Region - Aff'd, Report LW

FILE COPY

PHYTOPLANKTON ABUNDANCE AND GENERIC COMPOSITION DATA FOR THE POTOMAC RIVER AND ESTUARY, MARYLAND

U.S. GEOLOGICAL SURVEY
Open-File Report 84—859

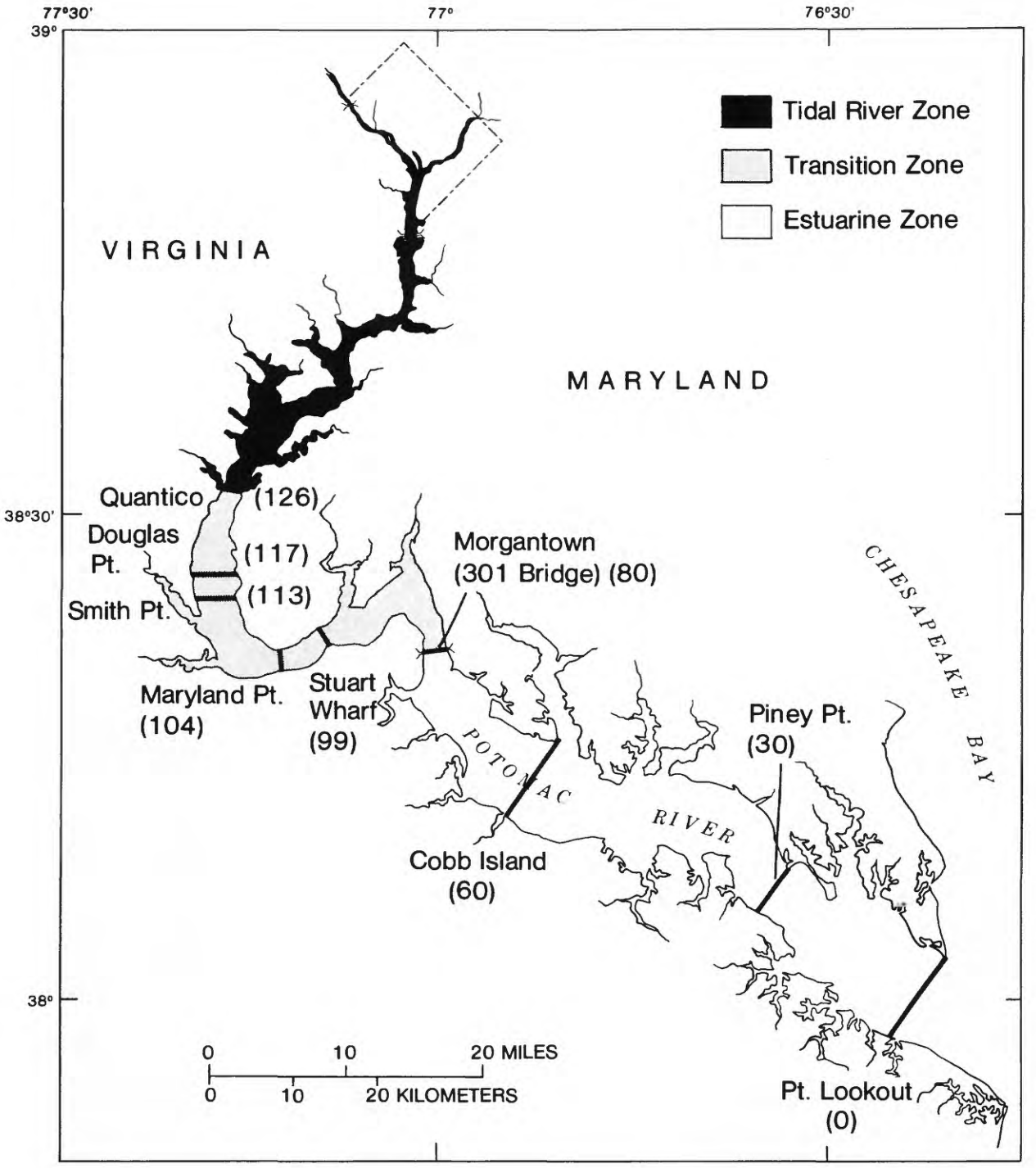

Figure 2b.--Location of sampling stations in the transition zone and Estuary. Sampling station distance, in kilometers from mouth of Potomac, are in parentheses.

METHODS

Sampling Stations.--Table 1 lists stations and station numbers at which phytoplankton samples were taken.

Methods for Phytoplankton Cell Counts and Identification

Depth-integrated samples were collected from the water column and 250-milliliter of the raw sample were preserved with either Lugol's iodine or Lugol's iodine with acetic acid and transported to the laboratory. The samples were shaken thoroughly before placing 5-milliliter subsamples into 10-milliliter Wild-Heerbrugg [1/]settling chambers. The bottom of the chambers were #1 coverslips. Phytoplankton sampled in 1979, 1980 and January to June 1981 were counted at a magnification of 400 by K. E. Boulukos and V. A. Stoelzel using the Utermohl inverted-microscope method (Utermohl, 1958; Lund and others, 1958). From 60 to 120 cells in six to ten grids were counted in each sample. On some rare occasions, when phytoplankton abundance was very low, fewer cells were counted and where densities exceeded 5×10^7 cells per liter, fewer than six grids were counted. Phytoplankton sampled in July, August, and September 1981 were counted by a technician at Wapora Inc.[1/], and a minimum of 100 cells were counted at 280 magnification. Small (1 to 5 μm) cells in samples counted in our laboratory at Reston, Va. were examined frequently at a magnification of 500-600 to ensure that they were not detritus or bacteria. The technique is similar to that described by Greeson and others (1979) and Hasle (1978).

[1/]The use of brand names in this report is for identification purposes and does not constitute endorsement by the U.S. Geological Survey

Table 1.--A list stations at which phytoplankton were sampled. The stations are marked on figure 2.

Station Number Listed in WATSTORE	Station Name stated as Potomac River at:	River distance from Chesapeake Bay in kilometers
01646580	Chain Bridge, Washington, D.C.	187.2
385315077031800	Memorial Bridge, Washington, D.C.	179.5
385315077022400	14th Street Bridge, Washington, D.C.	177.3
385223077012600	Geisboro Point, Washington, D.C.	173.7
384852077020500	Marbury Point, Washington, D.C.	170.4
01652590	Alexandria, Virginia	168.0
384605077015800	Rosier Bluff, Maryland	165.6
384318077020300	Hatton Point, Maryland	160.0
384136077054600	Marshall Hall, Maryland	151.0
383818077072800	Hallowing Point, Virginia	144.0
01655480	Indian Head, Maryland	138.9
01658710	Quantico, Virginia	125.6
382640077159900	Douglas Point, Maryland	116.7
382233077102000	Stuart Wharf, Virginia	98.9
01660800	Morgantown, Maryland	80.4
381516076503000	Cobb Island, Maryland	60.0
01661475	Piney Point, Maryland	29.8
380212076195000	Pt. Lookout, Maryland	6.5

The primary, general references used for identification of genera were Prescott (1978), Campbell (1973), Whitford and Schumacher (1973), Wood and Lutes (1967), and Prescott (1962). A secondary general reference was Butcher (1959). References for the identification of particular classes of phytoplankton are as follows: Cocke (1967) for the coccoid blue-green algae; Drouet and Daily (1956) for the coccoid myxophyceae; Hustedt (1930) for the centric diatoms; Patrick and Reimer (1966, 1975) for diatoms; Prescott (1962 and 1978) for euglenoids, flagellated green algae and filamentous bluegreens; Hulbert (1965) for brackish water flagellates; and Saunders and Glenn (1969) for diatoms. When identification was uncertain, photographs were taken or drawings were made at the microscope and were occasionally brought to local phycologists at Georgetown University (Phillip Sxe) and the Smithsonian Institution for consultation.

Phytoplankton identifications, cell counts, station, date and time were entered into a computer file called the Biological File, which is an adjunct of WATSTORE, (the U.S. Geological Survey National Water Data Storage and Retreival System). Each phytoplankton taxa is entered as an identification code obtained from a list supplied by the Atlanta Laboratory of the U.S. Geological Survey. Due to name changes, differences and disagreement in the taxonomy literature, uncertainties of genera identification and presence of unknown organisms, special classifications were set up in the Biological File. The description or names of the organisms and corresponding Biological File classification are presented in table 2. Phytoplankton that frequently were observed in the Potomac River and Estuary and previously were not part of the Biological File were issued new identification numbers. These phytoplankton and their identification numbers are listed in table 3.

Table 2.--Differences between classification schemes used by the Potomac Estuary Study Project and those of the U.S. Geological Survey Biological File.

Identification	As listed on Biological File
coccoid green	Chlorococcales
unknown green	Chlorophyceae
unknown algae	unknown 200000000000000
unknown flagellate	Euglenophyta
unknown diatom	Bacillariophycaea
unknown blue-green	Cyanophyceae
unknown dinoflagellate	Dinophyceae
unknown desmid	Desmidiaceae
unknown yellow-green	Xanthophyceae
unknown cyst	Unknown 200000000000000
dinoflagellate cyst	Dinophyceae
zoospore	Euglenophyta
epiphyte	Xanthophyceae
Chlamdydomonas	Chlorococcales
Merismopedia	Agmenellum
Katodinium	Massartia
Aphanocapsa	Anacystis
Ebria tripartita	Ebriales*
Gleothece	Coccochloris
Marssoniella	Gomphosphaeria
Amphiprora	Entomoneis
Holopedium	Agmellum
Protococcus	Desmococcus
Mallomonopsis	Chrysophyceae
Chroococcus	Chroococcaceae
Lagerhemia	Chodatella
Aphanothece	Coccochloris
Pseudoanabaena	Oscillatoria
Chlorella	Chlorococcales
Tribonema	Rhizoselenia

*Given an order classification by the U.S. Geological Survey Atlanta Laboratory.

Table 3.--New identification numbers added to the Atlanta Labs list of organisms.

Hymenomonas	216	02	08	01	002	000
Pseudopedinella	216	02	01	13	001	000
Tetraselmis	211	01	01	09	001	000
Heterocapsa	215	02	01	03	002	000
Cladopyxis	215	02	01	08	001	000
Polykrikos	215	02	01	10	001	000
Sennia	213	01	01	04	001	000
Ptychodiscus	215	02	01	09	001	000
Dicellula	211	01	09	10	014	000
Pseudostaurastrum	216	01	02	01	014	000
Pseudotetraedron	216	01	02	03	008	000

The following is a list of additional notes concerning taxonomy:

1. The diatom Cyclotella was identified only if marginal costae were visible, otherwise they were considered Stephanodiscus;
2. Wapora reported the genera Platymonas where Stoelzel and Boulukos reported Tetraselmis. The genera are synonomous. Wapora reported observing Westella. Westella was not seen by the Reston laboratory. In all other cases, Wapora reported no other organisms that were not seen also by the Reston laboratory:
3. Chroococcus and Anacystis, both members of the Order Chroococcales, were present in July and August 1980 samples. In some samples of that period, Chroococcus was undifferentiatable from Anacystis and was classified as Anacystis in the Biological File.
4. Stephanodiscus decreased in number at the transition zone and increased again in the estuary. Therefore, they may have been different species.
5. In one case, we were uncertain about the identification of a filamentous colony. It was initially identified as Ulothrix, a green algae, due to the shape and color of the parietal chloroplasts. The organism resembled Melosira, a centric diatom, but did not survive standard tests to identify the siliceous cell wall (Hasle, 1978). The cells did not survive burnt slide preparations. The cells dissolved upon treatment with acid. They lacked the spines that are typical of Melosira. Initial cultures of the organisms by Boulukos were green but became brown when settled out for identification. Photographs of cultures, however have revealed spines. We have

concluded, with the help of Phillip Sxe (personal commun. 1982), that the organism is a weakly siliceous form of Melosira. Wherever Ulothrix appears in the tables, it should be considered the diatom Melosira.

There are several procedural steps involved in counting and identifying phytoplankton. Each step is a source of variability. First, a sample has to be taken from a time and space variable system. For example, when one sample a week was taken during the first two weeks of July 1980 at the Alexandria station, cell counts were 18000 cells per milliliter the first week and 60000 cells per millimeter the second week. When 11 and 6 samples were taken the week of July 23 and July 30, 1980, respectively, the weekly averages were 12,464 and 11,733. Thus, a high system variance was averaged out by taking many samples.

Second, a 250-milliliter subsample is taken from the original sample and is fixed with Lugol's solution. A 5-milliliter subsample is placed in a counting chamber and several grid areas are selected for counting (the grid is a subsample of the bottom area of the chamber). One to ten grids are required to observe all species when cell densities are greater than 2×10^5 cells per liter (Eloranta, 1978).

The limits of error due to sampling can be calculated as

$$\text{error}_{max} = \pm 2 \cdot \left(\frac{100}{\sqrt{n}}\right) \text{ percent}$$

(with 95 percent confidence) where n is the number of cells counted (Eloranta, 1978). The number of organisms counted per sample in the Reston and Wapora laboratories almost always was between 60 and 120, yielding a maximum sampling error for any sample of between ± 25 and 20 percent, with

95 percent confidence. The precision of replicated counts performed by Stoelzel was ± 10 percent of the mean and was less than the theoretical error due to sampling. Lund states (Lund and others, 1958) that, if replicate counts by an individual yield a variation that is less than the theoretically determined error inherent in random sampling, the personal counting error can be ignored. Therefore, the confidence limits based on theoretical random sampling error (± 20 to 25 percent) can be used as a measure of an individual's counting precision. It is rarely necessary to count more than 100 cells because the accuracy of the count varies inversely with the square root of the number counted (Frontier, 1972; Venrick, 1978). Thus, we would have had to count 400 cells per sample to increase the random sampling error to ± 10 percent. The Potomac River and Estuary were not dominated by large colonies of algae in 1980 and 1981. If colonies were present in large numbers, counting variability would be expected to be much higher.

We tested counting precision by performing two double-blind experiments using samples taken at the same time and place and treated the same way. In the double blind test, the counter did not know that the test was taking place and the testor did not organize the samples to be tested. In the first test, five samples counted had a mean of 14,958 cells per milliliter and a standard deviation (S.D.) of 1,566 cells per milliliter. For comparison, the five samples had a mean chlorophyll-a of 60.5 micrograms per liter with an S.D. of 9.6 micrograms per liter. The second test with four samples yielded a mean of 20,588 cells per milligrams and an S. D. of 2,122 cells per milliliter. The chlorophyll-a mean was 117 micrograms per liter, with an S.D. of 13.9 micrograms per liter. Zero-blind tests yielded single-person precision estimates with 2 to 5 percent error.

Personal counting error for any individual counter may be insignificant compared to sampling error. However, as reported by Lund and others (1958) and Hobro and Willen (1977), counts by more than one observer or laboratory may differ significantly.

Stoelzel performed nearly 80 percent of the counts done by the Reston laboratory and over two-thirds of all the counts. Therefore, Stoelzel counts were used as a standard to which other counters could be compared. Five percent of the samples counted by Wapora were subsampled and counted by Stoelzel and Boulukos. Regressions were performed such that Boulukos' and Wapora's counts could be converted to counts comparable to Stoelzel's. A non-linear equation, $y = A \cdot X^B$, fit the data well (fig. 3). The data, however, demonstrated heteroscedasticity. Therefore, linear regressions were done in logarithmic space: $\ln Y = A + B \ln X$.

Logarithmic tranformation has the property of converting absolute error to proportional error and does not give undue weight to the residuals of large numbers. The logarithmic, least-squares regressions are shown in figure 4. Stoelzel's counts are considered the dependent variable because the model must predict a count that is comparable to those of Stoelzel. Thus, any comparison between July to August 1980 counts and July to August 1981 counts must be corrected by the use of the equations in figures 3 and 4.

There were occasional, inadvertent duplicates of counts. If the second sample was stored for longer than 6 months, some degradation of the sample was apparent, as demonstrated by a decrease in the cell count. In 41 percent of the cases there was little or no change in the counts. Cell numbers decreased in 38 percent and increased in 21 percent of the cases. The increase can come about due to clumping of degrading cells and resulting non-random distribution.

PHYTOPLANKTON ABUNDANCE AND GENERIC COMPOSITION DATA FOR THE POTOMAC RIVER AND ESTUARY, MARYLAND

by R.R.H. Cohen, S.O. Pollock, V.E. Stoelzel and K.E. Boulukos

U.S. GEOLOGICAL SURVEY
Open-File Report 84—859
1985

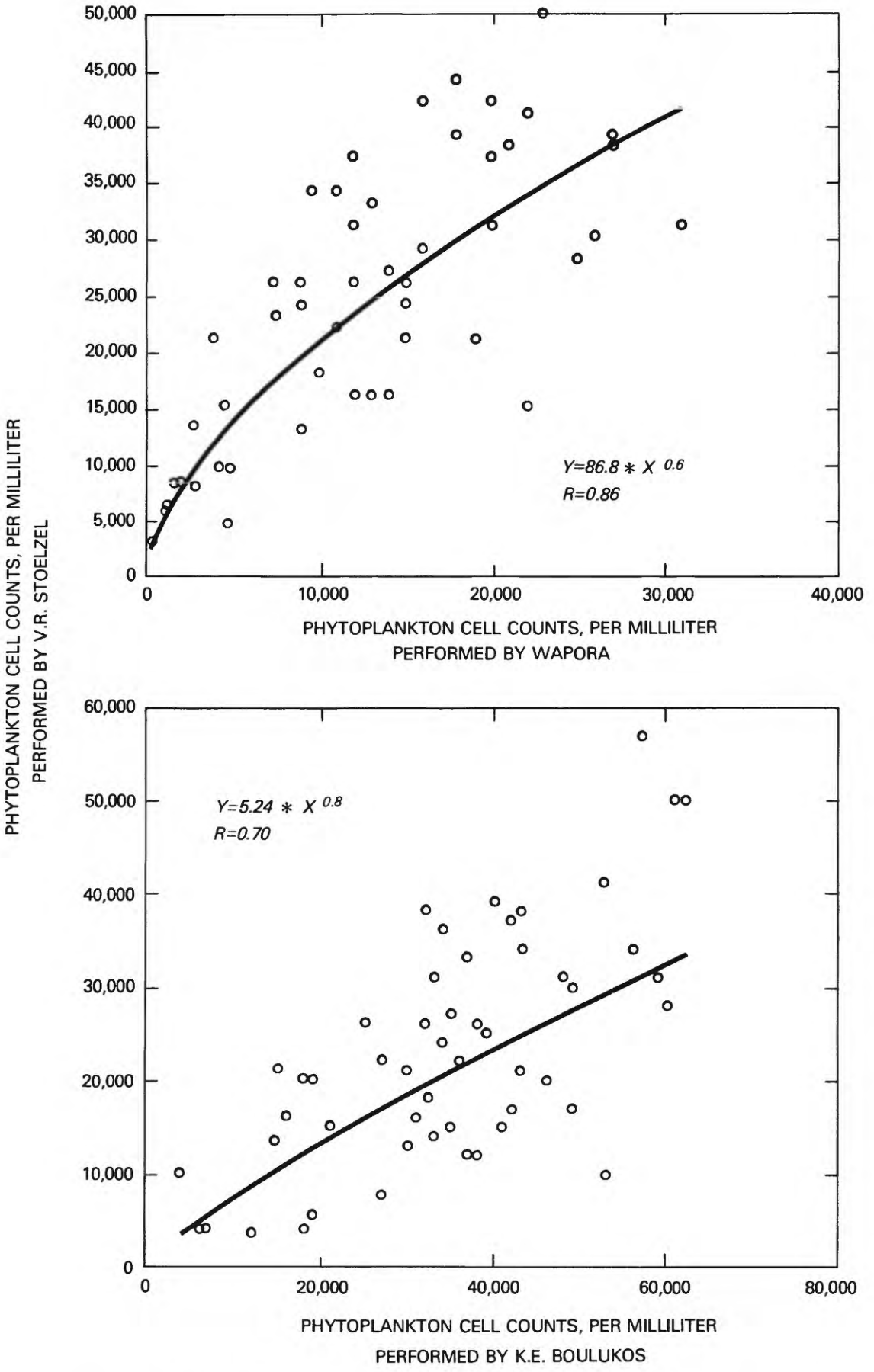

Figure 3.--Least squares regression of counts performed by Boulukos and Wapora to counts performed by Stoelzel

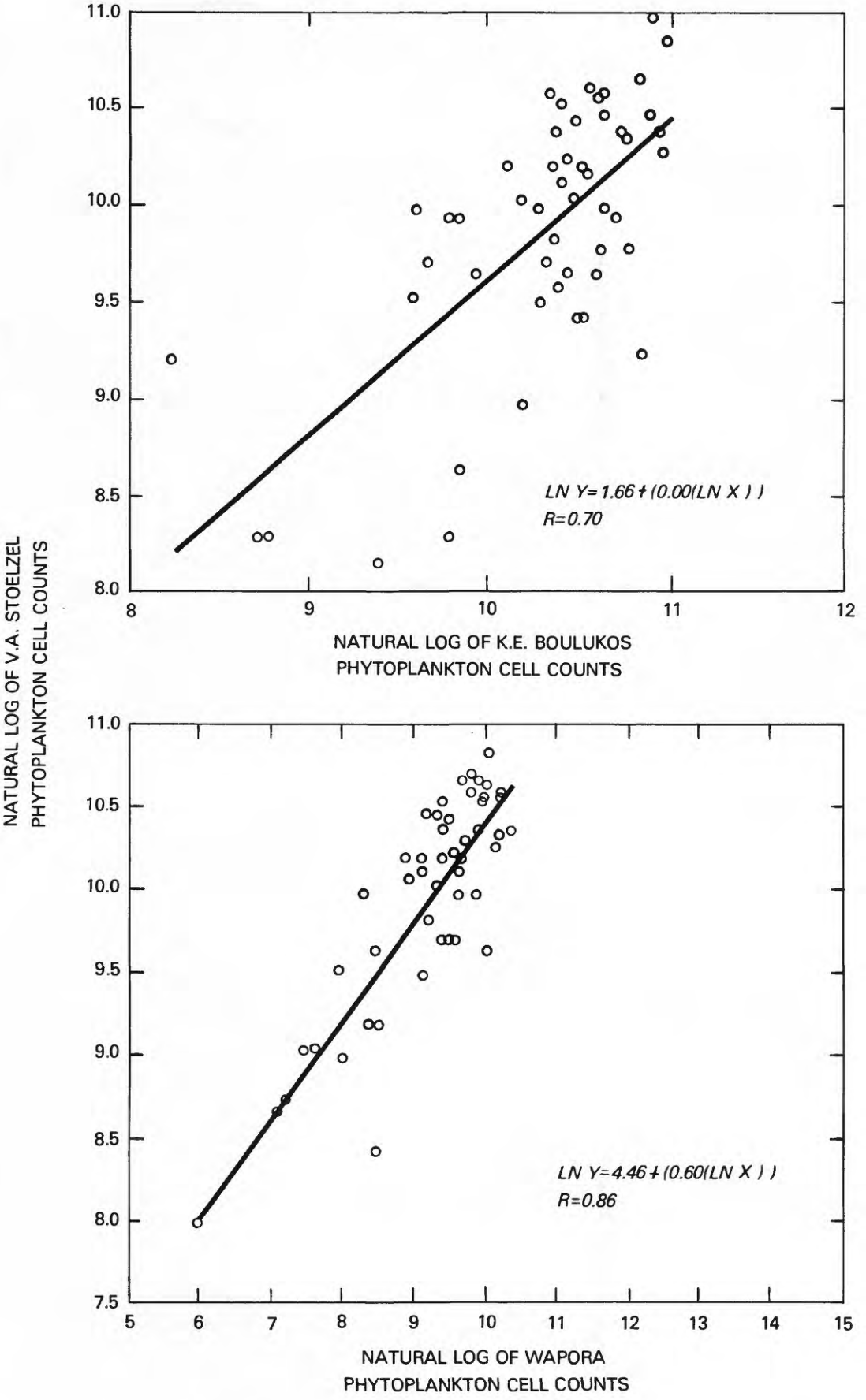

Figure 4.--Natural logarithm regressions of counts performed by Boulukos and Wapora to counts performed by Stoelzel.

If a duplicate count was found, the cell count selected for the original sampling time in the WATSTORE data files was selected using the following priority list.

1. In July and August 1981, Wapora counts were used to be consistant because 95 percent of the counts of that period were performed by Wapora.
2. The identification performed closest to the sampling date was used to reduce the effects of sample degradation.
3. If Stoelzel and Boulukos both counted a sample, those counted by Stoelzel were used because she counted 80 percent of the samples done by the Reston laboratory.

Calibration counts were entered into the Biological File. If Wapora was one of the summer 1981 counters, the sample was labelled with the correct sampling time. Stoelzel's count was labelled with a time that had one minute added. Then, Boulukos' count was given a time with an additional minute added (eg. 1040, 1041, and 1042 respectively). If there was no Wapora count, then Stoelzel's count was given the correct sampling time and Boulukos' count was given a time with one minute added (eg. 1040 and 1041).

It is important that class and generic composition of samples identified by the Reston laboratory and Wapora are comparable. Thirty-two samples that were counted in both laboratories were examined. The dominant class (diatoms, greens, bluegreens and others) as determined as a percent of total cells and the class with the second highest percent of total cells were the same in 28 of 32 cases. In three of the remaining four cases, there was little difference between the percent composition of the top two classes. Only one sample (August 15, 1981, Memorial Bridge) differed dramatically.

In order to determine how well the class compositions compared between Stoelzel and Wapora, the percent composition of a class as determined by Wapora was subtracted from the percent composition determined by Stoelzel. The absolute value of the difference in percent composition was used for the following calculations. The mean percent difference between Stoelzel and Wapora for all classes combined was 7 percent. The mean diatom, green algae, bluegreen algae, and cryptophyceae percent difference was 13, 6, 6, and 4, respectively.

Wapora's percent diatom composition of samples was, on the average, 29 percent higher than that reported from the Reston laboratory. Reston percen· green algae was ten percent higher than Wapora. The percent composition of cryptophyceae reported by Wapora was five percent higher than that by Reston There was less than one percent average difference between percent composition of bluegreen algae reported by Wapora and Reston.

DATA PRESENTATION

Table 4 is a full size, representative sample of the phytoplankton cell counts and percent composition by station, date and time that is to be found in the microfiche supplied with this report.

Table 4. A full size of the microfiche listing of phytoplankton genera. The data are grouped by station (shown on top of the listing) progressing downstream. Within each station, phytoplankton samples are organized by date and time horizontally. The sample data are printed vertically and are continued onto the following pages. Total cells per milliliter for each sample is printed at the top of each column. When there is no notation next to the total cell number the count was performed by V. Stoelzel. A greater than sign (>) signifies that the count was performed by WAPORA. A less than sign (<) signifies that the count was performed by K. Boulukos. The phytoplankton genera are phylogenetically organized by division, class, order, family and genus. Cells-per-milliliter and percent of the total count are listed for each genus in the sample. Shannon and Weaver's diversity indices are presented at the top of the sample listing by division, class, order, family and genus. # represents a dominant organism (equal to or greater than 15 percent). Dashes (--) mean that genus was not present in count. Asterisk (*) means that the organism was present but at less than one half of a percent of the total count. Pages are arranged on the microfiche by column from top to bottom and from left to right.

PHYTOPLANKTON ANALYSIS, SEPTEMBER 1979 TO SEPTEMBER 1981

DATE	SEP 13,79	SEP 13,79	OCT 7,79	OCT 7,79	OCT 7,79	DEC 18,79
TIME	0845	0850	1100	1102	1105	1220
TOTAL CELLS/ML	4700	14000	2200	7100	27000	13000
DIVERSITY: DIVISION	2.0	2.1	1.5	1.8	1.8	2.0
.CLASS	2.0	2.2	1.5	1.9	1.8	2.1
..ORDER	2.5	2.3	1.8	2.3	2.0	0.0
...FAMILY	0.0	0.0	0.0	0.0	0.0	0.0
....GENUS	0.0	0.0	0.0	0.0	0.0	0.0

ORGANISM	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT
BACILLARIOPHYTA (DIATOMS)												
.BACILLARIOPHYCEAE												
..BACILLARIALES												
...NITZSCHIACEAE												
....NITZSCHIA	--	-	--	-	--	-	490	7	260	1	200	2
..EUPODISCALES												
...COSCINODISCACEAE												
....CYCLOTELLA	--	-	130	1	--	-	--	-	520	2	--	-
....MELOSIRA	--	-	--	-	--	-	--	-	260	1	--	-
....SKELETONEMA	--	-	260	2	--	-	490	7	--	-	--	-
....STEPHANODISCUS	1400#	30	3300#	24	470#	21	2500#	34	2400	9	200	2
..FRAGILARIALES												
...FRAGILARIACEAE												
....FRAGILARIA	310	7	--	-	--	-	--	-	--	-	--	-
..NAVICULALES												
...CYMBELLACEAE												
....CYMBELLA	--	-	--	-	--	-	--	-	1300	5	--	-
...NAVICULACEAE												
....NAVICULA	310	7	130	1	160	7	250	3	260	1	--	-
..RHIZOSOLENIALES												
...RHIZOSOLENIACEAE												
....RHIZOSOLENIA	--	-	--	-	--	-	--	-	--	-	200	2
CHLOROPHYTA (GREEN ALGAE)												
.CHLOROPHYCEAE	--	-	--	-	--	-	--	-	--	-	390	3
..CHLOROCOCCALES	630	13	1700	12	1100#	50	490	7	13000#	50	200	2
...CHLOROCOCCACEAE												
....SCHROEDERIA	--	-	400	3	--	-	250	3	--	-	--	-
...OOCYSTACEAE												
....ANKISTRODESMUS	310	7	3000#	22	160	7	250	3	790	3	200	2
....SELENASTRUM	--	-	--	-	--	-	--	-	520	2	--	-
...SCENEDESMACEAE												
....SCENEDESMUS	--	-	--	-	--	-	--	-	520	2	--	-
....TETRASTRUM	--	-	--	-	--	-	--	-	260	1	--	-
..VOLVOCALES												
...CHLAMYDOMONADACEAE												
....CHLAMYDOMONAS	--	-	--	-	--	-	--	-	--	-	390	3
CHRYSOPHYTA												
.CHRYSOPHYCEAE												
..CHROMULINALES												
...CHROMULINACEAE												

....CHROMULINA	--	-	--	-	--	-	--	-	--	-	200	2
CRYPTOPHYTA (CRYPTOMONADS)												
.CRYPTOPHYCEAE												
..CRYPTOMONADALES												
...CRYPTOCHRYSIDACEAE												
....CHROOMONAS	470	10	1200	8	160	7	1200#	17	520	2	1600	13
...CRYPTOMONADACEAE												
....CRYPTOMONAS	160	3	920	7	--	-	250	3	520	2	4100#	33
CYANOPHYTA (BLUE-GREEN ALGAE)												
.CYANOPHYCEAE												
..CHROOCOCCALES												
...CHROOCOCCACEAE												
....AGMENELLUM	--	-	--	-	--	-	--	-	1300	5	--	-
..OSCILLATORIALES												
...OSCILLATORIACEAE												
....OSCILLATORIA	--	-	130	1	--	-	--	-	--	-	--	-
EUGLENOPHYTA (EUGLENOIDS)												
.EUGLENOPHYCEAE												
..EUGLENALES												
...EUGLENACEAE												
....EUGLENA	160	3	130	1	--	-	--	-	--	-	--	-
....EUTREPTIA	--	-	--	-	--	-	--	-	260	1	--	-
....PHACUS	--	-	--	-	--	-	--	-	260	1	--	-
....TRACHELOMONAS	--	-	130	1	--	-	--	-	--	-	--	-
...PERANEMACEAE												
....CALYCOMONAS	--	-	--	-	--	-	--	-	--	-	3700#	30
PYRRHOPHYTA (FIRE ALGAE)												
.DESMOKONTAE												
..DESMOMONADALES												
...PROROCENTRACEAE												
....PROROCENTRUM	--	-	660	5	--	-	250	3	--	-	590	5
.DINOPHYCEAE												
..DINOKONTAE												
...GLENODINIACEAE												
....GLENODINIUM	--	-	--	-	--	-	490	7	260	1	--	-
...GYMNODINIACEAE												
....GYMNODINIUM	630	13	1800	13	--	-	--	-	2400	9	200	2
....GYRODINIUM	--	-	--	-	160	7	250	3	790	3	--	-
....MASSARTIA	--	-	--	-	--	-	--	-	260	1	390	3
...PERIDINIACEAE												
....PERIDINIUM	310	7	--	-	--	-	--	-	--	-	--	-

01661475 POTOMAC R AT PINEY POINT, MD

GROUP 2 OF 5

PHYTOPLANKTON ANALYSES, SEPTEMBER 1979 TO SEPTEMBER 1981

DATE	DEC 18,79	JAN 17,80	JAN 17,80	JAN 17,80	JAN 17,80	FEB 18,80
TIME	1225	1030	1035	1120	1125	1300
TOTAL CELLS/ML	19000	8800	6400	8600	9000	11000
DIVERSITY: DIVISION	1.8	1.6	1.9	2.0	1.5	2.4
.CLASS	0.0	2.0	0.0	0.0	1.8	0.0
..ORDER	0.0	2.0	0.0	0.0	1.9	0.0
...FAMILY	0.0	2.0	0.0	0.0	0.0	0.0
....GENUS	0.0	2.1	0.0	0.0	0.0	0.0

ORGANISM	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT
BACILLARIOPHYTA (DIATOMS)												
.BACILLARIOPHYCEAE												
..BACILLARIALES												
...NITZSCHIACEAE												
....NITZSCHIA	200	1	--	-	--	-	--	-	--	-	--	-
..BIDDULPHIALES												
...CHAETOCERACEAE												
....CHAETOCEROS	--	-	--	-	--	-	--	-	--	-	470	4
..EUPODISCALES												
...COSCINODISCACEAE												
....SKELETONEMA	--	-	--	-	160	2	--	-	--	-	790	7
....STEPHANODISCUS	390	2	--	-	160	2	630	7	--	-	630	6
....THALASSIOSIRA	--	-	--	-	--	-	--	-	--	-	160	1
..FRAGILARIALES												
...FRAGILARIACEAE												
....SYNEDRA	--	-	160	2	--	-	--	-	--	-	--	-
CHLOROPHYTA (GREEN ALGAE)												
.CHLOROPHYCEAE												
..CHLOROCOCCALES	1200	6	--	-	940	15	160	2	160	2	1100	10
...CHLOROCOCCACEAE												
....SCHROEDERIA	200	1	--	-	--	-	--	-	--	-	--	-
...COCCOMYXACEAE												
....DIOGENES	--	-	--	-	--	-	--	-	--	-	790	7
...MICRACTINIACEAE												
....MICRACTINIUM	--	-	160	2	--	-	--	-	--	-	--	-
...OOCYSTACEAE												
....ANKISTRODESMUS	200	1	--	-	160	2	630	7	160	2	--	-
..ULOTRICHALES												
...ULOTRICHACEAE												
....ULOTHRIX	200	1	--	-	--	-	--	-	--	-	160	1
..VOLVOCALES												
...CHLAMYDOMONADACEAE												
....CHLAMYDOMONAS	390	2	160	2	--	-	160	2	--	-	160	1
....LOBOMONAS	--	-	--	-	--	-	--	-	--	-	310	3
...PYRAMIMONACEAE												
....PYRAMIMONAS	390	2	--	-	--	-	--	-	790	9	--	-
CHRYSOPHYTA												
.CHRYSOPHYCEAE												
..CHROMULINALES												
...CHROMULINACEAE												

....CHROMULINA	--	-	470	5	--	-	--	-	--	-	--	-
CRYPTOPHYTA (CRYPTOMONADS)												
.CRYPTOPHYCEAE												
..CRYPTOMONADALES												
...CRYPTOCHRYSIDACEAE												
....CHROOMONAS	7300#	39	3800#	43	2200#	34	3300#	38	3300#	37	940	9
...CRYPTOMONADACEAE												
....CRYPTOMONAS	2700	15	--	-	790	12	1300	15	--	-	--	-
CYANOPHYTA (BLUE-GREEN ALGAE)												
.CYANOPHYCEAE												
..CHROOCOCCALES												
...CHROOCOCCACEAE												
....AGMENELLUM	--	-	160	2	--	-	--	-	--	-	--	-
..OSCILLATORIALES												
...OSCILLATORIACEAE												
....OSCILLATORIA	200	1	--	-	--	-	--	-	--	-	--	-
EUGLENOPHYTA (EUGLENOIDS)												
.EUGLENOPHYCEAE												
..EUGLENALES												
...EUGLENACEAE												
....TRACHELOMONAS	--	-	--	-	--	-	--	-	160	2	--	-
...PERANEMACEAE												
....CALYCOMONAS	200	1	--	-	160	2	790	9	--	-	1100	10
PYRRHOPHYTA (FIRE ALGAE)												
.DESMOKONTAE												
..DESMOMONADALES												
...PROROCENTRACEAE												
....PROROCENTRUM	1600	8	3100#	36	790	12	940	11	3800#	42	1700#	16
.DINOPHYCEAE												
..DINOKONTAE												
...GYMNODINIACEAE												
....GYMNODINIUM	980	5	160	2	310	5	--	-	160	2	--	-
....GYRODINIUM	--	-	310	4	--	-	--	-	--	-	--	-
....MASSARTIA	2200	11	310	4	630	10	630	7	470	5	1900#	17
UNKNOWN 2000000000COCCO	590	3	--	-	160	2	160	2	--	-	630	6

PHYTOPLANKTON ANALYSES, SEPTEMBER 1979 TO SEPTEMBER 1981

DATE	FEB 18,80		FEB 18,80		FEB 18,80		FEB 18,80		MAR 17,80		MAR 17,80	
TIME	1305		1315		1345		1350		1100		1120	
TOTAL CELLS/ML	6600		6900		19000		6900		15000		24000	
DIVERSITY: DIVISION	2.0		2.6		1.7		2.0		2.0		2.1	
.CLASS	2.2		0.0		2.0		2.2		0.0		0.0	
..ORDER	2.5		0.0		2.4		0.0		0.0		0.0	
...FAMILY	0.0		0.0		0.0		0.0		0.0		0.0	
....GENUS	0.0		0.0		0.0		0.0		0.0		0.0	
ORGANISM	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT	CELLS /ML	PER-CENT
BACILLARICPHYTA (DIATOMS)												
.BACILLARIOPHYCEAE												
..BACILLARIALES												
...NITZSCHIACEAE												
....NITZSCHIA	--	-	--	-	610	3	--	-	--	-	250	1
..BIDDULPHIALES												
...CHAETOCERACEAE												
....CHAETOCEROS	470	7	1400#	20	--	-	98	1	--	-	980	4
..EUPODISCALES												
...COSCINODISCACEAE												
....COSCINODISCUS	--	-	--	-	--	-	--	-	--	-	490	2
....CYCLOTELLA	--	-	--	-	--	-	200	3	--	-	--	-
....MELOSIRA	--	-	--	-	1200	6	--	-	--	-	--	-
....SKELETONEMA	--	-	--	-	610	3	98	1	--	-	490	2
....STEPHANODISCUS	--	-	470	7	6100#	32	2200#	31	8300#	55	7900#	33
..FRAGILARIALES												
...FRAGILARIACEAE												
....FRAGILARIA	--	-	--	-	200	1	--	-	--	-	--	-
..NAVICULALES												
...NAVICULACEAE												
....NAVICULA	--	-	--	-	--	-	98	1	--	-	250	1
..RHIZOSOLENIALES												
...RHIZOSOLENIACEAE												
....RHIZOSOLENIA	--	-	--	-	820	4	--	-	--	-	--	-
CHLOROPHYTA (GREEN ALGAE)												
.CHLOROPHYCEAE												
..CHLOROCOCCALES	2500#	38	470	7	2900#	15	690	10	1500	10	4700#	20
...OOCYSTACEAE												
....ANKISTRODESMUS	--	-	160	2	200	1	--	-	740	5	--	-
..ULOTRICHALES												
...ULOTRICHACEAE												
....ULOTHRIX	--	-	--	-	--	-	590	9	--	-	980	4
..VOLVOCALES												
...CHLAMYDOMONADACEAE												
....CHLAMYDOMONAS	470	7	--	-	--	-	--	-	--	-	--	-
..ZYGNEMATALES												
...DESMIDIACEAE												
....STAURASTRUM	--	-	--	-	--	-	98	1	--	-	--	-
CHRYSOPHYTA												
.CHRYSOPHYCEAE	--	-	--	-	--	-	--	-	--	-	250	1

UNITED STATES DEPARTMENT OF THE INTERIOR
DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY
Dallas L. Peck, Director

For additional information
write to:

Chief Hydrologist
U.S. Geological Survey
Water Resources Division
430 National Center
Reston, Virginia 22092

Copies of this report can be
purchased from:

Open-File Services
Western Distribution Branch
U.S. Geological Survey
Box 25425, Federal Center
Denver, Colorado 80225

.XANTHOPHYCEAE	--	-	--	-	--	-	98	1	--	-	--	-
CRYPTOPHYTA (CRYPTOMONADS)												
.CRYPTOPHYCEAE												
..CRYPTOMONADALES												
...CRYPTOCHRYSIDACEAE												
....CHROOMONAS	1300#	19	630	9	1000	5	200	3	1500	10	2700	11
...CRYPTOMONADACEAE												
....CRYPTOMONAS	--	-	160	2	410	2	690	10	--	-	250	1
CYANOPHYTA (BLUE-GREEN ALGAE)												
.CYANOPHYCEAE												
..CHROOCOCCALES												
...CHROOCOCCACEAE	--	-	940	14	--	-	--	-	--	-	--	-
..NOSTOCALES												
...NOSTOCACEAE												
....ANABAENA	--	-	--	-	--	-	--	-	490	3	--	-
..OSCILLATORIALES												
...OSCILLATORIACEAE												
....OSCILLATORIA	--	-	--	-	--	-	--	-	250	2	--	-
EUGLENOPHYTA (EUGLENOIDS)												
.EUGLENOPHYCEAE												
..EUGLENALES												
...PERANEMACEAE												
....CALYCOMONAS	630	10	630	9	--	-	--	-	--	-	490	2
PYRRHOPHYTA (FIRE ALGAE)												
.DESMOKONTAE												
..DESMOMONADALES												
...PROROCENTRACEAE												
....PROROCENTRUM	940	14	1100#	16	2700	14	1200#	17	490	3	1700	7
.DINOPHYCEAE												
..DINOKONTAE												
...GLENODINIACEAE												
....GLENODINIUM	--	-	--	-	--	-	290	4	--	-	--	-
...GYMNODINIACEAE												
....GYMNODINIUM	--	-	--	-	410	2	98	1	250	2	490	2
....GYRODINIUM	--	-	--	-	--	-	--	-	250	2	--	-
....MASSARTIA	310	5	630	9	1600	10	290	4	--	-	980	4
UNKNOWN 2000000000COCCO	--	-	310	5	--	-	--	-	1500	10	980	4

References

Butcher, R. W., 1959, An introductory account of the smallar algae of British coastal waters: Part I: Introduction and Chlorophyceae, Fishery Investigations, Ser. IV, p. 1-74.

Campbell, P. H., 1973, Studies on brackish water phytoplankton: Sea Grant Publication UNC-SG-73-07, 361 p.

Cocke, E. C., 1967, The Myxophyceae of North Carolina: Edwards Bros., Ann Arbor, Michigan, 206 p.

Cohen, Ronald R. H., 1984, Phytoplankton dynamics, in Callender, E., and others (eds.), A water quality study of the tidal Potomac River and Estuary - an overview: U.S. Geol. Survey Water Supp. Pap. 2233.

Drouet, F. and Daily P., 1956, Revision of the Coccoid Myxophyceae: Butler Univ. Botanical Studies, v. 12, p. 1-218.

Eloranta, P., 1978, Effects of size of sample counted in phytoplankton analyses: Ann. Bot. Fennici, v. 15, p. 169-176.

Frontier, S., 1972, Calcul de l'erreur sur un comptage de zooplankton: J. Exp. Mar. Biol. Ecol., v. 8, no. 2, p. 121-132.

Greeson, P. E., Ehlke, T. A., Irwin, G. A., Lium, B. W., and Slack, K. V., 1977, Methods for collection and analysis of aquatic biological and microbiological samples: U.S. Geol. Survey Techniques of Water-Resources Investigations, Book 5, Chapter 4, 1977, p. 91-112.

Hasle, G. R., 1978, The inverted microscope method, in Sournia, A., (ed.), Phytoplankton Manual: Unesco, Paris, p. 88-96.

Hasle, G. R., 1978, Diatoms, in Sournia, A., Phytoplankton Manual: Uresco, Paris, p. 136-142.

Hobro, R. and Willen, E., 1977, Phytoplankton countings, Intercalibration results and recommendations for routine work, Int. Revue ges. Hydrobiol. v. 62, no. 6, p. 805-811.

Hubbert, E. M., 1965, Flagellates from brackish waters in the vicinity of Woods Hole, Massachusetts: Phycol., v. 1, p. 87-94.

Hustedt, F., 1930, Die Kieselalgen, in Rabenhorst, L., (ed.) Kryptogamenflora von Deutschland, Osterreich, und der Schweiz, Band VII., Part I, Academische Verlagsgesellschaft, Leipzig (Johnson Reprint Co.), New York, 920 p.

Lund, J. W. G., Kilpling, C., LeCren, E. D., 1958, The inverted miscroscope method of estimating algal numbers, and the statistical basis of estimation by counting: Hydrobiologia, v. 11, no. 2, p. 143-170.

Patrick R. and Reimer, C. W., 1966, The Diatoms of the United States, v. 1, monograph no. 13: Academy of Natural Sciences of Philadelphia, Phila, Pa., 688 p.

Patrick, R. and Reimer, C. W., 1975, The Diatoms of the United States, v. 2, part 1, monograph n. 13: Academy of Natural Sciences of Philadelphia, Phila., Pa., 213 p.

Prescott, G. W., 1962, Algae of the western Great Lakes Area: Wm. C. Brown, Co., Dubuque, Iowa, 977 p.

Prescott, G. W., 1978, How to know the freshwater algae, 3rd ed.: Wm. C. Brown, Dubuque, Iowa, 293 p.

Sakshaug, E., 1980, Problems in the methodology of studying phytoplankton, in Morris, I., (ed.), The Physcological ecology of phytoplankton, p. 57-94. Blackwell, U. of Calif. Press, Berkeley.

Saunders, R. P. and Glenn, D. A., 1969, Memories of the Hourglass Cruises, v. 1, part 3: Marine Research Laboratory, Dept. of Natural Resources, St. Petersburg, Florida, 119 p.

Utermohl, H., 1958, Zur Verwollkommnung der quantitativen Phytoplankton - Methodik: Mitt. int. ver. theor. angew. Limnol., v. 9, p. 1-38.

Venrick, E. L., 1978, How many cells to count? in Sournia, A., (ed.), Phytoplankton Manual: Unesco, Paris, p. 167-180.

Whitford, L. A. and Shumacher, G. J., 1973, A manual of fresh-water algae: Sparks Press, Raleigh, N.C., 324 p.

Wood, R. D. and Lutes, J. 1968, Guide to the phytoplankton of Narragansett Bay, Rhode Island: Univ. of Rhode Island Press, Kingston.

*U.S. GOVERNMENT PRINTING OFFICE: 1985-461-431:20016

CONTENTS

ILLUSTRATIONS

TABLES

FACTORS FOR CONVERTING INTERNATIONAL SYSTEM OF UNITS TO INCH-POUND UNITS

For use of readers who prefer to use inch-pound system of units, the data may be converted to metric (International System) units by using the following factors:

Multiply metric unit	by	To obtain inch-pound
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	nautical mile (nt mi)
gram (g)	0.0022	pound (lb)
cubic meter per second ($m^3\ s^{-1}$)	35.31	cubic foot per second (ft^3/s)

Concentration Conversions

Constituent	From	To	Divide by
Nitrate	micromoles per liter	milligrams per liter (as N)	0.014
Ammonia	micromoles per liter	milligrams per liter (as N)	0.014
Phosphate	micromoles per liter	milligrams per liter (as N)	0.031

PHYTOPLANKTON ABUNDANCE AND GENERIC COMPOSITION DATA FOR POTOMAC RIVER AND ESTUARY, MARYLAND

By R. R. H. Cohen, S. O. Pollock, V. E. Stoelzel and K. E. Boulukos

ABSTRACT

Phytoplankton of the Potomac River and Estuary were counted and identified to the generic level. Double-blind precision tests for an individual counter yielded a standard deviation that was ± 10 percent of the mean. Differences between three counters exceeded ± 10 percent, and a curve could be fit to calibration counts to yield correlation coefficients of 0.70 to 0.86 between counters. Counters identified the same genera that comprised the highest and second highest percentages of the population in 88 percent of the calibration samples.

INTRODUCTION

Phytoplankton are a major component of aquatic ecosystems because they produce organic materials from inorganic nutrients using sunlight as an energy source. The microalgae that make up the phytoplankton are the primary energy source for most aquatic-ecosystems.

Counting phytoplankton cells is the oldest method of estimating biomass (Sakshaug, 1980). The method was used in the U.S. Geological Survey Potomac Study (Cohen, 1984) to help understand phytoplankton dynamics because cell enumeration and identification yields more information about aquatic-ecosystems than any other measure of phytoplankton biomass (Sakshaug, 1980). This report presents phytoplankton enumeration and generic identification data collected September 1979 through October 1981 as part of the Potomac River and Estuary study of the U.S. Geological Survey.

The tidal Potomac River, Maryland extends 187 kilometers (km), from above Washington, D.C. at Chain Bridge to the Chesapeake Bay (fig. 1). Its tidal, fresh portion, approximately 62 km long, has a volume of 3.4×10^8 m^3 and receives drainage from metropolitan Washington, D.C. as well as the non-tidal Potomac River (fig. 2a). It has an average flow of 310 m^3 sec^{-1} and accepts approximately 1.4×10^6 m^3 per day of waste water from municipal treatment facilities.

A zone of high, summer phytoplankton biomass extends from river kilometer 180 at Memorial Bridge to km 126 at Quantico (fig. 21), the approximate, late-summer location of the brackish water/freshwater interface.

Downstream from Quantico (km 125.6) to Morgantown (km 80.4) is the transition zone from fresh- to brackish-water (figs. 1 and 2b). The estuary, from Morgantown to Pt. Lookout (km 6.5), is shown in figure 2b.

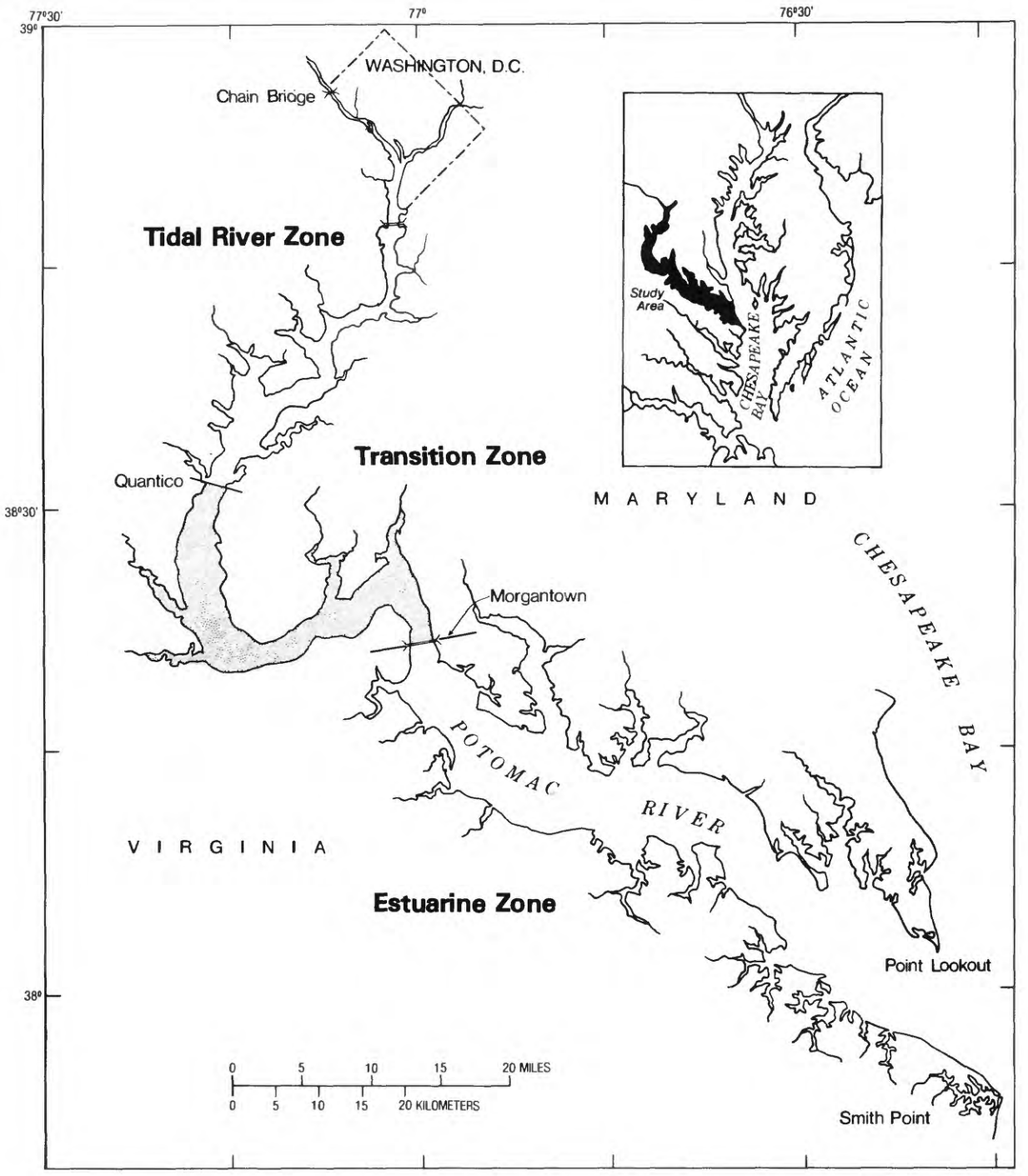

Figure 1.--Map of the Potomac River and Estuary, Maryland

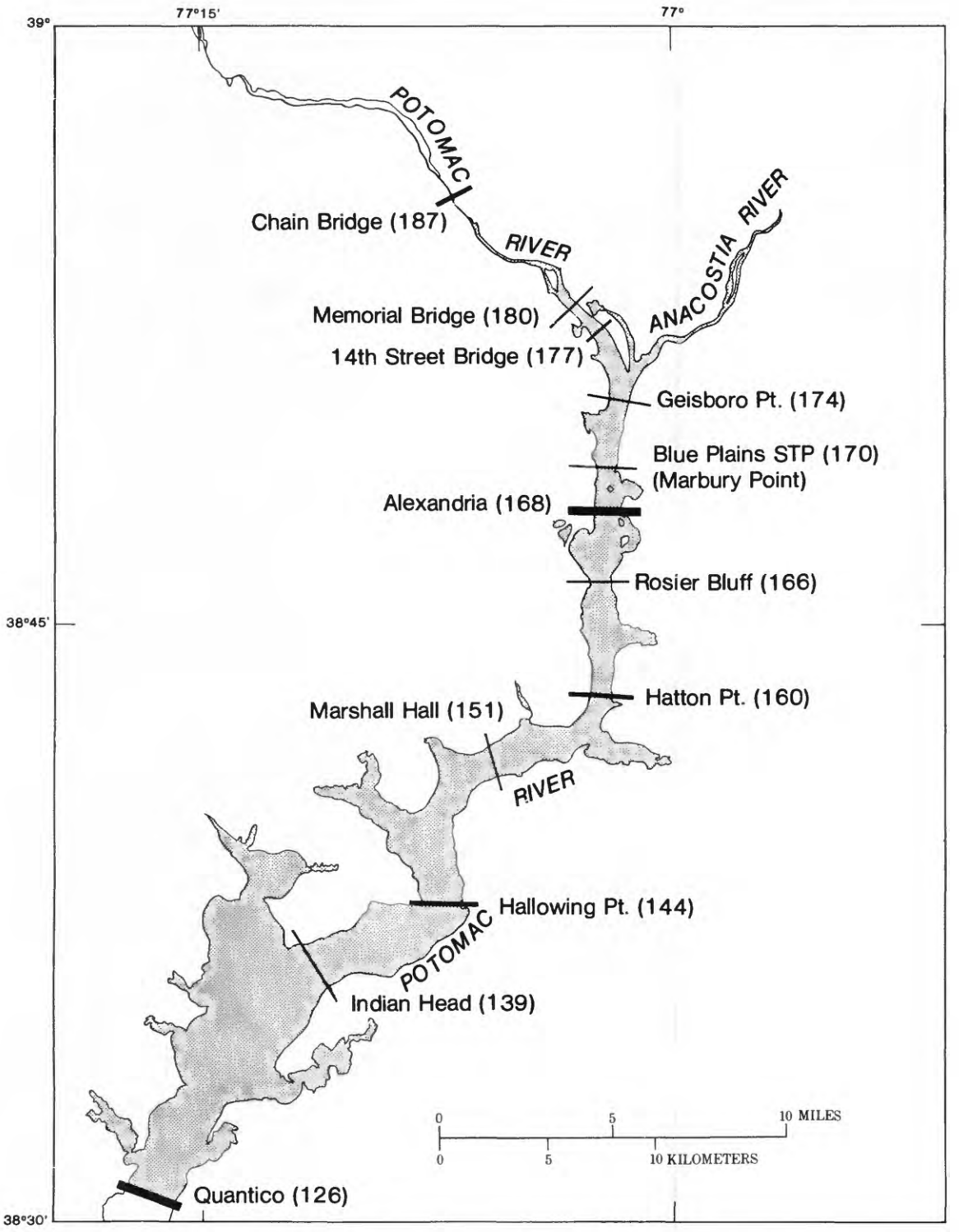

Figure 2a.--Location of sampling stations in the fresh, tidal Potomac River, Maryland. The Blue Plains Sewage Treatment Plant (STP) station is identical to Marbury Point. Sampling station distance, in kilometers from mouth of Potomac, are in parentheses.