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Biomass and Productivity Studies of Up-Land and Low-Land Vegetation in the Neglected Margin of a Tropical Lake

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***Abstract*—**Present paper deals with an evaluation of magnitude of changes in biomass and net primary productivity at 'Gujar Tal' sloppy lake margin at Jaunpur in tropical semi-arid region of eastern U.P. (India). The study site abandoned or neglected lands (50 ×125 m) was divided into two zones, i.e. upper zone (up-land) and lower zone (low-land). Maximum biomass in the upper zone of dominant weed *Desmostachya bipinnata* (L.) Stapf. was 207.47 g m^{-2} and 'rest weeds' was 457.45 g m^{-2} both in the month of September. In contrast, the peak biomass value in the lower zone of dominant weed *Oryza rufipogon* Griff. was 1571.44 g m^{-2} in October and 'rest weeds' 270.65 g m^{-2} in February. Among the two zones, the peak total community biomass was observed 1655.62 g m^{-2} (October) in the lower zone while its peak value for the upper zone 457.45 g m^{-2} (September) was comparatively low. Maximum percentage contribution of dominant weeds (*D. bipinnata* and *O. rufipogon*) in the respective upper and lower zones and 'rest weeds' in both the zones varied in different months in the total community biomass. The peak net primary productivity of dominant weed (*D. bipinnata*) was 2.09g m^{-2} day^{-1} (September) and 'rest weeds' was 2.37 g m^{-2} day^{-1} (August) in the upper zone, while the lower zone for *O. rufipogon* was 5.25 g m^{-2} day^{-1} (June) as this zone was inundated later and 'rest weeds' was 2.08 g m^{-2} day^{-1} (January, 2009). The annual net production of total community at site I was highest, 409.58 g m^{-2} yr^{-1} in the upper zone followed by 395.58 g m^{-2} per eight month in the lower zone as this zone was flooded with water during rainy season. The site significance of variations in biomass in relation to plant species was tested by analysis of variance. It was significant between months in all the two zones ($p<0.01$ and $p<0.05$).

***Keywords*—**Biomass, Neglected Lake Margin, Productivity, Vegetation.

I. Introduction

LAKE margins are transitional areas between aquatic and terrestrial ecosystems. It is usually referred to marshy or swampy habitats, usually transitional between land and water bodies [1]. They enjoy some of the best ecological conditions found in terrestrial and aquatic habitats and store-house of 'gene pools' and are being converted into weed-bowls [2], [3]. These habitats are characterized by sloppy habitat, i.e. up-land and low-land, face cyclic inundation or submergence during rainy season and some time extreme dry condition in summer.

Most of the ecological studies in Indian lakes are confined to deep water and limnology [4], [5]. Therefore, the present investigation has been carried out to understand the ecological attributes of the biomass accumulation and net primary productivity pattern.

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II. Materials And Methods

A. Study Area and Climate

This study was carried out on the north western part 28km. from Jaunpur city and 1.5km. away in the west of Khetasarai town area, at lake margins of 'Gujar Tal' ($24^0$6'- $25^0$5'N and 80^0-82^0 E longitude) in the tropical semiarid region in the eastern U.P. (India) by selecting a study site (abandoned or neglected lands-80×125 m) at lake margin. It was divided into two ecological zones, i.e. upper (up-land, 8-20^0 slope) and lower (low-land, 5-8^0 slope) zones from top upland to lower region near water margin (May, 2008) (Fig. 1). The climate is typically monsoonic with three different seasons viz. summer, rainy and winter. The total rainfall during study period (April, 2008 to March, 2009) was 1346.8 mm out of which about 1295.4 mm was during rainy season. Therefore, duration of inundation was also noted. The soil of present study site is alkaline (7.3 to 9) in pH.

Fig. 1 A view of upper zone of study site showing dominance of *Desmostachya bipinnata* (L.) Stapf.

B. Biomass and Net Primary Productivity Measurements

Standing dry matter was estimated by "short term harvest method" [6] in which variation was estimated at monthly intervals from April, 2008 to March, 2009. In order to get shoots and roots intact of different species of the community, the core technique [7], [8] was followed. Monoliths in triplicate were excavated on 25×25cm area up to a depth of 30

cm from the two different zones at study site. Monoliths were washed carefully with water in wire cage avoiding root breakage as for as possible. On the basis of IVI [9] *D. bipinnata* was most dominant weed in the upper zone and wild rice *O. rufipogon* in the lower zone and remaining weeds were put together as 'rest weeds' for the purpose of study. The samples were brought to the laboratory and parts of the plants were divided in two distinct components, aboveground (AG) and Underground (UG) parts. Samples were dried at 80^0C for 48 hr in oven and weighed to find out the value of biomass. It has been expressed in g m^{-2}. Analysis of variance applied to the biomass of total community [10] and standard error was also calculated. Productivity different components of the plant and total community have been calculated separately by deducting their respective biomass values of the preceding month [11]. The some positive increase in biomass/net productivity of the community has been taken into consideration for the total annual production [12].

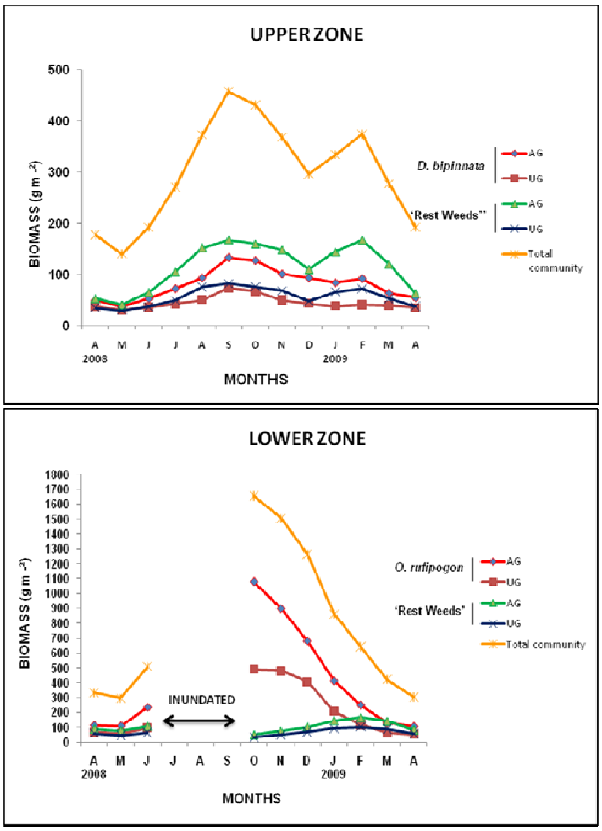

Fig. 2 Monthly variation in standing biomass (g m^{-2}) of different components of dominant weeds *D. bipinnata* (in upper zone), *O. rufipogon* (in lower zone), 'rest weeds' and total community in two different zones at study site
AG=Aboveground, UG=Underground

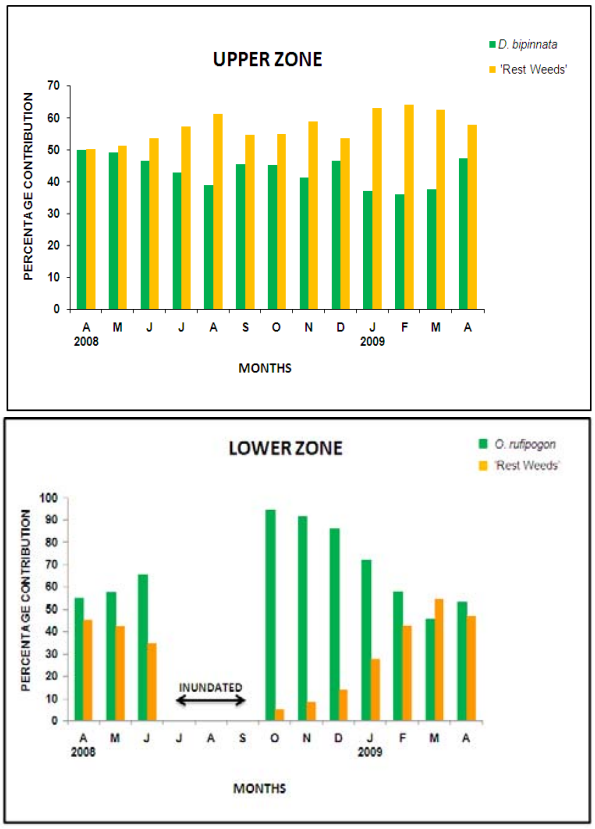

Fig. 3 Monthly variation in percentage contribution of dominant weeds *D. bipinnata* (in upper zone), *O. rufipogon* (in lower zone) and 'rest weeds' in the total community biomass, in two different zones at study site

III. Results and Discussion

The major part of uncared lake margin remains neglected and abandoned. The upper zone was occupied by dominant weed *D. bipinnata* and lower zone by wild growth of dominant weed *O. rufipogon* and remaining weeds in both the zones named as 'rest weeds'. The maximum biomass of dominant weed *(D. bipinnata)* in the upper zone for aboveground and underground parts was 133.12 and 74.35 g m^{-2}, respectively in the month of September. In contrast, the respective peak biomass of dominant plant (*O. rufipogon*)in the lower zone for aboveground and underground parts were comparatively more 1080.34 and 491.10 g m^{-2} in October though this zone was earlier submerged with water but *O. rufipogon* survived. Similarly the respective maximum biomass for 'rest weeds' of aboveground and underground parts was recorded 167.86 and 82.12 g m^{-2} in September in the upper zone and 166.34 and 104.31g m^{-2} in February in the lower zone, as this zone was flooded with water during rainy season. The peak biomass of total community was 457.45 (September) and 1655.62 (February) g m^{-2} in the two respective zones, i.e. upper and lower (Fig. 2). It seems to be *O. rufipogon* well adapted in flooded condition of lower zone. In the present study throughout the year zone wise

visualization of biomass at study site revealed two peaks in upper zone one during rainy season in the month of September, 2008 and other in February, 2009. This kind of trend for peak biomass has also been reported for grassland and neglected wetland communities [13], [14] in Indian climatic condition. In contrast, lower zone has shown decreasing trend (641.48 g m^{-2}) of community biomass in February mainly due to dominant plant *O. rufipogon* (370.83 g m^{-2}) declined sharply due to death through the 'rest weeds' had shown second peak (270.65 g m^{-2}) in the month of February, as this zone was flooded with water during rainy season (Fig. 2).The site significance of variations in biomass in relation to plant species was tested by analysis of variance. The biomass was significant between months in all the two zones ($p<0.01$ and $p<0.05$) but plant species contribution was not significant in both the zones at study site (Table I). Maximum percentage contribution of dominant weed *D. bipinnata* (47.79%) in April, 2008 and 'rest weeds' (64.25%) in Jan., 2009 was in the upper zone whereas in lower zone it was 94.92% for dominant weed *O. rufipogon* in October, and 'rest weeds' 54.49% in February of the total community biomass at study site (Fig. 3).

TABLE I
ANOVA FOR BIOMASS (G M^{-2}) BETWEEN PLANT SPECIES ACROSS THE MONTHS AT STUDY SITE, IN TWO DIFFERENT ZONES

ZONE	SOURCE	S. S.	D.F.	M. S.	F
Upper Zone	Plant Species	243747.15	1	121873.57	1.02 ^{ns}
	Months	5111793.65	7	2555896.83	21.39 **
	Error	313.53	8		
	Total	53558554.33	16		
Lower Zone	Plant Species	93355.28	1	46677.64	1.02 ^{ns}
	Months	447346.69	7	223673.34	4.89 *
	Error	105.75	8		
	Total	540807.72	16		

^{ns} not significant, **significant at $p < 0.01$ & *significant at $p < 0.05$

TABLE II
MONTHLY VARIATION AND NET ANNUAL PRODUCTION IN UPPER ZONE(G M^{-2} YR^{-1}) AND IN LOWER ZONE (G M^{-2} PER EIGHT MONTH) OF DOMINANT WEEDS, 'REST WEEDS' AND TOTAL COMMUNITY AT STUDY SITE IN TWO DIFFERENT ZONES

Zones	Plant Species	Components	Months												Total Annual Production
			May, 2008	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan., 2009	Feb.	Mar.	Apr.	
Upper Zone	*D. bipinnata*	AG	–12.09	15.00	19.53	21.08	39.30	–5.58	–26.40	–7.75	–9.61	8.40	–28.21	–8.70	103.31
		UG	–7.75	5.70	6.51	8.06	23.40	–7.75	–16.20	–6.51	–5.27	2.80	–1.68	–3.90	46.47
		Total	–19.84	20.70	26.04	29.14	62.70	–13.33	–42.60	–14.26	–14.88	11.20	–29.89	–12.60	149.78
	'Rest Weeds'	AG	–12.71	24.00	39.99	46.81	15.30	–7.75	–11.70	–39.68	34.10	23.24	–47.12	–5.67	183.44
		UG	–4.65	7.50	11.78	26.66	6.00	–5.27	–8.40	–20.77	17.98	6.44	–19.22	–15.00	76.36
		Total	–17.36	31.50	51.77	73.47	21.30	–13.02	–20.10	–60.45	52.08	29.68	–66.34	–20.67	259.80
	Total Community		–37.20	52.20	77.81	102.61	84.00	–26.35	–62.70	–74.71	52.08	40.88	–96.23	–33.27	409.58
Lower Zone	*O. rufipogon*	AG	–3.72	120.90	Inundated			*	–182.1	–224.75	–267.22	–162.96	–119.97	–24.60	120.90
		UG	–8.06	36.60	Inundated			*	–11.40	–75.02	–205.53	–87.92	–57.97	–6.90	36.60
		Total	–11.78	157.50	Inundated			*	–193.5	–299.77	–472.75	–250.88	–177.94	–31.50	157.50
	'Rest Weeds'	AG	–10.23	31.50	Inundated			*	26.40	28.83	42.47	19.60	–23.87	–58.80	148.80
		UG	–14.57	18.60	Inundated			*	17.10	19.53	22.01	11.76	–15.81	–29.70	89.00
		Total	–24.80	50.10	Inundated			*	43.50	48.36	64.48	31.64	–39.68	–87.50	238.08
	Total Community		–36.58	207.60	Inundated			*	43.50	48.36	64.48	31.64	–217.62	–119.00	395.58

* Values were not calculated due to lack of previous month's values due to inundation of water.

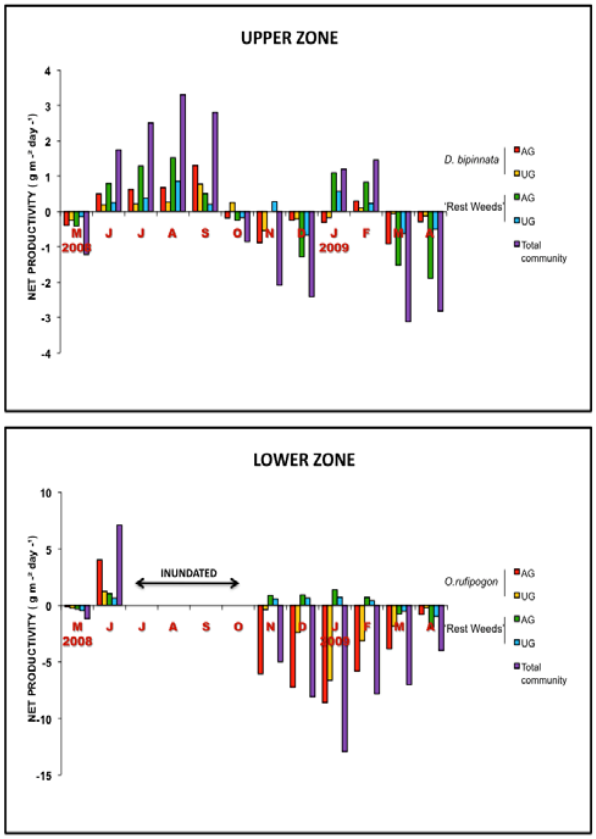

Fig. 4 Monthly variation in net productivity (g m^{-2} day^{-1}) of different components of dominant weeds *D. bipinnata* (in upper zone), *O. rufipogon* (in lower zone), 'rest weeds' and total community in two different zones at study site
AG=Aboveground, UG=Underground

The peak net primary productivity of dominant weed (*D. bipinnata*) for aboveground and underground parts was 1.31 (September) and 0.78 (September) g m^{-2} day^{-1} respectively in the upper zone. In contrast, the peak value in the lower zone of dominant plant (*O. rufipogon*) for aboveground and underground parts was 4.03 and 1.22 g m^{-2} day^{-1}, respectively in the month of June as this zone got submerged later. Similarly, the maximum net primary productivity values of 'rest weeds' for respective aboveground and underground parts were recorded 1.51 and 0.86 g m^{-2} day^{-1} during the month of August in the upper zone, and 1.37 and 0.71 g m^{-2} day^{-1} in the lower zone both in Jan., 2009 (Fig. 4). The productivity value of aboveground parts was always higher in both the zones except during November in the lower zone as this zone was heavily flooded or inundated earlier but dominant weed *O. rufipogon* survived reached their maturity a month earlier in October, as this plant is well adapted to flooded condition of water.

The annual net productivity of total community at site I was highest, i.e. 409.58 g m^{-2} yr^{-1} in the upper zone followed by 395.58 g m^{-2} per eight month in the lower zone as this zone was flooded with water during rainy season (Table II). The annual net production of upper zone of present study site can be compared and observed slightly lower than tropical neglected riparian ecosystem, 476.9 g m^{-2} yr^{-1} [15] but value of lower zone was high on the basis of per eight month.

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