A Survey of Phytoplankton Taxa from Three Types of Wetlands in Ohio[1]

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Abstract. **In an effort to better understand the broad heterogeneity of different wetlands, we sampled the phytoplankton communities from three types of wetlands (constructed, non-impacted, and temporary) in Ohio. During the summer of 1995, one phytoplankton sample from each of 18 wetlands was collected in order to describe and compare the phytoplankton communities. No significant differences were evident in species richness, J's evenness, and Shannon-Wiener (H') diversity indices among the three classes of wetlands. In addition, there were no significant differences in the total abundance of any algal division among the wetland types. Large variability in the total abundance of algal divisions within each wetland type was observed. Trend detection may have been masked by limitations of the one-time sampling regime. Nonetheless, this study provides a preliminary taxonomic listing of the phytoplanktonic algae from the three wetland types.**

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INTRODUCTION

Wetlands provide many diverse ecosystem functions such as flood prevention (Vymazal 1995), nutrient retention and removal (Wetzel 1990), as well as providing a habitat for many endangered organisms (Sherman and others 1996). Wetland ecosystems are subject to increasing anthropogenic disturbances. For example, Ohio alone has lost more than 98% of its pre-European settlement wetlands due to human impacts (Andreas and Knoop 1992).

Algae are a ubiquitous group of organisms whose members include both prokaryotes (for example cyanobacteria) and eukaryotes (for example diatoms and green algae). They are the primary producers in most aquatic systems and may account for a significant portion of system primary productivity (Vollenweider 1974). The algal community also acts as a biological filter, accumulating and removing nutrients flowing through the system (Cronk and Mitsch 1994).

One feature of wetlands is their diverse algal community whose composition potentially may be used as a way of assessing the level of anthropogenic stress to the system (Lowe and Pan 1996). The purpose of this paper is to describe and compare the phytoplankton communities in three types of wetlands in Ohio. In our study 18 wetlands from eight counties in Ohio were selected and designated as constructed, non-impacted, or temporary. By characterizing the phytoplankton community, long term monitoring may be employed to assess changes in the community from abiotic pressures (for example anthropogenic effects).

MATERIALS AND METHODS

Using National Wetland Inventory maps prepared by the US Department of the Interior Fish and Wildlife Service, 18 sites were chosen (Fig. 1). Detailed site characteristics, including specific locations, are given in Acton (1996). Temporary wetlands were categorized as ephemeral, non-impacted wetlands were sites relatively free of anthropogenic disturbances, and constructed wetlands were designated as having been created within the last five years. Six representatives of each of three wetland types (temporary, non-impacted, and constructed) were sampled between 4-6 August 1995. Physical and chemical data for the sample sites are provided in Table 1. Additional information describing the characteristics of the sample sites and the sampling regime are provided in Acton (1996) and Beaver and others (1998). Triplicate phytoplankton samples from each wetland were collected approximately 10 m from the water/macrophyte interface at a depth ranging from 13-60 cm. The samples were then pooled on shore.

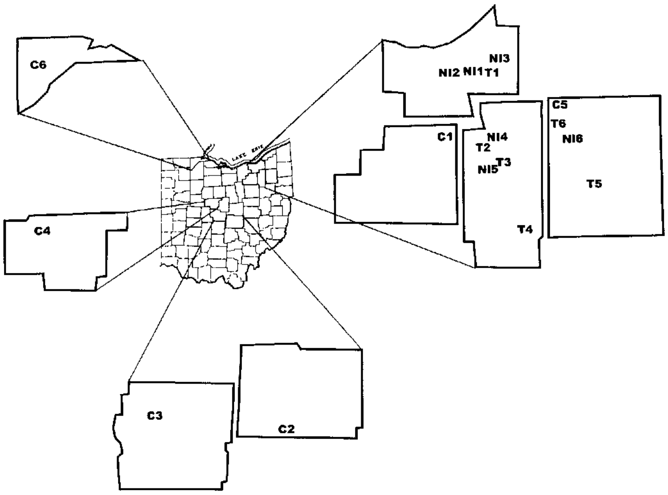

Figure 1. Location of the 18 wetland sites (T1-6 = temporary, NI1-6 = non-impacted, C1-6 = constructed).

Phytoplankton samples were preserved with Lugol's solution. Quantification of algal densities was performed using standard counting techniques (APHA 1985). The samples were mildly homogenized using a magnetic stirrer and subsequently, appropriate aliquots were filtered through type HA 0.45-µm polycarbonate filters.

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TABLE 1

Physical and chemical parameters of the three types of wetlands.

Site	County	Wetland Type	Depth (cm)	Chl *a* (μg/m^3)	pH	T°	D.O. (mg/L)
T1	Cuyahoga	Temporary	29.0	2.53	7.0	23.2	4.4
T2	Summit	Temporary	23.0	44.08	7.2	21.2	2.5
T3	Summit	Temporary	35.0	8.66	7.2	19.0	4.7
T4	Summit	Temporary	13.0	20.17	7.5	24.8	3.3
T5	Portage	Temporary	20.0	39.79	7.0	24.0	5.4
T6	Portage	Temporary	13.0	35.79	6.9	22.8	3.3
NI1	Cuyahoga	Non-impacted	30.0	6.01	7.6	25.8	4.1
NI2	Cuyahoga	Non-impacted	46.0	9.04	7.6	27.5	8.2
NI3	Cuyahoga	Non-impacted	48.2	5.27	7.2	22.4	1.8
NI4	Summit	Non-impacted	61.0	1.52	7.2	22.6	7.2
NI5	Summit	Non-impacted	76.0	9.98	7.3	25.3	10.4
NI6	Portage	Non-impacted	15.0	14.52	7.2	25.4	2.7
C1	Medina	Constructed	51.5	92.13	7.0	21.2	0.1
C2	Licking	Constructed	15.0	88.35	6.9	21.6	5.2
C3	Franklin	Constructed	61.0	22.38	7.0	28.0	6.0
C4	Marion	Constructed	32.4	27.83	7.0	24.2	0.8
C5	Portage	Constructed	18.0	4.48	6.9	26.9	4.2
C6	Lucas	Constructed	38.4	16.81	7.0	25.2	2.0

Filters were then placed on slides with immersion oil and allowed to dry. A minimum of 30 fields per slide were counted, and a minimum of 400 algal cells were enumerated. Identifications followed Smith (1950), Patrick and Reimer (1966, 1975) and Prescott (1962). One-way analysis of variance (ANOVA) tests were performed to determine significant ($p<0.05$) differences among the three wetland types.

RESULTS AND DISCUSSION

Physical and chemical site characteristics are presented in Table 1. In general, limited statistically significant differences between wetland site physical and chemical characteristics were observed among the wetland types (Beaver and others 1998).

A total of 58 taxa from six different divisions were identified from the 18 wetlands (Table 2). Relative densities of algal taxa by wetland type are reported in Acton (1996). Bacillariophyta (diatoms) and Chlorophyta (green algae) dominated in terms of species richness and accounted for 67% of the total number of taxa. Several algal divisions were more diverse within some wetland types. For example, twice as many chlorophyte genera occurred in the constructed wetlands as in temporary ones.

Cyanophytes comprised the greatest percentage of phytoplankton abundance in all three wetlands (Table 3). Cyanophyte dominance was most pronounced in constructed wetlands (88.6%). Cryptophytes were also prevalent in temporary wetlands. Other algal divisions contributed little to overall abundance. Bacillariophytes in all three wetland types and chlorophytes in non-impacted wetlands did have a greater number of

TABLE 2

Number of times each phytoplankton taxon was recorded and mean species richness, evenness, and Shannon-Wiener diversity (H') for phytoplankton communities within each of three wetland types. Final cell densities can be found in Acton 1996.

	Wetland type		
Algal taxa	Temporary no. of occurences (n = 6)	Non-impacted no. of occurences (n = 6)	Constructed no. of occurences (n = 6)
Bacillariophyta (18 taxa)			
Acnanthes lanceolata	2	2	1
Amphora ovalis	2	0	0
Centrics unidentified	2	3	3
Cocconeis placentula	5	3	2
Cyclotella spp.	4	4	4
Cymbella minuta	3	4	3
Eunotia pectinalis	0	2	0
Fragilaria crotonensis	0	0	1
Gomphonema olivaceum	0	1	2
Gyrosigma acuminatum	3	1	2
Melosira spp.	0	1	1
Navicula spp.	6	6	5
Nitzschia spp.	1	0	0
Pennates unidentified	5	5	5
Pinnularia sp.	4	5	6
Rhoicosphenia curvata	3	2	2
Rhopalodia gibbera	1	0	0
Synedra ulna	0	1	3
Total representation	41	40	40
Chlorophyta (20 taxa)			
Characium sp.	1	1	0
Chlamydomonas globosa	2	3	4
Chlamydomonas pseudopertyi	0	1	0
Chlorella ellipsoidea	0	0	1
Closterium lunula	2	4	3
Cosmarium sp.	0	0	2
Dictyosphaerum pulchellum	0	0	1
Kirchniriella lunaris	0	1	0
Micrasterias radiata	0	1	0
Microspora floccosa	0	1	0
Pediastrum duplex	1	0	0
Pediastrum tetras	0	1	0
Rhizoclonium hieroglyphicum	0	0	2
Scenedesmus bijuga	3	2	4
Scenedesmus dimorphus	0	0	2
Scenedesmus quadricauda	2	1	2
Sphaerocystis schroeteri	0	0	1
Spirogyra sp.	0	1	0
Tetraedon sp.	0	1	1
Tetraedon gracile	0	0	1
Total representation	9	14	20
Cryptophyta (2 taxa)			
Cryptomonas erosa	6	6	4
Cryptomonas ovata	6	6	6
Total representation	14	16	14
Cyanophyta (7 taxa)			
Anabaena circinalis	0	1	0
Anabaena sp.	3	3	4
Aphanocapsa elachista	1	0	0
Chroococcus spp.	2	0	4
Oscillatoria spp.	4	6	5

TABLE 2 (CON'T.)

	Wetland type		
Algal taxa	Temporary no. of occurences (n = 6)	Non-impacted no. of occurences (n = 6)	Constructed no. of occurences (n = 6)
Phormidium spp.	0	1	0
Spirulina Nordstedtii	0	0	1
Total representation	10	11	14
Pyrrhophyta (3 taxa)			
Ceratium hirundinella	0	0	1
Peridinium cinctum	0	1	0
Peridinium sp.	0	0	2
Total representation	1	2	6
Euglenophyta (8 taxa)			
Euglena sp.	2	2	2
Euglena elongata	0	1	0
Euglena proxima	3	4	2
Euglena spirogyra	2	2	3
Phacus longicauda	1	1	1
Phacus tortus	1	0	0
Trachelomonas hispida	2	4	6
Trachelomonas horrida	0	1	1
Total representation	8	11	13
Total species richness	15.7 (± 1.6)	15.5 (± 1.4)	17.7 (± 1.2)
Total species evenness	0.6 (± 0.1)	0.6 (± 0.1)	0.5 (± 0.1)
Shannon-Wiener diversity (*H'*)	1.2 (± 0.2)	0.9 (± 0.2)	1.0 (± 0.2)

individual taxa than the other algal divisions.

One-way ANOVAs for each division indicated that there were no significant ($p<0.05$) differences between the relative abundances of any algal division among the wetland types. One possible reason for this lack of significance may be the heterogeneity of the samples. Within individual wetland types, not all divisions were always present. For example, the relatively large mean abundance of cryptophytes observed in temporary wetlands resulted from two sites with significant blooms. Conversely, the other four wetlands had very few cryptophytes present. This variability, coupled with our limited sample size, may mask some significant differences. Similarly, species richness, J's evenness (Pielou 1966), and Shannon-Wiener (H') diversity indices (Shannon and Weaver 1949) were not significantly different (Table 2). This implies that, taken as a whole, the taxonomic organization of the phytoplankton communities in the different types of wetlands was not distinguishable from each other.

Principal Component Analysis (PCA) was performed using the abundances of the six algal divisions as variables in an attempt to detect and summarize linear relationships in the data set (UNISTAT 1997). The resulting eigenvalues indicated that three components explained 80% of the variance in the data. The first component (43%) had a high positive loading on cryptophyte abundance. The second (22%) and third components (15%), respectively, had high positive loadings on the abundances of pyrrophytes and bacillariophytes. We subsequently performed cluster analyses (squared Euclidean) on the community composition for both the three factor model indicated by the PCA and the six factor (all algal divisions) model. The resulting dendrogram differed little; and in this paper we report the cluster analysis based on the six factor model (Fig. 2). Four of the six temporary wetlands clustered closely with each other as did four of the non-impacted sites, suggesting that phytoplankton communities in some of these wetland types were similar. The remaining wetlands did not show any specific clustering pattern demonstrating that considerable variability existed in phytoplankton abundance at the division level of community organization in some of the wetland sites. We also performed a PCA and cluster analysis based on the abundance of algal genera. The resulting dendrogram demonstrated poor grouping by wetland classification.

TABLE 3

Percentage abundances of the algal divisions for the three types of wetlands. The ranges of percentages are in parentheses.

Division	Temporary	Non-impacted	Constructed
Bacillariophyta	2.9% (1.3-6.3)	2.5% (0.4-7.9)	6.1% (1.8-13.2)
Chlorophyta	0.2% (0.1-3.1)	14.9% (3.2-34.9)	0.6% (0.2-3.6)
Cryptophyta	40.8% (0.0-74.3)	8.4% (0.0-21.4)	4.0% (0.0-13.4)
Cyanophyta	56.0% (21.6-88.4)	74.0% (27.9-94.6)	88.6% (57.4-93.8)
Pyrrophyta	0.0% (0.0-0.8)	0.0% (0.0-0.3)	0.0% (0.0-0.1)
Euglenophyta	0.1% (0.0-0.9)	0.3% (0.0-0.7)	0.6% (0.0-3.1)

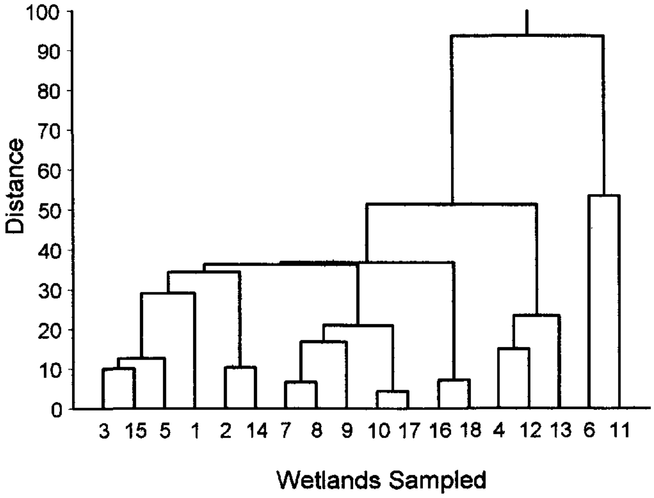

FIGURE 2. A squared Euclidean average between groups cluster dendrogram comparing the average algal abundance by divisions between individual wetlands. Wetlands 1-6 correspond to temporary sites (T1-6), 7-12 to non-impacted wetlands (NI 1-6,) and wetlands 13-18 to constructed sites (C1-6).

One benefit of taxonomic knowledge is in the establishment of indicator species which can be trophic indicators used to assess the "state" or "health" of a system (for example, Williams and others 1996; Resh and others 1996). Algae may be ideal indicators in aquatic systems because of their ubiquitous distribution and rapid response to variable environmental stresses (Hutchison 1967). Several taxa of algae, most notably the diatoms and cyanophytes (blue-green algae) are often used as water quality indicators in freshwaters (Lowe and Pan 1996). The community composition from our single sampling event did not suggest any key indicator species. While the diatoms and greens were the most common phytoplankton taxa, their representatives tended to fall within the range of organisms considered benign, or oligotrophic indicators. Cyanophyte taxa, often indicative of eutrophic conditions, were not very diverse during our study but were the numerical dominants in all wetland classifications. The dominant genus in terms of abundance and biovolume across all wetlands classifications was *Oscillatoria* (Beaver and others 1998). The importance of cyanophytes in these wetland systems was likely related to higher temperatures and low nutrient conditions typical of temperate regions in late summer (Wetzel 1983). Both phosphorus limitation and zooplankton grazing have been suggested as factors structuring the taxonomic composition of phytoplankton communities in these wetlands (Beaver and others 1998).

Our study design limits interpretation. Seasonal variations in wetland phytoplankton community structure were not addressed in the one-time sampling regime. The use of filters in our analyses may prove problematic because some cyanophytes and cryptophytes may be easily distorted after vacuum filtering. As such, some of our identifications were only to the genus level, perhaps masking the presence of some potential indicator species. Despite these limitations, these data provide a valuable preliminary characterization of the phytoplankton community assemblage in these categories of wetlands in Ohio. Further study is needed to better describe the temporal variations in the phytoplankton communities of Ohio wetlands and the importance of zooplankton grazing and anthropogenic stresses on community organization.

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