

ANALYSIS OF PHYTOPLANKTON DATA IN THE NON-TIDAL DELAWARE RIVER

REPORT NO. 4 UPPER DELAWARE RIVER SUMMER LIMNOLOGICAL PROGRAM

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I. INTRODUCTION

The use of biological indicators rather than sole reliance on physicochemical parameters to assess environmental quality has been underrated. However, this technique has many advantages. In aquatic environments pollution most generally reduces usefulness of water for some biological purposes: human consumption, agriculture, recreation or the maintenance and propagation of aquatic organisms. Changes in biological indicators such as changes in the numbers and types of organisms are a reliable indication of alteration in the quality of the ecosystem.

Biological indicators are integrators of environmental change. They, thus, are extremely valuable detectors of environmental degradation due to diffuse sources of pollution, toxic chemicals that are not normally assessed in traditional monitoring programs, synergistic reactions caused by the interreaction of various chemicals and slugs of pollutants that only intermittently appear in the water environment. In the case of phytoplankton, both the absence and over-abundance of algal species indicate an alteration of the aquatic environment from natural conditions. Over-abundance, for example, is usually associated with excessive amounts of nutrients (e.g. nitrogen and phosphorus) derived from sewage discharges, fertilizers and other sources. The

lack of phytoplankton and other biological life forms can, on the other hand, indicate the discharge of toxic pollutants or can indicate an environment which naturally does not provide adequate requirements for biotic success.

Biological data may be analyzed in numerous ways:

1) determination of the presence or absence of specific kinds of pollution tolerant or intolerant organisms, 2) analysis of the quantity and quality of combinations of populations, i.e., analysis of the community of pollution tolerant or intolerant forms and 3) determination of diversity or the number of different kinds of organisms present. This latter determination is quite important because typically a healthy natural environment has considerable species diversity. Increased diversity itself helps promote the stability and general health of an ecosystem.

The use of biotic indicators of pollution is not without difficulties. Sampling error is an important problem, especially with algae. Where the sample is taken, how it is concentrated and by what method the sample is preserved create important variables between investigations. Counting techniques are very tedious and, therefore, can introduce experimental error. Identification and interpretation of data can be somewhat subjective, causing uncertainty and making comparisons difficult.

The Delaware River Basic Commission has conducted studies of the biology of the upper Delaware River since 1969. Primary parameters have been benthic macroinvertebrates and plankton. In recent years studies have been conducted on related subjects: aquatic macroinvertebrates (Albert, 1980), primary productivity (Albert, 1981a) and sanitary water quality (Albert 1981b and 1983). In every year related water chemistry parameters have been monitored. Publications of the DRBC's Upper Delaware River Summer Limnological Program are listed in the References.

Algal samples were collected at various locations during the period 1969 to 1978. DRBC's biologist identified and counted the samples collected in 1969 to 1975. In 1979 algal sampling was suspended due to the backlog of unanalyzed samples and the lack of in-house expertise to identify algal species. A primary objective of the study reported here was the identification and analyses of algal samples collected in the 1974-79 period and the publication of resultant data.

The second objective of this consultant study was to define the water quality of the Upper Delaware using the available algal data as biological indicators. Water chemistry data collected by DRBC during the time of sampling and data collected by various state agencies (available in printout from the EPA Storet system) augmented the

interpretation. Descriptions of the sampling locations were provided by DRBC and occur in Appendix I. Lastly, special studies conducted by DRBC provided background information that assisted the interpretations at specific locations.

A final objective was to interpret the algal identifications made by DRBC personnel from 1969 to 1975 and to compare them with the algal data analyzed by the consultants.

II. MATERIALS AND METHODS

A. Sample collection

Samples were collected by DRBC personnel and concentrated by pouring 10 to 20 gallons of water through a "standard" plankton net. This yielded approximately 50 ml samples. These were preserved by adding several drops of neutralized formalin solution. Plankton samples were collected during summers from 1969 to 1978 at various locations. Samples collected in the 1969-1975 period were analyzed by DRBC staff and the results reviewed by the consultants.

B. Collection sites

The upper reaches of the Delaware River and its East and West Branches were sampled. The uppermost sampling locations were Downsville and Stilesville, N.Y., and the most downstream location was Portland, Pa. several miles south of the Delaware Water Gap. These sites encompass fast-moving, well aerated, typically clean (low nutrient) water as well as slower moving edge (littoral) habitats where localized eutrophication could occur. The sampling sites are graphically located on Figure SL and described in Appendix I. 1969-1975 samples include Belvidere, N.J.

C. Algal identification

Algae were provided to the consultants in a concentrated condition. Subsamples were pipetted into a Sedgewick-Rafter counting chamber as described in Standard Methods (1975). Counting and identification was usually done with high power

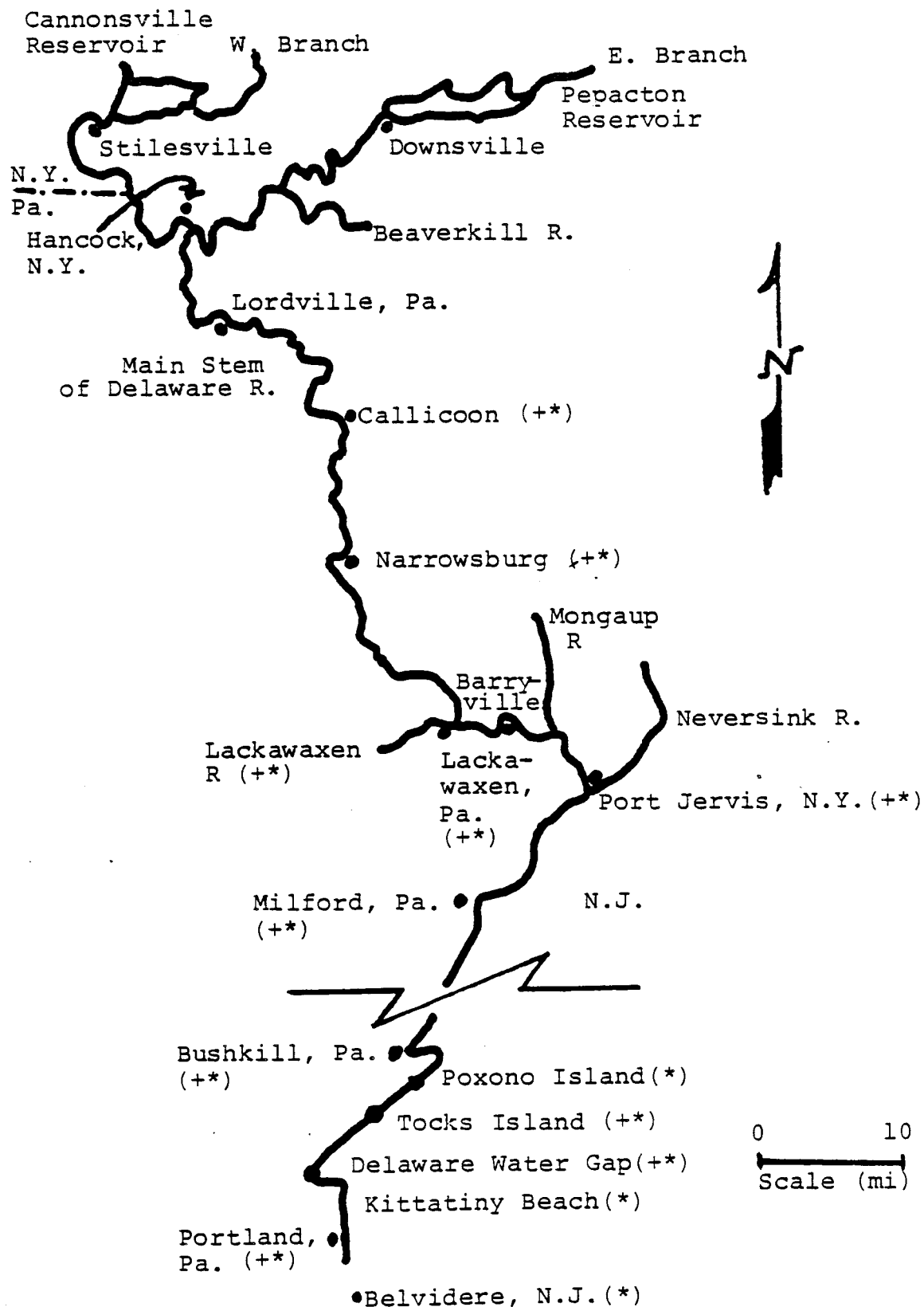


Figure SL. Sampling locations along the Non-tidal Delaware River.

NOTE: * = 1969-75 sample site only
 +* = 1969-79 sample site
 no star = 1974-79 sample site

of an inverted light microscope. Occasionally sub-samples were examined by a traditional wet-mount procedure, using oil emersion to enable study of greater morphological detail.

For each specimen, at least ten fields were sampled. Where a sample yielded no observable algae, as many as 100 fields were sampled to verify the accuracy. Where no algae were seen, replicate specimens were also sampled and observed.

Identification was determined using keys developed by Prescott (1962, 1964), and Smith (1951), and modified by the consultants. Identifications were principally to genus and occasionally to species. Prolonged storage of the algal specimens caused considerable deterioration of key morphological characteristics. A notable change was bleaching. Owing to the taxonomic deterioration of samples, some algae were necessarily identified to broader taxon groups than genus or species.

Nomenclatural changes have occurred in algology. In anticipation of adapting pre-1974 algal data to these data, the nomenclature used by DRBC personnel from 1969 through 1973 in their identifications of algae have been employed in this report. However, salient changes in names are noted in Appendix IV.

D. Analyses of data

In this study algae are used as indicator organisms. The abundance or absence of an algal species or community can

indicate such things as concentration of nutrients, toxicants, salts, etc. The presence, rather than the absence, of algae is usually a better diagnostic index, however. The absence of algae, while it can be significant, is more difficult to interpret. Ideally the best situation is the presence of some resistant forms combined with the absence of some sensitive forms.

Palmer (1969) developed a method of evaluating organic pollution on the basis of species composition and population levels which can be converted into numerical values.¹

¹Explanation of the Palmer Index:

0-14* Little organic pollution is present.

15-19 Moderate organic pollution is present.

20+ High organic pollution is present.

(Assume no significant toxicants are present.)

*These values are listed on the tables in Appendix II.

III. Results and Discussion

A. Generalizations

The Delaware River and selected tributaries are characterized by algal communities with low population numbers and little species diversity. Algal growth in the Upper Delaware is clearly limited due to either natural environmental conditions or to an undefined toxic condition. The following paragraphs discuss the general findings of the study and the resultant implications concerning water quality in the region.

The specific data of this study pose considerable problems because the algae always occurred at low numbers. A rule of thumb among population algologists is that a population must exist at a level of at least 50 members per ml to be considered to be representative of a positive growth condition caused by some definable environmental parameter. Such a population level occurred very infrequently.

Using the Palmer Index, data in this study show practically no organic pollution as the following tables reveal. All sites showed an index of 0 to 1, indicating the least level of organic matter present by the Palmer Index. This could be interpreted as indicating that there was essentially no organic pollution present in the non-tidal Delaware River.

The most significant finding of this study was the low numbers of algae, generally less than 50 per ml. This is in marked contrast to levels which exist in eutrophic situations,

where algae can be as numerous as 100s of thousands per ml. The finding of so few in the upper reaches of the Delaware River system clearly point to a stream which is naturally limited in nutrients or other growth conditions which favor algae. The clarity of the Delaware River as measured by Secchi disc is a very good indication that sunlight is not limiting.

During June, July and August when the sampling occurred, the high water conditions associated with spring is usually dissipated. Dilution of existing populations of algae in the river therefore should not have been a significant factor in the low algal community levels.

Because data collection occurred over several years and each data set portrayed similar low-population levels of algae, there is no reason to expect that a toxicant inimicable to algal growth was present in the water. Also, not much industry and other point sources exist along the upper Delaware. Therefore toxics would not be expected to be present. Macroinvertebrate data collected simulatenously with the phytoplankton samples support the conclusion that toxics are not a factor. Rather, the upper Delaware River is a very clean stream which, from the standpoint of algal populations, is nearly oligotrophic.

The possibility that limited niches exist for the algae also is discounted. In the upper reaches of the Delaware River the continuum of niches ranges from rapid, well oxygenated areas through quiet pools. Also springs which

discharge into the river contribute cold water into deep and also shallow areas. The river itself ranges in depth from less than an inch to over 100 feet at Narrowsburg. The annotated list of algae found in this study (appendix III) reveals a similar myriad of habitat preferences.

Community diversity indicates the degree of stability in a natural ecosystem. The observed diversity of the algal samples was never greater than 13 taxon groups (mostly genera) per sample. This is a relatively low diversity, generally indicating an environmental stress or environmental limitation. In this case the low diversity is not synonymous with pollution but rather with a paucity of nutrients.

Along with the limited diversity was also low numbers of organisms. This is another indication of resource shortage. The limited population numbers weighed against the extant diversity, suggests that a larger sample size would more than likely reveal greater diversity. Thus when the degree of variety is weighed against the size of the algal populations, a healthy stream with limited nutrients is suggested.

During the time period of phytoplankton sampling, water quality information was being collected by various state agencies and the DRBC. The DRBC data were obtained on the same date as the phytoplankton samples and are published separately (Albert, 1981b, 1983). The State agency data are available

from the EPA Storet system for some locations. These data were not collected temporally with the phytoplankton samples but do provide some information concerning ambient conditions.

The available water quality data suggest strongly that low levels of nitrogen and phosphorus limit the growth of algal populations. It appears that either one or both of these nutrients can be limiting at any given location and time. The DRBC data, although not conclusive, tend to indicate that the sampling locations are more apt to be nitrogen-limited rather than phosphorus-limited.

B. Analysis by Sample Site

Analysis of results is presented from the upper-most sample stations to the most downstream site. Also, data from each site have been summarized into a table although specific reference to each table is not necessarily made in the following text. The tables are located in Appendix IIa.

Because two different teams analyzed the data, i.e., DRBC personnel from 1969 to 1975 and the consultants from 1974-1979, the data are analyzed as two separate sets. However, the generalizations indicated previously in section III.A. apply to both sets of data.

Consultant Analyses

Stilesville, West Branch of Delaware River

The range of counts for total algae present was 3.35 to 75.9 per ml. From a microbiological standpoint, this is not an extensive variation. Diversity varied from one to nine for the series of samples. For individual algal types, all samples had less than 50 except for the diatom Fragilaria which occurred as a high of 70.3 per ml on 7/28/75. Fragilaria was also dominant June, 1976. However, such blooms were not evident again after this time.

Fragilaria is a widely distributed euplankter which, when present in high numbers, i.e. at least 50/cc, can be an indicator of nutrient pollution. The reason for the bloom of these algae in 1975 and 1976 is not definitely explainable. A significant increase in nitrogen and phosphorus should cause a concurrent increase in other members of the algal community. No such concurrent increase was clearly evident, although Coelosphaerium, a blue-green alga, which is also abundant in response to elevated nitrogen and organic conditions, was somewhat abundant on 8/18/76, at 38 per ml. The more prolonged bloom of Fragilaria along with Coelosphaerium could indicate continued organic and/or nitrogen presence because Coelosphaerium can tolerate warmer water conditions than Fragilaria, such as in August.

In spite of these two groups' apparent, but minor blooms, by applying the Palmer Index for determining degree of organic pollution, none to very little organic pollution existed.

Information on nutrient levels available for the Stilesville site from the EPA Storet Retrieval System showed a mean of 3.5 mg/l for nitrogen as a nitrate from 10/19/73 to 4/23/75. This period does not encompass the period of the algal blooms but could indicate a eutrophic condition. Nine samples for nitrate taken by DRBC in 1974, 75 and 78 averaged 0.71 mg/l with a range from 0 to 2 mg/l. These values taken at the same time as the algal samples suggest that excessive nitrogen is present at the sampling site during the time of sampling. During summer, any nitrate level above .2 mg/l is excess. While B.O.D. information is limited, very little organic pollution is indicated by the values. This, with the elevated nitrate levels, indicates a mineralized nitrate rather than an organic origin for the nitrate. This situation probably rules out direct sewage pollution and tends to indicate nitrogen from an inorganic source such as from agricultural runoff or from organics well upstream of Stilesville. Further, the observed algae could have grown in the Cannonsville Reservoir upstream.

Schumacher and Wagner (1973) reported high levels of algae from the Cannonsville Reservoir which is approximately two miles upstream of the Stilesville collection site. They deduced that high levels of nitrate and phosphate flowing into the reservoir principally from upstream agricultural sources were responsible.

Downsville, East Branch of the Delaware River

Both quantity and diversity of algae was noticeably low at this location. Total algae/ml ranged from .82 to 16.18. Diversity was as great as 6. Such low numbers show little significant difference between samples.

Hancock

The algal community was very small. Unquestionably, no blooms were evident. Total algal communities ranged from 1.43 to 23.13 per ml while diversity ranged from 2 to 11.

Lordville, Delaware River

The algal population was very small. Even diversity was depressed, with 4 and 3 taxon groups present in respective samples although there were variations in taxa composition. The most common alga was Oscillatoria although their population was quite limited.

Data from Pennsylvania Department of Environmental Resources for Lordville showed average (0.67 mg/l) and maximum (1.1 mg/l) level of nitrate-nitrogen. Phosphorus was present but an accurate average was biased by one high sample of this eutrophicant (1.98 mg/l). The depressed algal population levels therefore are unexplained.

Callicoon

The algal community while diversified in several samples was never large. A striking character of this site's algal community was the complex mixture of taxon groups comprising

the respective samples. Few other sites approached this variety. This might be attributed to the swift current of this site and the varying potential, depending on various factors including streamflow, for the resulting mixing of top and bottom forms of algae.

No single taxon group exceeded 50 individuals/ml although this site was unique in that it generally had a greater variety of algae than other sites. Still, this variety is really not extensive and with low population numbers indicates that conditions were much less than ideal for algal growth.

Storet chemistry data revealed phosphates as not being present although nitrates were not limiting (1.5 mg/l average).

Narrowsburg

Narrowsburg is a cold, deep water area. It has an extensive volume of water, which, owing to its depth and resulting limitation of light availability, cannot support algal growth. This large algal desert serves as a reservoir for diluting algal stocks which could be present at higher population levels at upstream sites.

This phenomenon of dilution of algal stocks was borne out by the data. The highest number of algae in any sample was only 6.36/ml. The highest number of algae representing any single variety was also very low, not exceeding 1.39/ml. In two samples, no algae were present.

Storet water chemistry data reveal very low nitrogen and phosphorus levels. These two nutrients, however would not be expected to be diluted with the greater river depth as would algal stocks.

Because of the physical attributes of the river at this location, this site is probably the most oligotropic of any of those addressed in this report.

Lackawaxen

Two samples were analyzed. There were very low algal populations and diversity. Total algae per ml did not exceed 2 while diversity amounted to three or four different taxon groups.

Storet chemistry data, for the Delaware River above Lackawaxen, indicate a low level of total nitrogen as nitrate and a low, but not limiting, phosphate level.

Barryville

The total algal community for the samples varied from less than 2 to 48.28 individuals per ml. The diversity ranged from 1 to 15 with June, 1977 showing the greatest number and diversity of algae. The diversity in June was three times higher than any other sample. There were several samples with higher populations than the others. However, neither was comprised of numbers of individual algal types indicative of an algal bloom. For example, on 6/28/77 the average count was 39.74 algae/ml with 15 different types

being present. Two algal groups occurred in the range of 6.2 to 8.5 individuals/ml. Obviously therefore, the algal community was diverse, but present in quite low numbers. In the 7/5/78 sample the total number of algae was 48.28 per ml and there were six different types present; four of these six were present in the range of 20 to 31. In both of these cases, the general growth conditions for algae were apparently improved over other sampling times, but no dominant algal group was present.

Port Jervis

Relatively few algae were found at this site. The range of total algae was 0 to 13.93 and no taxon group was represented by more than 5 individuals/cc.

Storet data reveal quite low pollutional indicator parameter levels for this site: B.O.D., nitrates and phosphates were low. Port Jervis is therefore characterized as a clean water site.

Neversink River

The total algal community found in the samples varied from 3.48 to 40.84 individuals/ml. The diversity ranged from 4 to 12 different types/cc. No taxon group had more than 16.56 individuals/cc and all except one were below 6.62/ml.

In general there were few algae with no group at a level suggestive of an algal bloom.

Milford

The algae per sample ranged from 0 to 17.03/cc with a diversity range of one to 11. The various kinds of algae present usually were represented by less than 2 individuals/ml.

Bushkill

The total algal community per sample varied from .47 to 20.53/ml. This site, like numerous other sites, supports a very meager algal population. Diversity ranged from 1 to 9 taxon groups. No taxon group except for Anabena on 7/6/76 (at a level of 10.79 individuals/cc) occurred at a level higher than 5.74 algae/cc.

Anabena, a blue-green alga, while a potential pollution indicator, was present at a low population level. Anabena is capable of growing well in the absence of macronutrients. Judging from the dearth of other algae, it is concluded that the Bushkill reach of the river has limited nutrients although Storet or other water chemistry data were not available to the investigators.

Tocks Island

Algal populations were exceedingly low. No single taxon group was more abundant than 4.05 individuals per ml. The total number of algae/ml ranged from .75 to 15.2 while diversity ranged from 3 to 9.

These algal populations point toward a stream reach with very limited nutrients.

Delaware Water Gap

Totals and individual aglae/cc were very low while diversity ranged from 1 to 7.

Portland

Here too, the algal community was very limited both in total numbers and types. The total community ranged from .82 to 14.64 algae/ml and the diversity was two to seven. However, there were no groups represented by more than 5.89 cells/ml.

DRBC Algal Analyses

The analyses of algal counts and identifications from the 1969 to 1975 study of algae by DRBC personnel are given in Appendix IIB. The data showed trends strikingly similar to those of the consultant identifications. Specifically, those trends reveal low populations of individual taxon groups of algae and small algal communities in the numerous samples collected.

Even the samples with the highest community levels were less than 100 members/cc strong. The three samples that exceeded 50 members/cc were seen at Tocks Island with a population of 85.72 algae/cc and a relatively high diversity of 13 on 3/19/69. One was at Milford with a population of 80.16 cells/cc but the highest diversity found in the study: 24 on 6/25/70. The last sample, exceeding 50 cells/cc, was seen at Poxono Island. It had a population of 63.9 cells/cc and a diversity of 13. One other sample had a high diversity of 18. It was collected on 3/19/69 from the Delaware Water Gap

and had a density of 18 but a relatively low community of 31.27 algae per cc.

Several aspects are striking from the above data:

1) The greatest diversity was seen from one sampling date (6/25/70) for all data (1969-1979) 2) An early spring sample (3/19/69) showed high or relatively high population levels with above average diversity. 3) Surprisingly these somewhat elevated population indices occurred at sites which typically showed low levels of parameters which would augment algal growth according to available Storet water quality data.

There was a slight spring-time algal bloom on 3/19/69. Such an early sample was atypical for the sampling regimen. Also, owing to the fact that there is typically an algal bloom during spring, but not usually so early as March in this locale, the elevated diversity and community levels can not be easily explained on a seasonal basis. However, diatoms can bloom this early in spring.

IV. CONCLUSIONS

The most striking feature of this study was the dearth of algae comprising the planktonic community of the upper reaches of the Delaware River. This paucity of algae was a consistent feature for most dates and for most sample sites. In spite of the low population levels, there was a variety of algae present. This diversity, although low in total numbers of species present, tends to indicate a healthy stream, albeit one with very dilute micronutrients.

Both pollution tolerant and pollution sensitive forms of algae were present. However, the numbers of pollution-tolerant algae invariably were at such low levels that there was never any indication of pollution.

This study also related available water chemistry data to algal populations. It appears that the river provides limited nutrients at most locations and this in turn is most likely the primary causal factor for the very limited algal populations. In actuality, there are instances where nutrients were not limiting by their concentration in the water. It is much more likely that factors other than nutrient, play a more important role in inhibiting algal growth during summer: shaded reaches of the stream and tributaries, drying of tributaries, cold water from springs and fast water conditions.

V. RECOMMENDATIONS

This study provides useful baseline information on planktonic algae of the upper reaches of the Delaware River. Because the algal populations are so low, almost indicative of oligotrophic conditions, eutrophication or other pollution of the river could easily be monitored through routine biological monitoring using algae as a natural bioassay. The technique is particularly useful when conducted during summertime low-flow conditions.

Because the algal populations are so very low, if planktonic algae are to be used as a pollution monitor, then the volume of the pour through a plankton net should be increased from 10 to 20 gallons up to at least 40 gallons and possibly even to 100 gallons. The larger volumes will decrease sampling error and permit later assessment of the total range of algal types comprising the community. Use of larger-volume samples would increase the sensitivity of the assessment.

If algal samples are to be stored for a period of time approaching a year prior to analysis, a standard wet mount should be prepared for each sample when fresh. Identifications of total kinds of algae present should be accomplished by a knowledgeable algal taxonomist before bleaching of specimens, (a consequence of storage) complicates identifications.

The consultants recommend that the DRBC consider development of an attached stream algae monitoring program on

a routine basis. Attached algae more accurately reveal long-term influences on a stream than do floating algae. Further, the observed effects are those that impinge upon that particular site.

An attached algae monitoring program would provide an important and reliable pollution monitoring system and permit useful assessment of water quality changes.

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APPENDIX I: DESCRIPTION OF THE STUDY SITES

The Study sites were along reaches of the Delaware River in New York, Pennsylvania and New Jersey (see Figure SL). The reaches encompass the West Branch, the East Branch, one station on the Neversink River and the mainstem of the Delaware River. A characterization of the sampling sites follows:

A. West Branch Stations:

Stilesville--Unshaded, gently sloping banks are covered with grass or grass and ferns; the bottom is rocky with mud along the shore. Cannonsville reservoir spillway is upstream 1/2 to 2 miles. Dark green algae cover rocks. There are areas of sandy-silt bottom. This is a rural setting with an occasional house or cluster of houses.

Overall--The West Branch Delaware runs through a rural area of forests or fields with small settlements. Water quality and biological parameters are highly influenced by releases or non-releases from Cannonsville Reservoir. The reservoir has known algae problems. Releases are cold water and are not uniform in flow volumes.

B. East Branch Stations:

Downsville--The banks are wooded and gently sloping and the bottom is rocky with abundant attached algae. Large rafts of floating algae have also been noted (12 July 1979)¹. The station is just downstream from Pepacton Reservoir, a 454,000 acre-feet reservoir which supplies water to New

¹Based on field notes of DRBC personnel.

York City. Formerly New York City would make only minimal releases from Pepacton to meet New York State requirements and periodic major releases from Cannonsville to meet U.S. Supreme Court requirements. Recent programs have attempted to balance releases. This is a rural area with small villages and some agriculture.

C. Delaware River--Hancock to Port Jervis:

Hancock--The station is located several miles downstream from the town and the confluence of the East and West Branches at the Pennsylvania Fish Commission's Buckingham Access Area. Low, gently-sloping banks and a slow-moving pool above a riffle occur here. The bottom is rocky with no shading.

Lordville--There is a very steep, wooded bank on the Pennsylvania side. The New York side is gentler with trees and tall grasses. There are slow moving pools in spots with riffles elsewhere. The bottom is rocky. Large rocks occur on the Pennsylvania side. It is rocky to silty on the New York side. Lordville consists of about a dozen houses on the New York side plus a railroad. The area is rural.

Callicoon--The sampling site is a large, slow moving pool with riffles above the pool. It has a rocky and gravelly bottom. The Delaware is wide and shallow largely above town (but not totally). Callicoon is a large town for this region.

Narrowsburg--Samples were taken in a very large, slow-moving pool below the Narrowsburg Bridge. The bridge crosses the river which has cut through rock outcroppings to form the

deepest part of the entire river (145 feet deep). Surface foam indicates that this deep area can trap or concentrate substances floating on the river. The pool receives influences of town (if any). The bottom (in the downstream sampling area) is rocky and much shallower with some mud areas. Rooted macrophytes (Elodea, eelgrass, pondweed, rushes) are evident. Algae (attached) have been noted as abundant. The banks are steep and flat and there is no shading.

Lackawaxen--The sampling site is a pool area at the Pennsylvania Fish Commission Lackawaxen Access Area. There are gentle banks on the Pennsylvania side where samples were taken. This site is subjected to reservoir releases entering the Delaware from the Lackawaxes River, just upstream of the sampling site. There is no shading.

Barryville--This site consists of a slow-moving pool with a rocky bottom. It is not shaded. Small villages and resorts are on both sides of the stream. Moderately sloped banks with grass and trees typify the shores.

Port Jervis--This station is located up river from the city of Port Jervis, N.Y. and Matamorus, Pa., but below the outfall from a rendering plant on the Pennsylvania side of the river. Samples were from a moving pool at the Pennsylvania Fish Commission Matamorus Access Area which has a rocky bottom. The banks are grassy or weed covered. The New York side is bedrock bottom and has steep banks.

Neversink River, Port Jervis--This station is located in the Neversink River adjacent to the city. It is just upstream from the confluence of the Neversink and Delaware

Rivers. The west or northern side has steep banks covered with large trees which are located on both sides. The bottom varies from rocky to silty and is slow-moving. There are abundant rooted macrophytes and attached algae. The Neversink River is subject to reservoir releases. Neversink Valley contains small settlements with some farming activity.

D. Delaware River--Milford to the Delaware River Gap:

Milford--The sample site is located upstream of the town of Milford. There is a rock to gravel bottom.

Bushkill--A large, slow-moving pool with rocky silt bottom is the sample site. Macrophytes such as elodea are abundant in areas. The Pennsylvania side is adjacent to U.S. Route 209 and the Pennsylvania Fish Commission Bushkill Access Area. The New Jersey side is undeveloped (part of the Delaware Water Gap National Recreation Area). Both banks are gently sloped with weeds and trees except for the access area which has a high retaining wall.

Tocks Island--This site is located in an open, slow-moving pool area which has a rocky bottom. It is just downstream from the National Park Service's Smithfield Beach and boat/canoe launch area. Approximately 3/4 mile upstream of the site is a privately operated campground and tavern on the New Jersey side. Bottom vegetation of rooted aquatic macrophytes is abundant in spots particularly on the New Jersey side adjacent to the campground.

Delaware Water Gap--This site is located in the Delaware Water Gap at the National Park Service's visitor center (Kittittinny Beach). The Pennsylvania side is a railroad-highway embankment and the New Jersey side has a steeply sloped bank and flat beach area used for canoe launching. There is a rocky bottom with beds or rooted aquatic plants on the New Jersey shore in spots. In 1981 algal blooms were present near or behind islands near this station.¹ The site is downstream from Stroudsburg and East Stroudsburg, Pa., the major urban areas near the site. Studies done in 1982 (Albert, 1983) indicate the sewage treatment plants in the Stroudsburgs influence the water quality at this site.

Portland--This station has changed locations several times. Most samples were taken in a slow-moving pool with typical bottom and bank conditions. Samples were all taken below the towns of Portland, Pa., and Columbia, N.J., where a rock-sand/silt bottom occurs.

¹DRBC field notes

APPENDIX IIa: TABLES-SITES:
1974-1979

Table SV. Algal Community of Stilesville.

Taxon Group	7/17/74	8/15/74	7/28/75	8/18/75	6/28/76	8/18/76	6/30/77	7/13/77	8/18/77 ¹	7/17/78 ¹	8/16/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<i>Aphanocapsa</i> sp.											
<i>Asterionella</i>											
sp.											
<i>Ceratium</i>											
<i>hirundinella</i>											
<i>Chlorella</i>		.46	13.8			6.18	1.10				
<i>vulgaris</i>						18.54					
<i>Cladophora</i>		.58	17.2					.59			
<i>Closteriopsis</i>		.12	3.4								
sp.	3.03	13.6									
<i>Coelosphaerium</i>		.23	6.9								
<i>naegelianum</i>											
<i>Coelosphaerium</i>						37.97	.37				
<i>kuetzingianum</i>											
<i>Fragilaria</i> sp.	14.8	.58	17.3	70.31	92.6	1.76	5.89	2.94			1.98
<i>Microcystis</i>				5.19	6.8						33.3
sp.											
<i>Microspora</i> sp.											
<i>Oscillatoria</i>	.34	1.5	10.3				1.10	8.8			
sp.							3.31	26.5			
<i>Pediastrum</i>	1.68	7.6									.49
<i>duplex</i>						1.76	2.6				8.3
<i>Pediastrum</i>											
<i>duplex</i> var.											
<i>gracillium</i>											
<i>Pediastrum</i> sp.											
<i>Scenedesmus</i>				.48	1.8						
<i>bijuga</i>	1.01	4.5				.88					
<i>Scenedesmus</i>							.71	5.9			
<i>dimorphus</i>											

¹ No algae seen in 10 fields.

Taxon Group	7/17/74	8/15/74	7/28/75	8/18/75	6/28/76	8/18/76	6/30/77	7/13/77	8/18/77	7/18/78 ¹	8/16/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Scenedesmus</u>	1.35	6.1									
<u>quadricauda</u>		.35	10.3								
<u>Spirogyra sp.</u>		.23	6.9	.48	1.8						
<u>Staurastrum</u>		.46	13.8								
<u>Vlothrix sp.</u>											
<u>Unknown</u>											
<u>filaments</u>											
<u>Volvox sp.</u>			.40	5		.88	1.3	1.18	31.43		3.46
TOTAL	22.20	3.35	75.90	26.60	49.79	67.94	12.51	5.89	34.16		5.93
Diversity	6	9	3	5	1	7	6	4	2		3
Palmer Index	0	0	1	1	1	0	0	0	0	--	0

Table DV. Algal Community of Downsville.

Taxon Group	7/28/75	8/18/75	6/28/76	7/19/76 ^a	7/19/76 ^b	8/18/76	6/30/77	7/13/77	8/18/77	7/20/78	8/8/78	6/26/79
Ankistrodesmus falcatus												
Asterionella sp.	.45	8.1										
Coelosphaerium kuetzingianum												
Fragilaria sp.												
Gleocapsa sp.												
Microcystis sp.												
Microspora sp.												
Mougeotia sp.	.27	4.8										
Navicula sp.	.09	1.6										
Oscillatoria sp.												
Pediastrum sp.												
Scenedesmus abundans												
Scenedesmus bijuga												
Scenedesmus incrassalatus												
Scenedesmus quadricauda												
Scenedesmus sp.	.18	3.2										
Schizomeris sp.												
Spirogyra sp.												
Staurastrum sp.												
Synedra sp.	1.70	30.6										
Tabellaria sp.	2.86	51.6										
TOTAL	5.54	100	6	0	0	0	0	0	0	0	0	0
Diversity												
Palmer Index												

^a Downsville, East^b Downsville, West

Taxon Group	6/24/74	6/25/76	7/19/76	8/18/76	6/30/77	7/13/77	8/18/77	7/14/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Scenedesmus</u>								
<u>abundans</u>								
<u>Scenedesmus</u>								
<u>bijuga</u>								
<u>Scenedesmus</u>								
<u>dunoiophus</u>								
<u>Scenedesmus</u>								
<u>quadricauda</u>								
<u>Scenedesmus</u> sp.	.40							
<u>Staurastrum</u> sp.								
<u>Synedra</u> sp.								
<u>Tetradron</u> sp.								
<u>Westella</u>								
<u>linearis</u>								
TOTAL	4.80		1.43	3.45	3.51	23.13	13.96	7.18
Diversity	100	100	100	100	100	100	100	100
Palmer Index	50	20	50	30	50	110	70	60

Table LV. Algal Community of Lordville, Pa.

<u>Taxon Group</u>	<u>7/14/78</u>		<u>8/14/78</u>	
	Count per ml	%	Count per ml	%
<u>Ankistrodesmus</u> sp.			3.15	25
<u>Oscillatoria</u> sp.	.46	7.1	6.94	55
<u>Pediastrum</u> sp.	.93	14.3		
<u>Scenedesmus</u> <u>bijuga</u>	2.31	35.7		
<u>Scenedesmus</u> sp.	2.78	42.9		
<u>Staurostrum</u> <u>leptocladum</u>			2.53	20
TOTAL	6.48	100	12.62	100
Diversity	4		3	
Palmer Index	0		0	

Table CC. Algal Community of Callicoon.

Taxon Group	6/24/74	7/17/74	8/13/74	7/28/75	9/18/75	6/28/76	7/19/76	6/30/77	7/11/77	8/15/77	7/11/78	8/14/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Ankistrodesmus</u>												
<u> falcatus</u>			.64	.76	15.8		.17	2.33	7.4	3.68	10.6	4.94
<u>A. falcatus</u>												
<u>Ankistrodesmus</u>												
<u> sp.</u>												
<u>Aphanocapsa</u>												
<u> sp.</u>									.65	4		
<u>Aphanochaete</u>												
<u> sp.</u>												
<u>Chlorella sp.</u>												
<u>Chlorella</u>								3.11	10	1.58	6.5	.99
<u> vulgaris</u>								2.72	8.8		4.12	8.9
<u>Chlorococcum</u>												
<u> humicola</u>												
<u>Chlorococcus</u>			.32		2.2							
<u> dispersus</u>												
<u>Coelastrum</u>								9.78	25		5.30	11.4
<u> microporum</u>												.49
<u>Cocconeis</u>			.64		4.4							
<u> placentula</u>												
<u>Coelastrum sp.</u>												
<u>Cymbella</u>			.32	.25	5.3	1.60	8			7.88	22.7	
<u> cistula</u>												
<u>Dinobryon sp.</u>												
<u>Fiagalaria</u>			.32		2							
<u> capuciana</u>												
<u>Fragilaria sp.</u>			.32	.50	10.5	2.20	14.9					
<u>Gleocapsa sp.</u>				.50	10.5		.17					
<u>Hydrodictyon</u>							.34					
<u> sp.</u>							15.4					

[illegible]

Table NB. Algal Community of Narrowsburg.

Taxon Group	6/25/74	7/17/74	8/13/74	7/28/75	9/18/75	7/21/76 ¹	8/16/76 ¹	6/28/77	7/11/77	8/15/77	7/11/78	8/14/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Ankistrodesmus</u>	.74	20	1.15	18.2								
<u>falcatus</u>												
<u>Chlorococcus</u> sp.					.28	25						.47
<u>Closteriopsis</u>			.29	4.5						.32		33.3
<u>longissima</u>												
<u>Closteriopsis</u>			.97	13.6								
sp.												
<u>Coelastrum</u>												
<u>microporum</u>												
<u>Coelastrum</u> sp.				.40	9.5					.32		
<u>Cosmarium</u> sp.				.20	4.8							
<u>Cymbella</u>			1.45	22.7	.38	25			.38	10		
<u>cistula</u>												
<u>Fragilaria</u> sp.			.57	9.1						.63		
<u>Gleocapsa</u> sp.												
<u>Kirchneriella</u>												
sp.								1.04	.38	10	.77	2.5
<u>Microspora</u> sp.				1.00	23.8							
<u>Mougeotia</u> sp.			.57	9.1								
<u>Navicula</u> sp.	1.48	40	.35	10								
<u>Nostoc</u> sp.				.20	4.8						.38	12.5
<u>Oscillatoria</u> sp.				.60	14.3				.38	10	.38	12.5
<u>Pediastrum</u>					.57	50						
<u>boryanum</u>												
<u>Pediastrum</u>	.74	20							.76	20		
<u>duplex</u> var.												
<u>cohaerens</u>												.47
												33.3

Taxon Group	6/25/74	7/17/74	8/13/74	7/28/75	9/18/75	7/21/76 ¹	8/16/76 ¹	6/28/77	7/11/77	8/15/77	7/11/78	8/14/78
	count	count	count	count	count	count	count	count	count	count	count	count
	per	per	per	per	per	per	per	per	per	per	per	per
	ml	ml	ml	ml	ml	ml	ml	ml	ml	ml	ml	ml
Pedeastrum								1.04		.32		.47
duplex var.								30				33.3
gracillium												
Pedeastrum sp.			.58	9.1					.38			
Scenedesmus									10			
acutiformis										.94		
Scenedesmus								1.39	.76		.77	
bijuga								40	20		25	
Scenedesmus												
quadricauda												
Scenedesmus sp.			.87	13.6					.76			
Spirogyra sp.				.40	9.5							
Synedra sp.	.74	20		.60	14.3							
Unspeciated				.80	19							
filamentous												
forms												
TOTAL	3.7	100	.35	100				3.47	3.78	2.52	3.07	1.42
Diversity	4		1	7				3	7	5	5	3
Palmer Index	0		0	0				0	0	0	0	0

¹ No algae were present in 10 fields.

Table LW. Algal Community of Lackawaxen.

Taxon Group	5/17/74		8/5/74	
	Count per ml	%	Count per ml	%
<u>Cymbella cistrila</u>			.80	40
<u>Microcystis</u> sp.			.40	20
<u>Navicula</u> sp.	.256	33		
<u>Oscillatoria</u> sp.	.256	33	.60	30
<u>Pediastrum</u> sp.	.256	33	.20	10
<u>Scenedesmus bijuga</u>				
<u>Scenedesmus</u> <u>quadricauda</u>				
TOTAL	.76	100	2.0	100
Diversity	4		3	
Palmer Index	0		0	

Table BV. Algal Community of Barryville.

Taxon Group	7/30/75	8/20/75	7/21/76	6/28/77	7/7/77	8/15/77	7/5/78	8/8/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Actinastrum</u> sp.				1.14				
<u>Aphanocapsa</u> sp.	.46					.64	8.96	
<u>Chlorella</u> <u>ellipsoidea</u>	14.3			2.9			19.4	
<u>Chlorococcum</u> sp.								
<u>Coelastrum</u> <u>microporum</u>				1.14				
<u>Coelosphaerium</u> <u>keutzingarinum</u>		.18		5.11	3.55			
<u>Cymbella</u> <u>cistula</u>				3.97		.64		
<u>Fragilaria</u> sp.	.84	.18		8.52				
<u>Hydrodictyon</u> sp.		.18		.57	.39			
<u>Lyngba</u> sp.					1.18			
<u>Merismopedia</u> sp.				1.14				
<u>Microcystus</u> sp.				1.14				
<u>Microspora</u> sp.				1.14				
<u>Mougeotia</u> sp.						1.93		
<u>Navicula</u> sp.				1.14		1.28		
<u>Oscillatoria</u> sp.	1.47					37.5		
<u>Pediastrum</u> <u>duplex</u>	50			.57		25		
<u>Pediastrum</u> <u>duplex</u> <u>var. gracillium</u>								.48
<u>Pediastrum</u> sp.					.39			
<u>Rivularia</u> sp.	.21				11.8			
<u>Scenedesmus</u> <u>acutiformis</u>	7.1						5.22	
<u>Scenedesmus</u> <u>bijuga</u>			1.60				7.46	
<u>Scenedesmus</u> <u>dimorphus</u>			100	3.97	.79		16.1	
				10	11.8			1.45
								75

Taxon Group	7/30/75	8/20/75	7/21/76	6/28/77	7/7/77	8/15/77	7/5/78	8/8/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Scenedesmus</u>								
<u> incrassatulus</u>								
<u>Scenedesmus</u>								
<u> quadricauda</u>				3.41		.64	11.20	
<u>Scenedesmus sp.</u>				6.24			9.70	
<u>Staurastrum sp.</u>				.57			21	
<u>Tetraedron</u>		2.5						
TOTAL	2.94	3.04	1.60	39.74	6.70	5.13	48.28	1.93
Diversity	4	4	1	15	5	5	6	2
Palmer Index	0	0	0	0	0	0	0	0

Table PJ. Algal community of Port Jervis.

Taxon Group	6/24/74	7/15/74	8/9/74	7/11/75	9/14/75	7/21/76	8/5/76	6/23/77	7/7/77	8/8/77 ¹	7/6/78	8/10/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Ankistrodesmus</u>												
<u>falcatus</u>			.63	.40			1.16					1.11
<u>Ankistrodesmus</u>												
<u>sp.</u>			.13				.58					1.67
<u>Aphanocapsa</u>												
<u>sp.</u>												
<u>Ceratium</u>												
<u>hirundinella</u>												
<u>Chlorococcum</u>												
<u>humicola</u>								.37	4.5		1.14	3.34
<u>Closterium sp.</u>			.13									
<u>Coelastrum</u>												
<u>microporum</u>												
<u>Coelastrum sp.</u>												
<u>Coelosphaerium</u>												
<u>kuetzingianum</u>												
<u>Cymbella</u>			.38		.50	.28.6	.48	3.31	40.9	2.78	9.5	.56
<u>cistula</u>							50		25			4
<u>Fragilaria sp.</u>				.20								
<u>Gleocapsa sp.</u>				14				2.58	31.8			
<u>Melosira</u>		.3				.24	25	.74	9.1			
<u>varians</u>												
<u>Microcystis</u>			.50									
<u>sp.</u>			.76									
<u>Microspora</u>												
<u>sp.</u>												
<u>Navicula sp.</u>	.8	66.6										
<u>Nostoc sp.</u>		.24	.13									
<u>Oscillatoria</u>			3.28				.58	1.39	12.5			3.34
<u>sp.</u>			52				25					24

¹ No identifiable algae seen in 10 fields or by scanning the entire counting chamber.

Table NS. Algal Community of Neversink River.

Taxon Group	7/7/75		6/17/76		7/7/77		8/1/77		7/6/78		8/10/78	
	count per ml	%	count per ml	%	count per ml	%	count per ml	%	count per ml	%	count per ml	%
<u>Ankistrodesmus</u>												
<u>falcatus</u>	1.14	12.8	1.05	30	1.64		1.54	16.7			6.62	16.2
<u>Chlorella</u>						20			.32	9.1		
<u>ellipsoidea</u>												
<u>Chlorella vulgaris</u>	.38	4.3										
<u>Chlorococcum</u>			.7	20								
<u>humicola</u>												
<u>Chlorococcum</u> sp.	.19	2.1			.82	10						
<u>Closteriopsis</u>	.19	2.1										
<u>longissima</u>					.41	5					2.21	5.4
<u>Closteriopsis</u> sp.												
<u>Coelastrum</u>	.19	2.1										
<u>microporum</u>												
<u>Cyclotella</u>							3.07	33.3				
<u>Gleocapsa</u> sp.	.19	2.1			.41	5					16.56	40.5
<u>Kirchneriella</u> sp.												
<u>Merismopeodia</u> sp.												
<u>Mougeotia</u> sp.	1.9	21.3			.82	10			.32	9.1	1.10	2.7
<u>Oscillatoria</u> sp.					1.23	15						
<u>Pediastrum duplex</u>												
<u>var. gracillium</u>							3.07	33.3			3.31	8.1
<u>Pediastrum</u> sp.	.19	2.1	.7	20	.82	10						
<u>Scenedesmus</u>												
<u>acutiformis</u>												
<u>Scenedesmus bijuga</u>	.57	6.4	.35	10					.63	18.2		
<u>Scenedesmus</u>									.63	18.2		
<u>dimorphus</u>												
<u>Scenedesmus</u>									1.26	36.4	7.73	18.9
<u>quadricauda</u>	1.30	14.9	.7	20								

Taxon Group	7/7/75	6/17/76	7/7/77	8/1/77	7/6/78	8/10/78
	count per ml	% count per ml	% count per ml	% count per ml	% count per ml	% count per ml
<u>Scenedesmus</u> sp.	1.71	19.1				
<u>Staurastrum</u> sp.	.38	4.3	.82	1.54		3.31
<u>Tetraedron</u> sp.	.57	6.4	1.23			
Unknown desmids			10	16.7		8.1
TOTAL	8.93	100	8.20	9.22	3.48	40.84
Diversity	12	5	9	4	6	7
Palmer Index	0	0	0	0	0	0

Taxon Group	6/18/74	7/11/74	9/14/75	7/6/76	7/30/76	8/25/76	6/23/77	7/5/77 ¹	8/9/77	6/29/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Pedeastrum</u>										
<u>duplex</u>				.93						
<u>Pedeastrum</u>				16.7			1.14		.86	
<u>duplex var.</u>							6.2		20	
<u>gracillium</u>			.39							
<u>Pedeastrum sp.</u>										
<u>Scenedesmus</u>		.25								1.12
<u>abundans</u>										4.5
<u>Scenedesmus</u>			1.17	1.39	.43		2.27			3.73
<u>bi-luca</u>			27.3	25	100		13.3			19.2
<u>Scenedesmus</u>										
<u>dimorphus</u>							2.27		.86	7.6
<u>Scenedesmus</u>							13.3			
<u>incrassatulus</u>						.69				1.49
<u>Scenedesmus</u>						18.8	1.51			6.1
<u>quadrifida</u>							8.9			
<u>Scenedesmus</u>				.93			20		.86	
<u>sp.</u>				16.7						
<u>Selenastrum</u>										3.36
<u>gracile</u>										13.5
<u>Westella sp.</u>										.75
<u>3</u>										3
TOTAL	2.28	2.48	4.28	5.55	.43	3.70	17.03		4.31	24.63
Diversity	4	6	5	6	1	5	11		4	12
Palmer Index	0	0	0	0	0	0	0		0	0

¹No algae seen in 10 fields.

Table II. Algal community of Tocks Island

Taxon Group	6/18/74	7/11/74	8/8/74	7/2/75	9/12/75	7/14/76	7/26/76	6/22/77	7/5/77	6/29/78	8/2/78	Undated ¹
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Ankistrodesmus</u>												
<u>falcatus</u>				.52	29.2	.38	18.2		1.05	13.3		
<u>Aphanocapsa</u> sp.					.25	33.3	.19	9.1			4.05	68.8
<u>Asterionella</u> sp.								1.01	12			
<u>Chlorella</u>								1.01	12	.46	25	
<u>ellipsoidea</u>												
<u>Chlorella</u> sp.								1.35	16			
<u>Chlorococcum</u>						.38	18.2			.93	50	
<u>humicola</u>												.40
<u>Cladophora</u> sp.						.19	9.1					20
<u>Closterium</u> sp.												
<u>Cocconeis</u> sp.	.29	6	1.08	14.3								
<u>Coelastrum</u>				.15	8.3				1.05	13.3	1.10	18.8
<u>microporum</u>												
<u>Crucigenia</u> sp.									2.10	26.7		
<u>Cymbella</u>									1.58	20		
<u>cistula</u>												
<u>Fragilaria</u> sp.						.57	27.3		.53	6.7		
<u>Gleocapsa</u> sp.								.34	4			
<u>Gomphosphaeria</u>								.34	4			
<u>lacustralis</u>												
<u>Hydrodictyon</u>								1.01	12			
sp.								2.35	28			
<u>Kirchneriella</u>												
sp.												
<u>Melosira</u>												
<u>varians</u>												
<u>Merismopedia</u>												
sp.	1.08	14.3	6.16	40.5			.26	4				.40

¹ No date was on this sample container.

Taxon Group	6/18/74	7/11/74	8/8/74	7/2/75	9/12/75	7/14/76	7/26/76	6/22/77	7/5/77	6/29/78	8/2/78	Undated ¹
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<i>Microcystis</i> sp.					.25		1.84					1.20
<i>Microspora</i> sp.	.87	18.9	4.05	33.6	5.6	36.8						
<i>Navicula</i> sp.	.29	6.3			.56	3.7						
<i>Nitzschia</i> sp.				.07	4.2		.53				.74	12.5
<i>Nostoc</i> sp.												
<i>Oscillatoria</i> sp.							.26					
<i>Pediastrum</i> <i>duplex</i>				.07	4.2							
<i>Pediastrum</i> <i>duplex</i> var <i>gracillium</i>				.15	8.3							
<i>Pediastrum</i> sp.				.07	4.2		1.31	20	.67	.46	.25	
<i>Scenedesmus</i>				.22	12.5		1.05	16				
<i>Scenedesmus</i> <i>bi-juga</i>				.29	16.7	.38	18.2					
<i>Scenedesmus</i> <i>dimorphus</i>				.74	41.7		.79	12	.34			
<i>Scenedesmus</i> <i>quadricauda</i>									4	1.58	20	
<i>Scenedesmus</i> sp.		.27	4		.56	3.7						
<i>Sphaucocystis</i> <i>schrotteri</i>												
<i>Staurastrum</i> sp.		.27	4		.56	3.7						
<i>Synedra</i>												
<i>Oscillatoria</i> <i>orabiformis</i>												
TOTAL	7.56	7	100	4.6	8	100	15.2	7	100	1.85	3	100
Diversity				2.28	9	100	6.57	8	100	5.80	100	2.00
Palmer Index												3
												0

Table DWG. Algal Community of Delaware Water Gap, Delaware River.

Taxon Group	6/18/74	7/11/74	9/12/75 ¹	8/23/76	6/25/77	7/5/77	8/4/77	6/27/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Ankistrodesmus</u>								
<u>falcatus</u>							.49	
<u>Aphanocapsa</u>							.98	
<u>sp.</u>								
<u>Asterionella</u>	.34							
<u>formosa</u>								
<u>Chlorella</u>								
<u>vulgaris</u>								
<u>Cocconeis</u>	.65	.68						2.26
<u>placentula</u>								35.7
<u>Cymbella</u>		10.17			1.47		.98	
<u>cistula</u>					22.2		14.3	
<u>Fragilaria sp.</u>						1.35		
<u>Kirchneriella</u>		3.39				28.6		1.81
<u>sp.</u>								28.6
<u>Microcystis</u>							.49	
<u>sp.</u>					.74	11.1	7.1	
<u>Navicula sp.</u>	.78							
<u>Oscillatoria</u>		.68			.74	11.1		
<u>sp.</u>								
<u>Pediastrum</u>	.11			1.26				
<u>duplex</u>				100				
<u>Pediastrum sp.</u>								
<u>Scenedesmus</u>					1.47	21.4	1.47	
<u>bi-juga</u>					22.2	21.4		
<u>Scenedesmus</u>					2.35	50		.90
<u>dimorphus</u>		.68					.98	14.3
<u>Scenedesmus</u>								
<u>quadricauda</u>								
<u>Scenedesmus</u>					2.21	33.3	1.47	21.4
<u>sp.</u>								1.36
								21.4

¹ All sample water evaporated--unable to count

Taxon Group	6/18/74	7/11/74	9/12/75 ¹	8/23/76	6/25/77	7/5/77	8/4/77	6/27/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
	1.46 4 0	15.6 6 0	1.26 1 0	6.62 5 0	4.71 3 0	6.84 7 0	6.33 4 0	100 100 100
TOTAL								
Diversity								
Palmer Index								

Table PL. Algal Community of Portland.

Taxon Group	7/12/73	7/11/74	8/8/74	7/18/75	9/1/75	7/26/76	8/23/76	6/22/77	7/5/77	8/4/77	6/27/78	8/2/78	
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	
<u>Ankistrodesmus</u>													
<u>falcatus</u>			.80										
<u>Asterionella</u>	.68	14											
<u>formosa</u>													
<u>Chlorella</u>													
<u>ellipsoidea</u>													
<u>Chlorococcum</u>													
<u>humicola</u>													
<u>Chroococcus</u>		.29	25										
<u>minimus</u>													
<u>Coelastrum</u>													
<u>microsporum</u>													
<u>Coelastrum</u> sp.													
<u>Coelosphaerium</u>													
<u>kuetzingianum</u>							.17	50					
<u>Cymbella</u>			.60	9									
<u>cistula</u>													
<u>Fragilaria</u> sp.			1.00	14.7									
<u>Gleocapsa</u> sp.					.53	50		.48	33.3				
<u>Kirchneriella</u>													
sp.													
<u>Melosira</u>													
<u>Microspora</u> sp.				1.99	53.9								
<u>Mougeotia</u> sp.				1.70	46.1								
<u>Navicula</u> sp.													
<u>Nostoc</u> sp.		.58	50		.26	25		.79	25				
<u>Oscillatoria</u>	.68	14											
sp.													
<u>Pediastrum</u>			1.00	14.7			.17	50					
<u>duplex</u>													
<u>Pediastrum</u>			1.80	27									
<u>duplex</u> var.													
<u>cohaerens</u>													
										2.21	20	.41	50
											3.25	22.2	
						</							

Taxon Group	7/12/73	7/11/74	8/8/74	7/18/75	9/1/75	7/26/76	8/23/76	6/22/77	7/5/77	8/4/77	6/27/78	8/2/78
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Pedeastrum</u>												
<u>duplex var.</u>												
<u>gracillium</u>												
<u>Pedeastrum sp.</u>												
<u>Scenedesmus</u>												
<u>abundans</u>												
<u>Scenedesmus</u>												
<u>bijuga</u>		.29	25									
<u>Scenedesmus</u>												
<u>quadricauda</u>			1.20	.26								
<u>Scenedesmus</u>			.40									
<u>sp.</u>												
<u>Selenastrum</u>												
<u>gracile</u>												
<u>Synedra acus</u>	3.42	71.5										
TOTAL	4.78	1.16	6.79	3.60	1.05	1.45	.34	3.14	2.88	11.05	14.64	.82
Diversity	3	3	7	2	3	2	2	5	4	4	4	2
Palmer Index	0	0	0	0	0	0	0	0	0	0	0	0

APPENDIX Iib: TABLES-SITES:
1969-1975

Callicoon

	6/24/74		7/17/74		8/13/74	
	Count per ml	%	Count per ml	%	Count per ml	%
<u>Ankistrodesmus</u>						
<u>falcatus</u>					.69	4.3
<u>Chroococcus</u>					.35	2.2
<u>dispersus</u>					.69	4.3
<u>Cocconeis</u>					.35	2.2
<u>placentula</u>					.35	2.2
<u>Cymbella</u>					.35	2.2
<u>mexicanum</u>					.35	2.2
<u>Fragilaria sp.</u>					.35	2.2
<u>Fragilaria</u>					.35	2.2
<u>capaciana</u>					7.98	49.9
<u>Navicula sp.</u>	1.26	60	3.31	64.3	2.78	7.4
<u>Oscillatoria</u>	.42	20				
<u>acutissima</u>			.37	7.2		
<u>Oscillatoria</u>						
<u>angustissima</u>						
<u>Pediastrum</u>					.35	2.2
<u>boryanum</u>					.35	2.2
<u>Rotifer</u>					.35	2.2
<u>Scenedesmus</u>					1.04	6.5
<u>abundans</u>					.35	2.2
<u>Scenedesmus</u>			.37	7.2		
<u>bijuga</u>						
<u>Scenedesmus</u>						
<u>incrassatulus</u>						
<u>Scenedesmus</u>	.42	20				
<u>obliquus</u>						
<u>Sphaerocystis</u>			1.10	21.4		
<u>schroeteri</u>						
Total	2.1	100	5.15	100	15.98	100
Diversity	3		3		13	
Palmer Index	0		0		0	

Narrowsburg

	6/25/74		7/17/74	
	Count per ml	%	Count per ml	%
<u>Chroococcus</u> <u>dispersus</u>	.82	20		
<u>Navicula</u> sp.	1.64	40	.39	100
<u>Oscillatoria</u> <u>acutissima</u>	.82	20		
<u>Synedra</u> sp.	.82	20		
Total	4.1	100	.39	100
Diversity	4		1	
Palmer Index	0		0	

Lackawaxen

	5/17/74	
	Count per ml	%
<u>Cymbella ventricosa</u>	Trace	
<u>Navicula</u> sp.	.28	33.33
<u>Scenedesmus bijuga</u>	.28	33.33
<u>Scenedesmus quadricauda</u>	.38	33.33
Totals	.84	100
Diversity		3
Palmer Index		0

Port Jervis

	7/26/72		6/24/74		7/15/74	
	Count per ml	%	Count per ml	%	Count per ml	%
<u>Diatoma elongatum</u>	.26	3.7				
<u>Fragilaria</u>	3.42	48.3				
<u>crotonensis</u>						
<u>Melosira</u>	.26	3.7			.34	9.0
<u>granulate</u>						
<u>Melosira</u>						
<u>varians</u>						
<u>Navicula sp.</u>	.26	3.7				
<u>Oscillatoria</u>	.26	3.7	.90	66.2	2.69	73.3
<u>prolifera</u>	.26	3.7				
<u>pandorina</u>						
<u>monum</u>	.26	3.7				
<u>Pediatrum duplex var</u>						
<u>clathratus</u>						
<u>Pediatrum itetras</u>			.23	16.9		
<u>Scenedesmus bijuga</u>	1.84	26	.23	16.9		
<u>Scenedesmus</u>						
<u>denticulatus</u>					.64	18.0
<u>Scenedesmus obliquus</u>	.26	3.7				
<u>Synura sp.</u>						
<u>Total</u>	7.08	100	1.36	100	3.67	100
<u>Diversity</u>						
<u>Palmer Index</u>						

Milford

	6/27/69	6/25/70	7/11/72	7/10/73	6/18/74	7/11/74	7/11/75
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Achnanthes</u> sp.							
<u>Actinastrum</u>		3.85					
<u>hantzschii</u>							
<u>Amphora ovalis</u>		1.28				.27	
<u>Anabaena</u> sp.		8.8	.41		.84	10	
<u>Ankistrodesmus</u>							
<u>falcatus</u>			1.23	1.77			
<u>Asterionella</u>			8.1	15.36			
<u>formosa</u>					.42		
<u>Asterionella</u>					16.7		
<u>Plactonica</u>							
<u>Ceratoneis arcus</u>		.64					
<u>Chlamydomonas</u> sp.		.64					
<u>Cocconeis</u> sp.	2.12	11.1					
<u>Cocconeis</u>		13.47				.27	.36
<u>placentula</u>		16.8				10	4.17
<u>Coelosphaerium</u>							
<u>naegelianum</u>		.64					
<u>Cosmarium</u>							
<u>punctulatum</u>				.44			
<u>Cyclotella</u> sp.				3.84			
<u>Cymbella turgida</u>		3.85	2.87		.42		
<u>Cymbella vetricosa</u>		1.28	18.9		16.7	10	
<u>Diatoma hiemale</u>							
<u>Diffugia</u> sp.	4.25	22.2	.41				
<u>Dinobryon</u>		.64					
<u>cylindricum</u>							
<u>Euastrum</u> sp.		.64		.44			
<u>Eudonira elegans</u>		.64					
<u>Fragilaria capucina</u>		.64	1.23	.88			.36
<u>Fragilaria coatonensis</u>			4.92	7.68			4.17
<u>Melosira varians</u>		.64	.41				
<u>Mougeotia</u> sp.	2.12	11.1					
<u>Navicula</u> sp.	4.25	22.2	1.23	1.32		50	5.36
<u>Nitzschia</u> sp.	4.25	22.2	8.1	11.52	.42		
<u>Oscillatoria tenuis</u>	2.12	11.1			16.8	10	.36
		25.65					
		1.28					

	6/27/69	6/25/70	7/11/72	7/10/73	6/18/74	7/11/74	7/11/75
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Pediastrum sp.</u>							
<u>Pediastrum</u>		.64	.41				
<u> biradiatum</u>		.8	2.7				
<u>Pediastrum duplex</u>		.64		.44			
<u>Scenedesmus</u>				3.84			
<u> arcuatus</u>							
<u>Scenedesmus bijuga</u>		9.62				.27	1.78
<u>Scenedesmus</u>		.64				10	20.85
<u> opoliensis</u>		1.92					
<u>Scenedesmus</u>		2.4					
<u> quadriricauda</u>							
<u>Staurastrum</u>		.64					
<u> hexacenum</u>			1.23	4.86			
<u>Staurastrum</u>			8.1	42.24			
<u> paradoxum</u>		.64					
<u>Stichosiphon</u>							
<u> regularis</u>							
<u>Synedra acus</u>		2.56	.82	.88			4.17
<u>Unk. Diatom</u>		.64	5.4	.44	.42		.36
<u>Totals</u>	19.11	80.16	15.17	11.48	2.52	2.73	8.58
<u>Diversity</u>	99.9	100	99.94	99.84	100.2	100	100.08
<u>Palmer Index</u>	6	24	11	9	5	6	6
	0	0	0	0	0	0	0

Bushkill

	6/30/69	6/25/70	6/20/72	7/10/73	6/18/74	8/9/74	7/31/75
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Achnanthes</u>							
<u>sp.</u>							
<u>Ankistsodesmus</u>							
<u>falcatus</u>		3.95					
<u>Anthrodesmus</u>		5.93			.14		
<u>Anabaena sp.</u>			.99		3.85		
<u>Asterionella</u>			4.9	3.42	1.42		
<u>formosa</u>			31.25	25	38.50		
<u>Cladophora sp.</u>							.97
<u>Closterium sp.</u>			.99				9
<u>Cocconeis placentula</u>		7.9	6.25				
<u>Crucigenia tetrapedia</u>	2.19	.99					
<u>Cymbella</u>	2.19	3.95			.57		
<u>Diatomic hiemale</u>		.99			15.4		
<u>Endonina elegans</u>		.99		2.05			1.45
<u>Fragillaria entonensis</u>		2.22		.68			13.5
<u>Melosina varians</u>		10.87	.99			.86	
<u>Navicula sp.</u>	4.37	25	4.9	1.37	.99	.43	3.38
<u>Oscillatoria sp.</u>		.99	31.25	.68	26.95		1.45
<u>Pedistatorium</u>	4.37	2.56					.97
<u>Scenedesmus bijuga</u>	2.19	1.98					4.5
<u>Scenedesmus</u>							4.5
<u>quadricauda</u>							
<u>Sphaenocyotis</u>	2.19						
<u>schroeleni</u>							
<u>Staurastrum</u>				3.42			
<u>paradoxum</u>				25			
<u>Synedra ascus</u>		1.98	.99	.68	.14		
<u>Synedra ulna</u>		1.98					
<u>Unoglenopsis</u>				1.37			
<u>americana</u>				10			
Totals	17.5	100	15.81	13.67	100.1	99.9	10.64
Diversity	6	12	7	8	7	2	8
Palmer Index	0	0	0	0	0	0	0

Poxono Island*

	3/19/69	
	Count per ml	%
<u>Achnanthes minutissima</u>	.62	1
<u>Amophora</u> sp.	16.13	25
<u>Asterionella formosa</u>	1.24	2
<u>Cevadoneis arcus</u>	.62	1
<u>Cymbella</u> sp.	1.24	2
<u>Filamentous</u> unknowns	14.26	22.3
<u>Fragilaria capucina</u>	2.48	3.9
<u>Melosira</u> sp.	1.86	2.9
<u>Melosira varians</u>	1.24	2
<u>Meridion circularis</u>	2.48	3.9
<u>Navicula</u> sp.	11.16	17.5
<u>Synedra acus</u>	.62	1
<u>Synedra ulna</u>	.62	1
<u>Tabellaria fenestrata</u>	6.82	10.7
<u>Tabellaria floculasa</u>	.62	1
<u>Ulothrix zonata</u>	1.86	2.9
Total	63.9	100
Diversity		13
Palmer Index		0

*This site is north of Tocks Island by approximately 3 miles.

Delaware Water Gap

	3/19/69	7/14/69	6/24/70	7/7/72	7/9/73	6/18/74	7/11/74	7/3/75
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Actinanthus sp.</u>								
<u>Actinastrium</u>		2.16	3.45	6.8				
<u>gracillium</u>								
<u>Amphora sp.</u>	4.05	12.76	1.72	3.4	1.13	2.56		
<u>Anabaena sp.</u>	.37	1.16						
<u>Ankistrodesmus</u>								
<u>falcatus</u>	.74	2.32			4.53	10.24	8.98	24.99
<u>Asterionella</u>								
<u>formosa</u>							.72	4.17
<u>Cocconeis</u>			27.58	54.4				
<u>Placentula</u>								
<u>Chlorella</u>					3.40	7.68		
<u>vulgaris</u>								
<u>Cyclotella</u>	1.10	3.48						
<u>glomesulosa</u>								
<u>Cymbella sp.</u>	1.47	4.64						
<u>Cymbella</u>								
<u>amphicephala</u>								
<u>Cymbella</u>			1.72	3.4			3.61	20.85
<u>ventricosa</u>			.86	1.7				11.12
<u>Dinobryon</u>								
<u>cylindricum</u>								
<u>Eudonina elegans</u>					1.13	2.56		
<u>Filamentous</u>	5.15	16.24			1.28	3.57		
<u>l or A</u>					1.28	3.57		
<u>(no sheath)</u>								
<u>Fragilaria</u>	1.47	4.64						
<u>capucina</u>								
<u>Fragilaria</u>					2.56	7.14		
<u>crotonensis</u>								
<u>Fragilaria</u>	.74	2.32						
<u>coatanensis</u>								
<u>Melosira</u>								
<u>granulata</u>					6.80	15.36		
<u>Melosira</u>	.37	1.16	.86	1.7			.72	4.17
<u>varians</u>								5.56
<u>Meridon</u>	.74	2.32						22.24
<u>circulare</u>								
<u>Navicula sp.</u>	11.77	37.12	8.62	17.0			10.82	6.255
<u>Nitzschia sp.</u>			.86	1.7				
<u>Oscillatoria</u>	.37	1.16						
<u>tenuis</u>								
<u>Pediastrum</u>								
<u>boryanum</u>								

	3/19/69	7/14/69	6/24/70	7/7/72	7/9/73	6/18/74	7/11/74	7/3/75
	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml	count per ml
<u>Pediastrum duplex</u>								
<u>var gracilium</u>								
<u>Pediastrum tetras</u>		2.16						
<u>Rhoicosphenia</u>	.37	1.16						
<u>curvata</u>								
<u>Scenedesmus dimorphus</u>								
<u>Scenedesmus</u>			.86		1.28		.72	
<u>quadricauda</u>					3.57		4.17	
<u>Staurastrum paradoxum</u>								
<u>Stigeodorum</u>	.37	1.16		22.66	19.24			
<u>stagnatite</u>								
<u>Synedra acus</u>	1.47		.86	2.26				
<u>Synedra ulna</u>	.37	4.64		5.12				
<u>Tabellaria</u>		1.16		1.13	2.56			
<u>fenestrata</u>								
<u>Ulthorix tenuis</u>	.37	1.16						
<u>Unk. I</u>			3.45					
<u>Unoglenopsis sp.</u>	.37	1.16		1.13	1.28			
<u>Unoglenopsis</u>					3.57			
<u>americana</u>								
Totals	31.27	99.76	50.86	99.84	35.91	99.9	17.31	100.8
Diversity	18	7	11	9	7	2	6	5
Palmer Index	0	0	0	0	0	0	0	0

Kittatiny Beach

	3/19/69		5/27/69		6/26/69	
	Count per ml	%	Count per ml	%	Count per ml	%
<u>Achnanthes</u>	7.99	19.6				
<u>minutissima</u>						
<u>Amphora ovalis</u>	13.46	32.9				
<u>Asterionella</u>	.42	1	2.73	23.5		
<u>formosa</u>					2.78	66.7
<u>Crucigenia</u>						
<u>tetrapedia</u>						
<u>Cymbella sp.</u>	5.05	12.4				
<u>Draparnaldia</u>	.42	1				
<u>plumosa</u>						
<u>Fragilaria</u>						
<u>crotonensis</u>	1.26	3.1	4.78	41.2		
<u>Fragilaria</u>						
<u>sapucina</u>	.42	1				
<u>Melosira varians</u>	1.68	4.1	3.42	29.5	1.39	33.3
<u>Navicula sp.</u>	.42	1	.68	5.9		
<u>Synedra ulna</u>	.42	1				
<u>Tabellaria</u>						
<u>fenestrata</u>	9.67	23.7				
<u>Ulothrix</u>						
<u>temussima</u>	40.79	100	11.61	100	4.17	100
Totals		110		100		200
Diversity		0		0		0
Palmer Index						

Portland

	8/19/71		7/12/73		7/11/74		7/18/75	
	Count per ml	%	Count per ml	%	Count per ml	%	Count per ml	%
<u>Asterionella</u>			.68	50				
<u>formosa</u>								
<u>Chroococcus</u>					.29	25		
<u>minimus</u>								
<u>Cocconeis</u>	2.52	28.9						
<u>placentula</u>	.25	2.9						
<u>Cymbella</u>								
<u>ventricosa</u>	.38	4.5						
<u>Melosira</u>	.13	1.5						
<u>granulata</u>								
<u>Melosira</u>								
<u>islandica</u>								
<u>Melosira</u>							1.99	53.9
<u>varians</u>								
<u>Mougeotia</u> sp.	.13	1.5						
<u>Navicula</u> sp.	1.51	17.3	.68	50	.58	50	1.70	46.1
<u>Rotifer</u>	.13	1.5						
<u>monostyla</u>								
<u>Scenedesmus</u> sp.	.13	1.5						
<u>Scenedesmus</u>	.13	1.5			.29	25		
<u>quadricauda</u>								
<u>Synedra acus</u>	3.42	39.2						
Totals	8.73	100	1.37	100	1.16	100	3.69	100
Diversity	10		2		3		2	
Palmer Index	0		0		0		0	

Belvidere

8/5/70		
	Count per ml	%
<u>Closterium</u> sp.	1.12	7.1
<u>Gyrosigma attenuatum</u>	2.25	14.3
<u>Melosina varians</u>	2.25	14.3
<u>Navicula</u> sp.	4.50	28.6
<u>Oscillatoria limosa</u>	4.50	28.6
<u>Pediastrum duplex</u> var <u>gacilimum</u>	1.12	7.1
Total	15.74	100
Diversity	6	
Palmer Index	0	

Appendix III¹: Annotated List of Algae Comprising the Algal
Communities of the Upper Delaware River

CYANOPHYTA--BLUE-GREEN ALGAE

Anabena--Although nitrogen fixing, these algae usually require organics. They can thrive in eutrophic conditions such as sewage ponds and streams. When abundant, taste and odor problems in drinking water may be generated.

Anacystis--This large group is comprised of both hardwater and softwater euplankters. Blooms can occur in late summer and may be associated with taste and odor problems in drinking water. Polysaccharides released at the death of the bloom can cause high organic loading. Toxins are also released. Some reports indicate phosphates stimulate blooms. Blooms occur in sewage ponds but can occur in streams. Some forms are heterocystous, anaerobic and nitrogen fixing. Some are phycobionts of fungi.

Agmenellum--Associated with soft water, these colonial algae can be associated with water treatment plant filter clogging. They sometimes grow in shallow ponds and streams as well as sewage ponds.

Coelosphaerium--These algae are typically abundant in habitats with high nitrogen, high organic content and adequate dissolved carbon dioxide.

¹This annotated list provides the most current nomenclature for groups. See the changes in algal names at the end of this section.

Lyngbya--With a preference for hard water, these shallow water algae can form blooms in eutrophic conditions.

Nostoc--These widespread filamentous algae are nitrogen fixers. They can form colonial blooms with names derived from the resulting appearance: "witches butter" and "starjelly."

Oscillatoria--An abundant shallow-water group capable of an oscillating movement of the filaments, these algae can form floating clots although they typically are attached. They can be associated with taste and odor problems and prefer elevated B.O.D. conditions up to 10 mg/l. They are polysaprobic.

Rivularia--A filamentous group which usually grows attached in moving water. They can thrive in elevated organics, can clog filters and cause taste and odor problems when abundant.

CHRYSOPTYA--GOLDEN-BROWN ALGAE, DIATOMS

Asterionella--These diatoms are widely distributed, particularly in hard water. They can proliferate in lower concentrations of phosphates. When abundant, they are associated with filter clogging and taste and odor problems.

Cyclotella--The indicator of acidic conditions, these surface diatoms of streams can bloom in response to eutrophants. Some members can clog filters and influence water taste when abundant.

Cymbella--Members are attached, planktonic or littoral.

Sometimes they are associated with water treatment plant filter clogging.

Dinobryon--These flagellated euplankters grow well in high phosphate conditions. Seasonal blooms are common.

Some species are associated with clean water.

Fragilaria--A widely distributed group of the euphotic zone, these algae can cause filter clogging and have been implicated in taste problems. Some morphological abnormalities have been reported in response to exposure to pollution.

Navicula--A widely distributed group, it has benthic as well as planktonic members. Some cause taste problems in drinking water.

Synedra--This widely distributed genus, particularly in hard water, responds positively to eutrophication. Members can tolerate high organic loading and where abundant, they are associated with taste and odor problems.

Tabellaria--A normal inhabitant of streams, these algae are found in eutrophic water. They are implicated with filter clogging, taste and odor problems.

PYRRHOPHYTA--RED ALGAE

Ceratium--The freshwater forms are dinoflagellated euplankters.

They are typical of cold water or of cooler seasons.

They may be phagotrophic.

CHLOROPHYTA--GREEN ALGAE

Actinastrum--A surface group of lakes and streams, these algae tend to be relatively rarely distributed.

Ankistrodesmus--These ubiquitous plankters are primarily clean water inhabitants. However, members are tolerant to a variety of potentially stressful parameters including acidic water, higher temperatures, crowding by other species and high concentrations of phosphates.

Aphanochaete--This rare filamentous form is found in clean water lakes.

Chlorella--Capable of enduring low nutrient conditions, this endophytic group is primarily represented by unicellular planktonic species.

Chlorococcum--These common algae occur in streams and soil. As soil inhabitants, runoff following a storm elevates their numbers in a stream.

Chlorococcus--These algae are considered to be indicators of organic pollution when abundant.

Cladophora--This clean water filamentous form typically attaches to rocks and cement walls. Members have a preference for elevated dissolved oxygen levels and therefore are more common in rapids and waterfalls. Positive growth can result from eutrophicants. Members typically grow in streams with a B.O.D. approximating 2.5 mg/l. They may clog filters and cause water taste and odor problems. Also, some members may

accumulate heavy metals and be negatively affected by power boats.

Closteriopsis--This rare chlorophyte is primarily found in soft water lakes.

Closterium--These plankton occur in swamps and bogs.

Coleastrum--This typically unicellular euplankter of streams can aggregate into colonies.

Cosmarum--Desmids of ponds, they can cause taste and odor problems in water when abundant.

Crucigenia--These plankton are typical of standing, but not highly polluted water, such as that found in streams, small lakes or ponds.

Hydrodictyon--So-called "water net" because of the branching and anastomosing of these filamentous algae, when abundant these colonial algae can cause filter clogging, taste and odor problems.

Kirchneriella--A larger free-floating or colonial algae, they are typified as clean water inhabitants. They are usually rare, occurring in lakes and streams.

Microspora--These unbranched filamentous algae may be free-floating or attached. They are typical of shallow water such as small lakes or swamps.

Mougeotia--These algae are filamentous attached or planktonic and are common in shallows of streams. They can clog water treatment plant filters.

Schizomeris--An attached, unbranched filamentous algal group, they are most commonly encountered along the water edges of hard and soft water swamps.

Pediastrum--These flagellates are common in smaller bodies of water. They are associated with water taste and odor problems when abundant.

Scenedesmus--Most members of this genus are widely distributed. These algae are littoral, planktonic indicators of eutrophic conditions. They occur in sewage ponds and in streams. When abundant, they can generate water taste and odor problems.

Selenastrum--These colonial tychoplankters typically inhabit lakes and swamps.

Spirogyra--Probably the most widely known algae because it produces "pond scum", these salt-intolerant, unbranched filamentous green algae are also well-known in the high school classroom from their spiralled ribbon-like chloroplasts. When abundant, they can cause water taste and filter clogging problems.

Staurostrum--These desmids of ponds are planktonic. Some species are exclusively clean water inhabitants. Some species, when abundant, are associated with influencing the taste and odor of drinking water.

Ulothrix--This group is represented by unbranched filamentous forms which often attach to debris or are planktonic. They are found in shallow water of lakes and swamps. Some species are indicative of clean water conditions.

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Westella--These colonial algae typically have 30 to 100 cells comprising a colony. The colony has a gelatinous investment. Though they are rare, these algae are usually found in soft water lakes.

Volvox--Colonial flagellated algae, some of these chlorophytes can indicate clean water while other members can indicate eutrophic conditions. When abundant, Volvox is associated with water taste and odor problems.

Upper Delaware Summer Limnological Program Reports

Upper Delaware Summer Limnological Program 1969-1979:

Background, Water Chemistry Data and Macroinvertebrate Data (February 1980)

Report No. 2 Primary Productivity of the Nontidal Delaware River, July and August 1980 (June 1981)

Report No. 3 Water Quality of the Upper Delaware Scenic and Recreational River: 1981 Survey (September 1981)

Report No. 4 Analysis of Phytoplankton Data in the Non-tidal Delaware River 1969-1979 (December 1983)

Report No. 5 Delaware River Water Quality in the Delaware Water Gap National Recreation Area (February 1983)

Report No. 6 1983 Water Quality Studies and Recommended Monitoring Program - Delaware Water Gap National Recreation Area (February 1984)

Report No. 7 Macroinvertebrate Trends and Water Quality Data - Upper Delaware River, East Branch and West Branch Locations (In-Press)

Reports are available from:
Delaware River Basin Commission
P.O. Box 7360
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