LAKE ERIE PROTECTION FUND FINAL REPORT

Analyses of Lake Erie Wetland Communities: Coastal Wetlands
Small Grant Number: SG38/96
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Introduction

The historic Lake Erie coastal wetland environment has undergone significant change due to the extensive draining and filling of these wetlands. The Black Swamp, an extensive wetland system, once covered an area of approximately 4,000 km^2, extending from the mouth of the Detroit River east to Vermillion, Ohio. Today, the combined wetland area encompassing the Lake Erie coast is only about 83 km^2. The remaining wetland system consists of remnant marshes, many of which are diked and managed for waterfowl hunting and to protect these wetlands and the surrounding land from flooding and severe erosion, or are maintained as natural areas and preserves by state and federal government.

Numerous descriptive studies of the aquatic and wetland flora of Lake Erie appear in the literature (e.g., Farney and Bookhout 1982; Lowden 1969; Marshall 1977; Moore 1973; Stuckey 1975; Robb 1989), and over 300 species of aquatic plants have been identified in western Lake Erie (Stuckey 1989). Few studies have been completed recently and even fewer document or quantify changes in plant community structure in response to varying environmental conditions. Moreover, analyses of plant community structure and species composition on a landscape level (among systems) are completely lacking. Despite a lack of quantitative vegetation data, broad-based assumptions are made regarding habitat structure, plant species diversity, and plant net productivity. Our recent vegetation studies in the Old Woman Creek estuary, and preliminary studies conducted as part of the past and current Sea Grant/LEPF project grant, suggest a greater ecological understanding of these systems and provide useful management information particularly in understanding functional relationships between the existing habitat and the aquatic macrofuana.

Vegetation Analysis

During the 1996 field season we selected three wetlands to sample which were in relatively close proximity to on another and allowed rapid vegetation assessments. Conducting our initial sampling effort in this manner provided a learning opportunity to refine the methodology prior to repeating the process in 1997. We identified a total of 40 species of wetland and aquatic plants in the three wetlands (Table 1). The greatest number of species were recorded in OWC (22), followed by Dupont Marsh (20), and Sheldon's Marsh (13). Only two species were observed that were common to all three wetlands. Overall plant diversity was low, in part, because this was a limited sampling effort and only those species encountered along the sampled transects were recorded. Sampling proposed for 1997 was to encompass a greater number of wetlands and more diverse wetland types. Specifically, we had hoped to sample at least one diked wetland, Pickerel Creek Wildlife Area (Sandusky County), and an additional undiked system, Arcola Creek (Lake County, Lake Metroparks). Although a permit to sample Pickerel Creek had been secured prior to the 1997 sampling season, it was not renewed by the Ohio Department of Natural Resources until early September of 1997 because of administrative changes within the ODNR. Site visits were allowed, however, and diked areas 1, 2, 3, and 40 were identified as potential sample locations.

Methods. In 1997 three Lake Erie coastal wetlands (Old Woman Creek, Dupont Marsh, and Sheldon's Marsh) were sampled using stratified random sampling within major vegetation zones. In addition, site visits were made to Arcola Creek and Pickerel Creek to provide a preliminary assessment of existing vegetation and generalities regarding plant community structure of these systems. Supporting data was generated from prior vegetation sampling at the Ottawa Shooting Club (Tawa Sale). Habitats sampled included the open water deep marsh, near shore shallow marsh, and the upper marsh which consisted largely of *Phragmites* beds.

Results. Intra-system comparisons of undiked wetland systems indicated that open water, near shore shallow marsh and *Phragmites* stands are distinct habitats with respect to water depth, conductivity, turbidity, and percent vegetation cover (Figures 1 and 2). In 1997, Lake Erie water levels (and adjacent wetlands) approached record high levels, significantly altering the physical habitat. Vegetation types for each of the sampled wetlands were similar, characterized by the dominant grass community in the upper and shallow marsh, and floating-leaf macrophytes in the open water (Table 2; Figure 3). The open water communities were characterized by deeper waters, typically greater than 30 cm and flooded year-round. Dominant vegetation in the open water communities consisted of the floating-leaf species *Nelumbo lutea*, *Nymphaceae tuberosa*, and *Nuphar advena*. Submersed species were also occasionally found in the deeper open water communities. These plant communities were largely monotypic with well developed canopies. The shallow marsh communities (near shore community) were characterized by a water depth of less than 30 cm, and a greater plant diversity. The substrate in these communities may be seasonally exposed, facilitating the germination of some annuals and perennials; however, these areas remained flooded throughout the 1997 growing season. *Phragmites* stands are generally seasonally flooded or retain saturated soil conditions throughout the year. In 1997, these communities remained flooded through the spring and in some areas were flooded for the entire growing season. In Sheldon's Marsh, *Phragmites* stands which ring the nearshore environment were flooded to a depth of 10-20 cm, facilitating the growth of other aquatic macrophytes including the emergent *N. advena*.

On a landscape level (between systems), variation in water depth may account for the differences in species composition among similar habitat types. *Nelumbo lutea* appears to dominate in systems experiencing both daily and seasonal fluctuations in water levels. In OWC, water level fluctuations are controlled by a sand-barrier beach. *Nuphar advena*, less tolerant to fluctuating water levels, is found in both Dupont Marsh and Sheldon's Marsh, which lack any hydrologic barrier that may cause sudden changes in system water levels. Overall, floating-leaved macrophytes are more tolerant to fluctuating water levels. Open water communities in the diked wetlands at Pickerel Creek and the Ottawa Shooting Club lacked populations of floating-leaved macrophytes. Arcola Creek, a barrier beach wetland, also lacked populations of floating-leaved macrophytes. We speculate that the lack the lack of any extensive shallow open water areas may make it more difficult for floating-leaved species to establish. Similar to the Ottawa Shooting Club, Arcola Creek contained a well developed submersed macrophyte community.

The description and comparison of Lake Erie coastal wetland and habitat types provided here is meant only as an a preliminary step to providing a more encompassing study to sample among habitats and among areas. Our initial efforts indicate local habitat differences exist, forming a mosaic of habitats of differing structure and species composition. Across the landscape, however, structure may be similar with species composition directly affected by hydrologic conditions. Expansion of this study, both on a small-scale between adjacent habitat types and on a large scale among wetlands could greatly enhance our existing database of the Lake Erie wetland and aquatic flora, and existing knowledge of associated biotic and abiotic parameters, providing a needed benchmark whereby continued biological and physical change in these systems may be assessed.

Old Woman Creek: *Potamogeton pectinatus* study

The objective of this study was to evaluate the growth of the submersed macrophyte *P. pectinatus* in shallow-turbid water areas that are often dominated by the floating-leaf macrophyte *N. lutea*. We selected a two small embayments located in the northwest corner and along the northeast shore of the wetland. The latter site was within an extensive bed of *N. lutea*.

Methods. The experimental design included three light treatments and a control. Two different light conditions were created by artificially shading shallow water areas, and a third light treatment was naturally produced by an existing bed of the floating-leaf macrophyte *N. Lutea*. Levels of artificial shading reduced the incident light by 75% and 90%. In the *Nelumbo* treatment, the combination of emergent and floating leaves reduced incident light by 65%. Each treatment included six 5-gallon buckets placed within a wire-mesh enclosure. Each bucket contained wetland sediment and two tubers. Prior to placement of the tuber containing buckets within the experimental enclosures, the tubers were allowed to germinate in the buckets in a secured area along the shoreline. Water depth was approximately 50 cm at the start of the experiment. After 8 weeks, we harvested the 6 replicate containers from each treatment to determine percent survival.

Results. We were only interested in percent survival to minimize any errors in the measurement of other growth parameters that may occur due to growth characteristics of the plant, although initial tuber sizes were all between 0.5-1.0 gram. Measurement of plant growth just prior to placement of the buckets in the experimental enclosures did reveal nonhomogeneous growth of among the plants, although all plants appeared healthy. Results were consistent with reduced levels of incident light (Figure 4). There was approximately a 17% survival rate in both the *Nelumbo* treatment and the 75% shading treatment. Mortality was 100% when plants were shaded at 90% of incident light. These results are consistent with annual observations in the OWC of varied *P. pectinatus* growth. The early-season growth of *P. pectinatus* has consistently been observed to be displaced by the subsequent development of a dense overhead canopy of *N. lutea*. Years in which turbidity levels are extremely high have also produced reduced *P. pectinatus* productivity.

Greenhouse Experiments: *Peltandra virginica, Potamogeton pectinatus, Nelumbo lutea*

The objective of this study was to determine the importance of light as a growth limiting factor to three macrophytes commonly found in the coastal wetlands of the western basin of Lake Erie. We chose *Peltandra virginica*, *P. pectinatus*, and *N. lutea* because they are all potentially involved in competition for light. *Nelumbo lutea* has only recently replaced the latter two species as the most common macrophyte in OWC.

Methods. The experiments were conducted in 50-gallon Rubbermaid tanks (Rubbermaid Products, Inc., Wooster, OH) housed in the greenhouse facilities at Miami University, Oxford, Ohio. An organic water dye was used to reduce the available incident light by 30% and 70%. Prior macrophyte growth experiments in our laboratory had shown that the use of an organic water dye was comparable to the use of neutral-density shade fabric and had no detrimental effects on the growth of macrophytes other than its ability to shade light. Midday photosynthetically active radiation levels in the greenhouse were about 900 $uE\ m^{-2}sec^{-1}$. Double-distilled water was used in all tanks. Sediment collected from OWC provided the principal source of nutrients for plant growth. Each tank contained 8-12 1-liter containers with a single plant per container. Every 1-2 weeks we measured maximum stem height and petiole production for all species. We harvested the replicate containers after 10-11 weeks and determined the biomass (dry weight-grams) of both shoots and roots, and any below ground tuber production. Percent survival was determined in all containers planted with *P. virginica*.

Results. *Peltandra virginica* was grown at a maximum depth of 30 cm based on reports in the published literature that these plants could tolerate flooding up to 50 cm. A 17% percent survival rate was recorded in all treatments including the control (Figure 5). Reduction of light did not appear to adversely affect the growth of these plants; instead, the maintained depth of 30 cm was apparently sufficient to limit production. Additional experiments will be required to accurately determine the relationship between light, depth and macrophyte production. Our results, however, do suggest that increased water levels may have been partly responsible for the disappearance of this once dominant plant from OWC.

Light appears to have limited the growth of *P. pectinatus* in both treatments of 30% and 70%, but only to the extent that growth of maximum shoot height lagged slightly (Figure 6). The control and the 30% and 70% treatments followed similar growth patterns, growing rapidly through week 6 before stabilizing their growth by week 7. The control which apparently had slowed its growth by week 7, subsequently continued its shoot elongation through week 12. In response to reduced light levels, *P. pectinatus* increased its shoot and biomass production, resulting in shorter but greater numbers of shoots (Figure 7). We had observed a similar growth pattern in prior enclosure experiments conducted in OWC.

Nelumbo lutea petiole elongation was similar between the control and at 70% reduced light (Figure 8). The numbers of petioles produced differed slightly (Figure 9). Through the first 5 weeks of growth the control consistently produced a greater number of petioles in each replicate; however, by week 7 petiole production under reduced light levels increased. At this time emergent leaves were also produced, apparently in response to low light. We have observed a similar pattern of *N. lutea* growth in OWC.

It is evident that each of these macrophytes responds to the altered light environment in different manners. Both *P. pectinatus* and *N. lutea* appear to tolerant to reduced light, although resource allocation patterns are altered. *Peltandra virginica* may be tolerant to reduced light but may require shallow water conditions to successfully propagate. Understanding patterns of resource allocation under reduced light levels may better help us to understand patterns of macrophyte growth as observed in OWC and other coastal wetlands.

Plans for Publication

It is anticipated that based on the work outlined here, we will be able to submit for publication 1-3 manuscripts. Specifically, we will seek publication in either the Journal of Great Lakes Research, Wetlands, or the Ohio Journal of Science. We have previously published related work in Wetlands, and curently have a manuscript in review with the Candian Journal of Botany. In addition, abstracted papers presented and those expected to be presented based on the work outlined in this report are listed below.

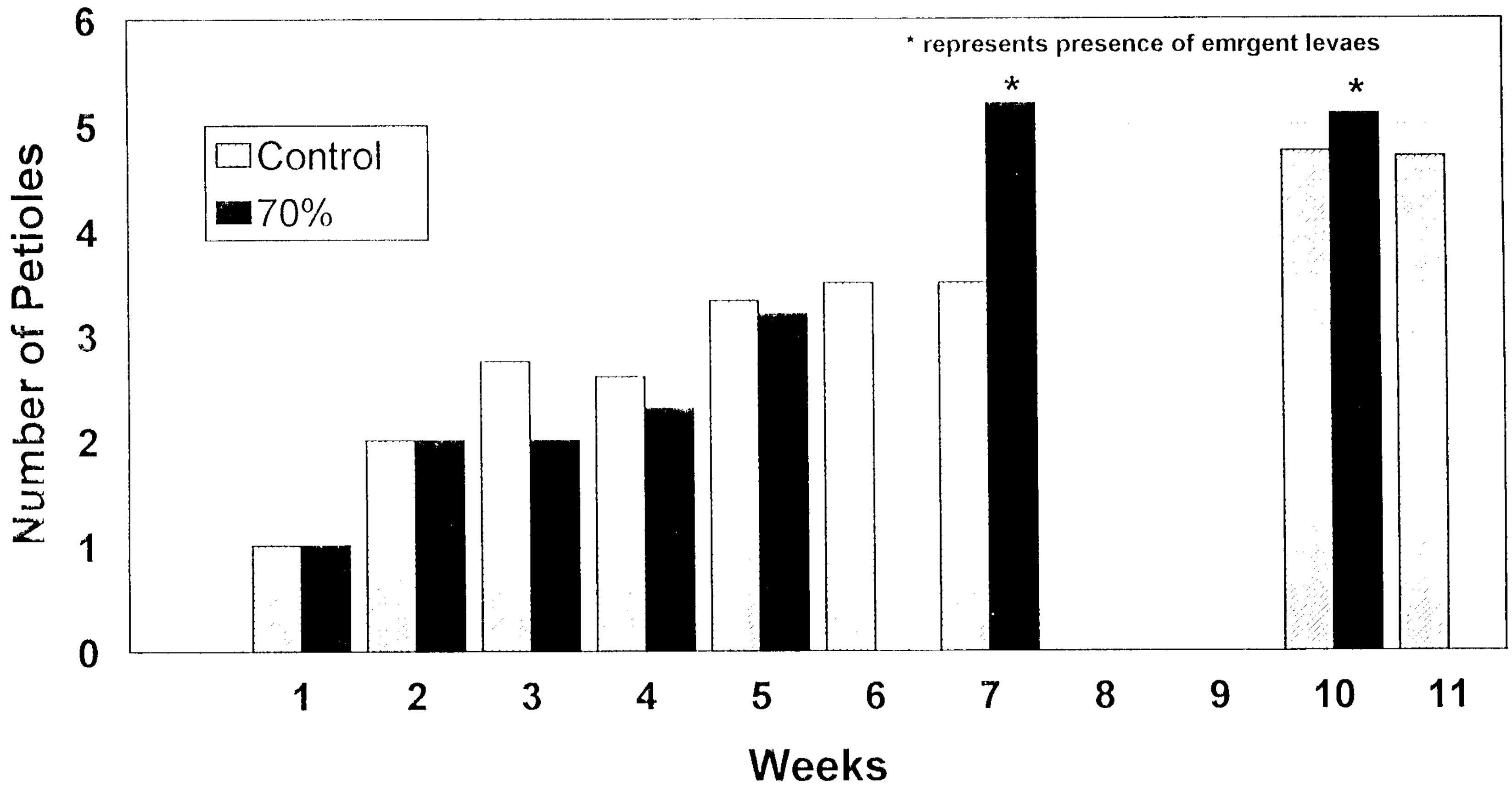


Figure 9. Mean number of Nelumbo lutea petioles produced by week under rduced lightlevels.

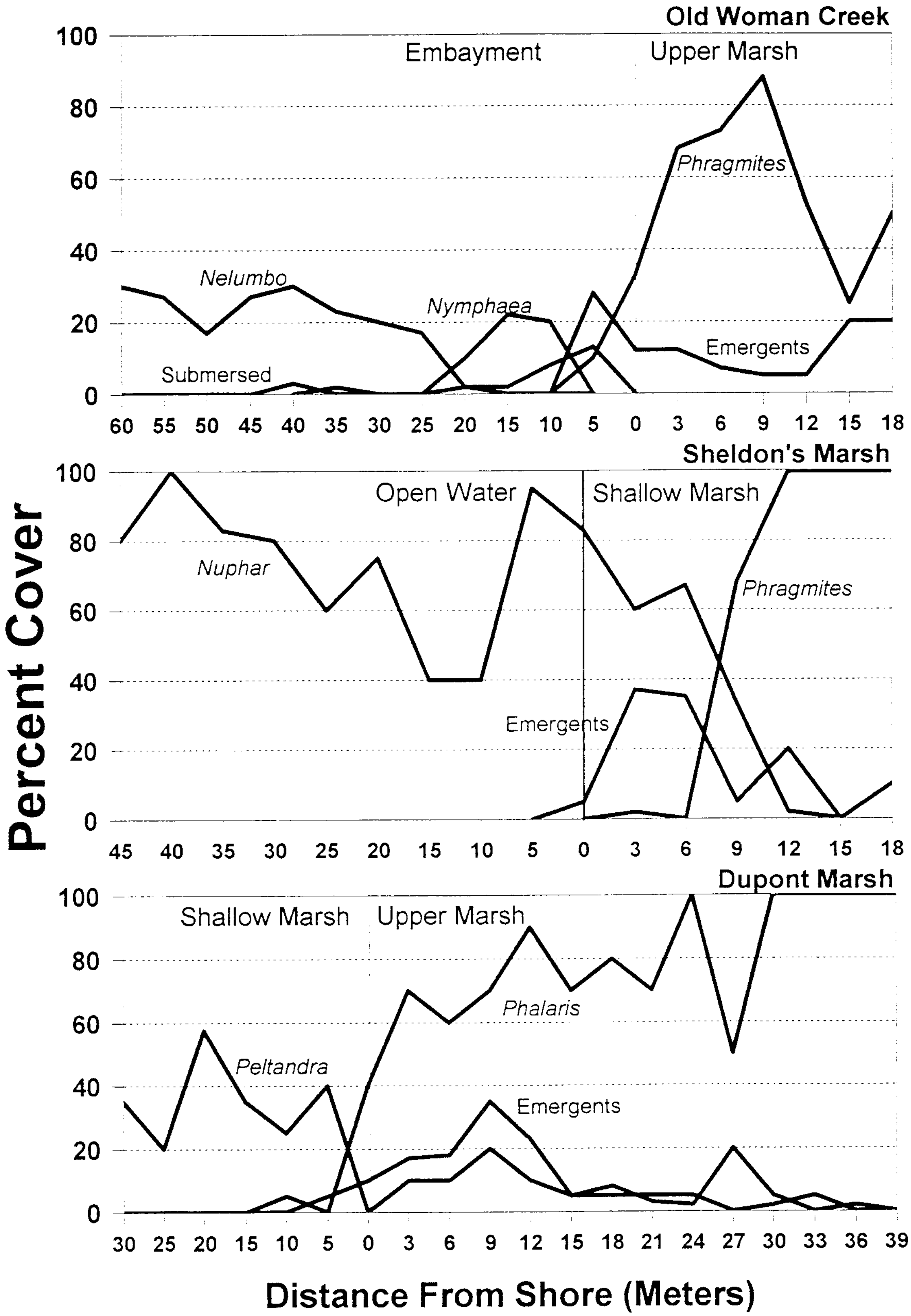
Table 1. Aquatic and wetland plant species observed (along sampled transects) in Old Woman Creek, Dupont Marsh, and Sheldon's Marsh.

Plant Species	OWC	Dupont Marsh	Sheldon's Marsh
Alliaria petiolata		X	
Boehmeria cylindrica	X	X	
Calystegia sepium		X	
Carex sp.		X	
Ceratophyllum demersum	X		X
Cirsium sp.	X		
Eupatorium perfoliatum			X
Hibiscus moscheutos		X	
Impatiens capensis		X	
Iris versicolor	X		
Juncus sp.			X
Lemna minor	X		X
Leersia orzyoides		X	
Lindernia dubia	X		
Lycopus americanus	X		
Lycopus sp.			X
Mentha arvense	X	X	
Myriophyllum spicatum	X		
Nelumbo lutea	X		
Nuphar advena			X
Nymphaea tuberosa	X		
Peltandra virginica		X	
Phalaris arundinacea		X	
Phragmites australis	X	X	X
Pilea pumila	X		
Polygonum amphibium	X	X	X
Polygonum sp.	X	X	X
Potamogeton pectinatus	X		
Potamogeton crispus	X		
Potamogeton foliosus	X		
Rhus radicans	X		
Rhus sp.	X	X	
Sagittaria latifolia	X	X	
Scirpus cyperinus		X	
Scirpus fluviatilis			X
Scutellaria lateriflora		X	X
Sparganium eurycarpum		X	
Spirodela polyrhiza	X		X
Typha sp.		X	X
Urtica dioica		X	
Number of Species	**22**	**20**	**13**

Table 2. Total mean percent cover of the dominant species occurring in Old Woman Creek, Dupont Marsh, and Sheldon's Marsh. Numbers in parentheses represent percent cover (based on sample plots in which the species occurred), and percent occurrence in sample plots, respectively.

	Wet Meadow/Shallow Marsh (% Cover)			Open Water (% Cover)	
Species	OWC	Dupont	Sheldon's	OWC	Sheldon's
C. demersum				<1(<10/11)	
L. minor			<5(<5/37)	<5(<5/67)	<5(5/89)
N. lutea				16(58/28)	
N. advena			38(56/68)		70(80/83)
N. tuberosa				5(20/22)	
P. arundinacea		60(82/73)			
Polygonum sp.		<5(5/38)	<1(8/8)		
P. australis	55(55/100)	<5(12/12)	48(83/58)		
P. pectinatus				<1(<5/17)	
P. virginica		12(20/63)			
S. latifolia		<5(9/18)			
S. fluviatilis			<5(20/21)		
S. polyrhiza					<5(<5/22)
Typha sp.		<1(8/8)			

Figure 1. Vegetation profiles depicting percent cover of the dominant species and groups of other species comprising the aquatic and wetland vegetation.



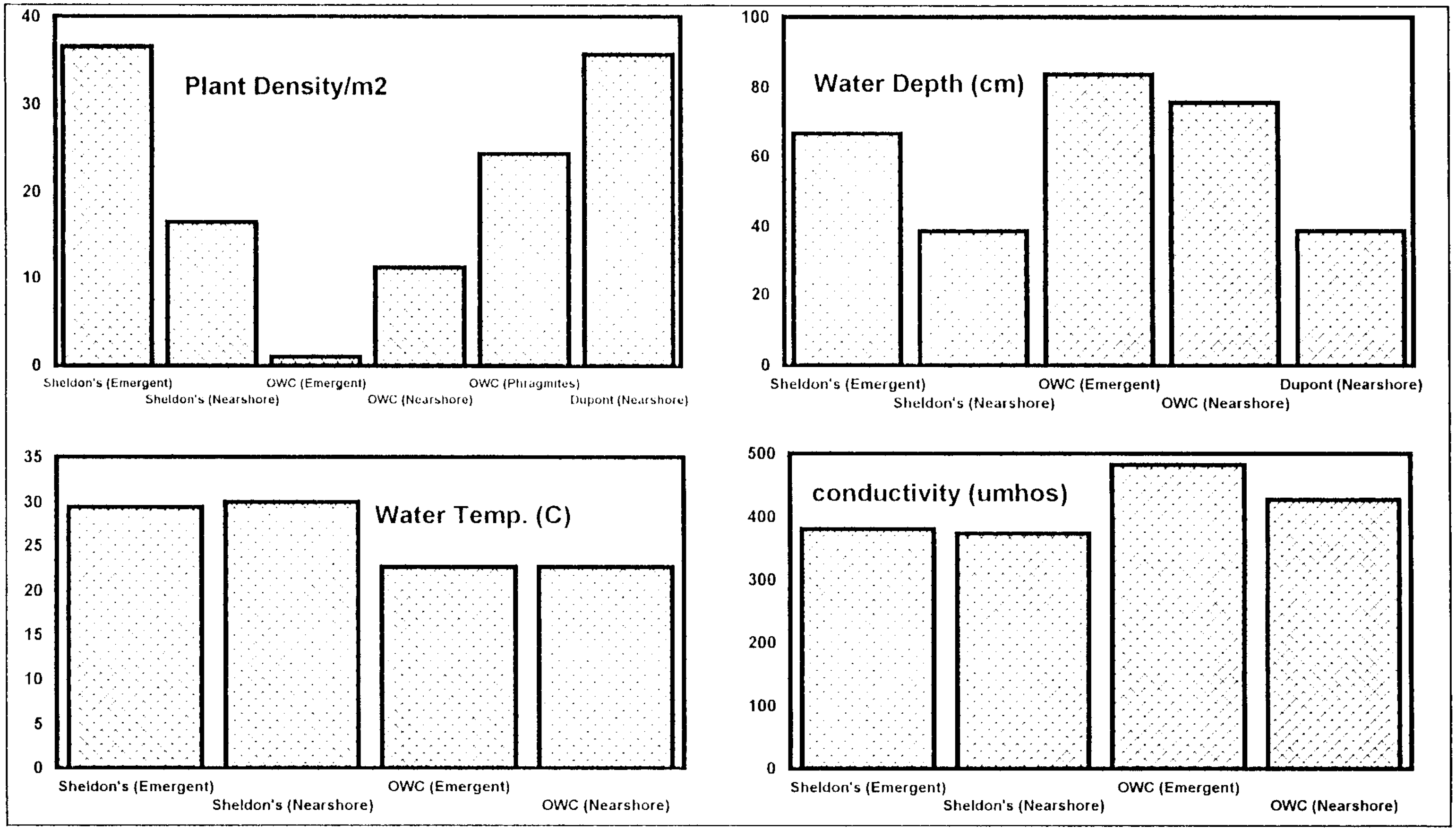


Figure 2. Plant density, water depth, water temperature and conductivty measure in three Lake Erie coastal wetlands.

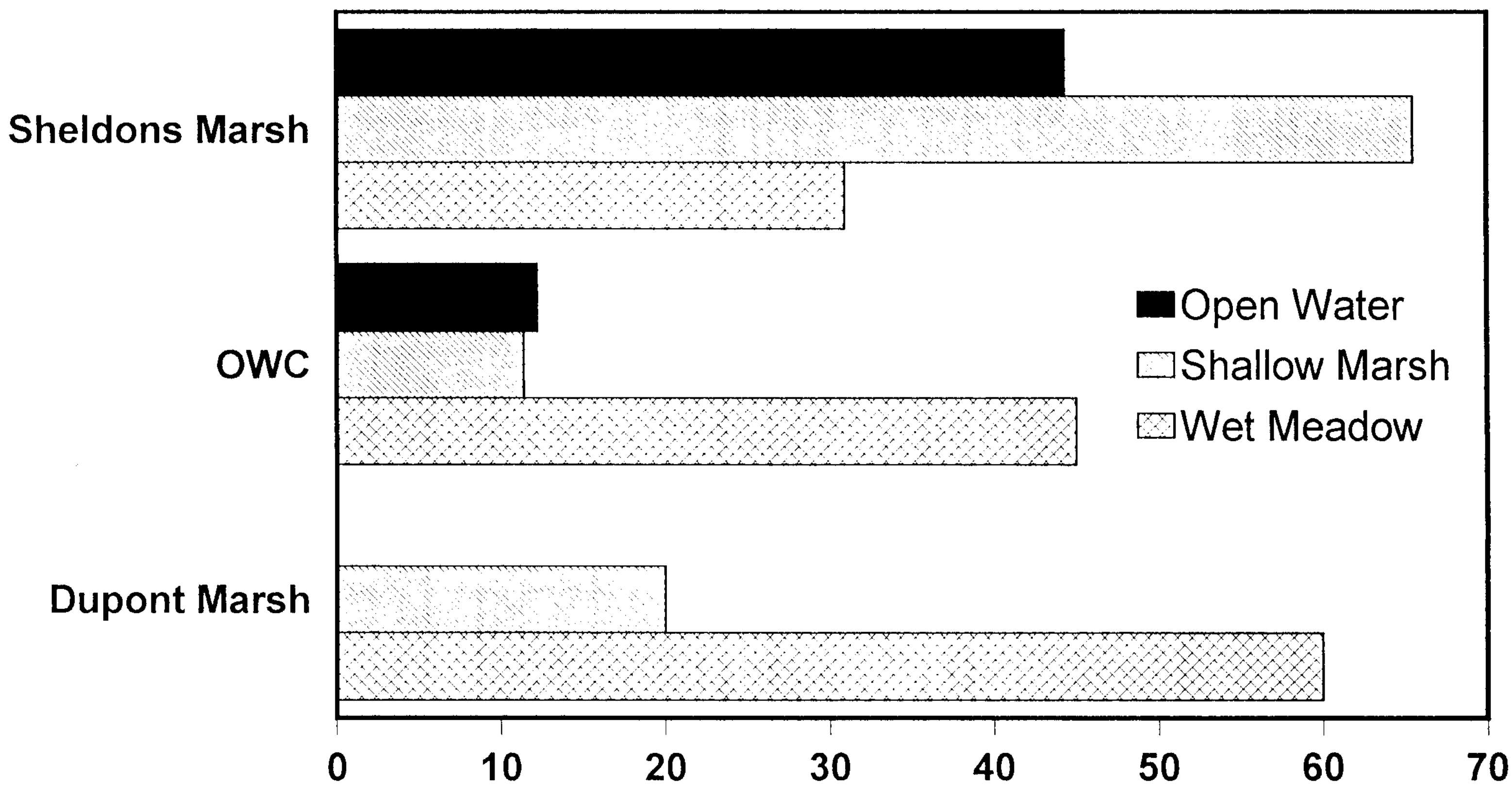


Figure 3. Mean percent cover of aquatic vegetation by habitat type among wetlands.

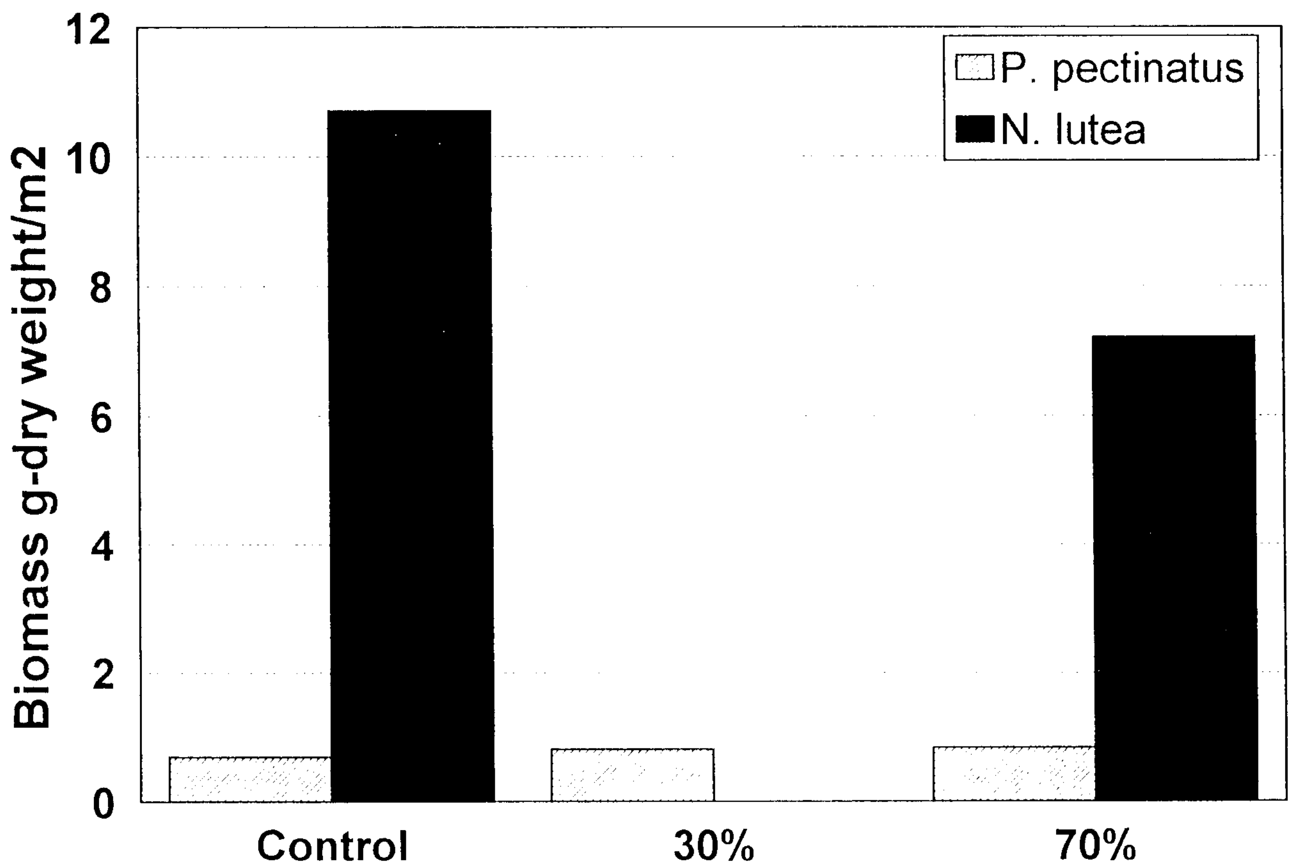


Figure 7. Dry weight biomass of Potamogeton pectinatus and Nelumbo lutea when grown under levels of reduced light in the greenhouse.

Abstracted Papers Supported by LEPF Small Grant SG 98/96

Francko, D.A., Whyte, R.S., Vance, H., and K. DeGroft. 1997. Biotic and abiotic factors affecting patch dynamics in wetland communities dominated by Nelumbo lutea (American lotus). ASB Bulletin 44:92. Annual Meeting, Association of Southeastern Biologists, Greenville, SC.

Francko, D.A., Whyte, R.S., Vance, H., and K. DeGroft. 1997. Biotic and abiotic factors Affecting species composition and patch dynamics in Great Lakes coastal wetlands dominated by American lotus. Amer. J. Bot. (Suppl.) 84:80. Annual Meeting, Botanical Society of America.

Francko, D. and R. Whyte. 1998. Dynamics of invasive macrophyte species in the Old Woman Creek wetland, Huron, OH. Annual meeting, Ohio Acad. Sci.

Francko, D., Whyte, R., Martz, T., Cesarov, S., and Merrill, C. 1998. Wetland vegetation in Western Lake Erie: Abiotic versus biotic factors. International Congress on Ecology, Florence, Italy.

Francko, D. and R. Whyte. 1998. Dynamics of invasive versus established macrophyte species in the Old Woman Creek wetland, Huron, OH. Annual Meeting, Internat. Assoc. Great Lakes Res, Hamilton, Ontario.

Cesarov, S., Francko, D. and Whyte, R. 1998. Factors affecting macrophyte community composition along the Ohio Lake Erie shoreline. Annual meeting, Ohio Acad. Sci.

Merrill, C., Francko, D., and Whyte, R. 1998. American lotus as an ecological keystone species in the Old Woman Creek wetland, Huron, OH. Annual meeting, Ohio Acad. Sci.