Net primary productivity of macrophyte communities after nine growing seasons in experimental planted and unplanted marshes

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Introduction

Direct measurements of macrophyte net primary productivity (NPP) were first made at the experimental wetland basins at the Olentangy River Wetland Research Park (ORWRP) in 1997. This study in 2002 represents the sixth set of such measurements. Before 1997 (the fourth growing season), harvesting was not considered a good option when vegetation was just getting started in the basins. By the fourth year (1997), we determined that limited harvesting of plants to estimate the productivity of the system was possible without affecting the general succession and productivity of the overall system.

Methods

Aboveground net primary productivity (NPP) was estimated by harvesting peak biomass at the end of the growing season (end of August 2002) at selected stations in the two experimental wetland basins at the ORWRP (Figure 1). The same stations established from the boardwalk system in 1997 (Mitsch and Bouchard, 1998) and used in 1998, through 2001 were used in 2002. To avoid harvesting the exact same spots, quadrats were not established at points were there had been harvesting in previous years. In each station, we used 1-m^2 quadrats to delineate the area of vegetation for harvest. When no vegetation was present, the station was skipped. Overall, there are potentially 22 stations in each wetland but a maximum of 16 sites are harvested. Because of sufficient macrophyte cover in 2002, 16 quadrats were sampled in Wetland 1 and 15 in Wetland 2. The only location where there were not sufficient locations for harvesting the maximum number of stations was in the inflow area of Wetland 2. Seven out of a possible eight plots were sampled in the northern half (inflow area) of Wetland 2.

In each quadrat, plants were clipped at ground level (the water was lowered in the wetlands to make sampling easier and to allow rapid recovery of the clipped plants). Samples were segregated both by quadrat and by species, placed in plastic bags and weighed in the field with a hanging balance (accuracy ± 40 g). Sub-samples were taken to the laboratory where both wet weight and dry weight (dried at 105°F for 48 hours) were determined to estimate dry/wet ratios. Average ratios for each species were multiplied by total wet weight of each species in a quadrat to estimate total dry weight production. The sum of all species in a quadrat was the estimated peak biomass and hence annual aboveground net primary productivity (NPP).

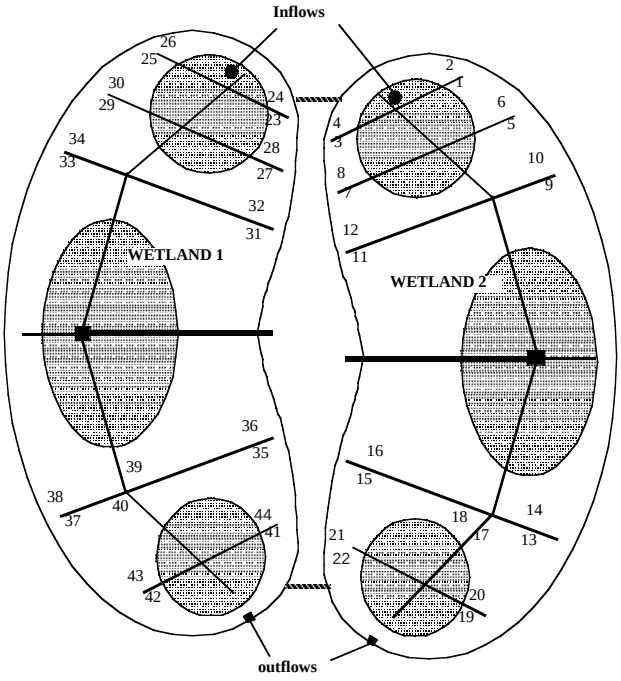

Figure 1. Potential sampling stations for macrophyte harvesting, August 2002. Sixteen were sampled in Wetland 1 and fifteen in Wetland 2 in 2002.

Results and Discussion

Comparison of Basins and Location

In 2002, macrophyte aboveground NPP was 689±93 $gm^{-2}yr^{-1}$for a full 16 sites in Wetland 1, considerably more than the 393±87 g m^{-2} yr^{-1} measured in 2001 for only 9 sites (Table 1). Productivity was 519±64 $gm^{-2}yr^{-1}$ for 15 sites in Wetland 2. Although 832±85 g m^{-2} yr^{-1} was recorded for the naturally colonizing Wetland 2 in 2001 for 9 sites (mostly *Typha*), only 17 percent of the wetland was covered by macrophytes that year. When normalized for 16 sites, aboveground net primary productivity more than doubled in Wetland 1 from 221 to 689 g m^{-2} yr^{-1} from 2001 to 2002 but increased only 4% in Wetland 2 from 468 to 486 g m^{-2} yr^{-1}. The productivity at the outflow was lower than the

Table 1. Estimated net above-ground primary productivity (NAPP) of macrophyte communities in the Olentangy River experimental wetlands based on peak biomass harvest. Numbers are ave±std error [# samples].

Wetland/ Year	Total NPP, g m^{-2} yr^{-1}	Inflow NPP, g m^{-2} yr^{-1}	Outflow NPP, g m^{-2} yr^{-1}
Wetland 1			
1999	657±76 [16]	601±126 [8]	714±90 [8]
2000	482±64 [16]	597±87 [8]	368±79 [8]
2001	393±87 [9]	454±98 [7]	181±120 [2]
2002	689±93 [16]	915±126 [8]	462±79 [8]
Wetland 2			
1999	1023±94 [16]	790±75 [8]	1256±130 [8]
2000	1013±105 [16]	882±126 [8]	1144±163 [8]
2001	832±85 [9]	746±76 [7]	1134±145 [2]
2002	519±64 [15]	699±84 [7]	361±53 [8]

inflow for both Wetland 1 and Wetland 2 in 2002 ($\alpha = 0.05$) (Figure 2).

Dry/wet Ratios

As in the previous annual reports, dry/wet ratios of individual plants which are necessary for estimating NPP are provided (Table 2). Dry/wet ratios of dominant plants averaged 15-16% for *Schoenoplectus* and *Polygonum* and 14.5-21% for *Typha*.

Comparison with Previous Years

Overall, macrophyte cover increased significantly in both wetlands in 2002. When paired sites were compared between the two wetlands (11 sites were paired in 2002) macrophyte plot productivity was not statistically different in 2002 ($t = 0.33$; $\alpha = 0.05$) for the first time in 5 years, an indication of relative convergence (Fig. 3). NPP was higher in plots in Wetland 1 but lower in Wetland 2 in 2002 compared to 2001.

Species Dominating the Productivity

As was the case in previous years, the species harvested in the two basins indicate some differences that are still attributable to the planting of 1994, although these differences are less than in past years and convergence continues. Wetland 1, which was planted with 12 species in May 1994, had four of those species still contributing to macrophyte productivity (*Schenoplectus tabernaemontani*, *Sparganium eurycarpum, Scirpus fluviatalis, and Sagittaria latifolia)*. But only one, *S. tabernaemontani*, dominated in 2002, accounting for 73% of the productivity in W1 (Table 3). *S. tabernaemontani*, which restored itself to W2 duirng the spring drawdown from the seed bank in W2, accounted for 56% of the productivity in W2 in 2002, only the second or third time in which a plant other than *Typha* has dominated

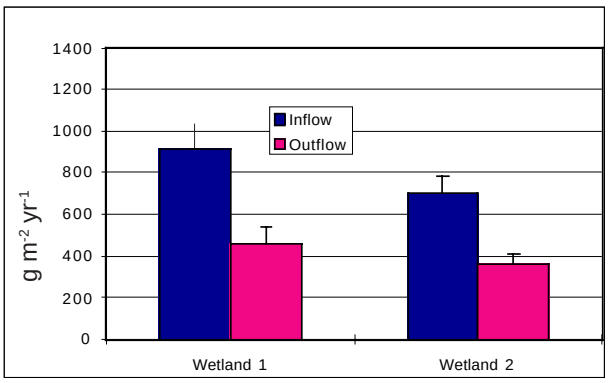

Figure 2. Aboveground net primary productivity in Wetland 1 and 2 in inflow and outflow areas for 2002.

Table 2. Dry/wet ratios (ave±std error (# samples)) of dominant macrophytes in the Olentangy River wetlands in 1999, 2000, 2001, and 2002.

Species/	Wetland 1	Wetland 2
Schoenoplectus tabernaemontani		
1999	0.35±0.01 (13)	0.33±0.01 (14)
2000	0.25±0.30 (6)	na
2001	na	na
2002	0.15±0.01 (14)	0.16±0.02 (14)
Polygonum sp.		
2002	0.16±0.01 (13)	0.15±0.01 (7)
Scirpus fluviatilis		
1999	0.30±0.01 (4)	na
2000	na	na
2001	na	na
2002	0.13±0.03 (3)	na
Sagittaria latifolia		
1999	0.13±0.02 (4)	na
2000	0.15±0.07 (4)	na
2001	na	na
2002	0.07±0.01 (3)	
Sparganium eurycarpum		
1999	0.23±0.00 (11)	na
2000	0.24±0.07 (8)	na
2001	0.16±0.03 (7)	na
2002	0.10±0.01 (10)	0.038 (1)
Typha spp.		
1999	0.26±0.00 (4)	0.26±0.01 (15)
2000	0.30±0.07 (7)	0.31±0.04 (16)
2001	0.20±0.05 (2)	0.29±0.03 (9)
2002	0.14±0.03 (4)	0.21±0.04 (8)
Leersia oryzoides		
2002	0.25±0.03 (10)	0.23 ± 0.02 (4)
Cyperus sp.		
2002	0.15±0.01 (8)	0.21±0.02 (9)
Echinochloa sp.		
2002	0.13 ±0.03 (5)	0.17±0.04 (2)
Lycopus americanus		
2002	0.18±0.01 (2)	na

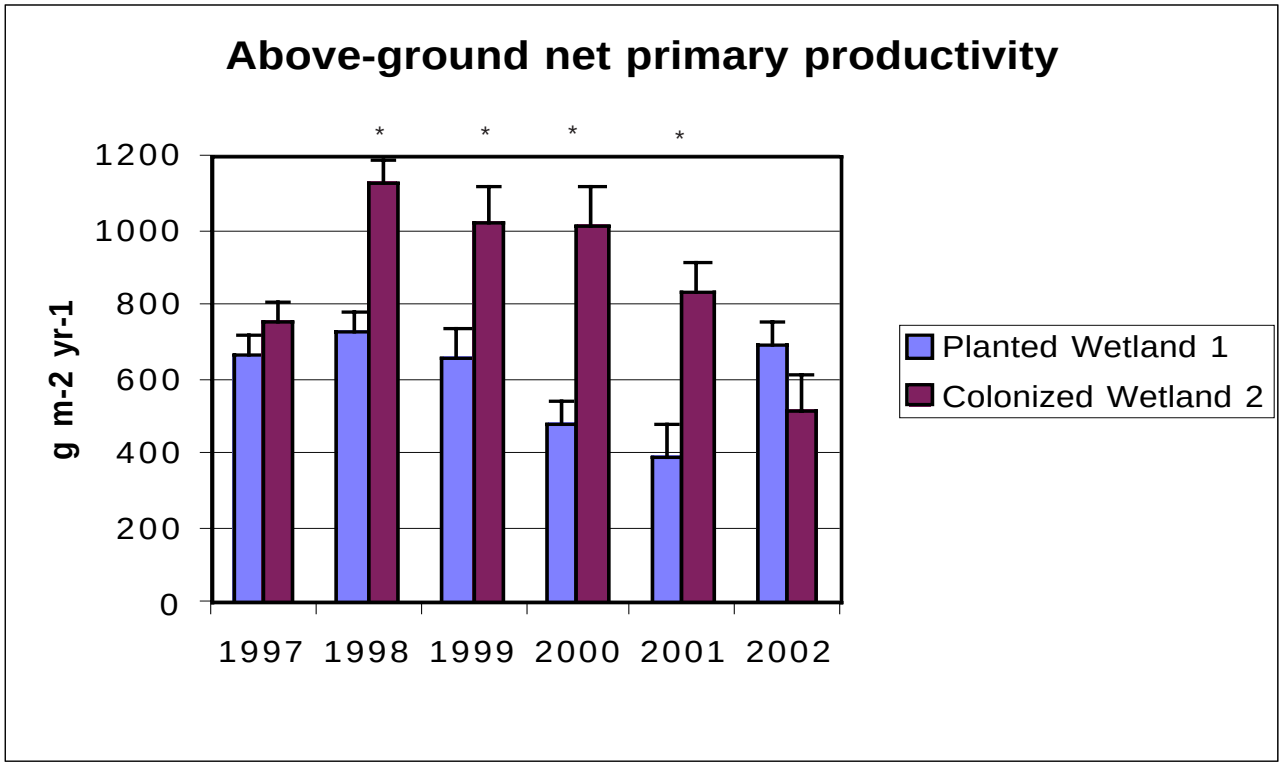

Figure 3. Aboveground net primary productivity for 1997-2002 in the experimental wetlands. * indicates significant differences between the two wetlands (α=0.05).

Table 3. Dominance of macrophytes by aboveground primary productivity in quadrats in 2002 (n = 16 for W1; n= 15 for W2). nd indicates not detected in biomass samples; 0.0 indicates presence but not significant contributor to productivity.

Species	W1	W2
Schoenoplectus t, %	72.8	55.9
Polygonum spp., %	12.5	21.8
Typha spp., %	6.9	16.1
*Sparganium eury*carpum, %	0.5	nd
Leersia oryzoides, %	5.1	6.3
Cyperus sp., %	1.9	5.7
Echinochloa, %	0.6	0.4
Panicum sp., %	0.0	0.2
Lycopus sp., %	0.5	nd
Scirpus fluviatilis, %	0.5	nd
Sagittaria latifolia, %	0.4	0.0
TOTAL	100.0	100.0

that wetland.

Colonizing *Typha* provided 6.9% of the productivity in Wetland 1 and 16.1% of the productivity in Wetland 2 Table 3). By contrast it contributed 41.4% of the productivity in Wetland 1 and 100% of the productivity in Wetland 2 in 2001. It lost dominance in both wetlands because of muskrat herbivory, seed bank restoration, and subsequent agressive competition from *Schenoplectus* in 2002.

Smartweed *(Polygonum* spp.) is a new colonizing plant to contribute significantly to the productivity of each basin (Table 3). It has particularly strong clumps growing on abandoned muskrat huts. There are three dominate species of *Polygonum, P. pensylvanicum, P. persicaria*, and *P. lapathifolium* in the wetland basins. Overall, *Polygonum* spp. contributed to 121.5% of the net primary productivity of macrophytes in W1 and 21.8% of the productivity in W2.

Basin Productivity

Based on the aboveground productivity estimates reported here and the estimates of macrophyte cover presented elsewhere in this annual report (Mitsch and Zhang, 2003; W1 = 6,500 m^2; W2 = 6,417 m^2), aboveground productivity by macrophytes is an estimated to be 4478 kg and 3330 kg per year in Wetlands 1 and 2 respectively (Table 4). These numbers are significant for two reasons. First, the numbers are almost 3 to 4 times the macrophyte productivy in the basins from the previous year. The macrophyte community substantially recovered from the herbivory and subsequent macrophyte losses of 2000 and

Table 4. Estimated macrophyte above-ground net primary productivity in each experimental wetland, kg dry-wt per wetland basin

Year	Wetland 1	Wetland 2
2002	4478	3330
2001	963	1250
2000	1960	4265
1999	5800	6800
1998	3300	3500
1997	2525	3040
Total	19,926	22,185

2001. Second, it is the first instance since biomass measurements began in 1997 where the planted Wetland 1 had a higher esimated productivity than Wetland 2 and probably the first time since plants first appeared in the planted wetland in 1995. Wetland 2 has still produced an estimated 11% more net primary production than Wetland 1 over the last 6-year period (Table 4).

References

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