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SEASONAL GROWTH OF SUBMERSED AQUATIC MACROPHYTES IN THE ST. CLAIR-DETROIT RIVER ECOSYSTEM

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Abstract

Growth of submersed aquatic macrophytes was determined using samples collected approximately monthly from April to November 1978 at seven locations in the St. Clair-Detroit River Ecosystem. At all seven locations, submersed macrophyte biomass was low in April and May, increased during early summer, peaked between July and October, and decreased by late November. Maximum seasonal biomass of submersed macrophytes at six of the seven locations (118-427 g/m^2 dry weight) was similar in range to that found in other rivers at similar latitudes.

Seasonal growth of common submersed macrophyte taxa represented in the samples followed one of three patterns at each of the seven locations: at two locations plants grew monospecifically; at two locations plants grew sympatrically without species succession; and at three locations plants grew sympatrically with species succession. Differences in growth and succession could, in some instances, be attributed to the presence of overwintering plant material, life cycle differences, and competition.

Introduction

The St. Clair-Detroit River Ecosystem (SCDRE), which includes the St. Clair and Detroit Rivers and Lake St. Clair, is considered to be one of Michigan's most valuable recreational resources (Jamsen 1976). In 1975, 48% of all non-salmonid fishing in Michigan's Great Lakes waters occurred in Lake St. Clair, and from 1961 to 1970, 40% of the total waterfowl harvest along Michigan's Great Lakes coastline occurred in counties bordering the SCDRE (Jaworski and Raphael 1978). Submersed aquatic macrophytes are a prominent biological feature of the littoral waters of the SCDRE (GLFL unpublished data) and may contribute substantially to the productivity of the fish and wildlife resources by providing cover for young fish and feeding opportunities for fish and waterfowl (GLFL unpublished data; Dawson 1975; Jaworski and Raphael 1978).

This study was conducted to provide base line information on the distribution and abundance of submersed aquatic macrophytes in the SCDRE to better demonstrate their importance to fish and wildlife resources, and to help prevent and document further loses of important macrophyte communities caused by man's water use practices and water development projects.

Methods

Samples of submersed macrophytes were collected in 1978 at Stag Island, Algonac, Sand Island, the Clinton River, Belle Isle, Grosse Ile, and Sugar Island (Figure 1; Appendix I). These locations were selected because they provided broad geographic coverage of the SCDRE and preliminary observations of the major macrophyte communities at these locations indicated they were generally representative of those present throughout the SCDRE.

Sampling began at all seven locations in April or May before macrophytes displayed the first new growth of the season, and continued on a monthly basis until October or November, when macrophyte biomass began to decline (Table 1). Fifteen samples of macrophytes were collected during each visit to a location except as otherwise indicated in Table 1. Samples were collected at each location along a transect parallel to the adjacent shore; the transect was 600 m long at the Clinton River and 100 m long at each of the other six locations. Samples were taken with a Ponar grab (484 cm^2 bottom coverage) which collected foliage from the water column and roots from the sediments. Vegetation protruding from the closed jaws of the Ponar was discarded according to the recommendations of Dromgoole and Brown (1976) for quantitative biomass sampling. Macrophytes were removed from the Ponar, washed over a 3-mm sieve, identified (Voss 1972; Fassett 1969), separated by taxa, and stored in the dark at 10°C for up to 3 days before being taken to the laboratory. In the laboratory, the macrophytes were dried at 105°C until they could be pulverized by forcing them through a 1-mm mesh sieve to remove shells, stones, and other miscellaneous debris. Dry weight determinations were made on the pulverized macrophytes after they had been held for 24 h at 105°C; ash-free dry weight determinations were then made after ignition for 6 h at 525°C. Both dry weight and ash-free dry weight measurements were made on each sample because the

former measure permits comparison with the majority of the published records, and the latter is now recognized as the more reliable measure of growth (Westlake 1963, 1965; Vollenweider 1969).

Results

The amount of submersed macrophytes in early spring was low throughout the study area (Table 1). No vegetation was found at the Clinton River, Belle Isle, and Grosse Ile in April. In April and May, the only vegetation collected at Stag Island, Algonac, Sand Island, and Sugar Island consisted of decaying or dormant (achlorophyllus) material from the previous growing season. The ash-free dry weight biomass of dormant plant material at Algonac, Sand Island, and Sugar Island in April and May (37-64 g/m^2) was similar to the maximum value (56.6 g/m^2) reported by Raynal and Geis (1978) for the St. Lawrence River in March. In mid-June, no vegetation was found at Belle Isle and most of the decayed, overwintering plant material collected at the other locations fragmented and passed through the washing sieve and was not found in samples collected after mid-June. By mid-June, dormant plant material at Stag Island, Algonac, Sand Island, and Sugar Island sprouted new growth at stem and leaf nodes, and by mid-July new growth which did not originate from overwintering material was found at all locations. The contribution of overwintering dormant plant material to the following season's production was not measured, but higher maximum biomass values were generally observed during the growing season at locations where dormant overwintering vegetation was observed in April and May.

Ash-free dry weight biomass reached its maximum in July at Stag Island (114 g/m^2); in August at the Clinton River (47 g/m^2), Belle Isle (19 g/m^2), Grosse Ile (283 g/m^2), and Sugar Island (118 g/m^2); and in October at Algonac (152 g/m^2) and Sand Island (112 g/m^2). The lack of published information prevents comparison of the maximum ash-free dry weight biomass values of Table 1 with those for other temperate waters. However, the maximum dry weight biomass values recorded at six of the seven locations studied were within the range (100 - 520 g/m^2) reported by Edwards and Owens (1960) and Westlake (1963, 1975) for submersed macrophyte stands in temperate rivers.

Macrophytes became senescent and biomass values decreased by late fall at all seven locations (Table 1). Ash-free dry weight biomass declined 40-63% at Stag Island, Clinton River, and Belle Isle from September to October and 14-70% at the other 4 locations from October to November. These results indicate that little or no macrophyte growth took place before June or after October. A similar growing season was reported by Adams and McCracken (1974) and Crowder et al. (1977) for submersed macrophytes in inland waters of the Great Lakes region.

The biomass values of Table 1 collectively reflect the growth of 10 submersed aquatic macrophyte taxa as follows:

Taxon	Stag Island	Algonac	Sand Island	Clinton River	Belle Isle	Grosse Ile	Sugar Island
Chara spp.		+	+	+	+		
Elodea canadensis		+	+	+	+	+	+
Heteranthera dubia				+		+	+
Myriophyllum spicatum			+	+	+		+
Najas flexilis				+	+		
Potamogeton crispus							+
Potamogeton gramineus		+	+				
Potamogeton spp.	+	+	+	+	+	+	+
Potamogeton richardsonii	+	+	+				+
Vallisneria americana		+	+	+	+	+	+

Biomass values of individual taxa observed over the growing season (Figures 2a-g; Appendix I) revealed that the macrophyte community at each location exhibited one of three patterns of growth. Monospecific growth took place at Sand Island and Grosse Ile, where the dominant plants were *Myriophyllum spicatum* and *Elodea canadensis*, respectively (Figures 2a and 2b). Sympatric growth without species succession took place at the Clinton River and at Belle Isle where *Vallisneria americana*, the most abundant taxon, grew simultaneously with 5 or 6 other taxa (Figures 2c and 2d). Sympatric growth with species succession took place at Stag Island, Algonac, and Sugar Island (Figures 2e-g). At Stag Island and Algonac, the dominant species in June and July were narrow-leaved *Potamogeton* spp., i.e., linear and filiform leaved pondweeds (Voss 1972); *Potamogeton richardsonii* replaced these taxa by late August at Stag Island and by September at Algonac (Figures 2e and 2f). At Stag Island no new growth took place after late August, but at Algonac *E. canadensis* replaced *P. richardsonii* by late October. At Sugar Island, dormant buds (turions) of *Potamogeton crispus* accounted for all biomass in April (Table 1); these turions were present in densities up to 460/m^2. By early June, rapid growth of *P. crispus* originating from turions produced 98 g/m^2 of biomass (Figure 2g). In July, *P. crispus* declined in abundance and was replaced by *M. spicatum*, which reached a maximum biomass of 99 g/m^2 in August. After August, *M. spicatum* declined in biomass as *Heteranthera dubia* increased. Little change in total biomass was observed from June to late October at Sugar Island, even though

species succession from P. crispus to M. spicatum to H. dubia took place (Table 1).

I attribute species succession of some taxa at Stag Island, Algonac, and Sugar Island to life cycle differences or species competition. At Stag Island and Algonac, the decline of narrow-leaved Potamogeton spp. may have been due to genetic factors, but the simultaneous increase of P. richardsonii at both locations suggests that competitive interaction took place between these taxa. I do not attribute the decline of P. richardsonii at Stag Island to competitive interactions with other submersed macrophytes, because P. richardsonii was not replaced by any other macrophyte at Stag Island. At Sugar Island, P. crispus grew from dormant turions in May, then declined in June and July. This pattern of growth is characteristic of P. crispus (Harman 1970; Andrews 1946). The decline of M. spicatum between August and October at Sugar Island was probably a result of competition with H. dubia because no such decline in the abundance of M. spicatum was found at Sand Island when H. dubia was absent.

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Table 1. Mean ash-free dry weight and (in parentheses) dry weight (both expressed as $\bar{x} \pm SE$, n = 15, g/m^2) of submersed macrophytes at seven locations in the St. Clair-Detroit River Ecosystem, April-November 1978.

Location	April 18-20	May 23	June 13-15	July 14-21	August 17-25	September 25-29	October 25-30	November 28-29
Stag Island		12[a] (28)[a]	24 ± 3 (72 ± 19)	114 ± 15 (267 ± 42)	68 ± 10 (103 ± 16)	27 ± 5 (38 ± 7)	10 ± 2[b] (15 ± 2)[b]	
Algonac	64[a] (148)[a]		29 ± 6[b] (54 ± 16)[b]	63 ± 9 (97 ± 11)	108 ± 10 (158 ± 13)	113 ± 14 (174 ± 27)	152 ± 19 (248 ± 29)	131 ± 21 (182 ± 30)
Sand Island		37[a] (104)[a]	51 ± 10 (85 ± 17)	67 ± 8 (113 ± 13)	100 ± 12 (135 ± 16)	101 ± 8 (133 ± 10)	112 ± 11 (146 ± 14)	52 ± 4 (69 ± 5)
Clinton River	0 (0)		7 ± 1 (24 ± 5)	26 ± 3 (63 ± 7)	47 ± 5 (118 ± 8)	20 ± 2 (33 ± 4)	10 ± 1 (16 ± 2)	
Belle Isle	0 (0)		0 (0)	15 ± 1 (38 ± 4)	19 ± 2 (52 ± 5)	15 ± 2 (38 ± 5)	9 ± 1 (17 ± 3)	
Grosse Ile	0 (0)		51 ± 15[b] (94 ± 32)[b]	130 ± 22 (216 ± 36)	283 ± 28 (427 ± 39)	151 ± 27 (220 ± 38)	93 ± 12 (145 ± 21)	28 ± 5 (42 ± 7)
Sugar Island	32[c] (33)[c]		98 ± 13 (287 ± 45)	76 ± 25 (135 ± 45)	118 ± 20 (192 ± 33)	109 ± 16 (160 ± 21)	115 ± 14 (172 ± 21)	62 ± 9 (82 ± 11)

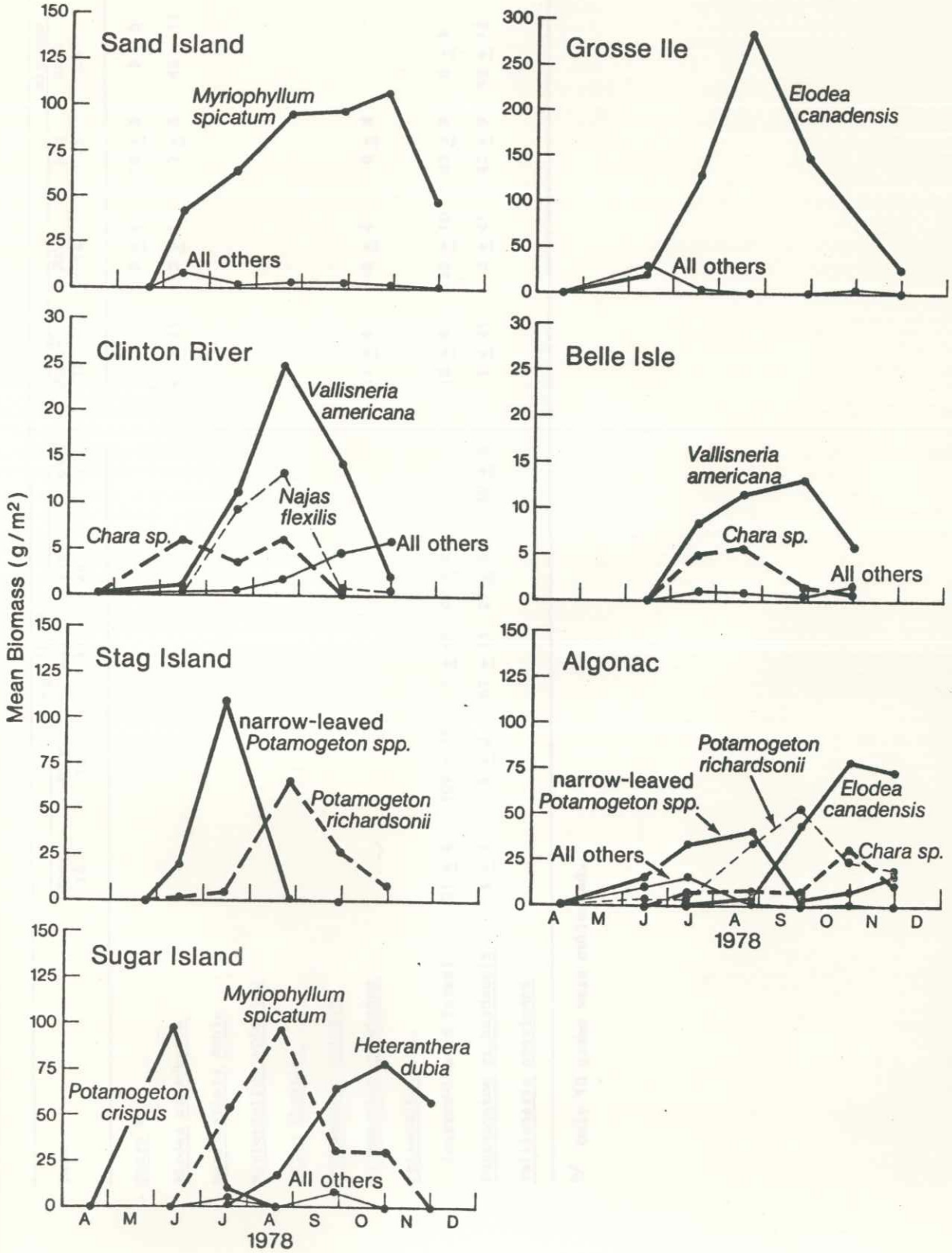
[a] Overwintering vegetation, n = 10 combined Ponar grabs.

[b] n = 10 Ponar grabs.

[c] Overwintering turions, n = 1 Ponar grab.

Figure 1. Locations in the St. Clair-Detroit River Ecosystem where submersed aquatic macrophytes were collected, April-November 1978.

Figures 2a-g. Seasonal growth (g/m^2 ash-free dry weight) of submersed macrophyte taxa in the St. Clair-Detroit River Ecosystem, April-November 1978. Taxa that individually composed less than 10 percent of the total season's biomass at a given location are combined for presentation as "All others"; these taxa are identified in Appendix I.



Appendix I. Mean ash-free dry weight ($\bar{x} \pm SE$, n = 15, g/m^2) of submersed macrophyte taxa at seven locations in the St. Clair-Detroit River Ecosystem, June-November 1978.

Taxa	Stag Island					Algonac					
	June 15	July 14	Aug 25	Sept 26	Oct[a] 27	June[a] 15	July 14	Aug 25	Sept 26	Oct 27	Nov 28
Chara sp.							9 ± 4	10 ± 2	9 ± 5	37 ± 15	12 ± 8
Elodea canadensis						<1 ± <1	2 ± 1	7 ± 3	46 ± 11	80 ± 25	77 ± 25
Heteranthera dubia											
Myriophyllum spicatum											
Najas flexilis											
Potamogeton crispus											
Potamogeton gramineus						11 ± 5	16 ± 4	6 ± 4			
Potamogeton spp. (narrow-leaved forms)	21 ± 4	109 ± 16	1 ± <1	<1 ± <1		16 ± 6	35 ± 10	43 ± 9	6 ± 3	10 ± 5	22 ± 5
Potamogeton richardsonii	3 ± 2	5 ± 2	67 ± 11	27 ± 5	10 ± 2	1 ± <1	2 ± <1	42 ± 9	52 ± 12	26 ± 7	20 ± 5
Vallisneria americana										<1 ± <1	

[a] Only 10 grabs were collected.

Appendix I. (Continued)

	Sand Island						Clinton River				
	June 13	July 21	Aug 23	Sept 27	Oct 26	Nov 28	June 13	July 19	Aug 17	Sept 27	Oct 26
Chara sp.		2 ± <1			<1 ± <1	2 ± <1	6 ± 2	4 ± 3	6 ± 3		
Elodea canadensis		<1 ± <1	2 ± <1	3 ± 1	2 ± 1	<1 ± <1		<1 ± <1	<1 ± <1	<1 ± <1	<1 ± <1
Heteranthera dubia										3 ± 2	2 ± <1
Myriophyllum spicatum	42 ± 12	64 ± 9	95 ± 13	96 ± 9	107 ± 11	50 ± 4	<1 ± <1	1 ± <1	2 ± 2	2 ± 1	4 ± 1
Najas flexilis							<1 ± <1	9 ± 2	13 ± 2	<1 ± <1	1 ± <1
Potamogeton crispus											
Potamogeton gramineus	4 ± 2										
Potamogeton spp. (narrow-leaved forms)	4 ± <1							<1 ± <1	<1 ± <1		
Potamogeton richardsonii	1 ± 1										
Vallisneria americana		<1 ± <1	3 ± 2	2 ± 1	1 ± <1		<1 ± <1	11 ± 2	25 ± 7	14 ± 2	2 ± <1

Appendix I. (Continued)

Taxa	Belle Isle				Grosse Ile					
	July 20	Aug 17	Sept 25	Oct 26	June[a] 14	July 20	Aug 21	Sept 29	Oct 30	Nov 29
Chara sp.	5 ± 1	5 ± 1	2 ± <1	1 ± <1						
Elodea canadensis		<1 ± <1	<1 ± <1	<1 ± <1	24 ± 14	128 ± 23	283 ± 28	150 ± 27	90 ± 12	28 ± 5
Heteranthera dubia								1 ± <1		
Myriophyllum spicatum		1 ± <1	<1 ± <1	<1 ± <1						
Najas flexilis	<1 ± <1	1 ± <1	<1 ± <1	<1 ± <1						
Potamogeton crispus										
Potamogeton gramineus										
Potamogeton spp. (narrow-leaved forms)	1 ± <1				19 ± 13					
Potamogeton richardsonii										
Vallisneria americana	9 ± 1	12 ± 1	13 ± 2	6 ± 1	8 ± 3	2 ± 1			3 ± <1	

a/ Only 10 grabs were collected.

Appendix I. (Continued)

Taxa	Sugar Island					
	June 14	July 20	Aug 21	Sept 29	Oct 30	Nov 29
Chara sp.						
Elodea canadensis		<1 ± <1			<1 ± <1	<1 ± <1
Heteranthera dubia		<1 ± <1	19 ± 9	67 ± 21	79 ± 17	60 ± 10
Myriophyllum spicatum		56 ± 26	99 ± 24	32 ± 14	33 ± 15	2 ± 1
Najas flexilis						
Potamogeton crispus	98 ± 13	12 ± 6				
Potamogeton gramineus						
Potamogeton spp.						
(narrow-leaved forms)		2 ± <1				
Potamogeton richardsonii		4 ± <1				
Vallisneria americana		<1 ± <1		10 ± 5	2 ± <1	