HYDRILLA VERTICILLATA IN THE TIDAL POTOMAC RIVER, MARYLAND, VIRGINIA, AND THE DISTRICT OF COLUMBIA, 1983 and 1984

By Nancy B. Rybicki, Virginia Carter, Robert T. Anderson, and Thomas J. Trombley

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CONTENTS

APPENDIXES

ILLUSTRATIONS

TABLES

CONVERSION FACTORS AND SYMBOLS

Multiply	By	To obtain
meter (m)	3.33	foot (ft)
square meter (m^2)	11.11	square foot (ft^2)
centimeter (cm)	0.39	inch (in)
square centimeter (cm^2)	0.16	square inch (in^2)
kilometer (km)	0.62	mile (mi)
kilometer (km)	0.54	nautical mile (nm)

Temperature in degrees Celsius (C) can be converted to degrees Farenheit (F) as follows:

$$F = 9/5\ (C) + 32$$

River kilometer (rkm) is defined as the distance from the mouth of the river or tributary in kilometers

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ABSTRACT

During 1983 and 1984, information on the distribution and abundance of Hydrilla verticillata, an exotic submersed aquatic macrophyte from Southeast Asia, was collected in the tidal Potomac River. Data were collected on four transects established on the Virginia side of the river as well as numerous other transects established for a concurrent submersed aquatic vegetation survey. Depth of water in which Hydrilla occurred, comparative seasonal biomass, tuber production, replacement rate, and competition with other species were measured. Laboratory experiments were conducted on salinity tolerances.

INTRODUCTION

From 1978 through 1981, the U.S. Geological Survey conducted a survey of the submersed aquatic vegetation of the tidal Potomac River and Estuary (Paschal and others, 1982; Haramis and Carter, 1983; Carter and others, 1985)(fig. 1). This survey was part of an interdisciplinary study of the hydrodynamic, chemical and biological processes in the tidal Potomac River and Estuary (Callender and others, 1984). The 1978-81 survey showed that the tidal river was nearly devoid of submersed aquatic plants, and that the greatest abundance and diversity was found in the transition zone (upper end of the estuary between Quantico, Virginia, and the U.S. Highway 301 Bridge).

In 1983, numerous species of submersed aquatic plants were found in the tidal river, giving scientists reason to believe that environmental conditions and water quality had improved. One of the new submersed aquatic plants was Hydrilla verticillata, an exotic species from Southeast Asia which has become a nuisance species in California, Florida, and other States. Hydrilla was positively identified in Dyke Marsh, Virginia, in 1982 (fig. 1). A shoreline survey in 1983 showed that Hydrilla was most abundant within 1 to 2 miles of Dyke Marsh on the Virginia side of the river, and south of Quantico, Virginia in a small tributary of Chicamuxen Creek, Maryland. Hydrilla is believed to be a relative newcomer to the Washington, D.C., area (Steward and others, 1984); it grows and reproduces rapidly and has the potential to outcompete other species.

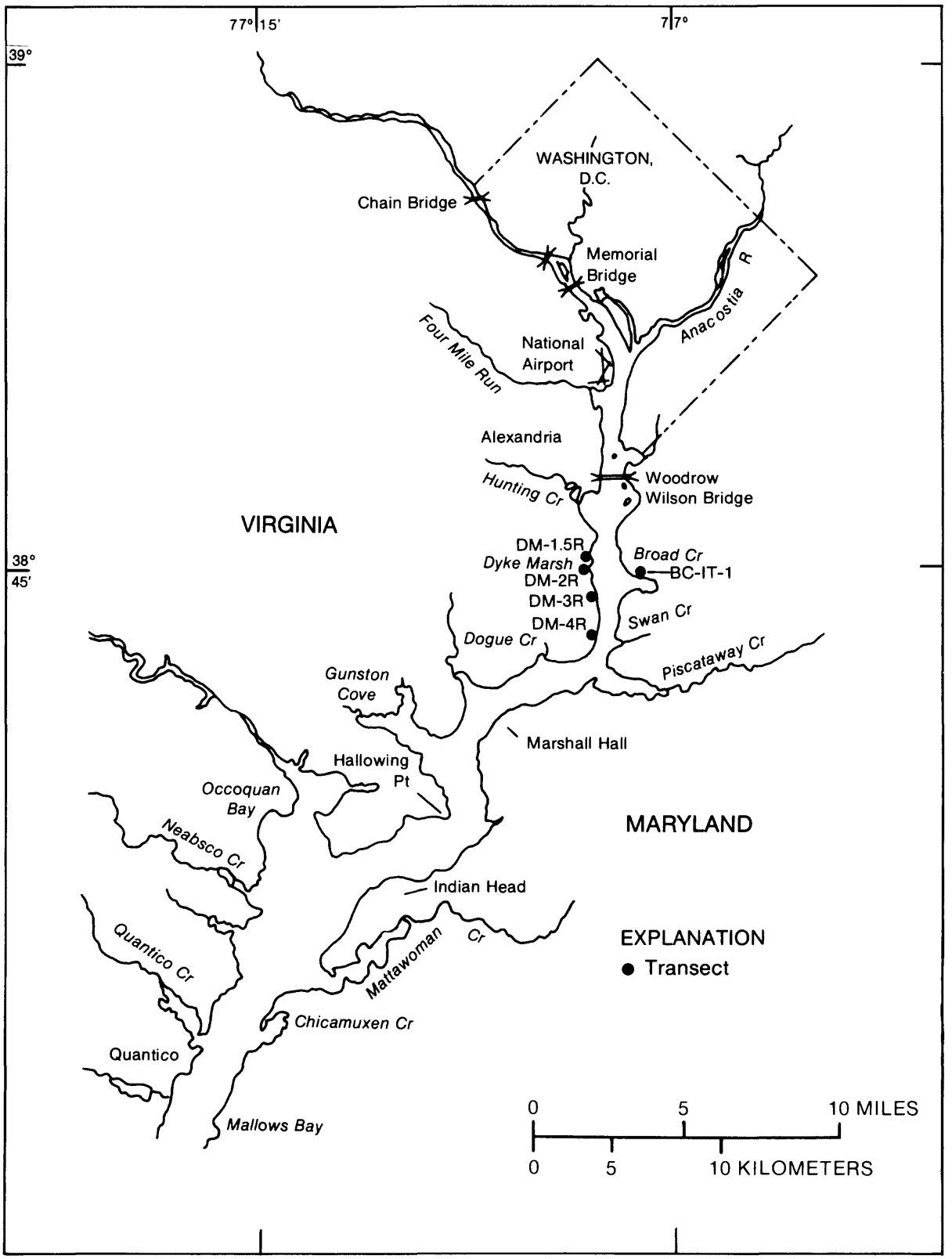

Figure 1: The tidal Potomac River showing transect locations for the Hydrilla verticillata study.

In order to assess the impact of Hydrilla on the tidal Potomac River and Estuary, more information is needed on the current distribution, salinity tolerance, growth rate, reproductive capability and maximum water depth in which Hydrilla will grow. A study of Hydrilla was begun in 1984. The objectives of the study were to:

(1) Document the changing distribution and abundance of Hydrilla in the tidal river;
(2) measure the growth rate of Hydrilla by monitoring biomass changes;
(3) measure the production of tubers;
(4) determine the maximum water depth in which Hydrilla will grow in the tidal Potomac River;
(5) determine the salinity tolerance of Hydrilla plants, fragments, and tubers; and
(6) document competition between Hydrilla and other species;

This report summarizes the data on distribution of Hydrilla in 1983 and 1984, as well as biomass and tuber production of Hydrilla in 1984. It also presents observations made in 1984 regarding competition with other species.

Acknowledgments

This work was partially supported by the U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi. We thank all our colleagues in the National Park Service, the Government of the District of Columbia, and the Northern Virginia Community College for their assistance. We also appreciate the assistance of associates from the Audubon Naturalist Society, who helped us with the field work on several occasions.

DESCRIPTION OF STUDY AREA

The tidal Potomac River extends from Quantico, Virginia, to Chain Bridge (fig. 1). It contains fresh water ($<$0.5 ppt (parts per thousand) salinity) except during extreme drought, is strongly influenced by river discharge, and is affected by tides and associated cyclical reversals of flow. The tidal river has a deep channel flanked on either side by wide shallow flats suitable for the growth of submersed aquatic plants. Most of the tributaries (tidal inlets) such as Piscataway Creek and Gunston Cove are wide and shallow.

METHODS

Shoreline surveys for Hydrilla and all other submersed aquatic macrophytes were made by boat at low tide in July 1983 and July 1984. Rakes were used to gather samples and to ascertain whether plants were rooted or floating. In 1983, cover was classified as dense or patchy. In 1984, percent cover by submersed aquatic vegetation and the proportion of each species were estimated and referenced to 1 km grids shown on U.S. Geological Survey 7½ minute quadrangles, with bathymetric data added. The ranges of percent cover used (<10, 10 to 40, 40 to 70 and 70 to 100) follow those of Orth and others (1979). Spot checks at selected locations also were made during 1984. Based on these data, maps were made of Hydrilla distribution and relative abundance in 1983 (fig. A-1, in appendix) and 1984 (fig. A-2, in appendix).

Four transects on the Virginia side were sampled to determine Hydrilla biomass as a function of water depth and distance from shore and to monitor any increase in Hydrilla downstream from Dyke Marsh. These transects (fig. 1) were sampled at stations located 5, 15, 25, 35, 45, 55 and 65 m from shore. Three grabs with oyster tongs were made at each station. (For a detailed description of methods see Paschal and others, 1982.) Water depth, uncorrected for tide, was measured at each station. Samples were dried at approximately 110 C^{o}; biomass for oyster-tong grabs was expressed as average grams per grab for each station (table B-1, in appendix).

Sampling techniques were compared by measuring biomass in three grids (9 m^2) consisting of nine 1-meter squares set up at the DM-1.5R and DM-3R transect locations. One oyster-tong grab was made in a randomly chosen numbered square in each grid during each sample day (table B-2, in appendix). Additional biomass samples were taken by hand-harvesting the plants in 0.09- and 1-meter-square quadrats at Dyke Marsh and at the transect site DM-3R, 1 mile downstream (table B-3, in appendix). Biomass for these samples was expressed as g/m^2 (grams per square meter). The oyster-tong grabs, although adequate when plants are not particularly dense or do not fill the water column, are not accurate for sampling Hydrilla where it completely fills the water column. For this reason, grab-biomass measurements are not directly comparable to hand-harvest measurements.

All plants were also manually removed from four 1-m^2 "replacement squares" at transect locations DM-1.5R and DM-3R every sampling day to see how rapidly small areas where plants were removed would recover (table B-4, in appendix).

The number of tubers was measured at transect locations DM-1R, DM-1.5R and BC-1T-1 in 1-meter-square quadrats within which plants were gently pulled up with tubers connected (July, September, October and November; table C-1, in appendix). In November, when plants began to disintegrate and tubers became detached, a sampling corer (Sutton, 1982) was also used to estimate number of tubers per square meter (table C-1, in appendix).

Five 9-m^2 competion grids were established over existing plant beds at DM-4R and BC-1T-1. The grids were divided into nine 1-m^2 quadrats and the total cover and percent of each species was recorded monthly in each square (tables D-1 to D-5, in appendix).

Water transparency, specific conductivity and temperature measurements made during the Hydrilla study are contained in Carter and others (1985).

Two laboratory experiments were conducted on salinity tolerance. In the first, solutions of 0,5,9,13,18, and 22 ppt salinity were prepared. Short pieces of Hydrilla bearing the apical meristem were floated in these solutions, and both prechilled (4 weeks at 10 C^0) and unchilled tubers (4 weeks at 23 C^0) were planted in washed sand saturated with the salt solutions (table E-1, in appendix). Salinities were allowed to increase for a period of 5 weeks. Plants were considered alive if the stem remained green and did not sink, fragment, or lose leaves. In the second experiment, short pieces of Hydrilla with the apical meristem were floated in salt solutions of 0,5,7,9,11, and 13 ppt (table E-2, in appendix). Salinities were maintained at a constant value. The plants used in the second experiment were collected at the very end of the growing season and therefore the results may not be entirely reliable. Plants in the second experiment were considered alive if some part of the stem remained green.

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Appendix A. *Hydrilla verticillata* distribution maps

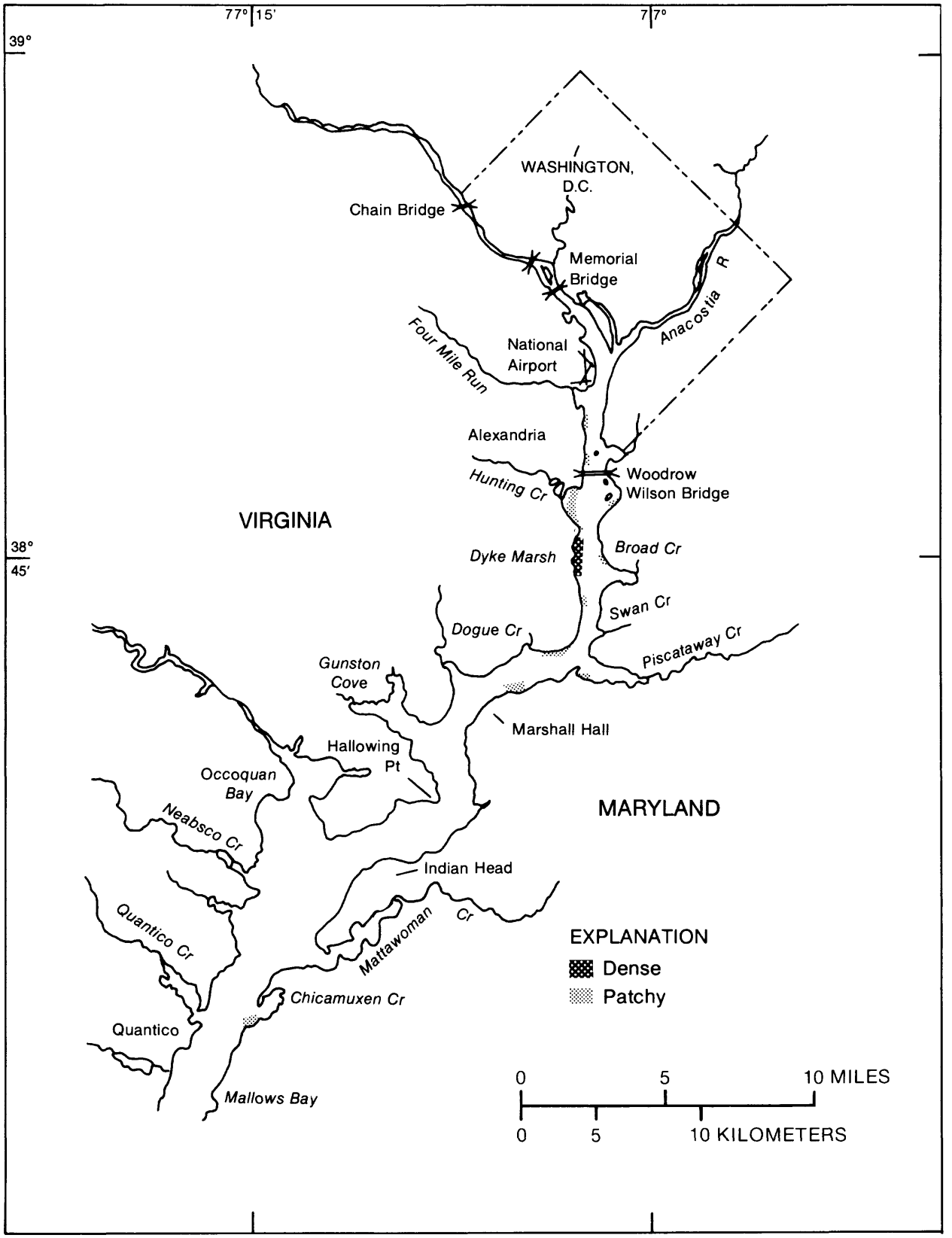

Figure A-1: Distribution of Hydrilla verticillata in the tidal Potomac River in 1983.

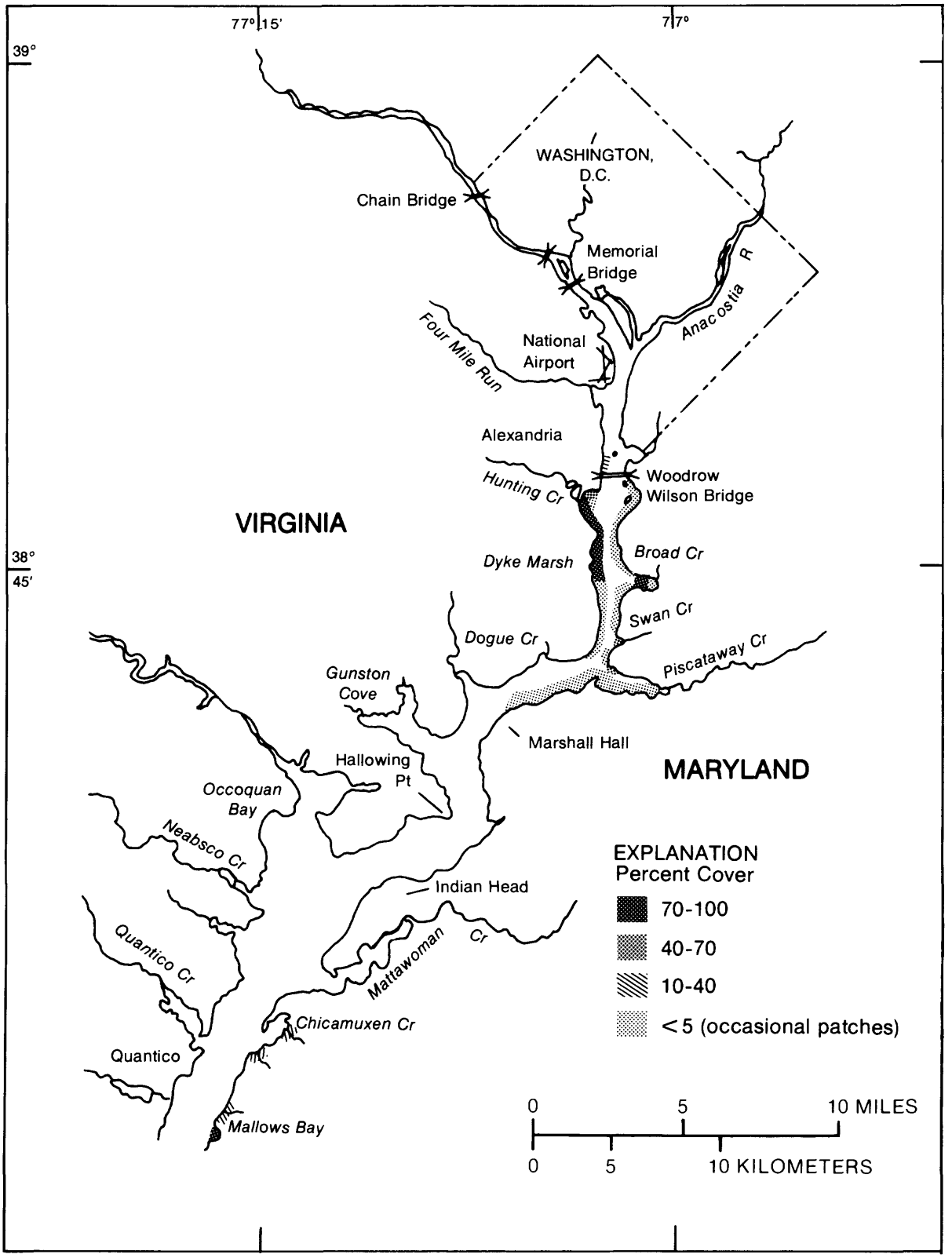

Figure A-2: Distribution of Hydrilla verticillata in the tidal Potomac River in 1984.

Appendix B. *Hydrilla verticillata* biomass data

Table B-1:--Average biomass of Hydrilla verticillata in the tidal Potomac River, 1984

[Tr is trace; est is estimated on the basis of previous month; n.d. is no data available]

Transects	Distance from shore (meters)	Water depth range (meters)	Average biomass (grams per grab)					
			July 3-12	July 24	August 14	September 9	October 3	November 8
DM-1.5R	5	0.4 to 1.0	11	23	50	160	(est) 160	Tr
	15	0.6 to 1.1	15	35	63	179	(est) 179	Tr
	25	0.7 to 1.2	2	10	37	124	(est) 124	Tr
	35	0.8 to 1.4	0	0	3	13	6.5	11
	45	1.2 to 2.1	0	0	0	Tr	0	Tr
	55	3.1 to 3.8	0	0	0	0	0	Tr
DM-2R	5	0.8 to 1.0	4	1	42	99	(est) 99	34
	15	1.1 to 2.0	10	7	19	10	4	1
	25	1.8 to 2.1	1	Tr	1	0	4	Tr
	35	2.3 to 2.6	Tr	Tr	0	0	Tr	0
	45	2.3 to 2.8	0	0	0	0	Tr	0
	55	2.6 to 2.9	0	0	0	0	0	0
DM-3R	5	0.7 to 1.1	7	11	10	92	(est) 92	1
	15	1.2 to 1.3	1	13	45	108	(est) 108	7
	25	1.2 to 1.9	0	9	2	49	21	1
	35	1.2 to 2.1	0	0	0	38	0	2
	45	1.8 to 2.1	0	0	0	2	Tr	28
	55	2.1 to 2.3	0	0	0	0	0	0
DM-4R	5	0.5 to 0.9	0	1	2	0	Tr	Tr
	15	0.5 to 1.0	0	Tr	Tr	0	Tr	Tr
	25	0.6 to 1.1	Tr	0	Tr	1	0	Tr
	35	0.7 to 1.4	0	0	0	0	Tr	0
	45	0.8 to 1.2	0	Tr	0	0	0	Tr
	55	0.9 to 1.4	0	Tr	0	0	0	2
	65	1.2 to 1.7	n.d.	0	n.d.	Tr	n.d.	0

Table B-2.--*Hydrilla verticillata* biomass in randomly selected squares in grids at DM-1.5R, 1984

[n.d. is no data]

Grid no.	Biomass (grams per grab)					
	July 3	July 24	August 14	September 6	October 3	November 8
1	32	45	48	n.d.	265	215
2	14	24	62	260	354	125
3	15	n.d.	99	458	n.d.	0
Mean (variance)	20(10.1)	35(14.8)	70(26.4)	359(140.1)	310(62.9)	113(107.9)

Table B-3:--Biomass of *Hydrilla verticillata* in sample quadrats, 1984

[Number of quadrats varied on different dates]

Location	Biomass (grams per square meter)					
	July 3	July 24	August 14	September 6	October 3	November 8
DM-1.5R	71	105		301	157	211
DM-1.5R	80	72				
DM-1.5R	93	146				
DM-3R	104	37	163			
DM-3R		20	196			
DM-3R		98	207			
BC-1T		142				
BC-1T		177				
BC-1T		99				
Hunting Creek					303	

Table B-4.--Replacement square (1-m square) biomass of Hydrilla verticillata, 1984

[July 3 was initial harvest date]

Location	Biomass removed on each sampling day (grams per square meter)			
	July 3	July 24	August 14	September 6
DM-1.5R	71	42	20	150
DM-1.5R	80	39	59	222
DM-1.5R	93	36	70	80
DM-3R	104	11	67	141
Mean (variance)	87 (14.5)	32 (14.2)	54 (23.1)	148 (58.2)

Appendix C. *Hydrilla verticillata* tubers

Table C-1.--Tuber production by Hydrilla verticillata, 1984

Date	Location	Tubers/m^2	Method
July 24	DM-1.5R	32	pulled up plants in 0.09-m square
		21	do
		74	do
	DM-3R	0	do
		11	do
		21	do
	BC-1T	106	do
		116	do
		32	do
September 6	DM-1.5R	72	pulled up plants in 1-m square
October 3	DM-1.5R	102	do
November 8	DM-1.5R	190	corer (10 cores)

Appendix D. Competition grid data.

Table D-1.--Competition grid data, DM-4R, grid no. 1, 1984

[Total cover: A is <10 percent, B is 10-40 percent, C is 40-70 percent, D is 70 to 100 percent, 0 is no vegetation; percent by species: 1 is <10 percent, 2 is 10-40 percent, 3 is 40-70 percent, 4 is 70-100 percent, 0 is species absent]

Date	Cover Percent	Grid cell no.								
		1	2	3	4	5	6	7	8	9
July 11	Total Cover	C	B	0	C	B	C	D	C	C
	Percent by species									
	Cerat	0	0	0	0	0	0	1	0	0
	Hydr	0	0	0	0	0	0	0	0	0
	Sago	4	4	0	3	4	4	3	4	2
	Vall	0	0	0	3	0	0	3	0	0
	Zann	0	0	0	0	0	0	0	0	3
July 24	Total Cover	C	A	A	D	C	B	D	C	B
	Percent by species									
	Cerat	0	0	0	0	2	0	0	0	0
	Hydr	0	0	0	0	0	1	1	0	0
	Sago	4	4	4	2	2	4	2	3	4
	Vall	1	0	0	3	2	0	4	2	0
	Zann	0	0	0	0	0	0	0	0	0
Aug. 14	Total Cover	A	0	0	D	A	A	D	A	A
	Percent by species									
	Cerat	0	0	0	0	0	0	0	0	4
	Hydr	0	0	0	0	0	3	0	0	0
	Sago	3	0	0	0	0	3	0	2	0
	Vall	3	0	0	4	4	0	4	3	0
	Zann	0	0	0	0	0	0	0	0	0
Sept. 6	Total Cover	B	0	A	D	B	A	D	B	0
	Percent by species									
	Cerat	0	0	0	0	0	0	0	0	0
	Hydr	0	0	1	0	0	1	1	0	0
	Sago	0	0	0	1	1	0	0	1	0
	Vall	4	0	0	4	4	0	4	4	0
	Zann	0	0	0	0	0	0	0	0	0

Table D-1--Competition grid data, DM-4R, grid no. 1, 1984
--continued

[Total cover: A is < 10 percent, B is 10-40 percent, C is 40-70 percent, D is 70 to 100 percent, 0 is no vegetation; Percent by species: 1 is < 10 percent, 2 is 10-40 percent, 3 is 40-70 percent, 4 is 70-100 percent, 0 is species absent]

Date	Cover Percent	Grid cell no.								
		1	2	3	4	5	6	7	8	9
Oct. 3	Total Cover	C	A	0	D	B	0	D	C	0
	Percent by species									
	Myrio	0	4	0	0	0	0	0	1	0
	Vall	4	0	0	4	4	0	4	4	0
Nov. 7	Total Cover	C	0	0	D	B	0	D	C	0
	Percent by species									
	Myrio	3	0	0	2	0	0	0	3	0
	Vall	4	0	0	4	4	0	4	4	0

Cerat = Ceratophyllum demersum; Hydr = Hydrilla verticillata;
Myrio = Myriophyllum spicatum; Sago = Potamogeton pectinatus;
Vall = Vallisneria americana; Zann = Zannichellia palustris

Table D-2.--Competition grid data, DM-4R, grid no. 2, 1984

[Total cover: A is <10 percent, B is 10-40 percent, C is 40-70 percent, D is 70 to 100 percent, 0 is no vegetation; Percent by species: 1 is < 10 percent, 2 is 10-40 percent, 3 is 40-70 percent, 4 is 70-100 percent, 0 is species absent]

Date	Cover Percent	Grid cell no.								
		1	2	3	4	5	6	7	8	9
July 24	Total Cover	D	C	B	D	C	B	D	B	A
	Percent by species									
	Hydr	0	1	0	0	2	3	0	0	0
	Sago	2	3	3	2	1	3	1	1	4
	Vall	3	3	2	4	4	1	4	4	0
Aug. 14	Total Cover	D	C	A	D	D	A	D	B	A
	Percent by species									
	Hydr	0	0	3	2	4	4	0	2	4
	Myrio	0	0	1	0	0	0	0	0	0
	Sago	0	0	2	0	0	2	0	1	0
	Vall	4	4	0	4	1	0	4	4	0
Sept. 9	Total Cover	D	D	C	D	B	A	D	B	A
	Percent by species									
	Hydr	0	2	4	0	1	3	0	0	0
	Myrio	0	0	1	0	0	0	0	0	0
	Sago	0	0	0	0	0	0	4	4	3
	Vall	4	4	0	4	4	3	0	0	3
Oct. 3	Total Cover	D	D	0	D	C	A	D	B	0
	Percent by species									
	Hydr	0	0	0	1	1	0	0	0	0
	Myrio	0	1	0	0	0	4	1	0	0
	Vall	4	4	0	4	4	0	4	4	0
Nov. 11	Total Cover	D	B	B	D	B	B	D	B	B
	Percent by species									
	Myrio	0	0	3	0	3	4	1	0	4
	Sago	0	2	2	0	0	0	0	0	0
	Vall	4	3	3	4	3	0	4	4	0

Hydr = Hydrilla verticillata; Myrio = Myriophyllum spicatum;
Sago = Potamogeton pectinatus; Vall = Vallisneria americana

Table D-3.--Competition grid data, DM-4R, grid no. 3, 1984

[Total cover: A is < 10 percent, B is 10-40 percent, C is 40-70 percent, D is 70 to 100 percent, 0 is no vegetation; Percent by species: 1 is < 10 percent, 2 is 10-40 percent, 3 is 40-70 percent, 4 is 70-100 percent, 0 is species absent]

Date	Cover Percent	Grid cell no.								
		1	2	3	4	5	6	7	8	9
July 11	Total Cover	D	D	D	D	D	D	D	D	D
	Percent by species									
	Heter	0	0	0	0	0	0	0	0	1
	Sago	0	0	1	0	0	0	0	0	0
	Vall	4	4	4	4	4	4	4	4	4
July 24	Total Cover	D	D	D	D	D	D	D	C	C
	Percent by species									
	Heter	0	0	0	0	0	0	0	0	3
	Hydr	0	0	1	0	0	0	1	0	0
	Myrio	0	0	0	0	0	0	0	0	0
	Sago	0	1	1	0	0	0	0	0	0
	Vall	4	4	4	4	4	4	4	4	2
Aug. 14	Total Cover	D	D	D	D	D	D	D	C	C
	Percent by species									
	Heter	0	0	0	0	0	0	0	0	3
	Hydr	0	0	0	0	0	0	1	0	0
	Myrio	0	0	1	0	0	0	0	0	0
	Sago	0	1	1	0	0	0	0	0	0
	Vall	4	4	4	4	4	4	4	4	2
Sept. 6	Total Cover	D	D	D	D	D	D	D	D	D
	Percent by species									
	Heter	0	0	0	0	2	0	0	2	4
	Hydr	0	0	0	0	0	0	0	0	0
	Myrio	0	0	2	0	0	0	0	0	0
	Sago	0	0	0	0	0	0	0	0	1
	Vall	4	4	4	4	4	4	4	4	2

Table D-3.--Competition grid data, DM-4R, grid no. 3, 1984
--continued

[Total cover: A is < 10 percent, B is 10-40 percent, C is 40-70 percent, D is 70 to 100 percent, 0 is no vegetation; Percent by species: 1 is < 10 percent, 2 is 10-40 percent, 3 is 40-70 percent, 4 is 70-100 percent, 0 is species absent]

Date	Cover Percent	Grid cell no.								
		1	2	3	4	5	6	7	8	9
Oct. 3	Total Cover	D	D	D	D	D	D	D	D	D
	Percent by species									
	Sago	0	0	0	0	0	0	0	0	3
	Vall	4	4	4	4	4	4	4	4	3
Nov. 7	Total Cover	D	D	D	D	D	D	D	D	D
	Percent by species									
	Cerat	0	0	0	1	0	0	0	0	0
	Heter	0	0	0	0	0	0	0	0	4
	Myrio	0	0	2	0	0	0	0	0	0
	Vall	4	4	4	4	4	4	4	4	1

Cerat = Ceratophyllum demersum; Heter = Heteranthera dubia;
Hydra = Hydrilla verticillata; Myrio = Myriophyllum spicatum;
Vall = Vallisneria americana

Table D-4.--Competition grid data, BC-1T-1, grid no. 1, 1984

[Total cover: A is < 10 percent, B is 10-40 percent, C is 40-70 percent, D is 70 to 100 percent, 0 is no vegetation; Percent by species: 1 is < 10 percent, 2 is 10-40 percent, 3 is 40-70 percent, 4 is 70-100 percent, 0 is species absent]

Date	Cover Percent	Grid cell no.								
		1	2	3	4	5	6	7	8	9
July 24	Total Cover	D	C	B	D	C	B	D	B	A
	Percent by species									
	Hydr	0	1	0	0	2	3	0	0	0
	Sago	2	3	3	2	1	3	1	1	4
	Vall	3	3	2	4	4	1	4	4	0
Aug. 14	Total Cover	D	C	A	D	D	A	D	B	A
	Percent by species									
	Hydr	0	0	3	2	4	4	0	2	0
	Myrio	0	0	1	0	0	0	0	0	4
	Sago	0	0	2	0	0	2	0	1	0
	Vall	4	4	0	4	1	0	4	4	0
Sept. 9	Total Cover	D	D	C	D	B	A	D	B	A
	Percent by species									
	Hydr	0	2	4	0	1	3	0	0	3
	Myrio	0	0	1	0	0	3	0	0	0
	Sago	0	0	0	0	0	0	0	0	0
	Vall	4	4	0	4	4	0	4	4	3
Oct. 3	Total Cover	D	D	D	D	D	D	D	D	D
	Percent by species									
	Cerat	1	1	0	1	0	0	1	0	0
	Elodea	0	0	0	0	0	0	1	0	0
	Heter	0	1	1	0	0	0	0	0	0
	Hydr	4	4	4	4	4	4	4	4	4
	Myrio	1	0	0	1	0	0	1	1	1

Cerat = Ceratophyllum demersum; Elodea = Elodea canadensis; Heter = Heteranthera dubia; Hydr = Hydrilla verticillata; Myrio = Myriophyllum spicatum; Sago = Potamogeton pectinatus; Vall = Vallisneria americana

Table D-5.--Competition grid data, BC-1T-1, grid no. 2, 1984

[Total cover: A is < 10 percent, B is 10-40 percent, C is 40-70 percent, D is 70 to 100 percent, 0 is no vegetation; Percent by species: 1 is < 10 percent, 2 is 10-40 percent, 3 is 40-70 percent, 4 is 70-100 percent, 0 is species absent]

Date	Cover Percent	Grid cell no.								
		1	2	3	4	5	6	7	8	9
July 12	Total cover	D	C	C	D	D	D	D	C	D
	Percent by species									
	Cerat	3	3	2	2	1	1	2	1	0
	Elodea	0	0	0	0	0	0	0	0	2
	Hydr	2	2	2	4	4	4	3	4	3
	Myrio	2	0	0	1	0	2	0	1	1
	Najas	0	0	0	0	0	0	1	0	0
	P. crisp	0	0	0	0	0	0	2	1	1
July 24	Total cover	C	D	D	D	D	D	D	D	D
	Percent by species									
	Cerat	3	3	1	1	0	1	2	2	1
	Hydr	3	3-4	4	4	4	4	4	4	4
	Myrio	1	0	1	0	0	0	0	0	1
	Najas	0	0	1	0	0	0	0	0	0
Sept. 9	Total cover	D	D	D	D	D	D	D	D	D
	Percent by species									
	Cerat	0	1	1	1	0	1	2	2	1
	Hydr	4	4	4	4	4	4	4	4	4
	Myrio	2	1	0	0	0	0	0	0	1
Oct. 3	Total cover	D	D	D	D	D	D	D	D	D
	Percent by species									
	Cerat	1	1	1	1	0	0	0	1	1
	Hydr	4	4	4	4	4	4	4	4	4
	Myrio	1	1	1	0	1	1	0	0	1
	Najas	0	1	0	0	0	0	0	0	0

Cerat = Ceratophyllum demersum; Elodea = Elodea canadensis
Hydr = Hydrilla verticillata; Myrio = Myriophyllum spicatum
Najas = Najas guadalupensis; P. crisp = Potamogeton crispus

Appendix E. Salinity studies.

Table E-1.--Salinity tolerance of Hydrilla verticillata

[Salinity in parts per thousand; 7 stems per beaker; 3 prechilled and 4 unchilled tubers per beaker; 3 beakers per treatment]

Treatment	Starting salinity	Final salinity	Survival	
			Stems	Tubers
A	0	1	all alive after 5 weeks	all prechilled tubers sprouted plants healthy
B	5	10	do	all prechilled tubers sprouted after 3 weeks - poor plant growth
C	9	14	all dead after 4 weeks	no tubers sprouted
D	13	28	do	do
E	18	30	do	do
F	22	30	do	do

Table E-2.--Salinity tolerance of Hydrilla verticillata

[Salinity in parts per thousand; 10 stems per beaker; 3 beakers per treatment]

Treatment	Starting salinity	Final salinity	Survival after 4 weeks
A	0	0	alive
B	5	5	alive
C	7	7	alive
D	9	9	all dead
E	11	11	all dead
F	13	13	all dead