# Seasonal variations in macrophytic biomass in a shallow pond at Biratnagar, Nepal

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**Abstract**

Macrophytic biomass in a shallow pond ranged between 82.8 - 1134.6 g/m$^2$; 16.0 - 75.7 g/m$^2$; 170.6 - 1600.1 g/m$^2$ for emergent, submerged and free floating community, respectively. Maximum total community biomass (2725.2 g/m$^2$) was recorded in August with major contribution of water hyacinth. During rainy season, total phosphate ($PO_4$-P) - 0.17 mg/l; nitrate ($NO_3$-N) - 0.7 mg/l; nitrite ($NO_2$-N) - 0.02 mg/l and ammonia ($NH_3$-N) - 5.2 mg/l; were maximum, whereas, pH (6.3), dissolved oxygen (6.3 mg/l) and conductivity (184 µs/cm); were minimum in water samples.

***Key words***: Macrophytes, community biomass, emergent, water quality.

## Introduction

Macrophytic communities influence the structural and functional characteristics of aquatic ecosystems (Canfield *et al.,* 1984). Aquatic habitats select the assemblage of plants, best adapted to the existing conditions (Mitsch *et al.*, 1998). They dynamically guide the cycle of minerals and other organic compounds, thereby influencing overall biomass production of water bodies. Aquatic species occurring therein act as bio-energy sources and agents of pollution abatements (Brooks, 1989; Oliver & Hill, 1998). Water bodies receive directly or indirectly sewage, domestic wastes, industrial effluents and agricultural run-off from the surrounding areas. Accumulation of nutrients in aquatic ecosystems leads to massive growth of macrophytes. Their control is possible through biomass utilization (Majid, 1998-99). Macrophytic biomass can be used for production of biogas, paper, fiber boards, fertilizer and fish feed. Water bodies must be assessed in terms of species composition, biomass production and water quality.

Aquatic macrophytes have been quantitatively studied in Nepal by Shrestha (2000), Burlakoti and Karmacharya (2004), Niroula and Singh (2011, 2012), and Upadhyay *et al.* (2011). Reddy and Sutton (1984), Sharma (1995), Khan and Shah (2010) and Jaiswal (2011) studied biomass production and water quality improvement through macrophytes in India. Present study deals with macrophytic biomass and physico-chemical properties of water of a shallow pond at Biratnagar, Nepal.

## Materials and Methods

The selected pond (1.5 ha) is surrounded by cultivated land. It has seasonal variation in water depth between 0.3-1.3 m. Biratnagar (lat N 26°20', long E 87°16'; and altitude 72 m msl) has alluvial soil and tropical monsoon climate with three distinct seasons *viz*., winter (Nov-Feb.), summer (March-June) and rainy (July-October) in a year. The average annual rainfall is 1312 mm, average annual minimum and maximum temperatures 14.2 and 30.6°C, respectively.

Samplings of aquatic macrophytes were done by harvest method using a quadrat of 50 cm× 50 cm size in adequate numbers at monthly intervals from January to December, 2009. Collected samples were washed, brought to the laboratory and after proper sorting and processing samples were oven dried to constant weight at 80$^oC$. Methods of Zobel *et al.* (1987) and APHA (1985) were adopted for determining biomass and water quality, respectively.

## Results and Discussion

In total 6 aquatic plants forming three communities; emergents, free floating and submerged were in the pond (Table 1). Physico-chemical properties of the pond water showed seasonal variation (Table 2). During rainy season, total phosphate ($PO_4$-P) - 0.17 mg/l; nitrate ($NO_3$-N) - 0.7 mg/l; nitrite ($NO_2$-N) – 0.02 mg/l and ammonia ($NH_3$-N) - 5.2 mg/l were maximum, whereas, water pH (6.3), dissolved oxygen (6.3 mg/l), and conductivity (184 µs/cm) were minimum. Water pH (10.4) and dissolved oxygen (10.3 mg/l), recorded maximum during winter season. Higher concentrations of ammonia, nitrite, nitrate and total phosphate in the rainy season might be attributed to input from running water, surface run-off and mineralization of organic matter. Maximum electrical conductivity (603 µs/cm) during summer season might be due to the accumulation of chlorides and sulphates of calcium, magnesium, sodium and potassium salts in decreasing water level of the pond (Upadhyay *et al.*, 2012).

**Table 1.** Macrophytic communities of the pond.

| Species/Community | Family | Common name | Local name |
|---|---|---|---|
| **Emergent** | | | |
| *Alternanthera philoxeroides* Griseb | Amaranthaceae | Alligator weed | Jaljamboo |
| *Ipomoea carnea* Jacq. subsp. *fistulosa* (Mart. ex Choicy) D.F. Austin | Convolvulaceae | - | Thetar |
| *Typha angustifolia* L. | Typhaceae | Cat tail | Pater |
| **Free floating** | | | |
| *Eichhornia crassipes* (Mart.) Solms. | Pontederiaceae | Water hyacinth | Jalkumbhi |
| **Summerged** | | | |
| *Chara schweinitzii* A. Braun | Characeae | Muskgrass | Leu |
| *Potamogeton crispus* L. | Potamogetonaceae | Curlyleaf pondweed | Panikhar |

**Table 2.** Seasonal variations in physico-chemical properties of the pond.

| Parameter | Winter | Summer | Rainy |
|---|---|---|---|
| Water depth (cm) | 34-48 | 32-44 | 90-135 |
| Temperature ($^0C$) | 22.7 | 26.4 | 27.3 |
| Transparency (cm) | 14 | 16 | 8 |
| pH | 7.9 | 6.5 | 6.3 |
| Dissolved oxygen (mg/l) | 10.4 | 7.8 | 6.3 |
| Conductivity (µs/cm) | 249 | 603 | 184 |
| Ammonia (($NH_3$-N) mg/l | 3.5 | 3.3 | 5.2 |
| Nitrate (($NO_3$-N) mg/l | 0.49 | 0.08 | 0.7 |
| Nitrite (($NO_2$-N) mg/l | 0.002 | 0.002 | 0.02 |
| Kjeldhal Nitrogen (mg/l) | 2.94 | 3.4 | 4.33 |
| Total Phosphate ($PO_4$-P) mg/l | 0.05 | 0.09 | 0.17 |

Monthly variations in percent contribution by dry biomass of total macrphytic community; emergent, submerged and free floating communities are shown in table 3.

**Table 3.** Monthly variation in dry biomass (g/m$^2$) of aquatic communities in a shallow pond. (mean ± SE), figure in parenthesis represents percent contribution.

| Month | Community biomass | | | |
|---|---|---|---|---|
| | **Emergent** | **Submerged** | **Free floating** | **Total** |
| January | 300. ±7.7 (56) | 16.0 ± 1.7 (3) | 220.0 ±6.6 (41) | 536.0±10.3 |
| February | 82.8 ± 4.1(25.1 | 75.7 ± 3.8 (23) | 170.6 ± 5.8 (51.8) | 329.1±8.1 |
| March | 370.6 ± 8.6 (47.6) | 62.1 ± 3.5 (8) | 346.6 ± 8.3 (44.4) | 779.3±12.4 |
| April | 479.2 ± 9.7 (48) | - | 520.0 ± 10.2 (52) | 999.2±14.1 |
| May | 313± 7.9 (26.8) | - | 856.0± 13.1 (73.2) | 1169.3±15.2 |
| June | 618.5± 11.1 (34.4) | - | 1034.6±14.3(65.3) | 1653.1±18.1 |
| July | 549.2± 10.4 (34.7) | - | 1034.6±14.3(65.3) | 1583.8±17.7 |
| August | 1134.6±15.1(41.6) | - | 1590.6±18.3(58.4) | 2725.2±23.3 |
| September | 914.5± 13.5 (49.5) | - | 932.6± 13.6 (50.5) | 1847.1±19.2 |
| October | 1000.0 ± 14.1 (52) | - | 924.0 ± 13.5 (48) | 1924.0±19.6 |
| November | 526.6± 10.2 (24.8) | - | 1600.1±17.8(75.2) | 2126.7±20.6 |
| December | 98.3 ± 4.4 (13.8) | - | 612.0± 11.1 (86.2) | 710.3±11.9 |

Emergents had maximum and minimum biomass on October (1000.0 g/m$^2$) and February (82.2 g/m$^2$) contributing 52 and 25% of the total community, respectively. Free floating had maximum (1600.1 g/m$^2$) and minimum (170.6 g/m$^2$) during November and February contributing 75.2% to 51.8%, of the total community biomass, respectively. However, percent contribution was maximum (86.2%) in December. The free floating *Eichhornia crassipes* dominated community biomass in all months except January, March and October. Submerged were recorded only during winter and early summer month (March), being maximum during February (75.7 g/m$^2$) and minimum during January (16.0 2g/m$^2$). Upadhyay *et al.* (2012) recorded 452-1238 g/m2 dry biomass in deep water and elongated depressions and 748.2 g/m$^2$ in a public pond surrounded by agricultural land at Biratnagar township. Among the dominant aquatic macrophytes, dry biomass ranged 4.6-202.9 g/m$^2$ and 9.3-1120.5 g/m$^2$ for *Alternanthera philoxeroides* and *Eichhornia crassipes*, respectively in Morang district, eastern Nepal (Niroula & Singh, 2012). Rai and Sharma (1991) reported biomass from a eutrophic pond of Bihar (India), which ranged 812.5-1170 g dry wt. /m$^2$. Maximum total community biomass (2725.2 g/m$^2$) was in August with major contribution of water hyacinth.

Macrophytic community biomass in the shallow pond may be utilized in the nearby agricultural land as compost. Manipulation of biomass for compost and biogas production could be a cheap and viable solution for nutrient cycling between aquatic and terrestrial ecosystems. Water hyacinth is a troublesome invasive alien species with prolific growth rate that absorb nutrients from the water body and becomes source of potash, phosphorus and nitrogen in the agriculture (Gopal, 1987). Chemical composition is correlated with the chemical status of the water and maximum nutrients are absorbed at the time of maximum growth (Denton, 1967).

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