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Community Structure of Aquatic Plants in Bung Khong Long, Nongkhai Province, A Ramsar Site of Thailand

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ABSTRACT

The community structure of aquatic plant in Bung Khong Long, a Ramsar site of Thailand was conducted during July 2001 to April 2002 to study the species diversity, density and distribution. Six 1 m^2 quadrates were randomly sampled in five different plant communities during three seasons. A total of 75 species, 62 genera, and 38 families was found with an average biomass of 296.50 g/m^2. The dominant species were *Utricularia aurea*, *Hydrilla verticillata* and *Eleocharis dulcis* var. *dulcis* with the Important Value Index (IVI) 84.66, 54.30 and 31.09%, respectively. This area had a high species diversity with H value 3.24 (Shannon-Weaver diversity index). The aquatic plants grew profusely in the rainy season especially the submerged and the free floating groups whereas the emerged and marginal groups grew profusely in summer. In the northern part of the reservoir, water surface was evenly covered by islets and free floating plants whereas the central part was the habitat of emerged plants such as *Nelumbo nucifera* and *Nymphaea lotus*. In contrast, the southern part was open water area and deeper. It was the habitat of submerged plants such as *Najas* sp.1 and *Chara* sp.1 without islets and free floating plants. A marginal plant, *Caldesia* sp.1 was found in the northern part. In addition, at least 34 species of aquatic plants were collected by local people for using as food, fodder and other purposes.

Key words: aquatic plants, community structure, wetland, Bung Khong Long

INTRODUCTION

Bung Khong Long is a large reservoir in Bung Khong Long Non-hunting Area at Nongkhai province. This area has been announced as a Ramsar site of Thailand in year 2002 (OEPP, 2002). The reservoir supports many fishing families living around and highly diverse fish species and waterfowls (Wolstencroft *et* al., 1993). Although this area is an important wetland as mentioned but there is little information available on biological diversity especially aquatic plants.

Aquatic plants (or wetland plants, or aquatic macrophytes) are an essential part of the wetland ecosystem. They, like all photosynthetic organisms, are crucial in fixing the energy that powers all other components of the system. They supply oxygen to the other biota and contribute to the physical habitat (Cronk and Fennessy, 2001). The abundance and composition of the rooted aquatic

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plant community has a great effect on a lake ecosystem, particularly for shallow lakes (Carpenter and Lodge, 1986). They are consumed by small vertibrates and provide habitat for animals in the wetlands especially waterfowls. Aquatic plants are a source of food and protective cover for fish (Weber, 1979). If too many aquatic plants are changed, fish and wildlife populations may suffer (Whittaker, 1975). Moreover, aquatic plants are also among the tools used by wetland managers and researchers in the conservation and management of wetland areas. They are often used to help organize environmental inventories and research programs, and to set goals for management programs or restoration project (Reed, 1997). Thus aquatic plants have major effects in terms of the physical and chemical environments of wetland (Cronk and Fennessy, 2001). The aquatic plants are the drivers of ecosystem productivity and biogeochemical cycles, in part because they serve as a critical interface between the sediments and the overlying water column (Carpenter and Lodge, 1986).

Species is the basic unit in ecology and that a list must be reasonably completed to be of value for the present purpose (Macan, 1974). The study on quantitative characteristics of plant community structure is a good method for presenting the comparisons among the plant community (Oosting, 1965). Important Value Index (IVI) is defined on relative values of frequency of distribution, dominance and biomass, which is the quantitative characteristic that can show what species be the most or more dominant in the plant community (Mueller-Dombois, 1974). This study was focused on the community structure of aquatic plants, including species diversity, biomass and distribution in each season. The climate aim of this study was to present the biological diversity which could be fundamental data of this wetland for sustainable management in the future.

MATERIALS AND METHODS

1. Study area

Bung Khong Long reservoir, in Bung Khong Long Non-hunting Area, is located at Bung Khong Long district, Nongkhai province, in the northeastern region of Thailand (about 155-160m above sea level and 17° 50'N, 18° 03'N and 103° 54'E, 104° 43'E). The reservoir covers approximately 12.90 km^2. It is approximately 13 km from north to south, varies 1-2 km wide, and connects with the Mekhong River by a small canal at southern boundary in the rainy season (Wolstencroft *et* al., 1993). The climate is tropical with annual rainfall of 2040 mm which highly fallen during May to September (highest in August, 531 mm). The annual maximum temperature averages 32.3 °C (up to 37.9 °C in April) and the annual minimum temperature averages 22.6 °C (down to 18.0 °C in December) (Crimatological group, 2002). The northern part has small islets floating on water surface densely, whereas the southern part is open water and deeper (up to 5.2m in rainy and down to 3.8m in summer at the deepest point).

2. Study on community structure of aquatic plant

The study was carried out during the three seasons, rainy (July 2001), winter (December 2001) and summer (April 2002). The initial survey was done visually by boat covering the whole reservoir to survey the various species and distribution of aquatic plant. The specimens of aquatic plant were collected by hand or rake or using a snorkel in the deeper areas. They were photographed, packed in the plastic bags for making dry herbarium mounts or kept in the bottles filled with 70% formalin aceto alcohol(FAA) (Sass, 1958), and taken to the laboratory for further identification. The aquatic plants were identified as belonging to families and species from Cook (1996), AICAF (1996), Simpson & Koyama (1998), Sripen (1999), and Haynes

(2001).

For quantitative studies such as density and frequency of distribution, after preliminary survey throughout the reservoir, five stations (S1-S5) were chosen in different communities according to the dominant species:

- S1, in northern, the free floating species was the dominant group, water depth as 1.42m (in summer) and 2.80m (in rainy) at the deepest point.

- S2, in northwestern, the sedge family (Cyperaceae) was the dominant group, water depth as 1.95m (in summer) and 2.79m (in rainy) at the deepest point.

- S3, in northeastern, *Nelumbo nucifera* was the dominant species, water depth as 1.36m (in summer) and 2.04m (in rainy) at the deepest point.

- S4, in central, *Nymphaea lotus* was the dominant species, water depth as 1.64m (in summer) and 2.84m (in rainy) at the deepest point.

- S5, in southern, the submerged species such as *Najas* sp. and *Chara* sp. were the dominant species, water depth as 3.82m (in summer) and 4.70m (in rainy) at the deepest point.

Six $1m^2$ sampling plots were randomly collected (Oosting, 1965) at each station in three seasons. The aquatic plants were harvested within each sampling plot above soil surface, separated by species, weighed Fresh weight (FW), weighed as the sample (FWs), and taken to the laboratory for dry weight or biomass (B) estimation. The biomass of samples (Bs) was estimated after drying in the oven at 105°C to a constant weight (Wood, 1975).

The quantitative characteristics such as Frequency (F), Dominance (D), Relative Frequency (RF), Relative Dominance (RD), Relative Biomass (RB), Important Value Index (IVI) were calculated according to Curtis (1959) and Mueller-Dombois (1974):

F (%) = (no. of sampling plots where the species found x 100) / total no. of sampling plots

D = FW of the species / total area of sampling plots

RF = (F of the species x 100) / sum of F of all species

RD = (D of the species x 100) / sum of D of all species

RB = (B of the species x 100) / sum of B of all species

IVI = RF + RD + RB

Biomass of the *i* species (B_i) was calculated from (Wood, 1975):

B_i = FW of the *i* species x C_i, where C_i = Bs of the *i* species / FWs of the *i* species

Species diversity of aquatic plants was analyzed by using Shannon-Weaver diversity index (H):

$H = -\Sigma P_i \log_2 P_i$ and $P_i = n_i/N$

Where P_i is the proportion of the total number of individual consisting of the *i* species, n_i is total B of the *i* species, and N is total B of all species (Hanson and Churchill, 1964).

RESULTS AND DISCUSSION

Species diversity

A total of 75 species, 62 genera, and 38 families of aquatic plants was found which consisted of 35 Monocotyledonae, 32 Dicotyledonae, 7 Pteridophytes, and 1 Charophyte (Table 1). They were divided into 4 groups according to their habitats which were marginal (and on islets), submerged, emerged and free floating. The number of species was the greatest among the marginal species with Cyperaceae and Poaceae families. The most interesting species was *Caldesia* sp.1 (called Leb Ma by local people) which grew in shallow water and the edges of the reservoir in the northern part, because Haynes (2001) reported only two species of this genus in Thailand (*C. oligococca* and *C. parnassifolia*) and they were rarely found. However, it was quite like *C. parnassifolia* but it had 6, 7, 8 stamens whereas *C. parnassifolia* had 6 stamens.

Table 1 Species lists of aquatic plant in Bung Khong Long and their uses (M = Marginal; E = Emerged; F = Free floating; I = On small islets; S = Submerged; FO = Food; FD = fodder; OTH = Other purposes).

Family		Species	Life form	Habitat	Use		
					FO	FD	OTH
Chlorophytes							
Characeae	1	*Chara* sp.1	Herb	S			
Pteridophytes							
Marsileaceae	2	*Marsilea crenata* C.Presl	Herb	M	+		
Parkeriaceae	3	*Ceratopteris thalictroides* (L.) Brongn.	Herb	M	+		
Pteridaceae	4	*Stenochlaena palustris*(Burm.f.) Bedd.	Shrub	M, I	+		+
Salviniaceae	5	*Salvinia cucullata* Roxb. ex Bory	Herb	F			
Schizaeaceae	6	*Lygodium microphyllum* (Cav.) R.Br.	Herb	M			+
Thelypteridaceae	7	*Menicium proliferum* (Retz.) Sw.	Shrub	M			
	8	*Thelypteris interrupta* (Willd.) K.Iwats.	Herb	M, I			
Dicotyledon							
Amaranthaceae	9	*Alternanthera sessilis* (L.) DC.	Herb	M			
Apiaceae	10	*Centella asiatica* (L.) Urb.	Herb	M	+		
Asteraceae	11	*Eclipta prostrata* (L.) L.	Herb	M			
	12	*Grangea maderaspatana* (L.) Poir.	Herb	M			
Balsaminaceae	13	*Hydrocera triflora* (L.) Wight & Arn.	Herb	I			
Convolvulaceae	14	*Ipomoea* sp.1	Herb	M			
Droseraceae	15	*Drosera burmannii* Vahl	Herb	M			
Euphorbiaceae	16	*Hymenocardia wallichii* Tul.	Shrub	M	+		+
Haloragaceae	17	*Myriophyllum tetandrum* Roxb.	Herb	S			
	18	*Myriophyllum tuberculatum* Roxb.	Herb	S			
Lentibulariaceae	19	*Utricularia aurea* Lour.	Herb	S		+	
	20	*Utricularia bifida* L.	Herb	M			
	21	*Utricularia minutissima* Vahl	Herb	M			
Lythraceae	22	*Rotala rotundifolia* (F.Hamilton ex Roxb.) Koehne	Herb	M			
Melastomataceae	23	*Melastoma malabathricum* L. subsp. *malabathricum*	Shrub	M, I	+		
Menyanthaceae	24	*Nymphoides indica* (L.) Kuntze	Herb	E		+	
Nepenthaceae	25	*Nepenthes mirabilis* (Lour.) Druce	Shrub	M, I	+		
Nymphaeaceae	26	*Nelumbo nucifera* Gaertn.	Herb	E	+		+
	27	*Nymphaea lotus* L.	Herb	E	+		
Onagraceae	28	*Ludwigia adscendens* (L.) H.Hara	Herb	F		+	
	29	*Ludwigia linifolia* (Vahl) Rolla Rao	Herb	M			
	30	*Ludwigia octovalvis* (Jacquin) Raven	Herb	M			
Polygonaceae	31	*Polygonum tomentosum* Schrank	Herb	M			
Rubiaceae	32	*Hedyotis diffusa* Willd.	Herb	M			
	33	*Kailasenia lineata* (Craib) Tirveng.	Shrub	M			
	34	*Neonauclea calycina* (Bratt. ex DC.) Merr.	Shrub	Fi			
Scrophulariaceae	35	*Limnophila indica* (L.) Druce	Herb	S			
	36	*Limnophila* sp.1	Herb	M, I			
	37	*Limnophila* sp.2	Herb	M, I			
	38	*Lindernia crustacea* (L.) F.Muell. var. *Crustacea*	Herb	M			
Trapaceae	39	*Trapa quadrispinosa* Roxb.	Herb	E			
Xanthophyllaceae	40	*Xanthophyllum lanceatum* (Miq.) J.J.Sm.	Tree	M	+		+
Monocotyledon							
Alismataceae	41	*Caldesia* sp.1	Herb	M	+		
	42	*Sagittalia guayanensis* Humb.	Herb	E	+		

Araceae	43	*Colocasia esculenta* (L.) Schott var. *aquatilis* Hassk.	Herb	M, I	+		
	44	*Lasia spinosa* (L.) Thwaites	Herb	M, I	+		
Butamaceae	45	*Limnocharis flava* (L.) Buchenau	Herb	M	+		
	46	*Tenagocharis latifolia* (D.Don) Buchenau	Herb	M	+		
Commelinaceae	47	*Floscopa scandens* Lour.	Herb	M			
Cyperaceae	48	*Actinoscirpus grossus* (L.f.) Goetgh. & D.A.Simpson	Herb	E			+
	49	*Cyperus brevifolius* (Rottb.) Hassk.	Herb	M			
	50	*Cyperus cephalotes* Vahl	Herb	I			
	51	*Cyperus platystylis* R.Br.	Herb	I			
	52	*Cyperus rotundus* L.	Herb	M			
	53	*Eleocharis dulcis* (Burm.f.) Hensch. var. *dulcis*	Herb	E		+	
	54	*Fimbristylis miliacea* (L.) Vahl	Herb	M			
	55	*Fuirena ciliaris* (L.) Roxb.	Herb	M			
	56	*Fuirena umbellata* Rottb.	Herb	I			
	57	*Lepironia articulata* (Retz.) Domin	Herb	I			+
	58	*Scleria sumatrensis* Retz.	Herb	M,I			
Eriocaulaceae	59	*Eriocaulon cinereum* R.Br.	Herb	M			
Hydrocharitaceae	60	*Blyxa echinosperma* (C.B.Clarke) Hook.f.	Herb	S			
	61	*Blyxa japonica* Maxim. ex Asch. & G?erke	Herb	S	+		
	62	*Hydrilla verticillata* (L.f.) Royle	Herb	S		+	
	63	*Vallisneria spiralis* L.	Herb	S		+	
Najadaceae	64	*Najas graminea* Delile	Herb	S		+	
	65	*Najas* sp.1	Herb	S		+	
Poaceae	66	*Brachiaria mutica* (Forssk.) Stapf	Herb	M		+	
	67	*Hygroryza aristata* (Retz.) Nees ex Wright et Arnott	Herb	F		+	
	68	*Hymenachne pseudointerrupta* C. Mueller	Herb	M			
	69	*Imperata cylindrica* (L.) P.Beauv.	Herb	I			
	70	*Ischaemum rugosum* Salisb.	Herb	M, I			
	71	*Leersia hexandra* Sw.	Herb	M			
	72	*Panicum repens* L.	Herb	M			
Pontederiaceae	73	*Eichhornia crassipes* (C.Mart.) Solms	Herb	F			
	74	*Monochoria hastata* (L.) Solms	Herb	F			
Xyridaceae	75	*Xyris indica* L.	Herb	M			

The species diversity index (H value of Shannon-Weaver) of the reservoir was 3.24 during all three seasons. It was found that H value during the rainy season (3.25) was higher than those of winter (3.11) and summer (3.03) though the number of species in the winter was greaten in the rainy season, since H value depended on distribution and biomass (Shannon and Weaver, 1949). Those were high in the rainy season.

With both species composition and species diversity index, they showed that Bung Khong Long reservoir had a high diversity of aquatic plants when compared with other wetlands in Thailand such as Bung Borapet, the greatest lake of the northern region which had 88 species reported by Nanakorn *et* al. (2002) and ONEP (2003); Thale Noi, an important wetland in the southern region which had 56 species reported by OEPP (1999); and Nong Han, the greatest lake of the northeastern region which had 44 species reported by Duangsawasdi *et* al. (1992).

Species distribution

The aquatic plants were clump distributed. The emerged species such as *Actonoscirpus grossus* and *Eleocharis dulcis* var. *dulcis* grew more or less evenly at the shallow area whereas the submerged species such as *Utricularia area*, *Hydrilla verticillata*, and *Najas graminea* grew densely below the surface of water in the northern part to the central part of the reservoir. In the northern part of the reservoir, water surface was densely covered by floating islets which were grassmats mixed with rushes, herbs and shrubs such as *Nepenthes mirabilis*, *Lasia spinosa*, *Stenoclena palustris*, *Scleria sumatrensis* and *Melastoma malabathricum* subsp. *malabathricum*. In addition, free floating species such as *Hygroryza aristata* and emerged species such as *Trapa quadrispinosa* were found here. The islets and the free floating species could be moved by the wind. In the central part, emerged species such as *Nelumbo nucifera* and *Nymphaea lotus* grew and mixed with the submerged species such as *U. aurea*, *H. verticillata* and *N. graminea*. The islets were sparsely found there and they were smaller than in the northern part. The deepest point of water level in the northern and the central part was less than 3m deep so the emerged plants and the free floating plants were abundant. This was because emerged plants commonly grow at shallow water (Moss, 1980) whereas free floating plants could be moved by the wind (Junk, 1973). They were protected by many islets in the northern part. In contrast, the southern part was open water and deeper up to 6m deep when flooded. Here, the dominant species were submerged species such as *Najas* sp.1 and *Chara* sp.1, which were densely distributed just below the water surface and could still grow at the deepest area throughout every season. Charophytes are usually considered as pioneer species, occurring in disturbed habitats (Bornette and Arens, 2002). In addition, the emerged plants, the free floating plants and the islets were rarely found here. The horizontal distribution diagram of aquatic plants in the reservoir is shown in Figure 1.

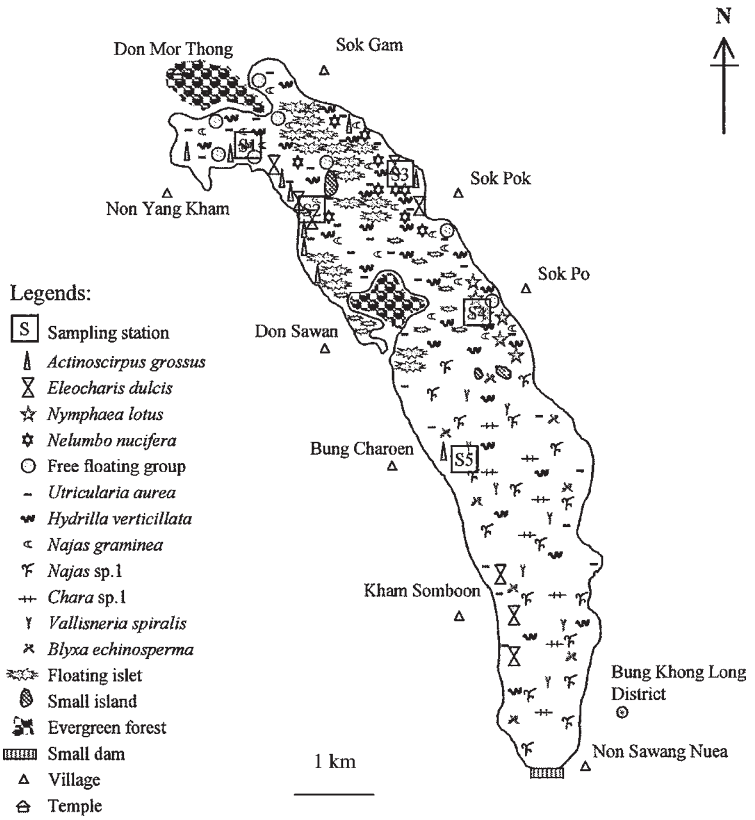

Figure 1 Horizontal distribution diagrams of aquatic plant in Bung Khong Long reservoir.

Considering the zonation of aquatic plants in the reservoir, the emerged group such as *A.grossus* and *E. dulcis* grew at the shallow water near the edges whereas some species such as *N. nucifera* and *N. lotus* grew at deeper zone up to 2m deep. The submerged group such as *U. aurea*, *Blyxa echinosperma*, *Vallisneria spiralis*, *H.verticillata* and *N. graminea* grew below the water surface from shallow water to about 2.5m deep and were rarely found in deeper water. Whereas *Najas* sp.1 and *Chara* sp.1 could grow from 2m deep to a depth of up to 4-5m (Figure 2). When focusing on the distribution value of aquatic plants, the dominant species were *U. aurea*, *H. verticillata* and *N. graminea* with 88.89, 73.33 and 40.00% frequency value (F), respectively (Figure 3). They also dominated in every season because they were widely distributed in variable water depth.

Quantitative characteristics

The biomass of aquatic plants in the reservoir averaged 296.50 g/m^2 with the highest in the rainy season (377.40 g/m^2), and lower in winter (266.66 g/m^2) and summer (245.85 g/m^2) (Figure 4). Station S3 at the northeastern part had the highest biomass (323.51 g/m^2), which was higher than station S4 (318.44 g/m^2), S1 (313.21 g/m^2), S2 (302.93 g/m^2) and S5 (224.44 g/m^2). This was because stations S3 and S4 were the habitats of *Nelumbo nucifera* and *Nymphaea lotus*, respectively and their conversion values were high (c=0.200 and c=0.052, respectively), whereas station S5 was the habitat of *Najas* sp.1 whose conversion value was low (c=0.027) and other species were rarely found at this station. The species with high a biomass value were *Utricularia aurea* (81.26 g/m^2), *Eleocharis dulcis* (43.57 g/m^2) and *Hydrilla verticillata* (43.13 g/m^2), respectively (Figure 5). The biomass of *U. aurea* was also at the highest in every season, because *U. aurea* grew profusely in every season and distributed from shallow water through deeper zone up to 2-3m deep, whereas *H. verticillata* only grew in deeper zone. *E. dulcis* was found in some plots but its conversion value was high (c=0.076) resulting in a high biomass value. Emerged aquatic plant community is clearly among the most productive, per unit area, of all types (Moss, 1980). Considering the three groups of aquatic plants excluding the marginal and on islets group, the submerged group had the highest biomass value (159.13 g/m^2) which was higher than the emerged group (115.14 g/m^2) and the free floating group (22.33 g/m^2) (Figure 6). All three groups of aquatic plant had higher biomass values in the rainy season

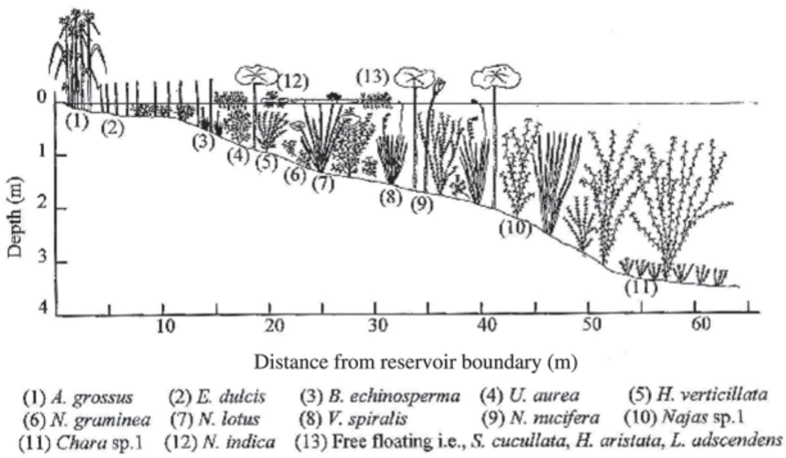

Figure 2 Profile diagrams of aquatic plant distribution in Bung Khong Long reservoir.

than the winter and the summer seasons, respectively. Most of aquatic plants grew profusely and distributed in the rainy season especially submerged group, free floating group and some species of emerged group, i.e. *N. lotus*, *N. nucifera* and *T. quadrispinosa*, because rainfall and depth of water affected the biomass of aquatic plants (Moss, 1980). The abundance and composition of the rooted aquatic plants (emerged and submerged group) had a great effect on lake ecosystem, particularly shallow lakes (Carpenter and Lodge, 1986). The emerged group and the marginal group such as *A. grossus* and *Caldesia* sp.1. grew profusely in summer Seedlings of *Caldesia* sp.1

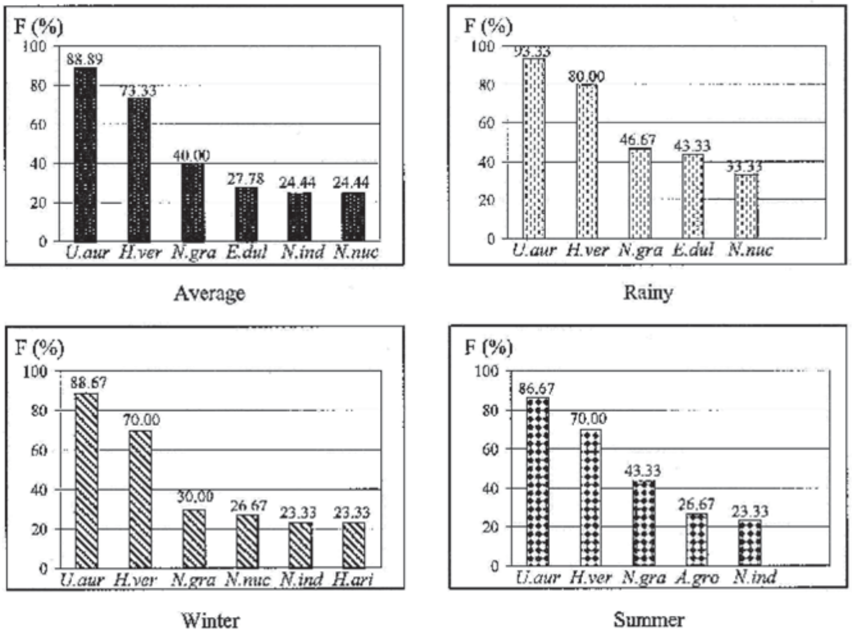

Figure 3 Frequencies of the dominant species in Bung Khong Long during the three seasons (*U.aur* = *Utricularia aurea*, *H.ver* = *Hydrilla verticillata*, *N.gra* = *Najas graminea* , *E.dul* = *Eleocharis dulcis*, *N.ind* = *Nymphoides indica*, *N.nuc* = *Nelumbo nucifera*, *H.ari* = *Hygroryza aristata*, *A.gro* = *Actinoscirpus grossus*).

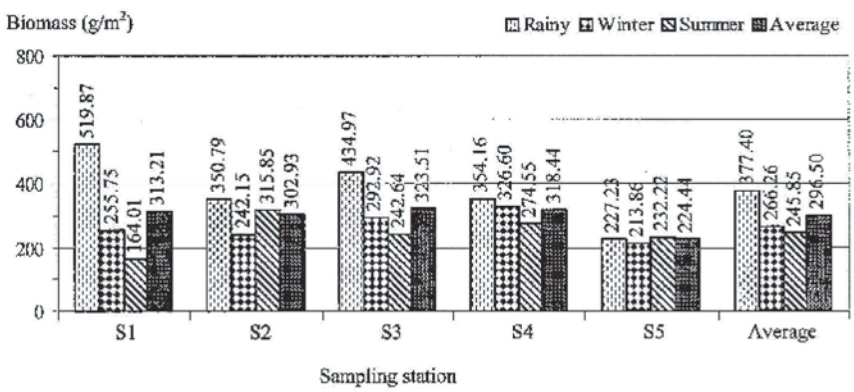

Figure 4 Biomasses of aquatic plant in each sampling station during the three seasons.

grew at the margin and shallow water in the northern part but were rarely found in the rainy season. whereas some species were only found on islets such as *N. mirabilis*, *Neonauclea calycina* and *Limnophila* sp.1 and sp.2.

In addition, it was also observed that leaves of *N. nucifera* were consumed by the caterpillars in the winter season. However many of the waterbirds species including the emigrated birds were found in this season and they consumed the caterpillars. ONEP (2004) reported that Bung Khong Long was a habitat of up to 33 visiting bird species during winter. In northern part, the aquatic plant community was changed by local people

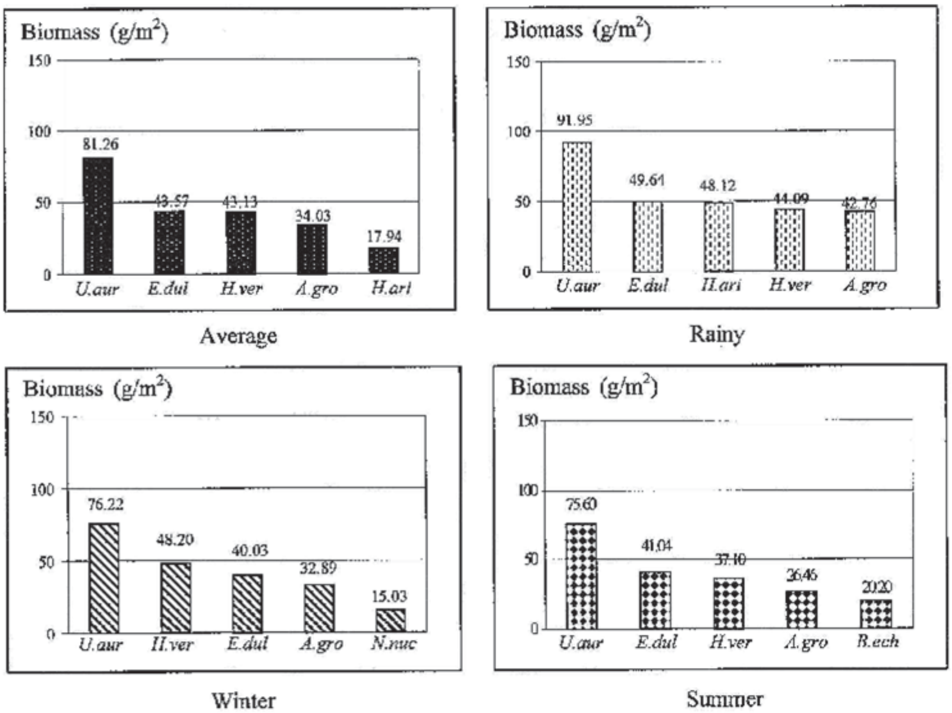

Figure 5 Biomasses of the dominant species in Bung Khong Long during the three seasons (*U.aur* = *Utricularia aurea*, *E.dul* = *Eleocharis dulcis*, *H.ver* = *Hydrilla verticillata*, *A.gro* = *Actinoscirpus grossus*, *H.ari* = *Hygroryza aristata*, *N.nuc* = *Nelumbo nucifera*, *B.ech* = *Blyxa echinosperma*).

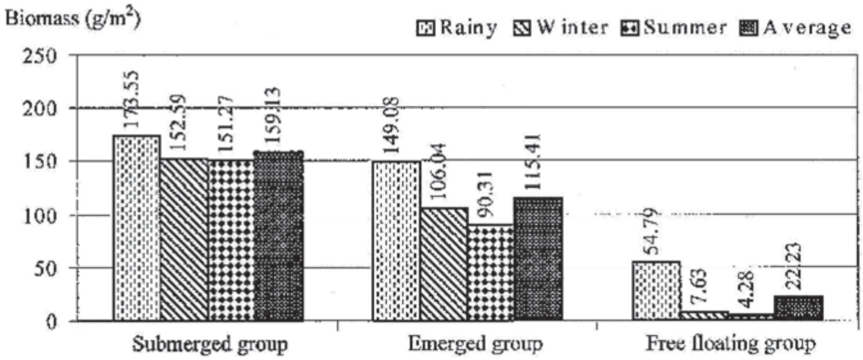

Figure 6 Biomasses of aquatic plant group during the three seasons.

since they used the area for pastoral and fishery, which affected waterfowls nested on islets and emigrated birds. At least 29 waterfowls, 27 shore birds, 3 residents and 26 migrant non-breeders were reported which consisted of globally threatened, endangered and vulnerable species (OEPP, 2002).

According to the Important Value Index (IVI), the dominant species were *U. aurea* (IVI=84.66), *H. verticillata* (IVI=54.30) and *E. dulcis* (IVI=31.09) (Table 2). *U. aurea* was more dominant in every season in all three aspects homely Frequency of distribution, Dominance (fresh weight) and Biomass (dry weight) so this species could greaten affect the ecosystem of this reservoir than the other species. However, many aquatic plant species were important for this reservoir, not only *U. aurea*, with the highest IVI value as 300 (Mueller-Dombois, 1974).

Use of aquatic plants for local people

The local people who live around the reservoir were interviewed and it was found that at least 34 aquatic plant species were harvested by the local people for use as food (17 species), fodder (10 species) and the other purposes (7 species) (Table 1). Some species were harvested as edible and medicinal plants such as *Centella asiatica*, *N. nucifera*, *M. marabathricum* and *Xanthophyllum lanceatum* whereas some species such as *Lepironia articulata*, *A. grossus*, *S. palustris* and *Lygodium microphyllum* were harvested as materials for making handicrafts for household use or for selling.

CONCLUSION

Bung Khong Long was an important area and had a high diversity of aquatic plants, most of which grew profusely in the rainy season especially the submerged and free floating groups, whereas emerged group and marginal group grew profusely in summer. The greatest dominant species was *Utricularia aurea* which dominated in both

Table 2 Importance Value Indice (IVI) of aquatic plant in Bung Khong Long reservoir (F = frequency; D = density, fresh weight; B = biomass, dry weight; RF = relative frequency; RD = relative density; RB = relative biomass, IVI=RF+RD+RB)

	Species	F (%)	D (g/m^2)	B (g/m^2)	RF (%)	RD (%)	RB (%)	IVI
1	*Utricularia aurea*	88.89	2114.78	81.26	21.11	36.15	27.40	84.66
2	*Hydrilla verticillata*	73.33	1307.00	43.13	17.41	22.34	14.55	54.30
3	*Eleocharis dulcis* var. *dulcis*	27.78	573.33	43.57	6.60	9.80	14.69	31.09
4	*Actinoscirpus grossus*	21.11	238.00	34.03	5.01	4.07	11.48	20.56
5	*Nelumbo nucifera*	24.44	340.22	17.69	5.80	5.82	5.97	17.59
6	*Najas graminea*	40.00	269.44	9.43	9.50	4.61	3.18	17.29
7	*Hygroryza aristata*	21.11	139.22	17.94	5.01	2.38	6.05	13.44
8	*Najas* sp.1	14.44	295.11	7.93	3.43	5.04	2.68	11.15
9	*Nymphoides indica*	24.44	110.56	8.29	5.80	1.89	2.80	10.49
10	*Blyxa echinosperma*	8.89	173.33	10.40	2.11	2.96	3.51	5.58
11	Other species	76.67	288.66	22.83	18.21	4.94	7.70	30.84
	Total	421.11	5,849.67	296.50	100.00	100.00	100.00	300.00

distribution and biomass aspects during all three seasons. Communities of aquatic plant were quite different in each part of the reservoir according to the depth of water. The northern part had many islets moved by the wind and were the habitats of waterfowl. In addition, many aquatic plant species were harvested by local people for used as food, fodder and other purposes. However, if the aquatic plant communities were changed because of overuse, it might affect the wetland ecosystem. Therefore, the data of this study could be used as the fundamental data for sustainable management planning of this wetland in the future.

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