# Diatom Communities in the Cuyahoga River (USA): Changes in Species Composition Between 1974 and 1992 Following Renovations in Wastewater Management[1]

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**ABSTRACT. Periphytic diatom communities along the Cuyahoga River were analyzed for possible changes in species composition resulting from improvements in wastewater management within the river basin during the past 18 years. The results, compared to a similar study conducted in 1974, and controlled for seasonality and microhabitat effects, show an increase in total diatom species (75 to 105), especially pollution-sensitive species, and a reduction in pollution-tolerant species—all indications of improved water quality. Reductions were evident in the number and proportion of pollution-tolerant species such as *Gomphonema parvulum*, *Melosira varians*, *Navicula cryptocephala*, *N. pelliculosa*, *Nitzschia communis*, *N. palea*, and *Synedra ulna*. The number and proportion of pollution-sensitive species such as *Achnanthes linearis*, *Amphora pediculus*, *Cocconeis pediculus*, *Diatoma vulgare*, *Navicula tripunctata*, and *Nitzschia dissipata* increased. Despite changes in species composition, headwaters of the river, managed as a domestic water supply and Ohio Scenic River, continue to support 2-3 X more taxa than the lower river below the City of Akron. Substantial degradation of water quality in the lower river persists despite recent restoration efforts. A major source of pollution occurs upstream from the Akron Water Pollution Control facility because sample sites above and below this facility were very similar in diatom species composition, each dominated by *Nitzschia amphibia* (~40%), a well known saprophilic diatom associated with organically polluted water. Overflows from combined stormwater-sanitary sewers, within the Akron metropolitan area are the most probable cause of the continued suppression of diatom species diversity.**

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## INTRODUCTION

In June 1974 periphytic diatoms were identified from several locations along the Cuyahoga River. The purpose of this analysis was to relate species composition and other community-structural parameters to ambient water quality in a river system that was heavily polluted with industrial and domestic wastes in the downstream region, but relatively unpolluted in the headwaters region (Price 1979, Olive and Price 1978). During the past 20 years numerous actions have been taken to eliminate, modify, or reduce wastewater discharges into the Cuyahoga River, particularly into the central and downstream reaches of the river. The major renovations were improvements in sewage treatment from villages and cities along the river. Improvements in pretreating industrial wastewaters and incorporating industrial wastes into city and regional wastewater treatment facilities also were made (Ohio EPA 1993).

Records from chemical-physical water quality monitoring programs of the United States Geological Survey (USGS 1992), the City of Akron (1993), and several smaller municipalities (Ohio EPA 1993) indicate that these renovations in wastewater treatment have resulted in significant reductions in suspended solids, biochemical oxygen demand, and ammonia levels. Water transparency has increased, noxious odors have diminished, and foaming has been eliminated in the lower river. Chemical-physical water quality in the upper region of the river, except for a few areas, has not changed significantly in the past 20 years (City of Akron 1993).

We report here a comparison of diatom species composition from three sites along the Cuyahoga River that were sampled before and after major renovations in wastewater management. We expected the number of diatom taxa to have increased, especially pollution-sensitive species, and the number of organic pollution-tolerant forms to have decreased following the improvements in wastewater management. We also expected that species composition in 1992 at the downstream sites, heavily polluted in 1974, would more closely resemble the relatively unpolluted headwaters sites.

## MATERIALS AND METHODS

### The Study Area

The Cuyahoga River is a relatively small, U-shaped tributary to south central Lake Erie (Fig. 1). The river is approximately 160 km in length and drains 2,100 km$^2$ of land with a mean annual discharge of 23 m$^3$ sec$^1$. The river can be divided into three approximately equal reaches: an upper rural area serving as a municipal water supply, a central region of alternating cascading flows and slow-flowing reservoirs with a highly urbanized and industrialized riparian zone, and a lower region of moderate gradient with a forested riparian zone. The lower region, however, has large inflows of treated sewage, industrial wastes, and raw sewage from overflowing combined stormwater-sanitary sewer systems. The study area has been described in more detail by Olive (1976) and Olive and Price (1978).

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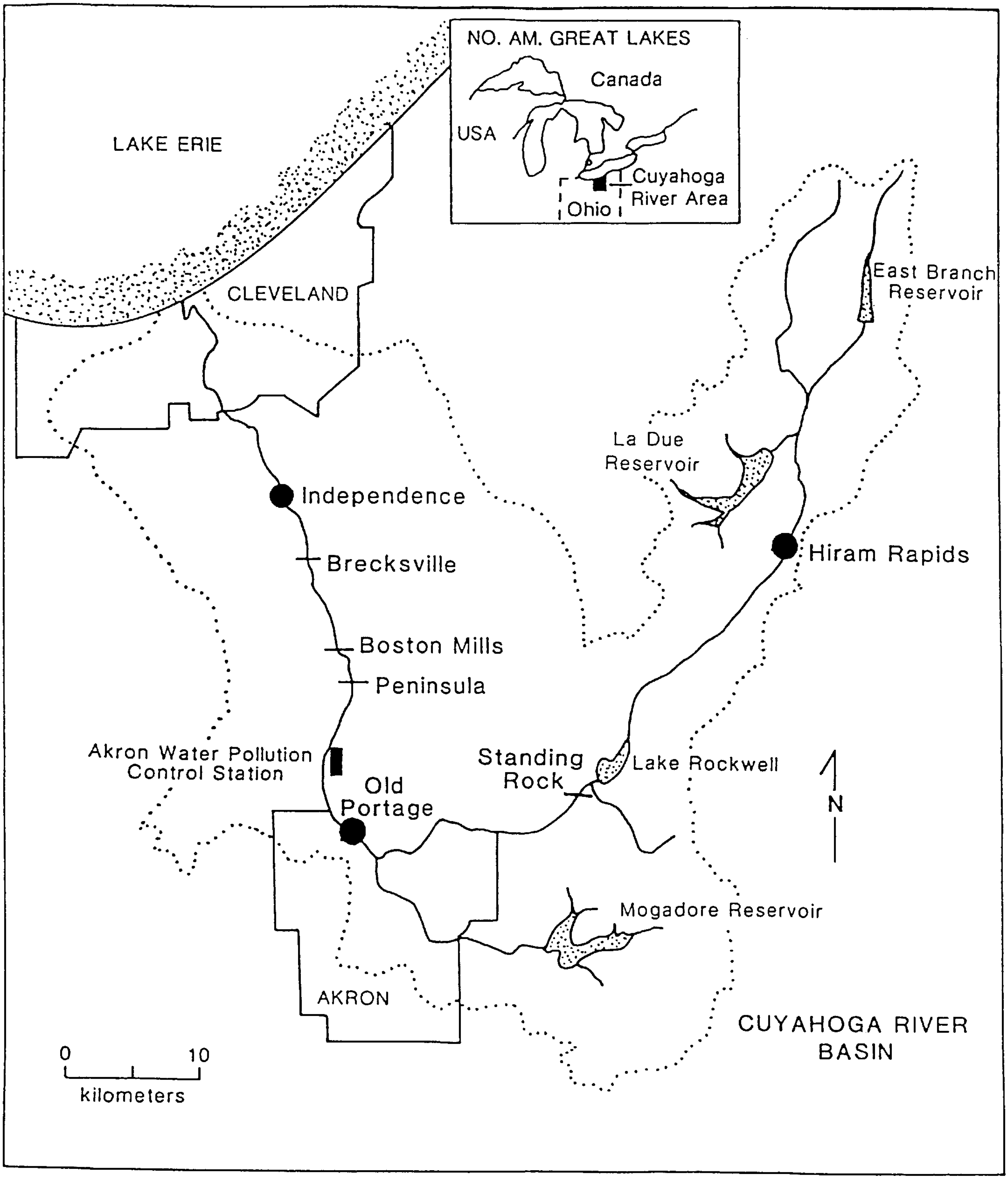


FIGURE 1. The Cuyahoga River showing diatom sample locations at Hiram Rapids, Old Portage, and Independence.

## Collection Sites

Three sites on the Cuyahoga River were selected for study: Hiram Rapids (HR), Old Portage (OP), and Independence (IN) (Fig. 1), representing upper, middle, and lower sections of the Cuyahoga River, respectively. These sites were identical to those sampled in 1974 prior to major improvements in wastewater discharge into the river (Olive and Price 1978). Diatoms were collected from riffle areas at these sites on 10 and 11 June 1992. Collections were made from microhabitats similar to those from which diatoms were collected during the 1974 survey. Microhabitats included the surface of natural rubble (>25 cm diameter) at all three sample locations, *Cladophora* filaments at HR, and *Potomogeton* sp. at OP. No aquatic vascular plants occurred at IN. No obvious changes have occurred in the physical nature of the riffles since 1974, nor have important changes occurred in the species of multicellular aquatic plants growing in these areas.

Bulk samples, i.e. entire pieces of rubble and ~500 ml of aquatic vegetation, from each microhabitat were placed into plastic bags and transported on ice to the laboratory for analysis. A total of seven bulk samples were collected, four from HR, two from OP, and one from IN, representing the number of microhabitats at each location. In the laboratory subsamples from each microhabitat, sufficient to provide in excess of 500 diatoms for microscopic examination, were processed within 12 hours. Artificial substrates of unglazed tile were deployed at each sample site, but they could not be relocated after six weeks exposure, probably because of vandalism or washout.

### Processing Diatoms

Organic matter was removed from diatoms by wet-oxidation in nitric acid and potassium dichromate (Patrick and Reimer 1966). Several drops of cleaned diatoms were placed on cover glasses and dried. Hyrax™ mounting medium was added and the cover glasses with diatoms were placed in the center of a standard microscope slide.

Approximately 500 diatoms per microhabitat from each sample location were counted using a Zeiss microscope equipped with phase contrast optics. Only diatoms with both valves and distinguishing marks visible were counted. Taxonomic references included Hustedt (1930a,b; 1942), Patrick and Reimer (1966, 1975), and Cleve-Euler (1951-1958). Diatoms were identified to the lowest practical taxon, usually to species level and variety although varieties have not been reported here. A complete list of taxa can be obtained from the first author.

### Analysis of Data

The data were evaluated on four criteria: diversity of taxa within each community, percent species composition, similarity in species composition between communities, and environmental requirements of selected water quality "indicator" species. Diversity was based on the number of taxa (species and varieties) present at each sample site. Similarity in species composition between communities was determined from Sorensen's coefficient of community similarity (Sorensen 1948), where $C_s = (2c)/(a + b)$, with a and b representing the total number of taxa in communities A and B, and c representing the number of taxa in common. Environmental requirements for selected taxa were obtained from Patrick and Reimer (1966, 1975), Lowe (1974), Round (1981), and others as indicated.

## RESULTS

One hundred forty (140) taxa of diatoms were collected at HR with 10 taxa each accounting for 2% or greater of the community (Table 1). *Cyclotella meneghiniana* was dominant (most abundant) accounting for 14% of the community. A subdominant group consisting of *Achnanthes lanceolata, Cocconeis pediculus, C. placentula, Cyclotella operculata, Melosira varians, Navicula minima, Navicula salinarum, Navicula tripunctata,* and *Nitzschia palea* comprised an additional 52.3% of the community.

Fifty-five (55) taxa were collected at OP including 10 taxa each accounting for more than 2% of the community. *Nitzschia amphibia* was the dominant (39%) species. *Achnanthes linearis, Amphora pediculus, Cocconeis placentula, Cyclotella meneghiniana, Cyclotella operculata, Navicula minima, N. odiosa, Nitzschia palea,* and *Stephanodiscus astrea* formed a subdominant group making up an additional 37.5% of the community.

Only thirty (30) taxa were collected at IN sample site and only two species, *Nitzschia amphibia* and *Amphora pediculus,* accounted for almost two thirds (65.3%) of the diatom community. *Cyclotella meneghiniana, Navicula viridula, Navicula dissipata, Rhoicosphenia curvata,* and *Stephanodiscus astrea* accounted for an additional 21.4% of the community.

## DISCUSSION

Most water pollutants, especially domestic organic wastes, are known to reduce diatom species diversity by eliminating sensitive species and enhancing reproduction of tolerant species (Patrick 1964). Using these criteria, the results of this study indicate overall improvement in water quality of the Cuyahoga River since 1974. Improvements are greater in the upper river at HR than in the lower river below the City of Akron.

Species diversity (number of taxa) at HR was much greater in 1992 than in 1974 (Fig. 2). Compared to 1974 seven additional taxa in *Achnanthes,* 14 in *Fragilaria,* 22 in *Navicula* and 16 in *Nitzschia* were noted in this study. Species diversity at OP and IN in 1992 was only slightly greater than in 1974. Five additional taxa of *Achnanthes,* 10 in *Navicula,* and three in *Nitzschia* accounted for most of the increase in species diversity in the lower river. Despite these additional taxa in the lower river species diversity remains 2-3 X greater in the upper river, a pattern similar to the situation in 1974 (Fig. 2). Substantial degradation of water quality in the lower river apparently continues despite recent restoration strategies.

Changes in diatom species composition since 1974 reinforces this assessment of water quality along the Cuyahoga River. A cluster diagram (Pielou 1984) of Sorensen's coefficient of community similarity (Fig. 3) indicates striking differences in species composition between years. Since seasonal effects were minimized by comparing samples from June of each year and because the same microhabitats were sampled each year, the differences in species composition can be best attributed to selective effects of changes in water quality between years. Similarity in species composition between sites in 1974 is greater than similarity between sites in 1992, mostly the result of the large increase in

TABLE 1

*Comparison of diatom communities at three sites along the Cuyahoga River for June 1974 and June 1992.* Values are mean percentage composition (number) for all microhabitats.*

| Taxon | Pollution Tolerance** | Hiram Rapids 1974 | Hiram Rapids 1992 | Old Portage 1974 | Old Portage 1992 | Independence 1974 | Independence 1992 |
|---|---|---|---|---|---|---|---|
| *Achnanthes affinis* | 3 | | 0.2 | | | | |
| *A. delicatula* | | | 0.1 | | | | |
| *A. exigua* | | 0.4 | | | 0.2 | | |
| *A. hauckiana* | | 0.5 | 1.7 | | 1.7 | | |
| *A. lanceolata* | 2 | 4.7 | 9.1 | 0.9 | 0.4 | 0.6 | |
| *A. lemmermanni* | | | 0.1 | | | | |
| *A. linearis* | 3 | | 0.2 | | 5.5 | | 1.9 |
| *A. microcephala* | | | | | 0.1 | | |
| *A. stewartii* | | | 0.1 | | | | |
| *A. sublaevis* | | | 0.2 | | 0.2 | | |
| *Amphora pediculus* | 3 | | 0.4 | 4.2 | 2.9 | 0.4 | 24.3 |
| *Anomoeonsis serians* | | | 0.1 | | | | |
| *Asterionella formosa* | | 0.9 | 0.1 | 0.9 | | | 0.2 |
| *Caloneis ventricosa* | | 0.2 | | | | | |
| *Capartogama crucicula* | | 0.2 | 0.1 | | | | |
| *Cocconeis pediculus* | 3 | | 7.9 | 0.2 | | | |
| *C. placentula* | 3 | 10.2 | 5.1 | 3.3 | 3.6 | 0.2 | 0.8 |
| *Coscinodiscus* sp. ? | | | 0.1 | | | | |
| *Cyclotella comta* | | 0.3 | | | 0.8 | | |
| *C. meneghiniana* | | 6.6 | 14.2 | 4.2 | 6.1 | | 3.1 |
| *C. operculata* | | | 3.4 | | 2.1 | | |
| *C. stelligera* | | | 1.2 | | 0.5 | | |
| *Cymatopleura solea* | 2 | 0.2 | 0.1 | | | | |
| *Cymbella microcephala* | | | 0.1 | | | | |
| *C. minuta* | 2 | 1.6 | 1.5 | 0.2 | 0.2 | | |
| *C. sinuata* | | | 0.1 | | 1.5 | | 0.8 |
| *C. triangulum* | | | 0.1 | | | | |
| *C. tumida* | | 0.2 | 0.1 | | | | |
| *Diatoma anceps* | | 0.4 | | | | | |
| *D. tenue* | 2 | 0.5 | | | | | |
| *D. vulgare* | 3 | 0.4 | 0.1 | | 0.2 | | 0.8 |
| *Diploneis puella* | | 0.2 | | | | | |
| *Eunotia pectinalis* | | 0.5 | 0.2 | | | | |
| *Fragilaria brevistrata* | | | 0.1 | | | | |
| *F. capucina* | | | 0.2 | | | | |
| *F. construens* | 3 | 0.7 | 0.4 | | | | |
| *F. crotonensis* | | | 0.6 | | 0.2 | | |
| *F. intermedia* | | | 0.2 | | | | |
| *F. lapponica* | | | 0.1 | | | | |
| *F. leptostauron* | | | 0.1 | | | | |
| *F. vaucheriae* | 2 | 3.0 | | 0.2 | 0.3 | | 0.2 |
| *F. virescens* | | | 0.6 | | | | |
| *Gomphonema angustatum* | 3 | 0.5 | 0.3 | | 0.1 | | |
| *G. olivaceum* | 3 | | 0.1 | 0.2 | 0.8 | | |
| *G. parvulum* | 1 | 2.6 | 1.7 | 2.2 | 0.8 | 0.9 | 0.2 |
| *G. subclavatum* | | | 0.1 | | | | |
| *Gyrosigma distortum* | | | 0.1 | | | | |
| *G. obtusatum* | | | | | | | 0.2 |
| *G. spencerii* | | 0.2 | | | | | |
| *Hantzschia amphioxys* | | | 0.1 | 0.2 | | | |
| *Aulacoseira ambigua* (=*Melosira ambigua*) | | | | 1.7 | | | |
| *Melosira clavigera* | | | 0.1 | | | | |
| *Aulacoseira distans* (=*Melosira distans*) | | | | 3.1 | | | |
| *A. granulata* (=*Melosira granulata*) | | | 0.7 | | | | |
| *Melosira varians* | | 6.8 | 9.8 | 1.1 | | | |
| *Meridion circulare* | | 3.3 | 0.6 | | | | |
| *Navicula arvensis* | | 0.5 | 0.1 | | | | |
| *N. biconica* | | | 0.1 | | | | |
| *N. capitata* | 2 | 0.4 | 0.5 | 0.2 | | | |
| *N. cryptocephala* | 1 | 8.5 | 1.6 | 7.6 | 1.4 | 5.2 | |
| *N. cuspidata* | 2 | 0.2 | | | | | |
| *N. declivis* | | | 0.1 | | | | |
| *N. elegensis* | | | 0.3 | | | | |
| *N. exigua* | | 0.2 | | 0.2 | | | |
| *N. festiva* | | | | | 0.1 | | |
| *N. gastrum* | | 0.2 | | | | | |

TABLE 1 (Continued)

| Taxon | Pollution Tolerance** | Hiram Rapids | | Old Portage | | Independence | |
|---|---|---|---|---|---|---|---|
| | | 1974 | 1992 | 1974 | 1992 | 1974 | 1992 |
| *N. graciloides* | | | 0.2 | | 0.1 | | |
| *N. gysingensus* | | 0.7 | | | | | |
| *N. halophila* | | | 0.2 | | | | |
| *N. hambergii* | | | 0.2 | | | | |
| *N. integra* | | 0.2 | | | | 0.2 | |
| *N. lanceolata* | | 7.6 | 0.7 | 3.5 | | 0.6 | 0.6 |
| *N. menisculus* | | 0.4 | 1.3 | 1.7 | 1.4 | | |
| *N. microcephala* | | | 0.2 | | | | |
| *N. minima* | | 3.7 | 9.0 | 0.4 | 4.6 | 0.7 | 1.2 |
| *N. minuscula* | | 0.7 | 0.1 | 14.6 | 0.5 | 65.1 | 0.2 |
| *N. minnewaukonensis* | | | 0.1 | | | | |
| *N. mutica* | 3 | 1.0 | 0.6 | | | | |
| *N. notha* | | | 1.7 | | 0.1 | | |
| *N. odiosa* | | 0.2 | 0.5 | | 5.1 | | 0.8 |
| *N. orbiculata* | | | 0.1 | | | | |
| *N. pelliculosa* | 1 | 1.2 | | 0.9 | | 14.9 | |
| *N. placentula* | | | 0.1 | | | | |
| *N. protracta* | | | 0.1 | | | | |
| *N. pupula* | 2 | 2.1 | 0.2 | 0.4 | | | |
| *N. radiosa* | | | 0.1 | | 1.7 | | |
| *N. rheinhardtii* | | | 0.1 | | | | |
| *N. rhyncocephala* | 3 | 0.7 | 1.5 | | 0.1 | | |
| *N. salinarum* | 2 | 1.0 | 2.8 | 0.2 | 0.5 | | 0.6 |
| *N. secreta* | 2 | | | | 0.6 | | 1.9 |
| *N. symetrica* | | 0.7 | | 0.4 | | 0.2 | |
| *N. tripunctata* | 3 | 0.2 | 2.1 | | 0.4 | | 0.2 |
| *N. viridula* | | | 0.7 | | 1.7 | | 3.5 |
| *Nitzschia acicularis* | | 1.7 | 0.5 | | 0.1 | 0.2 | |
| *N. acuta* | | | 0.2 | | | | |
| *N. amphibia* | 2 | | 0.7 | 1.5 | 38.9 | 0.6 | 41.0 |
| *N. angustata* | | | 0.1 | | | | |
| *N. baccata ?* | | | 0.1 | | | | |
| *N. communis* | 1 | 0.2 | | 0.9 | | | |
| *N. dissipata* | 3 | 1.4 | 0.1 | | 1.1 | 0.6 | 2.5 |
| *N. epiphytica* | | | | | 1.4 | | 0.2 |
| *N. filiformis* | 2 | | 0.1 | | | | |
| *N. fonticola* | 3 | | 1.6 | | 0.2 | | |
| *N. frustulum* | 3 | | 0.1 | | | | |
| *N. hungarica* | | | | 0.2 | | 2.8 | |
| *N. kutzingiana* | | | 0.2 | | | | |
| *N. lacunarum* | | 1.6 | | 7.6 | | 1.9 | |
| *N. linearis* | 3 | 0.5 | | | | | |
| *N. obtusa* | | | | 0.4 | | | |
| *N. ovalis* | | | | 1.5 | | 0.4 | |
| *N. palea* | 1 | 9.4 | 3.1 | 6.3 | 2.2 | 2.1 | 1.2 |
| *N. philliparum ?* | | | 0.1 | | | | |
| *N. parvula* | | | | 0.2 | | | |
| *N. recta* | | | | 0.4 | | | |
| *N. sublinearis* | 3 | 0.4 | | | | | |
| *N. subtilis* | | | 0.1 | | | | |
| *N. tryblionella* | 2 | 1.2 | 0.2 | | | 0.2 | |
| *N. vermicularis* | | 0.4 | | | | | |
| *N. vivax* | | | 0.2 | | | | |
| *Opephora martyi* | | 0.7 | 0.4 | | 0.1 | 0.4 | |
| *Pinnularia subcapitata* | | 0.4 | | 0.2 | | | |
| *Rhoicosphenia curvata* | 3 | 0.9 | | 23.8 | 1.8 | 0.6 | 9.2 |
| *Stauroneis smithii* | | 0.2 | | | | | |
| *Stephanodiscus astrea* | | 3.0 | 1.9 | 3.9 | 5.4 | 0.9 | 3.1 |
| *S. hantzschii* | | | 0.6 | | 0.8 | | 0.2 |
| *S. niagarae* | | 0.2 | | | | | |
| *Surirella angustata* | | 0.2 | 0.1 | 0.4 | | | |
| *S. ovata* | | 0.2 | 0.6 | 0.4 | 0.3 | 0.6 | 0.4 |
| *S. tenera ?* | | | 0.1 | | | | |
| *Synedra amphicephala* | | | 0.3 | | | | |
| *S. fasciculata* | | | 0.1 | | | | |
| *S. parasitica* | 2 | 0.5 | 0.2 | | | | |
| *S. radians* | | | 0.1 | | | | |
| *S. rumpens* | | 1.9 | 0.4 | | | | |
| *S. ulna* | 1 | 0.2 | | 0.2 | | | |

*Species varieties and species distinguished as "different," but for which a name could not be assigned, have been omitted.
**From Lange-Bertalot (1979): 1 - tolerant, 2 - moderately tolerant, 3 - intolerant

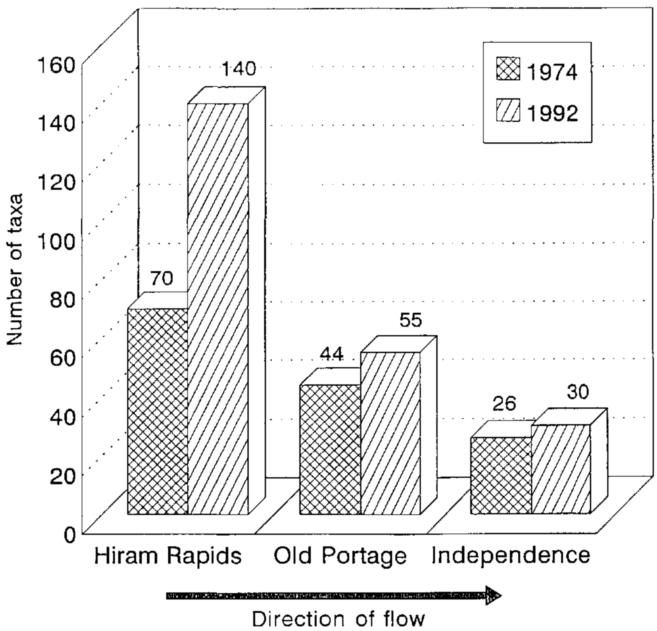


FIGURE 2. Comparisons of the number of diatom species found at three sites along the Cuyahoga River in 1974 and 1992. HR - Hiram Rapids, OP - Old Portage, IN - Independence.

numbers of species at HR since 1974. Similarity is highest between OP and IN in 1974 and in 1992. In both years, however, very little similarity is evident between HR and downstream sites. Since OP and IN are so similar and OP is located upstream from the City of Akron Water Pollution Control Facility (Fig. 1), major sources of water pollution occur between HR and OP, probably from the Little Cuyahoga River.

Species composition at each sample site has changed since 1974 from greater numbers of eutrophic and pollution-tolerant species to more oligotrophic and pollution-sensitive species (Table 2). Based on Lange-Bertalot's (1979) pollution-tolerance indexes for selected species, the number of pollution-tolerant taxa has declined since 1974 at all sample locations, while the number of pollution-sensitive taxa has increased (Table 2). Pollution-sensitive taxa are most numerous at HR and least numerous at OP and IN, a pattern similar to the situation in 1974.

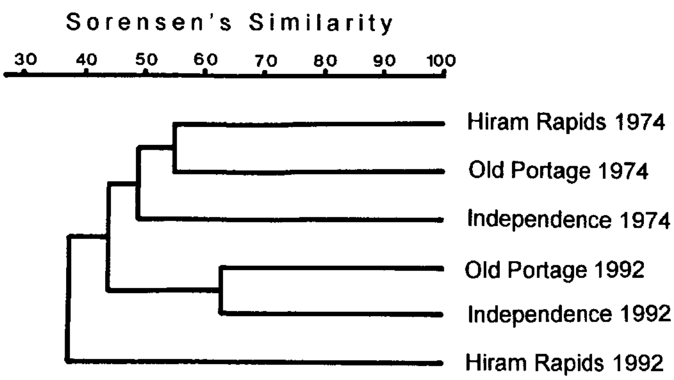


FIGURE 3. Cluster diagram (Pielou 1984) of Sorensen's coefficient of community similarity (Sorensen 1948) between sample sites along the Cuyahoga River in June 1974 and June 1992. HR - Hiram Rapids, OP - Old Portage, IN - Independence.

At HR in 1974, six of the eight dominant (>5%) diatoms including *Achnanthes lanceolata*, *Cyclotella meneghiniana*, *Navicula cryptocephala*, *Navicula minima*, *Nitzschia palea*, and *Melosira varians*, were pollution-tolerant species (Lowe 1974, Lange-Bertalot 1979). In 1992, only three of the six dominant taxa were pollution-tolerant forms.

The proportion of many pollution-tolerant diatoms in each community, including *Gomphonema parvulum*, *Navicula cryptocephala*, *Navicula pelliculosa*, *Navicula communis*, and *Nitzschia palea*, have declined since 1974 at all sites along the river. The disappearance of *Navicula pelliculosa* at IN in 1992 and the decline of *Navicula minuscula*, a probable pollution-tolerant diatom, in the lower river are especially noteworthy indications of improved water quality in this region. In contrast to the decline of pollution-tolerant diatoms, many pollution-sensitive species, including *Achnanthes affinis*, *Achnanthes linearis*, *Amphora pediculus*, *Nitzschia fonticola*, and *Nitzschia frustulum*, were noted in 1992, but not in 1974. The appearance in 1992 in the lower river of pollution-sensitive *Achnanthes linearis*, *Amphora pediculus*, *Diatoma vulgare*, *Gomphonema augustatum*, *Navicula rhyncocephala*, *Navicula tripunctata*, and *Nitzschia fonticola* are further indications of enhanced water quality since 1974.

Two diatoms, *Nitzschia amphibia*, and *N. palea* appear to be particularly sensitive to water quality differences along the river. *Nitzschia amphibia*, regarded as eutrophic and moderately tolerant of organic pollution (Lowe 1974, Lange-Bertalot 1979), accounted for <1% of the community at HR, but comprised approximately 40% of the diatom communities at OP and IN. *Nitzschia amphibia* was not noted at HR in 1974, but it accounted for <2% of the diatom communities at OP and IN. *Nitzschia amphibia* is known to be alkilibiontic, eutrophic, halobion indifferent, and tolerant of a range of temperatures (Lowe 1974). Guerrero and Rodriguez (1991) found *N. amphibia* to be a high percentage of the community at the discharge of a geothermal plant. Sumita (1988) considered *N. amphibia* as eurysaprobic. Although regarded as a moderately pollution tolerant diatom by Lange-Bertalot (1979), its increase in the lower river may reflect improved overall water quality in this region.

*Nitzschia palea*, regarded as a pollution-tolerant diatom, was prominent at all sample sites in 1974 and in 1992. *Nitzschia palea* is considered eutrophic and eurythermal (Lowe 1974) and is frequently found associated with organically enriched or polluted waters (Lowe and McCullough 1974, Dakshini and Soni 1982, Sabater and Sabater 1988, Round 1981). The proportion of *Nitzschia palea* in diatom communities at all sample sites, however, has declined since 1974, a further indication of improved water quality along the river.

## Conclusions

Notwithstanding improvements of water quality in the lower river, major impairments persist despite efforts to remove domestic and industrial wastes from the river. There is no reason other than water pollution to expect

TABLE 2

*Number of diatom taxa for each of three categories of tolerance to organic pollution in the Cuyahoga River.*

| Pollution Tolerance* | Hiram Rapids | | Old Portage | | Independence | |
|---|---|---|---|---|---|---|
| | 1974 | 1992 | 1974 | 1992 | 1974 | 1992 |
| 1 Tolerant | 6 | 3 | 6 | 3 | 4 | 2 |
| 2 Moderately Tolerant | 12 | 10 | 8 | 6 | 3 | 4 |
| 3 Intolerant | 11 | 15 | 4 | 11 | 3 | 7 |

*Pollution tolerance categories based on Lange-Bertalot (1979).

so few species of pollution intolerant diatoms in the lower river. Distances between sample locations were short thereby reducing microclimatic effects, and the physical habitats (i.e., riffles) were similar, not only between sample sites but between sample dates at identical sites. It is recognized that use of artificial substrates would have been preferable for both surveys to more completely control for possible differences in microhabitats.

These results correspond favorably with recent assessments of water quality based on benthic invertebrates and fish communities (Ohio EPA 1992). These assessments have shown moderate increases in species diversity of invertebrates and the return of a few species of fish to areas below Akron previously devoid of fish. Improvements in urban wastewater treatment facilities and pretreatment of industrial wastes undoubtedly have resulted in the slightly greater species diversity below the City of Akron. Despite these improvements the gain in species diversity of benthic invertebrates, fish, and diatoms is quite small. The most probable reason for this is stormwater overflows of combined stormwater-sanitary sewers (CSOs) from the City of Akron and surrounding suburban areas. The overflows are not treated for removal of organic matter or other potentially harmful substances. Old Portage, located upstream from the City of Akron's wastewater treatment facility, but downstream from most CSOs, is especially vulnerable to these overflows. Independence, with the least diatom species, not only receives overflows from CSOs, but is downstream from the City of Akron's wastewater treatment facility. CSOs have not been eliminated under the wastewater management plans for the region.

Each year as more watershed is paved or otherwise rendered impervious to rainwater, overflows of CSOs will become more frequent. We conclude that CSOs must be greatly reduced or eliminated before significant increases in diatom species diversity can be expected in the lower Cuyahoga River.

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