



Diversity and distribution of aquatic vascular macrophytes in lake Buluan, Philippines

Greta M. Noquilla*, Jonald C. Bornales, Naima G. Pendi, Ryan V. Fabay, Charess L. Gani

College of Fisheries, Mindanao State University, Maguindanao, Philippines 9601.

Abstract: This study aimed to determine the species composition and distribution of aquatic vascular macrophytes in Lake Buluan in Maguindanao and Sultan Kudarat, Philippines. A total of ten (10) macrophytic species in 16 sampling sites were studied. In our observation, a non-native invasive species *Eichhornia crassipes* found to be dominant with a frequency of 81% occupying 496 hectares. The species diversity is found to be uneven and absence of submerged aquatic vegetation induces stress and disturbance in the lake ecosystem. Photographs of identified vascular macrophytes, study sites, Distribution map were provided. We recommend substantial measures have to be implemented to protect Buluan lake ecosystem against eutrophication and invasion.

Keywords: Lake Buluan; Aquatic vascular macrophytes; *Eichhornia crassipes*.

Introduction

Aquatic vascular macrophytes are crucial component and function of aquatic biome which represents the major structural part of littoral habitats, acting as shelter, nesting, and feeding grounds for a wide variety of microorganisms, fish and waterfowl (Hudon *et al.*, 2000). These plant species occupy different ecological niche in the aquatic environment and colonize many different types of aquatic ecosystem such as the lakes, reservoirs, wetlands, streams, rivers, marine environment and even rapids and falls (Wetzel, 2001). The nature of these plant communities has been shown to affect light, temperature, turbulence, water and sediment chemistry, and the abundance and composition of other biotic assemblages from epiphytes to phytoplankton (Johnson and Ostrofsky, 2004; Patel, 2012).

Invasion of aquatic macrophytes in the lake ecosystem poses a threat not only to the biodiversity of aquatic organisms but also to the lake fishery itself (You *et al.*, 2014). In Philippines, proliferation of aquatic macrophytes especially the exotic ones have been a problem

for many years. In fact, as early as 1970's, report on *Eichhornia crassipes* (water hyacinth) being a troublesome pest impeding navigation and water-ways in the country's major rivers has been documented (Gangstad *et al.*, 1976; Patel, 2012). However, there are only scant attention on floristic inventories and distribution of aquatic vascular macrophytes in the country and most of those studies were focused in Laguna Lake (Vicencio and Buot 2017) and other parts of Luzon (Napaldet and Buot, 2019). There are also no published studies on aquatic vascular macrophytes present for lake Buluan which is among the major but the least studied lakes in Phillipines.

Due to the paucity in field exploration of aquatic vegetation and eutrophic systems in Phillipines, we have undertaken this research which aimed to identify vascular macrophytic species and to determine the composition, abundance as well as its impact along with mapping of the habitats in Lake Buluan in Sultan Kudarat and Maguindanao, Philippines.

*Corresponding Author:

Greta M. Noquilla,

E-mail: greta.noquilla@yahoo.com

Materials and Methods

The Study area Lake Buluan (6°39'N, 124°50'E) lies between the boundary of Municipality of Maguindanao and Mangudadatu, Sultan Kudarat in South Central Mindanao, Southern part of the Philippines. It has an estimated area of 61.34 km² making it the third largest lake in Mindanao and the sixth biggest lake in the Philippines (Baluyot, 1987). Lake Buluan is a

shallow lake with an average depth of 3.5m and a maximum depth of 5.5m near the center (Yap *et al.*, 1983). The lake has a loamy muddy bottom and a mildly sloppy banks which is covered by aquatic vegetation. Field explorations at the selected sites were done along with the collection of the macrophyte specimens for identification.

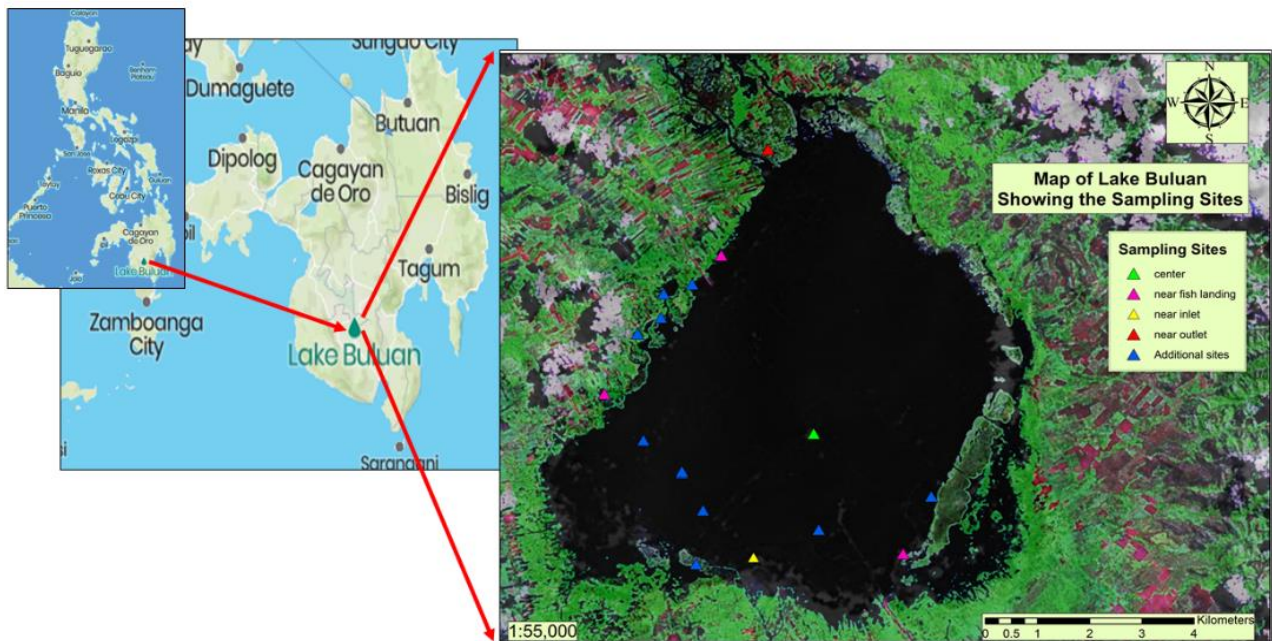


Figure 1. Map of Lake Buluan showing the locations of the different sampling sites.

Sampling method and data collection

Sixteen sampling sites were selected around the lake except in some areas in the Northeastern portion where boat passage is quite difficult due to the agglomerations of commercial fish pens as well as due to the unstable peace and order situation of the area during the time of sampling. One sampling site was located in the middle, one near the inlet, one in the outlet river and the rest were located along the littoral zone (Figure 1). Point-intercept sampling was done on board the boat following the guidelines described in Aquatic Plant Sampling Protocols (Parsons, 2001). Samples of aquatic macrophytes that are emergent, free-floating, and rooted with floating leaves were manually coll-

ected while the submerged macrophytes at the bottom was sampled with a grapnel. Collected specimens were identified perusing standard literature (Pacho and Gruezo 2006; Co's Digital Flora, Plants of the World Online) and voucher specimens were prepared. Frequency of occurrence of each plant species per site was then recorded. In order to map the coverage and distribution of macrophytes, GIS data taken at the furthest two end points of each significant phytocenosis and mapping was done from the beginning of the Phytolittoral zone to the maximum depth of plant colonization. The shape of plant beds was drawn in a scaled map on board the boat and its width were estimated. Digital map was done using ArcGIS 10.2.2.

Results and Discussion

A total of ten (10) species of aquatic macrophytes were found in Lake Buluan in which two were free-floating, two were rooted with float-ing leaves, and six were emergent (Table 1, Fig. 4). There were no submerged vegetation found in all 16 sampling sites which maybe attributed to the high abundance of floating and emergent plants forming extensive mats blocking the sunlight and impeding the growth of submerged plants and also with the high turbidity of the lake (minimum $SD_v = 30\text{cm}$).

The most dominant aquatic vegetation found in the lake was *Eichhornia crassipes* (Fig. 2), which was present in 13 out of 16 surveyed sites with a frequency of 81% (Fig. 2 & 3) and an estimated total bed area of 496 hectares (Table 1). The non-native invasive species *E.crasipes* formed extensive mats especially in the shore-line areas fringing the lake and is reported as a potential nuisance for navigation as some areas has become impassable due to its dense growth and causing habitat heterogeneity (Fig. 3).

Table 1. List of species of aquatic macrophytes in Lake Buluan with its estimated bed area.

Species	Common Name	Local Name	Estimated Bed Area (ha)
Floating			
<i>Eichhornia crassipes</i> (Mart.) Solms	Water hyacinth	Pusaw	496
<i>Pistia stratiotes</i> L.	Water lettuce	-	<1
Rooted with Floating Leaves			
<i>Nelumbo nucifera</i> Gaertn.	Sacred lotus	Sawa	7.2
<i>Nymphaea</i> sp.	Red lotus	Paguse	<1
Emergent			
<i>Brachiaria mutica</i> (Forssk.) Stapf.	Para grass	Barit	169
<i>Phragmites australis</i> (Cav.) Trin. ex Steud	Common reed	Tabing	102
<i>Sesbania sesban</i> (L.) Merr.	Sesban	-	72.7
<i>Polygonium barbatum</i> L.	Smart weed	Panusulen	5
<i>Ipomea aquatica</i> Forsk.	Water spinach	Kangkong	<1
<i>Scirpus grossus</i> L.	Reed	-	<1
			852

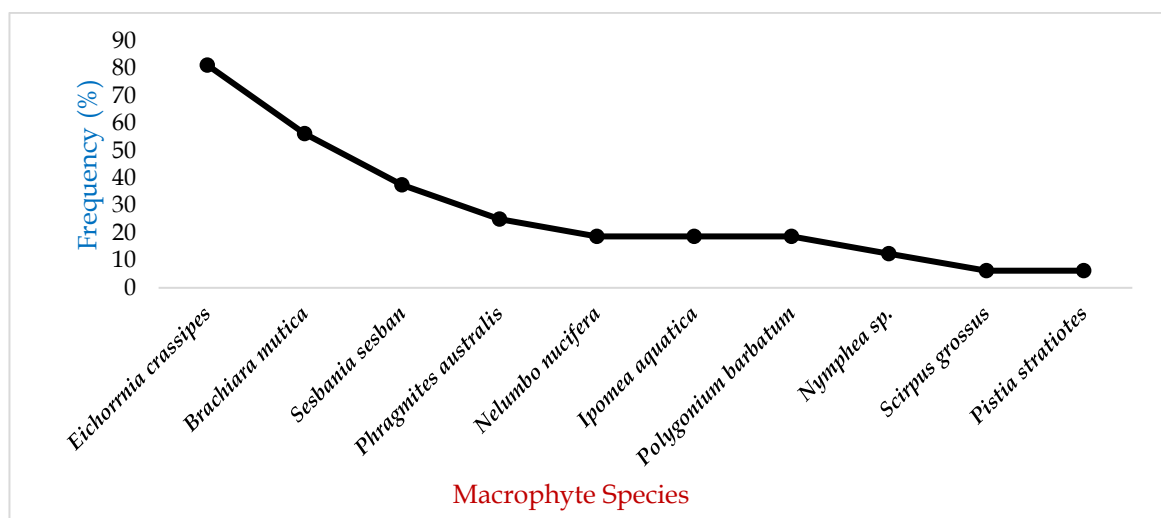


Figure 2. Frequency of occurrence of macrophyte taxa found in the lake (number of sites=16).

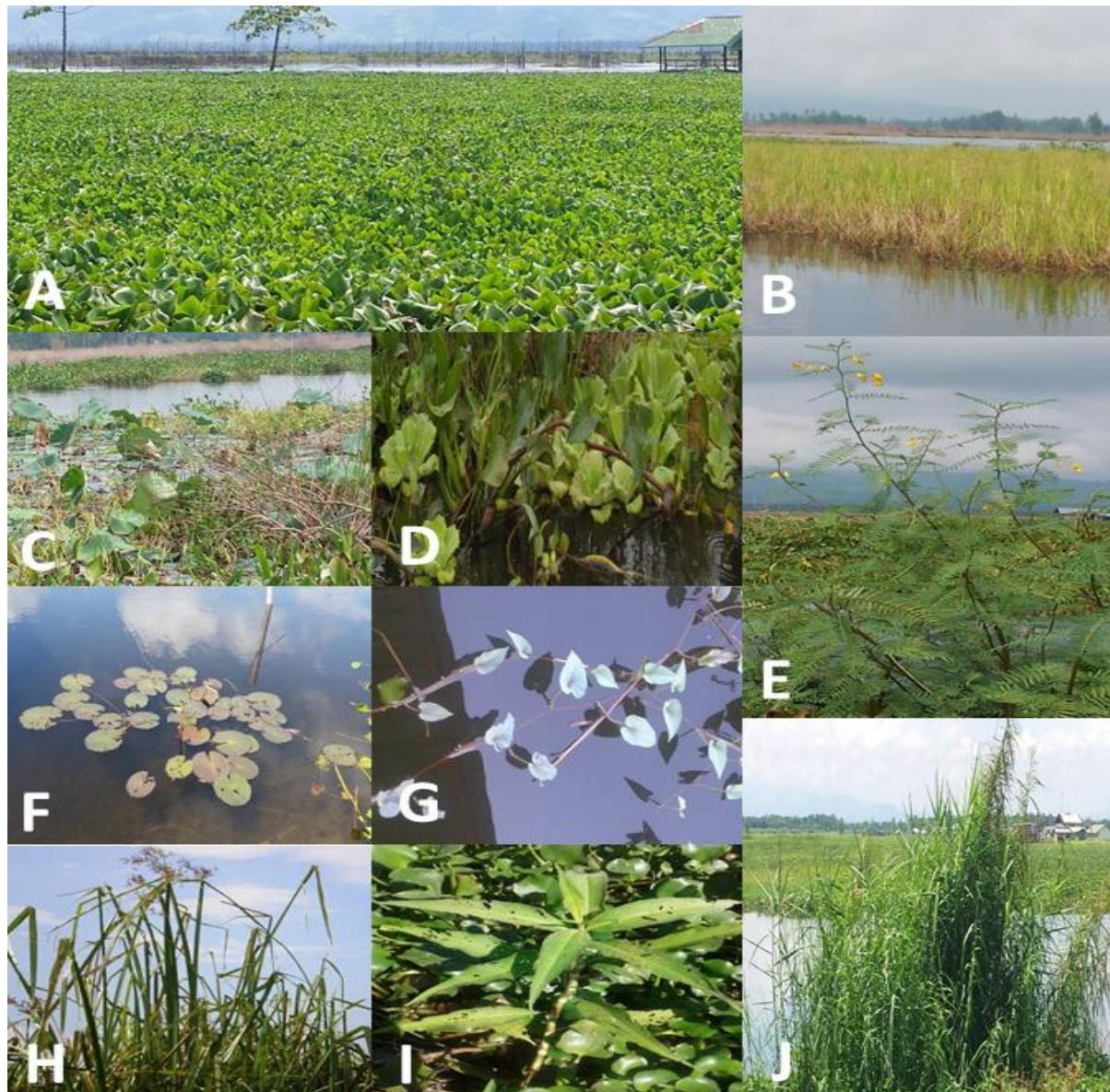


Figure 3. Aquatic macrophytes found in Lake Buluan: **A-** *Eichhornia crassipes*, **B-** *Brachiara mutica*, **C-** *Nelumbo nucifera*, **D-** *Pistia stratiotes*, **E-** *Sesbania sesban*, **F-** *Nymphaea sp.*, **G-** *Ipomea aquatica*, **H-** *Scirpus grossus*, **I-** *Polygonium barbatum*, **J-** *Phragmites australis*.

In our field studies, a dense agglomerations of *E. crassipes* has been observed in shoreline areas with high human influence like in the fishlanding sites of Maslabeng, Lutayan and Mangu-dadatu which attributed to eutrophication. The proliferation of this species has also been thought to be the reason of the decline of some macrophyte species like the edible *Nelumbo nucifera*, which was once abundant in Lake Buluan. The second dominant vegetation in Lake Buluan is *Brachiara mutica* with an estima-

ted total bed area of 169 ha and a frequency of 56%. This species is mostly located in the Western to South Western portion of the Lake (Fig. 4). *Phragmites australis* (102 ha) and *Sesbania sesban* (72.7 ha) were also observed in the Western side of the lake. Other macrophytes *Nymphaea sp.*, *Pistia stratiotes*, *Scirpus grossus* and *Ipomea aquatica* forming small patches (<1ha). The diversity of the studied macrophytes are uneven. The biotic drivers of this invasive species has to be studied.

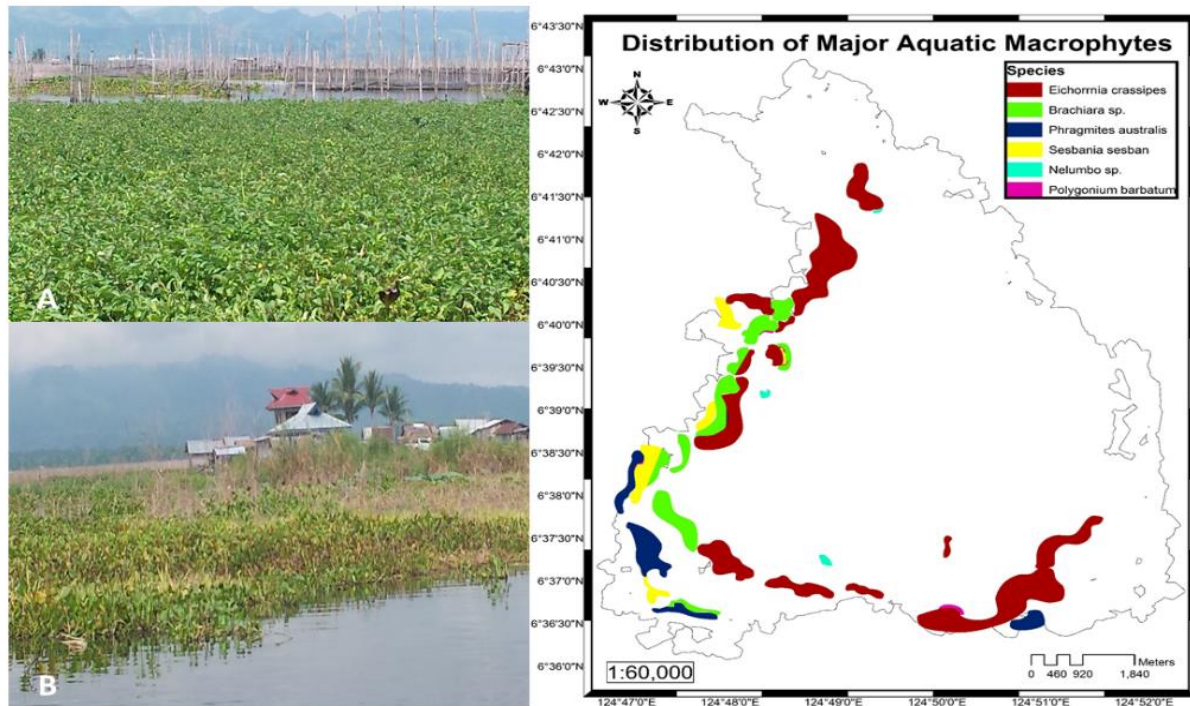


Figure 4. A,B, C : Coverage and distribution of aquatic vascular macrophytes in Lake Buluan.

The distribution and estimated area of studied vascular macrophytes were mapped in Fig. 4 which reveals coverage, distribution and colonization in the study area. The findings of this present exploration reveals that a major portion of the lake area is covered with aquatic macrophytes, of which a great percentage is found in the littoral zone especially near human settlements which showed to have dense to very dense macrophytes cover. Several small patches are found in the middle of the lake and some fringes fish pens and cages. The shallow depth, warm temperature and the high nutrient loading of the lake are considered to be the reason for the proliferation of these aquatic macrophytes especially *E. crassipes*.

This study revealed low species diversity and absence of submerged aquatic vegetation which indicates stress and disturbance in the lake ecosystem which poses negative impact on the lake fisheries. Furthermore, this paper often suggests that many aquatic habitats needed to be monitored and yet to be explored on various

grounds for ecological conservation and implementation of habitat conservation with management plans and Policies.

Conclusion

This field investigation provides an overview of the aquatic macrophyte diversity, distribution and colonization in Lake Buluan in Philippines. This baseline information is designed as a sample unit for understanding the aquatic vegetation growth patterns in aquatic ecosystem and identifies the consequences in increasing eutrophication.

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