24.1
TP	Tree plantation	191		
WO	Woodland	80		
KL	Khlong, open water	2		
KV	Khlong, floating plants	39	56 (Canals)	5.0
KC	Khlong, cattails	15		
PO	Ponds	129		11.6
DF	Dirt fill	2		
BU	Buildings	27		
WI	Wires, poles	90		
AB	Airborne	236		
	Unrecorded			
	Total	1,622		

Table 5. Summary of numbers of species by habitat type.

Habitat	Total No. species	No. species' major habitat[1]	No. species' primary habitat[2]	No. species' only habitat[3]
Fields	56	33	25	3
Tree plantation[4]	47	23	18	3
Lawn, gardens	41	13	12	2
Ponds	36	17	13	5
Woods	34	8	6	1
Khlongs	23	6	3	
Electric wires, poles	27	5	4	
Buildings	11	2	2	1
Airborne[5]	53	21	16	8[6]

[1] Greater than 25% of individuals

[2] Habitat with most individuals of species

[3] Species with no other major or minor habitats; species with more than one individual seen only

[4] Includes tree rows along roads

[5] Seen flying in the air without being flushed and without landing

[6] Species which habitually forage or hunt on the wing only

In summary, field habitats had the largest number of bird observations (31% of total), followed by habitats with planted trees (24%) and lawn and garden habitats (20%).

Table 2 lists the major (>25% of individuals seen) and minor (5–25% of individuals) habitats of each species. From these data one can determine the "species richness" (number of species seen) of each habitat type.

Species Richness of Habitats

Table 5 provides a breakdown of the number of species seen by habitat type. Field habitats lead the list with 56 species, and were a major habitat (>25% of all individuals seen) for 33 species. Only three species (Pintail Snipe, Lanceolated Warbler and Siberian Rubythroat) were found exclusively in fields, but several others (Great Reed Warbler, Zitting Cisticola, Stonechat) were seen elsewhere only in what is essentially field habitat along the sides of ponds or khlongs. Since there is so much ecotone between habitats, it is easy for birds to be seen in habitats bordering the preferred one.

Tree plantation is the second richest habitat type (45 species), and lawns and gardens the third. The latter are somewhat difficult to distinguish from nearby planted trees and roadsides. A surprising number of species foraged predominantly in planted tree habitats: Common Iora, bulbuls, Black Drongo, Eastern Crowned Warbler, and three species of sunbirds among them.

Ponds had 36 species, and the highest number (5) of exclusive species: Little Grebe, Little Cormorant, Garganey, Watercock and Barn Swallow. The last was always airborne but foraged almost exclusively over water.

Although no species occurred exclusively in khlongs, there are three 'khlong specialists': Yellow Bittern, Ruddy-breasted Crake and White-breasted Waterhen. Bronze-winged Jacana, perhaps the most interesting and sought after species, also is common in all khlongs, although this shy species is sometimes more easily spotted on the far sides of ponds. All khlong species prefer khlongs with floating vegetation on which to walk; few were seen in khlongs cleared of plants.

All members of the dove family on the campus are commensals of man and are specialists on man-made objects: the Rock Pigeon on buildings, the Red Turtle-Dove on wires and poles, and the Zebra Dove along roads. The Spotted Dove is more catholic but is at home around lawns and on wires. None of the many forest pigeons that occur in Thailand are found in such habitats.

Eight species forage almost exclusively in or from the air. Some are difficult to associate with ground habitats.

Few birds are associated with woods habitats on the campus. Black-crowned Night Herons sometimes roosted in the woods of area 5. In addition to this species, woods is the primary habitat only for Large Hawk-Cuckoo, Chestnut-headed Bee-eater (mostly by chance, due to the small number seen), Dusky Warbler, Pied-Fantail and Black-naped Monarch.

DISCUSSION

Relative Abundance

The most commonly observed species of birds are mostly those that sit in exposed positions (especially the Red Turtle-Dove) and are not necessarily the most abundant. Of the 10 most commonly seen, Plain Prinia and Streak-eared Bulbul are in all likelihood really the most abundant, being more hidden in grassy and shrub habitats.

Of the waterbirds, Little Grebe is the most visible, being an open-water species, but White-breasted Waterhen, Yellow Bittern, Common Moorhen and Bronze-winged Jacana are also common but more difficult to observe in the edge vegetation.

Species Richness

Grassland, the habitat with the lowest vertical complexity, has the highest species richness. Natural woodland had very low diversity, and tree plantations were intermediate. A number of woodland species expected on the plains were not found during the survey. This includes the Hoopoe, Laced Woodpecker, Common Goldenback, Lineated Barbet, Coppersmith Barbet, Racket-tailed Treepie, Small Minivet, Striped Tit-babbler, Abbott's Babbler, Puff-throated Babbler. Most of these species occur in mixed-species deciduous or scrub forest on or bordering the plains in Saraburi, Ratchaburi or Cholburi Provinces (PANTUWATANA et al., 1969).

The lack of any owls may be due to the diurnal bias of the survey but students staying at the campus told us of the presence of an owl species, possibly Barn Owl.

The woods habitat is not true forest habitat but a secondary woodland consisting of "weedy" tree species, some of them introduced, and there are no very large trees. It has low plant diversity and relatively little ground flora. It also occurs in small patches. These factors contribute to its relatively low bird species richness. The least abundant habitats of any region would be expected to be the most species-poor due to the "area effect" alone: few species would achieve populations in them large enough to persist over the long term.

Grassland is the most common natural habitat of the plains, as well as on the campus. Fallow rice paddies return to grass habitat within a year or two after cultivation. The Plain Prinia is the most common bird in this habitat, but other warblers occur in certain places such as wetter areas where taller grasses and reeds occur. This is the richest bird habitat simply because it covers the largest area of the plains.

Tree plantation is a close second in bird species richness, probably because it has been planted over much of the campus area and includes at least 17 species of trees. Some have showy flowers which are visited heavily by sunbirds. The birds of this habitat are mostly species that lived in edge and secondary forest habitats before colonization by man, and were probably less common at that time. These species do not occur in undisturbed forest habitats such as in Khao Yai Park. Most bird species seen in planted tree habitats are also common around residential areas in the city of Bangkok.

The species richness on the campus may be compared with that of Bangkok, which contains all of the habitats present on the campus. Early this century Williamson reported 127 species from Bangkok before 1917, and had recorded over 200 species before he left Bangkok (WILLIAMSON, 1914, 1915, 1917a, 1917b; AAGAARD, 1930). AAGAARD (1930) reported 110 species of relatively common birds in Bangkok. The number of woodland species on the Salaya Campus may be expected to grow somewhat as the planted trees mature, but the number of grassland species may decline as this habitat is gradually eliminated.

Habitat Changes

Since the survey during 1987–88 there have been major changes on the Salaya Campus. The development of new faculties and facilities has resulted in the loss of much grassland habitat. Approximately 21 ha of grassland, or about 39% of the total, is now being converted to buildings, lawns and athletic fields. The effect of eliminating grassland habitat will be to reduce bird species richness on the campus, and to increase populations of species which are already very common in planted tree and lawn habitats in Bangkok and nearby areas.

In this respect, the Salaya campus is a microcosm of the Central Plains. Grassland and marsh habitats throughout the lower Central Plain are being filled in as greater Bangkok expands farther and farther in all directions. The ecological effects of extensive land-filling include blockage of natural water flow to the sea without seasonal flooding, reduced recharge of underground aquifers and reduced humidification of the atmosphere.

The conversion of field, marsh and other wetland habitats by filling is irreversible. We believe that field, marsh and pond habitats should be set aside as permanent green-wet areas in the lower plain to preserve wildlife and ecosystem functions.

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REFERENCES

AAGAARD, C.J. 1930. *The Common Birds of Bangkok.* CHR. Bachhausen, Copenhagen. 239 pp.

LEKAGUL, B. and P.D. ROUND. 1991. *A Guide to the Birds of Thailand.* Saha Karn Bhaet Co., Ltd., Bangkok 457 pp.

PANTUWATANA, S., S. IMLARP and J.T. MARSHALL, Jr. 1969. Vertebrate ecology of Bang Phra. *Nat. Hist. Bull. Siam Soc.* 23(1-2): 132-183.

WILLIAMSON, W.J.F. 1914. The Birds of Bangkok. Part I. J. *Nat. Hist. Soc. Siam* 2(2): 71-92.

_____1915. The Birds of Bangkok. Part II. J. *Nat. Hist. Soc. Siam* I(3): 200-210.

_____1917a. The Birds of Bangkok. Part III. J. *Nat. Hist. Soc. Siam* 2(3): 185-214.

_____1917b. The Birds of Bangkok. Part IV. J. *Nat. Hist. Soc. Siam* 2(4): 319-339.