REPORT ON

GRASSLAND BIRDS SURVEY & CORRELATIONS BETWEEN GRASSLAND BIRDS AND THEIR HABITAT VARIABLES IN TRAM CHIM NATIONAL PARK

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1 Introduction

Habitat loss and degradation have been considered the most significant factor threatening global species (Pimm & Gilpin, 1989). For avian taxa currently endangered in the world, 82 percent are related with habitat loss (Temple, 1986). In a highly disturbed area like Tram Chim National Park (TCNP), Dong Thap Province, Vietnam, the viability of the park's surrogate species - Eastern Sarus Cranes *Grus antigone sharpii* - is often strongly associated with the park management practices. General consensus is that the high year-round water levels kept for fire prevention in TCNP period recently have substantially altered the park's typical seasonally inundated grasslands (Beilfuss & Barzen, 1994; Triet *et al.*, 2004a; Triet *et al.*, 2004b). There is evidence that the grass *Eleocharis spp* do not effectively produce below-ground tubers under the current water level regime. The ecological implication for the park's crane population, which favours *Eleocharis* tubers as a major food source, is a marked decrease in numbers has been associated with the decrease in favoured habitat.(Triet *et al.*, 2008).

The conservation of and correlation between the endangered cranes and the seasonally inundated wetland habitats in TCNP are of major governmental and public concern. The current Sarus Crane population declining trend in the park is implicitly assumed to be self-evident and more facts are needed to be gained to buttress the argument. An ecologically sound water management of the park needs to be based on understandings of the park's fire, water level and hydrological process characteristics. In 1993 Larsen examined the relationships among TCNP grassland bird species composition, abundance and their habitat structures (Larsen, 1996). His research models indicated that a large proportion of the avian community, including the Sarus Cranes, highly depends upon elevated and drier habitats for foraging activities. This research is valuable in providing relationships between the park indicator species groups and habitat features. Replication of the 1993 research in 2008 would be helpful in describing changes, if any, and trends in grassland bird and habitat features over the last thirteen years.

2 Methods

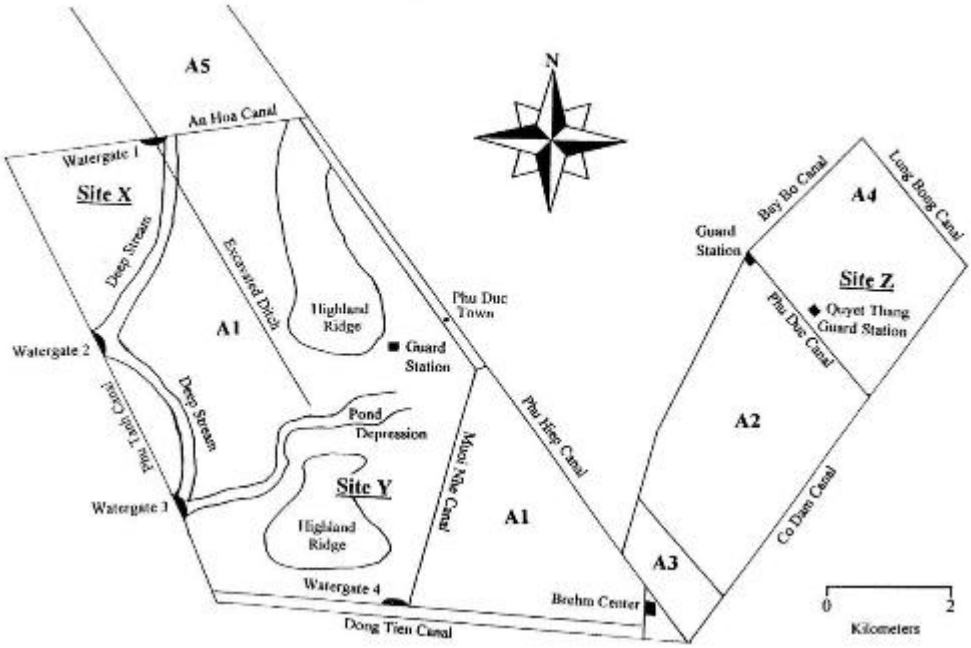
2.1 Sampling

The study area is the protected zone of TCNP. The area is characterized by 7588 hectares of seasonally inundated grasslands and planted *Melaleuca cajuputi* forest dispersed in an array of small to medium-sized patches. The outside boundaries of the protected zone abut agricultural and residential lands.

The complete habitat and bird community survey required 24 days of field time and was undertaken between March and April of the 2008 dry season. Total sampling area covered 251.2 hectares of grasslands and was divided by six non-stratified study sites (Figure 1). Together these sites provide a rough continuum of elevations and water levels from inundated to dry conditions in the park. Five of the study sites were located in Section A1 of the park which has been enclosed by a dike system since 1994.

Figure 1: Study sites in TCNP

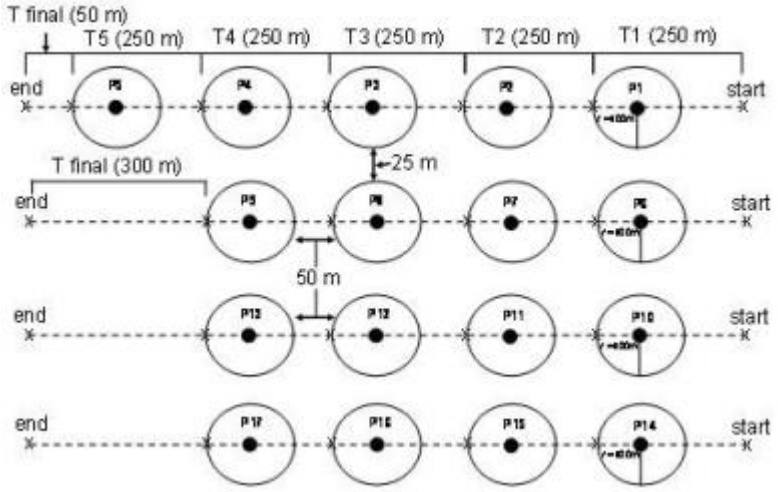
Site X, Y, and Z are reiterated of the 1993 survey. Site A, B, and C are new to this survey.
Round lines and figures indicate topographies and elevations in centimetres (above sea level) (provided by An Giang University's survey team, MWBP).



Study sites (X, Y, and Z) designed in the 1993 survey (after Larsen, 1996, p.10).

Surveys at each site involved counting grassland birds and measuring habitat variables along transects and within circular points. A complete site (Site X, Y, Z in 1993 and A, B, X, Y in 2008) had a size of 875m x 1050m and comprised of 16 circular plots and 4 transects (Figure 2). Plots (100m in radius) were to be arranged in a non-random 4x4 grid, the edges of plots in a same row were separated by 50m and in adjacent rows by 25m. Site C and Z in the 2008 survey had only 8 plots and 2 transects each site due to limited habitat availability.

Figure 2: Structure of one study site



Four 100m-radius points were grouped to make up a 'line'. In total a 'line' transect was 1,050m in length including four counting points and five transect segments (three between points and two at the beginning and end of the point cluster).

Each 1050m-long line transect was sampled once in one day for its bird compositions and densities by one team and continued by another team (when the bird survey had been finished) for vegetation and hydrological features. Sampling among sites was stratified one line transect at a time; it means that one line transect was sampled (either for birds or habitat features) at a site followed by a line at another site and going on. The process was then repeated.

2.2 Bird sampling

Grassland bird data were collected by employing a combination of point count and line transect observation (Bibby *et al.*, 1992) with adaptations following Larsen's research (Edwards *et al.*, 1981; Larsen, 1996). Modified point count techniques were used for detecting skulking bird species and line transect surveys were for recording birds flying overhead. In point count observations, a 100m rope, fitted with loops at 20m of each end to account for the rise of attachment to the waist of the samplers, was dragged in a circle around a fixed center point and all bird subsequently flush were recorded. By doing line transect observations, the observers walked along transects and recorded all bird seen (flying overhead and flushing away). Double-counting was avoided by counting only birds that flew across the transect segment or across the dragging rope (usually seen by the person standing at the point center) or birds that flew outside of the point circumference (usually seen by the person at the distal end of the rope).

Bird species seen in a plot and transect segment prior to the plot were noted in a dichotomous form where species presence was entered as "1" and absence was entered as "0" (Appendix III, IV). Birds were identified to species level if possible. Some species were recorded as genus (Button quail *Turnix spp*, Bee-eater *Merop spp*, Egret *Egreta spp*, large Heron *Ardea spp*, small Heron *Ardeola spp*, and Bittern *Ixobrychus spp*) or group ("Grouped Warblers" for Zitting Cisticola *Cisticola juncidis*, Lanceolated Warbler *Locustella lanceolata*, and Rusty-rumped Warbler *L. certhiola*). It is difficult to consistently differentiate these species to species level during field sampling.

"Grouped" Warblers are dominant species in grassland habitats of TCNP. Their samplings were, therefore, presented as total number of individuals recorded rather than the dichotomous form as described above.

2.3 Habitat variable sampling

Vegetation and water level were sampled at each plot using a modified line transect technique (Canfield, 1941) that adopted by Larsen (Larsen, 1996, p.17). Habitat measurements have been taken by 1 square-meter quadrat at 25m intervals in each cardinal direction, from the center to the edge of a plot; resulting in 16 quadrats sampled for each plot. There are 256 quadrats sampled (16 quadrats x 16 plots) for each site of A, B, X, and Y, and 128 quadrats sampled (16 quadrats x 8 plots) for each site of C and Z.

A pole of 2m long, 10cm wide, and 2cm thick was used for measuring vegetation structure and water level at quadrats. Habitat data collections include vegetation composition, maximum, average, matt vegetation height, water depths, and, in the absence of water, soil moisture:

- Vegetation composition: total species recorded in the quadrat.
- Max height: the tallest plant within the quadrat.
- Average height: height at which the pole was 50 percent obscured when viewed from a distance of one metre.
- Matt height: the pole was completely obscured.
- Soil moisture: "moist" soil was not saturated, but had a muddy quality and remained on a finger that was pressed into it, "damp" soil was wet to touch, but did not stick to a finger that was pressed into it, and "dry" soil was not wet to the touch.

Hydrology data for 1993 water depth and soil moisture were recorded in a standardized form. "Dry" soil was coded 1. "Damp" soil was coded 2. "Moist" soil was coded 3. Water depths from 0cm (saturated) to 10cm were coded 4, from 11cm to 20cm were coded 5, and so on up to a code of 10. The 2008 data followed this format; the exact water level measurements were kept for other analysis.

Direct sightings, local knowledge, and literature reviews were employed to compile and update the TCNP avifauna list (see Duc, 1993; Barzen, 1996; Larsen, 1996; Safford *et al.*, 1998; Buckton *et al.*, 1999; Buckton & Safford, 2004) (see also Yamashina project, 1998 - unpublished report; Waterbird and Wetland Working Group of Vietnam, n.d. - unpublished report; and photographic evidence from Tram Chim National Park staff). Nomenclature and order follow Inskipp *et al.* (Inskipp *et al.*, 1996).

2.4 Study sites

Below are descriptions of the survey sites:

Site X *(replication of the 1993 survey):* the water level in Site X was the highest of the six study sites (elevations at ca. 130cm above sea level, Figure 1). The 1993 water depths at Site X averaged from 23cm to 49cm and the 2008 levels ranging from 0cm to 80cm. Larsen (1996) reported that small patches of saturated soil at this site began to emerge by the late dry season of 1993. Observations in the 2008 survey, however, showed that the site was permanently flooded with lowest water level at 4cm taken in late April 2008.

Vegetation of Site X in 2008 is dominated almost exclusively by the grass *Leersia hexandra* and the sedge *Eleocharis dulcis*. Also represented at the site were patches of open swamps and ponds with very little matted vegetation (Picture 1).

Eastern Sarus Cranes have been commonly seen feeding in Site X during the survey time. The main roosting site of the flock was wetlands behind the large *Melaleuca* patch at southeast direction from the site. The birds were seen flying out their roosting site to the staging site between 0600 and 0630 on early mornings then families of cranes flew back the grasslands at Site X and fed scatteredly there.

The flooding conditions of Site X provides ideal foraging zone for large numbers of waterbirds. Diving species were the most abundant groups at the site with large flocks of Garganey *Anas querquedula* (ca. 5000 individuals), Lesser Whistling Duck *Dendrocygna javanica* (ca. 500 individuals), Spot-billed Duck *Anas poecilorhycha*, Little Cormorant *Phalacrocorax niger*, and Darter *Anhinga melanogaster* often seen.

Picture 1: *Leersia* grassland and open water at Site X

Site Y *(replication of the 1993 survey):* Site Y is bordered on nearly all sides by *Melaleuca* stands of various ages, with only one open corridor to the northwest. Elevations of this site were much higher that those in Site X, averaging from 175cm to 220cm. *Panicum repens*, *Leersia*, and *Eleocharis* are dominant in elevated patches of study Site Y (Picture 2) while *Utricularia*

aurea is commonly found in flooded areas. Site Y supported the poorest bird compositions among the six study sites. Purple Swamphen *Porphyrio porphyrio* was the most frequently sighted species. The site was not the feeding area of Eastern Sarus Crane during the survey period.

Picture 2: *Panicum* grassland of Site Y

Site A is situated on the edge of highland area and therefore displays a variety of flooding conditions. Water levels averages between 0cm and 38cm, while elevated areas featured open patches of damped soil. The grasses *Panicum* and *Oryza* are dominant species in elevated areas of Site A while *Eleocharis* and *Utricularia punctata* were particularly abundant in the flooded patches (Picture 3). Thick mat layers of *Panicum* and *Oryza* at Site A supported a diverse grassland bird community with high densities of Zitting Cisticola, Lanceolated Warbler, Rusty-rumped Warbler, and Striated Grassbird *Megalurus palustris* were often sighted.

Picture 3: *Eleocharis* grassland at flooded patches, Site A

Site B has the highest elevation levels among the five sites within the dyke impoundment of the park then is the driest site. Most of the study points of the site were damped to dry in April 2008. Grasslands in Site B had been completely burned down in 2005 (Nguyen Van Hung, *pers. comm.*). The newly replacing vegetation cover in 2008 was almost mainly *Panicum* grass and patches of bare soils were still seen in the site (Picture 4).

Picture 4: *Panicum* grass on damped soil, Site B

Standing water in Site B was found only in depression areas; in which fairly large numbers of egrets and herons were recorded. Due to its proximity to residential areas and its vegetation compositions, cattle were seen grazing in Site B on several occasions. Numerous well-worn paths also bisected the area and small groups of people were regularly seen. Bird communities of Site B are similar to those of Site A with grassland birds such as warblers and prinias are strongly dominant. Damped and bare soils at the study site supported large number of terrestrial and ground insect feeding birds such as Yellow Wagtail *Motacilla flava* and Oriental Pratincole *Glareola maldivarum*.

Site C has water levels ranging from 0cm to 47cm or elevations from 115cm to 130cm, of the six study sites. *Eleocharis* grassland is the dominated species at the Site (Picture 5). Bird species composition of Site C is quite similar to that of Site Y.

Picture 5: Dominated *Eleocharis* at Site C

Site Z *(replication of 1993 survey)*: Site Z is located outside the flooding regime of the impoundment (Zone A5**)** and therefore is the driest of the six sites. Large patches of dry and bare lands have often been observed in Site Z (Picture 6). The dry and management conditions and at Zone A5 make the area susceptible to the invasiveness of *Mimosa pigra* (Picture 7). Dry environment and bare soils greatly support the presence of terrestrial and running bird species such as wagtails, pipits, and pratincoles.

Picture 6: Dry and bare soils at Site Z

Picture 7: *Mimosa* at *Panicum* grassland at Site Z

3 Result: bird list

The total bird of TCNP recorded to date is 231 species (Appendix I). This avifauna is most diversified than any other protected areas in the Mekong Delta. Of the 231 species found at TCNP, 32 stand out as having important conservation values (Table 1). Of those 32 species, 15 appear in the 2008 IUCN globally threatened species list as endangered (EN), vulnerable (VU), or low risk (LR) category. 14 species, of which some are overlapped with the 15 IUCN species, are listed in the Vietnam Red Data Book as nationally endangered (E), vulnerable (V), threatened (T), and rare (R). Some other species are included in the Decree 32 of the Vietnamese Government (2006), Appendix IIB of species of conservation value, or in Appendix I and II of the CITES Convention.

Table 1: Species of high conservation value of TNCP

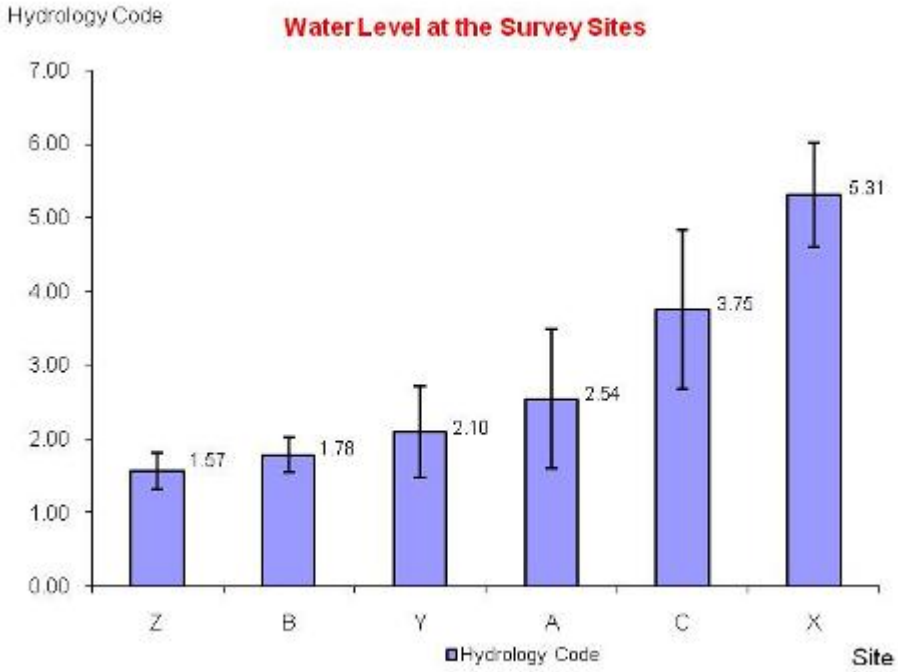
	Scientific name	**Common name**	**IUCN Redlist 2008**	**Vietnam Red Data Book**	**Decree 32**	**CITES**
1	*Cairina scutulata*	White-winged Duck - Ngan cánh trắng	EN	V	IIB	I
2	*Nettapus coromandelianus*	Cotton Pygmy-goose - Le khoang cổ		T		
3	*Halcyon capensis*	Stork-billed Kingfisher - Sả mỏ rộng		T		
4	*Megaceryle lugubris*	Crested Kingfisher - Bói cá lớn		T		
5	*Tyto capensis*	Grass Owl - Cú lợn lưng nâu			IIB	II
6	*Caprimulgus macrurus*	Large-tailed Nightjar - Cú muỗi đuôi dài, Chim ục				II
7	*Houbaropsis bengalensis*	Bengal Florican - Ô tác, Công đất, Công sấm	EN	V	IIB	I
8	*Grus antigone*	Sarus Crane - Sếu cổ trụi, Sếu đầu đỏ	VU	V		II
9	*Charadrius peronii*	Malaysian Plover - Choi choi lưng đen	LR			
10	*Pandion haliaetus*	Osprey - Ó cá				II
11	*Aviceda leuphotes*	Black Baza - Diều mào				II
12	*Haliastur indus*	Brahminy Kite - Diều lửa				II
13	*Circus aeruginosus*	Eurasian Marsh Harrier - Diều đầu trắng				II
14	*Circus melanoleucos*	Pied Harrier - Diều mướp				II
15	*Accipiter badius*	Shikra - Ưng xám				II
16	*Aquila clanga*	Greater Spotted Eagle - Đại bàng đen	VU			II
17	*Falco tinnunculus*	Common Kestrel - Cắt lưng hung				II
18	*Falco peregrinus*	Peregrine Falcon - Cắt lớn				I
19	*Anhinga melanogaster*	Darter - Cổ rắn, Điêng điểng	LR			
20	*Phalacrocorax carbo*	Great Cormorant - Cốc đế, Bạc má		R		
21	*Egretta eulophotes*	Chinese Egret - Cò trắng Trung Quốc	VU			
22	*Threskiornis melanocephalus*	Black-headed Ibis - Cò quăm đầu đen	LR			
23	*Platalea minor*	Black-faced Spoonbill - Cò thìa	EN	R	IB	
24	*Pelecanus philippensis*	Spot-billed Pelican - Bồ nông chân xám	VU	R		
25	*Mycteria leucocephala*	Painted Stork - Cò lạo Ấn Độ, Giang sen	LR	R		
26	*Anastomus oscitans*	Asian Openbill - Cò nhạn, Cò ốc		R		
27	*Ephippiorhynchus asiaticus*	Black-necked Stork - Cò Á châu		E		
28	*Leptoptilos javanicus*	Lesser Adjutant - Già đẫy Java, Già sói	VU	R	IB	
29	*Leptoptilos dubius*	Greater Adjutant - Già đẫy lớn	EN	E		
30	*Copsychus malabaricus*	White-rumped Shama - Chích chòe lửa			IIB	
31	*Ploceus hypoxanthus*	Asian Golden Weaver - Rồng rộc vàng	LR			
32	*Emberiza aureola*	Yellow-breasted Bunting - Sẻ đồng ngực vàng	LR			

4 Result: site comparisons

4.1 Water levels

Figure 3 below indicates the mean water depths for the 2008 six surveyed sites. These mean figures were derived from 256 samples each at Site A, B, X, any Y, and 128 samples each at Site C and Z. Generally water depths at these sites can be categorized: i) deep inundated at Site X (mean hydrology code at 5.31) and Site C (3.75), ii) inundated at Site A (2.54), iii) dry to moist at Site Y (2.10) and Site B (1.78), and iv) completed dry at Site Z (1.57). Site Z is also located outside the dyke embankment, and, thus, does not have the same hydrological regime as the other sites. Standard deviations for Site C and Z are smaller than those of the others. This is due to the smaller sampling counts at C and Z rather than the sampling method.

Figure 3: Water depths (code) of the six surveyed sites, 2008



Hydrology code: 1: dry soil, 2 damp soil, 3: moist soil, 4: water level 1-10cm, 5: 11-20cm, and 6: 21-30cm.

4.2 Plant species compositions and abundance

Nineteen herbaceous plant species have been recorded in the survey sites; they are: *Panicum repens, Leersia hexandra, Eleocharis dulcis, Oryza rufipogon, Ludwidgia hyssopifolia, Ipomaea aquatica, Hymenachne pseudo, Ultricularia aurea, Ischaemum rugosum, Cyperus elatus, Eleocharis ochrostachys, Ultricularia punctata, Scirpus articulatus, Nymphea lorus, Spilathes iabadicensis, Aniseia marrinicensis, Polygonum tomentosum, Sphaeranthus africarus, Commelina diffusa*. Numbers of plant species observed at each site are Site A: 15, Site B: 12, Site C: 8, Site X: 14, Site Y: 10, and Site Z: 9 species (Table 1). The plant species compositions at each site are, therefore, not significantly correlated to changes in the respective water levels.

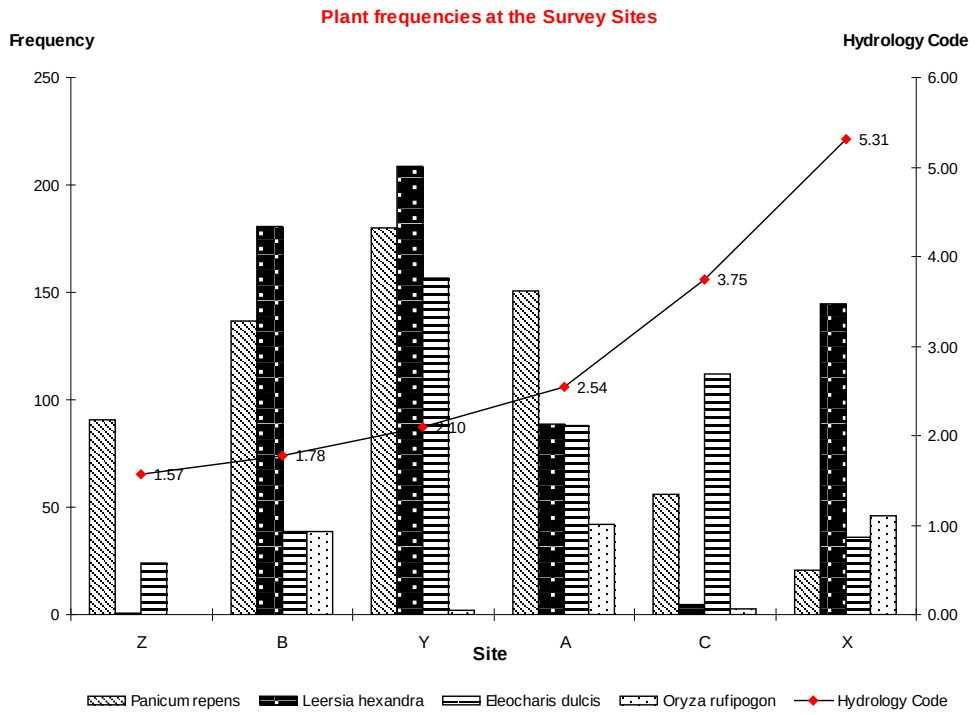
Four of the nineteen plant species recorded at the six survey sites have their frequencies, the presence at 1 square meter quadrat, greater than 100 times in 1280 quadrats (Table 1);

they are *Panicum repens* (636 times), *Leersia hexandra* (630 times), *Eleocharis dulcis* (456 times), and *Oryza rufipogon* (132 times).

Table 1: Presence frequency of plant species recorded at six survey sites

Site	A	B	C	X	Y	Z	TOTAL
(1) Panicum repens	151	137	56	21	180	91	636
(2) Leersia hexandra	89	181	5	145	209	1	630
(3) Eleocharis dulcis	88	39	112	36	157	24	456
(4) Oryza rufipogon	42	39	3	46	2	0	132
(5) Ludwidgia hyssopifolia	29	15	0	46	4	0	94
(6) Ipomaea aquatica	11	69	0	10	1	0	91
(7) Hymenachne pseudo	12	27	0	13	30	4	86
(8) Ultricularia aurea	7	0	11	50	15	0	83
(9) Ischaemum rugosum	1	14	0	9	16	1	41
(10) Cyperus elatus	4	13	0	17	0	3	37
(11) Eleocharis ochrostachys	1	0	7	1	0	23	32
(12) Ultricularia punctata	26	0	2	0	0	0	28
(13) Scirpus articulatus	1	19	0	0	0	0	20
(14) Nymphea lorus	0	0	7	6	1	0	14
(15) Spilathes iabadicensis	1	4	0	0	0	4	9
(16) Aniseia marrinicensis	6	2	0	0	0	0	8
(17) Polygonum tomentosum	0	0	0	6	0	0	6
(18) Sphaeranthus africarus	0	0	0	0	0	1	1
(19) Commelina diffusa	0	0	0	1	0	0	1

Figure 4: Presence frequencies of common plant species recorded at six survey sites



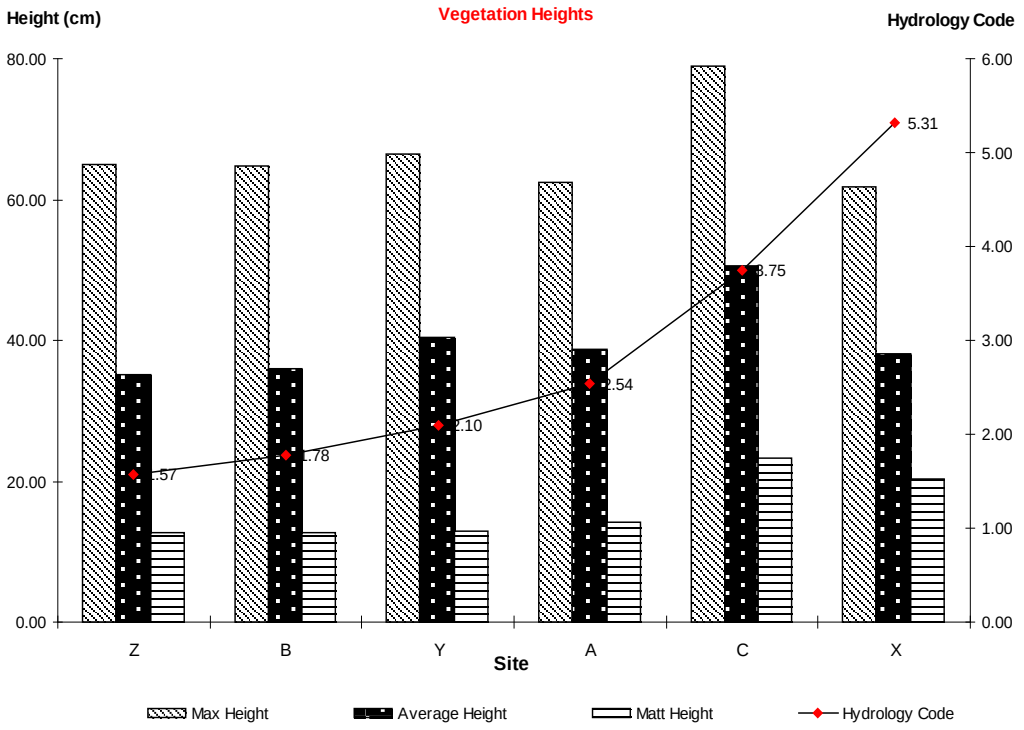
The four most commonly found plant species recorded at the survey sites were represent in Figure 4 above. Figure 4 indicates that *Panicum* and *Eleocharis* distribute optimally at areas that have hydrology code approximately at 2.00 and declines sharply with higher or lower water levels. *Leersia* and *Oryza,* on the other hand, have wide distributions at all survey sites

not depending on the water depth. Generally, plant species have been observed more abundant in areas with average water levels (mean depth at 2.00) than those in deep inundated or dry.

4.3 Vegetation heights

Mean vegetation heights (including max, average, and matt heights) among the sites are not greatly different to each other (Figure 5).

Figure 5: Recorded vegetation heights



4.4 Bird species compositions

Thirty three bird species or genera have been identified at the study area; they are: Lesser Whistling Duck, Spot-billed Duck, Garganey, Buttonquail *Tunrix spp.*, Bee-eater *Merops spp.*, Green-billed Malkoha *Phaenicophaeus tristis*, Greater Coucal *Centropus sinensis*, Dove *Streptopelia spp.*, Sarus Crane, Purple Swamphen, Painted Snipe *Gallinago gallinago*, Common Redshank *Tringa totanus*, Common Sandpiper *Actitis hypoleucos*, Pheasant-tailed Jacana *Hydrophasianus chirurgus*, Oriental Pratincole, Harrier *Circus spp.*, Little Grebe *Tachybaptus ruficollis*, Little Cormorant, Egret *Egret spp.*, Heron *Ardea spp.*, Heron and Bittern *Ardeola spp.* and *Ixobrychus spp.*, Pied Fantail *Rhipidura javanica*, Black Drongo *Dicrurus macrocercus*, Barn Swallow *Hirundo rustica*, Plain Prinia *Prinia inornata*, Striated Grassbird, "Grouped" Warbler (Zitting Cisticola, Lanceolated Warbler, and Rusty-rumped Warbler), Oriental Skylark *Alauda gulgula*, Yellow Wagtail, Richard's Pipit *Anthus richardi*, Baya Weaver *Ploceus philippinus*, and Black-headed Munia *Lonchura malacca*.

Site X has the highest bird species composition, 24 species, following are Site B with 22, Site A 20 species, Site Z 17 species, Site Y 12 species. Site C with 10 bird species recorded is the site with lowest bird species diversity. Table 2 below represents the presence frequencies of all bird at the surveyed 100m-radius plots in each site.

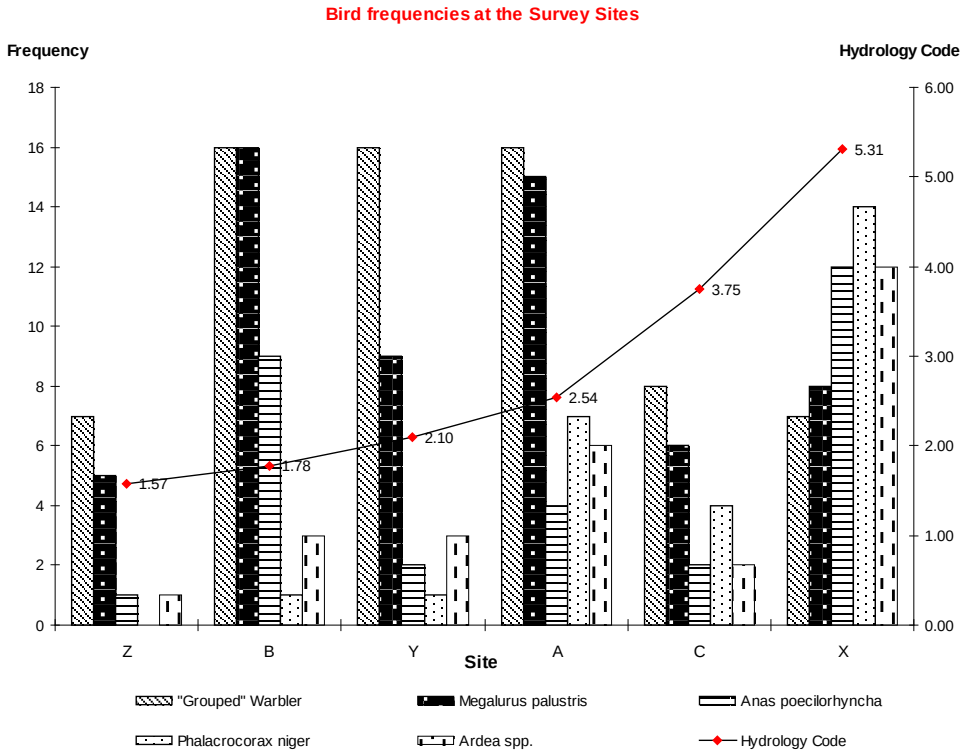
Table 2: Presence frequencies of bird species recorded at six survey sites

Species / Site	A	B	C	X	Y	Z	TOTAL
(1) Dendrocygna javanica	0	0	0	2	0	0	2
(2) Anas poecilorhyncha	4	9	2	12	2	1	30
(3) Anas querquedula	0	0	0	4	0	0	4
(4) Tunrix spp.	1	1	0	0	0	0	2
(5) Merops spp.	6	5	0	1	0	5	17
(6) Phaenicophaeus tristis	0	0	0	1	0	2	3
(7) Centropus sinensis	0	0	0	1	0	0	1
(8) Streptopelia spp.	2	1	0	0	0	2	5
(9) Grus antigone	0	0	0	7	0	0	7
(10) Porphyrio porphyrio	5	0	4	14	3	0	26
(11) Gallinago gallinago	2	2	0	1	0	0	5
(12) Tringa totanus	0	1	0	0	0	0	1
(13) Actitis hypoleucos	0	0	0	1	2	0	3
(14) Hydrophasianus chirurgus	1	1	0	14	0	0	16
(15) Glareola maldivarum	0	8	1	1	2	5	17
(16) Circus spp.	2	4	0	0	0	1	7
(17) Tachybaptus ruficollis	0	0	0	6	0	0	6
(18) Phalacrocorax niger	7	1	4	14	1	0	27
(19) Egret spp.	5	2	0	10	2	1	20
(20) Ardea spp.	6	3	2	12	3	1	27
(21) Ardeola spp.	5	2	3	8	0	0	18
(22) Ixobrychus spp.	6	2	5	4	1	0	18
(23) Rhipidura javanica	0	0	0	0	0	1	1
(24) Dicrurus macrocercus	5	5	0	6	2	4	22
(25) Hirundo rustica	0	0	0	0	0	3	3
(26) Prinia inornata	0	3	0	1	0	1	5
(27) Megalurus palustris	15	16	6	8	9	5	59
(28) "Grouped" Warbler	16	16	8	7	16	7	70
(29) Alauda gulgula	1	0	0	0	0	1	2
(30) Motacilla flava	0	2	0	0	0	0	2
(31) Anthus richardi	1	4	0	3	0	5	13
(32) Ploceus philippinus	0	1	0	0	0	0	1
(33) Lonchura malacca	4	3	1	1	3	1	13

4.5 Bird species abundance

Fifteen bird species have their presence frequencies greater than 10 times per 80 studied plots (Table 3). The five most abundant species are water-dependent "Grouped" Warbler (with 70 encounter times), Striated Grassbird (59), Spot-billed Duck (30), and Little Cormorant and large Heron (27 each). These frequencies were plotted in Figure 6 below. From Figure 6 it is specified that the "Grouped" Warblers, like the *Panicum* grass, mainly distribute at areas that have hydrology code approximately at 2.00 and declines sharply with higher or lower water levels. The three diving and wading waterfowl Spot-billed Duck, Little Cormorant and Heron, on the contrary, have their distributions correlative with increased water levels. The Striated Grassbird was found in all survey sites, and thus, its distribution is not connected with hydrological conditions.

Figure 6: Presence frequency of common bird species recorded at six survey sites



5 Result: correlations among habitat and plant variables

The presence frequencies of the four most commonly found plant species (in descending order *Panicum, Leersia, Eleocharis,* and *Oryza*, Table 1) and other habitat variables were compared and identified through the use of a pairwise correlation matrix (Table 3). Total number of sampling is 1280 one-meter-square quadrats. These variables include hydrology code, sociability (number of plant species recorded), vegetation height (max, average, and matt layer), and coverage percentage of plant species found at each quadrat.

Table 3: Correlated Habitat Variables *(Parametric, Pearson Correlation, two-tailed)*

	Hydro	Soc	MaxHei	AveHei	MatHei	PANREP	LEEHEX	ELEDUL	ORYRUF
Hydro	1	-.194(**)	0.004	.055(*)	.517(**)	-.361(**)	-.097(**)	.238(**)	0.029
Soc	-.194(**)	1	.105(**)	0.027	-.078(**)	-.104(**)	0.031	0.002	.109(**)
MaxHei	0.004	.105(**)	1	.832(**)	.515(**)	.133(**)	-0.034	.138(**)	.061(*)
AveHei	.055(*)	0.027	.832(**)	1	.555(**)	.076(**)	0.005	.172(**)	-0.013
MatHei	.517(**)	-.078(**)	.515(**)	.555(**)	1	-.154(**)	-0.033	.260(**)	0.029
PANREP	-.361(**)	-.104(**)	.133(**)	.076(**)	-.154(**)	1	-.444(**)	-.314(**)	-.145(**)
LEEHEX	-.097(**)	0.031	-0.034	0.005	-0.033	-.444(**)	1	-.339(**)	-.111(**)
ELEDUL	.238(**)	0.002	.138(**)	.172(**)	.260(**)	-.314(**)	-.339(**)	1	-.138(**)
ORYRUF	0.029	.109(**)	.061(*)	-0.013	0.029	-.145(**)	-.111(**)	-.138(**)	1

* Correlation is significant at 0.05 level (2-tailed). ** Correlation is significant at 0.01 level (2-tailed). **Hydro**: water level in hydrology code, **Soc**: sociability, number of plant species recorded, **MaxHei**: maximum vegetation height, **AveHei**: average vegetation height, **MatHei**: matt vegetation height, **PANREP**: *Panicum repens*, **LEEHEX**: *Leersia hexandra*, **ELECHA**: *Eleocharis dulcis,* **ORYRUF**: *Oryza rufipogon.*

Pairwise comparisons in Table 3 reveal positive relationships between water levels and average heights and matt heights of the vegetation while the max height is not affected by changes in water levels. The significant association between water levels and the plants' matt height, which in turn has significant correlations with average and max vegetation heights, implies that hydrological conditions within TCNP exert a strong influence upon wetland grassland structures including the composition and distribution of vegetation communities and the fauna which can be supported.

Data from Table 3 also indicate that water deepness within the surveyed areas negatively correlated with number of plant species, the higher the water levels the fewer grassland plant species. Water deepness also has strong negative relationships with plant communities dominated by the grass *Panicum* and *Leersia* while *Eleocharis* is, expectedly, positively correlated with high water levels. The wild rice *Oryza* does not show its association with water levels in the study area.

Occurrences of each of the four common plant species are significantly negatively correlated to one another; this indicates that environmental conditions in different areas bolster only one dominant plant species, in which *Panicum* is the most common plant species at the surveyed area. This grass was recorded 636 times from 1280 samples. The crouching lifeform of *Leersia* grass makes this plant species does not have any association with the height of plant community; while erected stalks of *Panicum* and *Eleocharis* contribute to the max, average and matt height of the communities.

6 Result: linear regression analysis

6.1 Model construction

Linear regression analysis have been used to build models associating the selected bird species with hydrological or vegetation features of the habitat in six survey sites. This analysis was employed to identify highly correlated variables which act as 'predictors' for the presence or absence of a bird species. Variables were entered into a bird species linear regression model and subjected to a backward elimination procedure. Those variables that exhibited a standard error larger than their coefficient were removed. Remaining variables were then systematically removed from the model, one at a time, with those displaying the largest p-values removed first. The negative log-likelihood for the reduced model was then compared to the negative log-likelihood for the more complex model. If the difference between the two was significant (p lesser than 0.05), the removed variables contributed to the explanatory power of the model and was returned. This procedure was followed until a model remained that contained only variables that contributed to the explanation of a species' presence or absence in the sample plots.

Data of the 15 most common bird species (Table 2) were entered in models to discover correlations between bird species presence and hydrological and vegetation features. The dichotomous response of presence versus absence was used for each 9 species and 5 genera; grouped observation of warbler species is the abundance of individual birds recorded at the surveyed plots (Section 2.2).

Bird data were samples by 100m-radius plot while habitat data were taken in square meter quadrat, a circular plot contains 16 quadrats; and there are totally 80 plots, with 1280 quadrats, were samples during the 2008 survey (Section 2.1). To make bird data and

habitat variables compatible, habitat variables were averaged for each sample plot: means of habitat variables in 16 quadrats of same plot were employed in models.

6.2 Results

The individual habitat features that were influential in determining bird species presence (or abundance) for each model, along with their respective significance levels are presented in Table 4.

Table 4: Predictor significance for logistic regression models

Model	Predictors	Coefficient	Significant
ANAPOE	Soc	-0.204	0.060
--	PANREP	-0.362	0.002
--	ELEDUL	-0.252	0.024
MERSPP	LEEHEX	-0.449	0.000
--	ELEDUL	-0.473	0.000
GRUANT	Hydrology Code	**0.518**	**0.000**
--	ELEDUL	-0.270	0.011
PORPOR	Hydrology Code	**0.678**	0.000
--	Average Height	0.169	0.019
--	PANREP	-0.142	0.075
HYDCHI	Hydrology Code	**0.462**	**0.000**
--	Sociability	-0.133	0.083
--	Max Height	-0.319	0.055
--	Average Height	0.361	0.031
--	PANREP	-0.443	0.004
--	LEEHEX	-0.310	0.030
--	ELEDUL	**-0.681**	**0.000**
--	ORYRUF	0.150	0.080
GLAMEL	Max Height	0.733	0.002
--	Average Height	**-0.882**	**0.000**
CIRSPP	none		
PHANIG	Hydrology Code	**0.459**	**0.000**
--	Max Height	-0.538	0.011
--	Average Height	0.586	0.007
--	ORYRUF	0.264	0.005
EGRSPP	Hydrology Code	**0.755**	**0.000**
--	Max Height	0.251	0.090
--	Matt Height	-0.456	0.035
--	ELEDUL	-0.335	0.004
ARDSP1	Hydrology Code	**0.542**	**0.000**
--	ELEDUL	-0.224	0.031
ARDSP2	PANREP	-0.626	0.001
--	LEEHEX	-0.527	0.009
--	ELEDUL	-0.324	0.075
--	ORYRUF	-0.271	0.034
IXOSPP	Average Height	0.216	0.050
--	PANREP	-0.209	0.058
DICMAC	Sociability	-0.210	0.047
--	ELEDUL	**-0.378**	**0.000**
MEGPAL	Hydrology Code	-0.401	0.004
--	Average Height	0.240	0.050
--	PANREP	-.0.366	0.065
--	LEEHEX	-0.380	0.054
--	ELEDUL	-0.303	0.089
GROWAR	Hydrology Code	**-0.508**	**0.000**
--	Sociability	0.257	0.009
--	Average Height	0.303	0.001
--	PANREP	-0.378	0.001

The model for GRUANT (Sarus Crane) reveals a strong positive relationship between bird presence and water levels. Site X had the highest water level recorded and this was also the only one site that had the presence of Sarus Cranes recorded during the survey. The PORPOR (Purple Swamphen) model shows a positive relationship between bird presence and hydrology code. The finding bolsters evidences that this waterfowl species is commonly seen only in inundated areas. The model for HYDCHI (Pheasant-tailed Jacana) indicates a positive association between bird presences with water deepness while having negative relationship with the coverage of *Eleocharis* grass. Long elongated stems of *Eleocharis* grassland clearly inhibit the presence of this long-toed surface floating vegetation walking species. The diving Cormorant (PHANIG model), Egret (ARDSP1), large Heron (ADRSP2) models reveal strong relationships between bird presence and the water depths. In contrast, the model for "grouped" warblers indicates a negative association between bird high density and hydrology code.

Models for Oriental Pratincole (GLAMEL) and Black Drongo (DICMAC) depicted inexplicable relationships between the bird species and some environmental variables (pratincoles with average vegetation height, drongos with *Eleocharis* grass). The presences of other bird species (ANAPOE model for Spot-billed Duck, MERSPP model for bee-eaters, CIRSSPP model for harriers, IXOSPP model for bitterns) are not being regulated by any plant and environmental variables.

6 Conclusions and Discussions

TCNP supports the last remnant of the natural ecosystem in the Plain of the Reed. During the conflict of the 1960s and 1970s a large network of canals was excavated across the Plain of Reeds to lower wetland water tables. The enhanced drainage altered the hydrological regime resulting in the desiccation of native vegetation whilst the incidence of high intensity fires increased (Beilfuss & Barzen, 1994). The inter-relationship of the different wetland ecosystem components means that changes in one can induce changes in others. Lower water levels within formerly waterlogged soils enhanced oxidation and hydrolysis lowering pH (pH < 3) and releasing toxic concentrations of iron and aluminum ions. In response to these changes and as the human population of the Plain of Reeds increased, the dikes and canals around the management zones of TCNP were constructed in order to retain water. The prolonged isolation and flooding of the area within the dikes from the surrounding area and in particular the Mekong River floodwaters had a number of impacts, positively and negatively.

Water levels and elevations: water levels within the park management zones (Zone A1 where located Site A, B, C, X, and Y) have generally been kept higher than natural and outside areas, elsewhere within the park conditions are very drier (Site Z, hydrology code 1.57, elevation mainly from 130-175cm amsl). Within Zone A1 there are various areas with different elevations. Generally, the northwest corner (Site X), southeast corner (Site C), and the west edge of Zone A1 support one of the lowest areas of the park; elevations in these areas range from 115 to 145cm above mean sea level (An Giang University's survey team, *pers. comm.*). The central area (Site Y, 2.10, Site B, 1.78) and the northeast corner (Site A, 2.54) of Zone A1 are higher with mean elevations ranging 175 to 220cm. (Please refer to **Appendix II** for topography of Tram Chim National Park).

Water regime: the dikes surrounding the Park management zones have reduced sheet flow and the exchange of Mekong floodwater into and out of the Park. Similarly, internal dikes

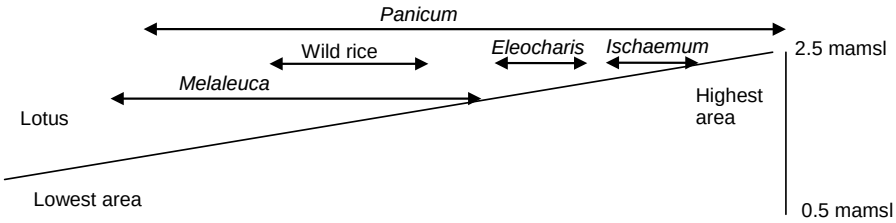
constructed within the Park limit the exchange of water between canals and surrounding areas. As a result standing water is found in every studied site within Zone A1.

Vegetation dominance: results in Section 4 substantiate the distribution and dominance of four major vegetation species (*Panicum, Leersia, Eleocharis,* and *Oryza*) having clear responses to different water levels.

At drier condition such as Site Z, where the soil is nearly completely dry in dry seasons, *Panicum* is an exclusively dominant species. *Eleocharis* had once been abundant in Site Z when water levels were suitable for the species. Relatively dry environment and the presence of *Eleocharis* had made Site Z an important feeding zone for Sarus Crane. The drainage of Site Z recently totally upsets the local ecosystem and *Eleocharis* is replaced by *Panicum*. Drier conditions also do not support the presence of *Leersia* and *Oryza*.

At the other end, very wet conditions in Site X, where average hydrology code at 5.31 or average water level between 11-20cm at the end of the 2008 dry season, also do not support many plant species. *Panicum* has been recorded nearly 100 times per 8 plots in dry conditions of Site Z while only occurred 20 times per 16 plots in flooded environment of Site X. Species with developed long stem such as *Leersia* and *Oryza* are dominant species at high water level areas (Figure 4). This judgment is similar to observations by other researches in the Park (MWBP, 2008) (Figure 7).

Figure 7: Distribution of dominant vegetation communities along an elevation and flood depth within TCNP (after MWBP, 2008)



Although *Panicum* is supposed to has a wide tolerance to water level and can grow either in dry and wet conditions, the grass's optimum water level apparently ranges from areas with hydrology code from 1.78 (Site B, 175-200cm in elevation) to 2.54 (Site A, 130-175cm). The high occurrences of *Eleocharis* in Site X imply that the grass can tolerate deeper water levels than does the *Panicum*; *Eleocharis,* however, also prefers average water level at Site Y, A, and C to deeper ones in X. These findings conclusively argue with a common statement that *Panicum* has been the most notable species which has benefited at the expense of *Eleocharis* when keeping water level with TCNP management zone high year-round. Generally, the tuber production processes in *Eleocharis* requires dry conditions while the growth of this grass species can be enhanced by high water level.

The wild rice *Oryza* can also have wide tolerance of water level as well as *Panicum* (Figure 4) although the presence frequencies of the first are much lesser than the later. Other habitat types within TCNP such as *Melaleuca*, open swamp, and lotus swamp were not addressed during the survey.

Vegetation structures: data in Figure 5 indicate the similar mean vegetation heights (including max, average, and matt heights) among the studied sites while water levels among them are significantly different.

Pairwise comparisons in Table 3 reveal positive relationships between water levels and average heights and matt heights of the vegetation while the max height is not affected by changes in water levels. The significant association between water levels and the plants' matt height, which in turn has significant correlations with average and max vegetation heights, implies that hydrological conditions within TCNP exert a strong influence upon wetland grassland structures including the composition and distribution of vegetation communities and the fauna which can be supported.

The composition of Tram Chim's bird population has been impacted by changes in water level regimes. As noted in Section 2.2, the most notable species impacted by higher water levels is the Sarus Crane. The number of these birds, for which Tram Chim is internationally renowned, using the Park has declined in response to the decrease in favored habitat. The reduction in the extent and quality of Eleocharis, including reduced tuber production, is cited as a particular reason for this decline. The main feeding area of the Sarus Crane is now Zone A5. Similarly, other bird species which prefer lower water levels such as waders have declined. Such species include Bengal floricans, Oriental praticoles and green bee-eaters. Higher water levels have favoured birds which prefer deeper water such as swamp hens and egrets which were less characteristic of the original bird populations with the Plain of Reeds.

Regression analysis has not been employed to interpret the responses among habitat and plant distribution variables because there are not

Fire: The risk of uncontrolled fires is greater in A4 and A5 due to the larger than historic draw-down. Higher water levels in some others parts of the Park (e.g. A1) will have limited the period when fires could occur. Ironically, however, high water levels combined with the reduction of sheet flow may have increased the chances of severe uncontrolled fires by enhancing the accumulation of dead plant matter beneath the *Melaleuca* canopy. Reduced incidence of low intensity fire, which under natural conditions would have removed dead biomass, coupled with the National Park policy of restricting human exploitation of natural resources which would reduce fuel load such as the collection of firewood compounds this problem. Similarly, in grassland areas the build up of dead plant matter may increase the severity of uncontrolled fires when they occur. Prohibition of human activity such as managed grazing further exacerbates this problem.

References

Barzen, J. (1996). *Avifauna sighted at tram chim nature reserve, 1988-1996*. Baraboo, Wisconsin: International Crane Foundation.

Beilfuss, R., & J. Barzen. (1994). Hydrological wetland restoration in the mekong delta, vietnam. In W. Mitsch (Ed.), *Global wetlands: Old world ad new* (pp. 453-468). Amsterdam: Elsevier.

Bibby, C., N. Burgress, & D. Hill. (1992). *Bird census techniques*. London: Academic Press.

Buckton, S., N. Cu, N. D. Tu, & H. Q. Quynh. (1999). *The conservation of key wetland sites in the mekong delta*. HCMC: BirdLife Vietnam.

Buckton, S., & R. Safford. (2004). The avifauna of the vietnamses mekong delta. *Bird Conservation International,* ***14***, 279-322.

Canfield, R. (1941). Application of the line interception method in sampling range vegetation. *Journal of Forestry,* ***39***, 388-394.

Duc, L. D. (1993). *Wetland's reserves in vietnam*. Hanoi: Agricutural Publishing House.

Edwards, D., G. Dorsey, & J. Crawford. (1981). A comparison of three avian census methods. *Studies in Avian Biology,* ***6***, 170-176.

Inskipp, T., N. Lindsey, & W. Duckworth. (1996). *An annotated checklist of the birds of the oriental region*. Bedfordshire: Oriental Bird Club.

Larsen, B. (1996). *The avifauna of a restored wetland: Tram chim national reserve, dong thap, vietnam*. Unpublished Master of Science, University of Minnesota.

MWBP. (2008). *Integrated water and fire management strategy tram chim national park*. Cao Lanh, Vietnam: IUCN.

Pimm, S., & M. Gilpin. (1989). Theoretical issues in conservation biology. In J. Roughgarden, R. May & S. Levin (Eds.), *Perspective in ecological theory* (pp. 287-305). Princeton: Princeton University Press.

Safford, R., T. Triet, E. Maltby, & D. V. Ni. (1998). Status, biodiversity and management of the u minh wetlands, vietnam. *Tropical Biodiversity,* ***5***, 217-244.

Temple, S. (1986). The problems of avian extinctions. *Curr. Ornithol.,* ***3***, 453-485.

Triet, T., N. P. B. Hoa, & J. Walston. (2008). *Sarus crane census in vietnam and cambodia, 2000-2008*. Baraboo, Wisconsin: International Crane Foundation.

Triet, T., L. C. Kiet, N. T. L. Thi, & P. Q. Dan. (2004a). The invasion by *mimosa pigra* of wetlands of the mekong delta, vietnam. In M. Julien (Ed.), *Research and management of mimosa pigra* (pp. 45-52). Canberra: CSIRO Entomology.

Triet, T., L. C. Man, & N. P. Nga. (2004b). Impacts of *mimosa pigra* on native plants and soil insect communities in tram chim national park, vietnam. In M. Julien (Ed.), *Research and management of mimosa pigra* (pp. 22-27). Canberra: CSIRO Entomology.