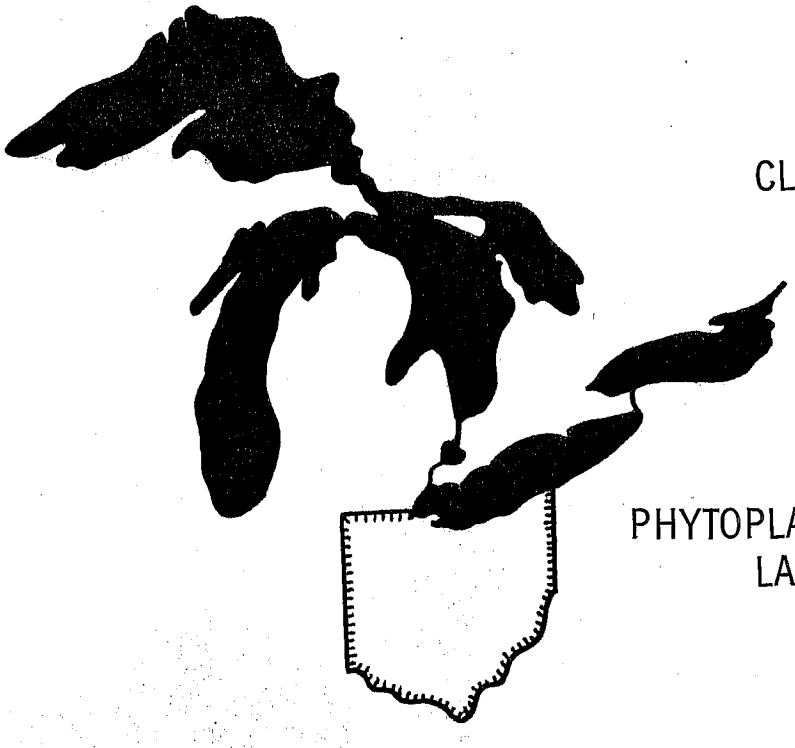

CLEAR TECHNICAL REPORT NO. 61

PHYTOPLANKTON ANALYSIS OF GREAT LAKES WATER SAMPLES

by

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and

Donna D. Larson

Prepared for

National Aeronautical and Space Administration
Lewis Research Center
Cleveland, Ohio

Order No. C-291-D

THE OHIO STATE UNIVERSITY
CENTER FOR LAKE ERIE AREA RESEARCH
COLUMBUS, OHIO

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PHYTOPLANKTON ANALYSIS OF GREAT LAKES WATER SAMPLES

Introduction

Ten water samples were collected in Lakes Michigan, Superior and Erie in 1976 as part of the tributary plume studies undertaken by NASA-Lewis Research Center in conjunction with the PLUARG investigation of the International Joint Commission. The locations of the sampling stations are shown on Figures 1-7 and the collection dates are given in Table 1.

The samples were analyzed for phytoplankton populations by The Ohio State University, Center for Lake Erie Area Research in February 1977. The results of these analyses are given in Tables 2-4.

At the time of collection the samples were preserved with Lugol's solution. Standard identification and counting procedures for an inverted microscope were used for the analysis. All the taxa are reported as cells per milliliter, except where otherwise noted. Colonial organisms such as Pediastrum, Merismopedia, and Coelastrum and filamentous organisms such as filamentous blue-greens and Melosira are reported as individual cells per ml whenever possible and not as colonies or filaments.

Lake Michigan

Both samples contained large quantities of resuspended material. Numerous empty diatom frustules, i.e., Navicula, Gomphonema and Achnanthes, were observed as well as inorganic particles. The two centric diatoms sp. 1 and sp. 2 are not distinguishable using the Utermöhl technique. Empty frustules of both Cyclotella and Stephanodiscus were observed, therefore, the two species categories represent a combination of the two taxa. The two Chrysophyte species are not as yet identified. These cells were approximately 10 μ long and 3 μ wide.

Lake Superior

The Lake Superior samples varied as to the quantity of sus-

pended material. Samples taken on 5 April and 6 April were relatively free from particulate material, samples, taken on 1 April and 4 April had moderate quantities and the 9 April sample contained large quantities of suspended matter. The Microcystis sp. found occurred in small colonies with the size of the cells being less than 5 μ. The same taxonomic problem with the small centric diatoms existed as found in the Lake Michigan samples. The Chrysophyte species were given numbers to separate them due to taxonomic problems. Species 1, the same one found in Lake Michigan, was 10 μ long and 3 μ wide; and species 5 was 4.5 μ long and 4 μ wide.

Lake Erie

The blue-greens found at the Lake Erie stations were numerous and very small. Merismopedia minima cell size was less than 1 μ. Both species of Microcystis were reported as colonies due to the density of cells within the matrix but in both species the cells were small (≈1 μ). The centric diatoms were grouped as sp. 1 and sp. 2 due to similar taxonomic problems as encountered in the other samples. Resuspended sediment did not present a problem in the Lake Erie samples.

TABLE 1

WATER SAMPLING DATES AND LOCATIONS

Date	Location		Sample Identification
	River	Lake	
23 March 1976	Grand River	Michigan	7603 1-2
23 March 1976	Grand River	Michigan	7603 5-2
1 April 1976	Nemadji River	Superior	76-37 UMD
4 April 1976	Nemadji River	Superior	76-78 UMD
5 April 1976	Nemadji River	Superior	#2 Surface
6 April 1976	Nemadji River	Superior	Station 1, 3 meters
9 April 1976	Nemadji River	Superior	Station 1, Surface
3 September 1976	Black River (Lorain)	Erie	Cyclops/Erie Station 0
3 September 1976	Black River (Lorain)	Erie	Cyclops/Erie Station 4
3 September 1976	Black River (Lorain)	Erie	Cyclops/Erie Station 6

TABLE 2

GRAND RIVER - LAKE MICHIGAN

Taxa	Station code and date	
	7603 1-2 3/23/76	7603 5-2 3/23/76
	#/ml.	#/ml.
CYANOPHYTA		
CHLOROPHYTA		
Actinastrum Hantzschii		20
Ankistrodesmus falcatus	10	48
Chlamydomonas sp.	45	44
Closterium aciculare		2
Eudorina elegans	80	
Kirchneriella lunaris		5
Lagerheimia geneviensis	2	
Microactinium pusillum		10
Oocystis Borgei		10
Platymonas sp.	4	
Scenedesmus quadricauda	15	15
Scenedesmus sp.	20	
Sphaerocystis schrodeteri		20
Tetrastrum staurogeniaeforme	72	
BACILLARIOPHYTA		
Asterionella formosa		47
Diatoma tenue	14	
Diatoma vulgare	7	
Diatoma sp.	15	
Fragilaria sp.		10
Melosira granulata	55	130
M. islandica	20	10
M. varians	10	12
Meridion circulare		10
Navicula spp.	17	7
Nitzschia sp. 1	20	17
Nitzschia sp. 2	2	
Nitzschia sp. 3		2
Rhizosolenia eriensis		10
Stephanodiscus niagarae		5
Stephanodiscus sp.	5	14
Synedra delicatissima		7
Synedra sp.	5	12

TABLE 2 CON'T.

GRAND RIVER - LAKE MICHIGAN

Taxa	Station code and date	
	7603 1-2 3/23/76	7603 5-2 3/23/76
	#/ml.	#/ml.
Tabellaria fenestrata	2	42
centric spp. 1 8-12μ	744	368
centric spp. 2 17-22μ	77	154
CHRYSOPHYTA		
Dinobryon sp.	10	
Ochromonas sp.		144
Stelexomonas sp.		60
sp. 1	184	36
sp. 2	112	15
PYRROPHYTA		
Cryptomonas sp. 1		22
Cryptomonas sp. 2	2	7
Glenodinium sp.		22
Rhodomonas minuta	80	284

TABLE 3

NEMADJI RIVER - LAKE SUPERIOR

Taxa	4/1/76 Sta.3 76-37 UMD	4/4/76 Sta.7 76-78 UMD	4/5/76 # 2 Surface	4/6/76 Station 1 3m	4/9/76 Station 1 Surface
	#/ml.	#/ml.	#/ml.	#/ml.	#/ml.
CYANOPHYTA					
Coelosphaerium Nagelianum	8	4			
Gomphosphaeria aponica		12			
Merismopedia elegans	4				
Microcystis sp.	2	11	93	81	60
filament 1 2	2	12	15	13	5
filament 2is sp.		8	15	19	65
CHLOROPHYTA					
Ankistrodesmus falcatus	11	2			
Ankistrodesmus spiralis			7	2	5
Chlamydomonas sp.					22
Crucigenia quadrata			20	16	10
Oocystis sp.			4	2	
Pediastrum simplex	15				
Quadrigula lacustris		3	7		
Scenedesmus abundans	2				
Sphaerocystis schrodeteri	20			7	
BACILLARIOPHYTA					
Asterionella formosa	18		2	2	
Fragilaria sp.	1	1			
Melosira sp.	2				12
Navicula sp.					1
Nitzschia sp.	1		2	6	
Rhizosolenia erienisis		1	1	1	
centric spp. 17µ	2	1	3	1	2
centric spp. 10µ	12	30	39	45	45

TABLE 3 CON'T.

NEMADJI RIVER - LAKE SUPERIOR

Taxa	4/1/76 Sta. 3 76-37 UMD #/ml.	4/4/76 Sta.7 76-78 UMD #/ml.	4/5/76 # 2 Surface #/ml.	4/6/76 Station 1 3m #/ml.	4/9/76 Station 1 Surface #/ml.
CHRYSOPHYTA					
sp. 1	424	16		295	488
sp. 3	16	4	60	48	20
sp. 5	61	45	83	55	87
sp. 6			4	5	
sp. 7					161
Ochromonas sp.	1	2			
PYRROPHYTA					
Cryptomonas sp. 1	16	4		2	
Cryptomonas sp. 2	187	31			
Glenodinium sp.			3		5
Katablopheris sp.	18	9			
Rhodomonas minuta	1	34	11	55	95
Rhodomonas minuta v. var nanoplanktonica	176	58			

TABLE 4

CENTRAL BASIN - LAKE ERIE

	Cyclops Erie Station 0	Cyclops Erie Station 6	Cyclops Erie Station 4
	#/ml.	#/ml.	#/ml.
CYANOPHYTA			
Anabaena flos-aquae (filaments)		92	213
Aphanizomenon sp.	14	22	
Chroococcus Kuetzingiana		22	16
Coelosphaerium Nagelianum (filaments)	76	224	105
Gomphosphaeria aponica var. delicatula	506	451	351
Merismopedia elegans	22		43
Merismopedia minima (colonies)	1022	1362	3029
Microcystis flos-aquae (colonies)	5	8	
M. minutissima (filaments)	16	35	170
Oscillatoria animalis	11		5
filamentous b-g d=1.5μ	8		3
filamentous b-g cells 1.5x2μ	197	87	95
filamentous b-g 7.3 x 2μ	186	281	554
CHLOROPHYTA			
Actinastrum Hantzschii			43
Ankistrodesmus falcatus	54	73	41
A. falcatus var. tumidus	3		
Chlamydomonas sp.	3	3	3
Closterium aciculare		3	
Closterium sp.		3	
Coelastrum cambricum		43	
C. microporum			273
C. reticulatum		46	
Cosmerium sp.		5	
Dictyosphaerium pulchellum	5		5
[illegible]			
[illegible]	5		5

TABLE 4 CON'T.

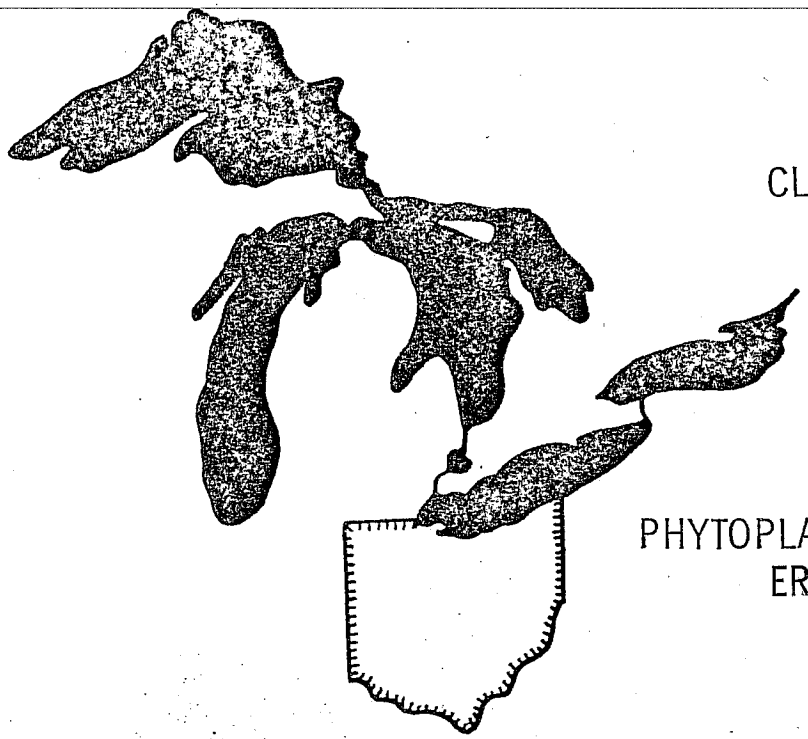
CENTRAL BASIN - LAKE ERIE

	Cyclops Erie Station 0	Cyclops Erie Station 6	Cyclops Erie Station 4
	#/ml.	#/ml.	#/ml.
Golenkinia paucispina	3	5	8
Kirchneriella lunaris	178	449	208
Lagerheimia geneviensis	27	38	11
L. subsalsa	3	16	8
Oocystis Borgei	32	89	92
O. lacustris	5	19	11
Pediastrum duplex		86	167
P. simplex	43	162	127
Platymonas sp.			14
Scenedesmus abundans	49	122	54
S. acuminatus		22	
S. bijuga	49	192	
S. denticulatus var. bicaudatus	16		24
S. intermedius	11	43	32
S. quadricauda	65	97	100
Scenedesmus sp. 1	8	111	32
Schroederia Judayi	5		
S. setigera	22	68	46
Sphaerocystis schrodeteri	422	41 cells 41 cells	140
Staurastrum paradoxum	5	5	5
Tetraedon caudatum var. longispinum			5
T. limneticum			3
T. minimum	5	8	5
T. trigonum var. gracile			3
Tetrastrum glabrum		5	
T. heteracanthum		11	
T. staurogeniforme	11	32	11
Treubaria setigerum	5	24	11
BACILLARIOPHYTA			
Coscinodiscus sp.	5		
Cyclotella sp.	3	3	11
Fragilaria crotonensis		54	
Fragilaria sp.		8	97
Melosira sp.			2
Navicula sp.	3	19	14
Nitzschia sp.	14	22	19
Stephanodiscus astraea	16	39	8

TABLE 4 CON'T.

CENTRAL BASIN - LAKE ERIE

	Cyclops Erie Station 0	Cyclops Erie Station 6	Cyclops Erie Station 4
	#/ml.	#/ml.	#/ml.
centric sp. 1 (4.0-7.0μ)	41	14	43
centric sp. 2 (9.0-14.0μ)	3	30	27
CHRYSOPHYTA			
Chrysococcus sp.	38	43	3
Dinobryon divergens	11		
Mallomonas sp.	3		
Ochromonas sp.	143	289	289
PYRROPHYTA			
Ceratium hirundinella	5	19	11
Cryptomonas sp. 1	127	100	130
Cryptomonas sp. 2	68	81	116
Cryptomonas sp. 3	27	16	11
Diplosalus sp.		3	5
Gymnodinium helvaticum	3		
G. ordinatum	24		5
Katablopheris sp.	43	92	324
Peridinium aciculiferum		3	
Rhodomonas minuta	430	581	570
R. minuta var. nano-planktonica	246	195	203



CLEAR TECHNICAL REPORT NO. 61
Addendum No. 1

PHYTOPLANKTON ANALYSIS OF LAKE ERIE WATER SAMPLES

by

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Prepared for

National Aeronautical and Space Administration
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Order No. C-6965-D

THE OHIO STATE UNIVERSITY
CENTER FOR LAKE ERIE AREA RESEARCH
COLUMBUS, OHIO

December 1977

THE OHIO STATE UNIVERSITY

9 December 1977

NASA - Lewis Research Center
Attn.: Roger Svehla
Mail Stop 54-2
21000 Brookpark Road
Cleveland, Ohio 44135

Dear Mr. Svehla:

Enclosed are the results of our analyses of your twenty whole water samples. The counts are expressed as #/ml of cells or colonies, as designated on the following tables. A brief explanation of methods used, along with a general overview of what was observed at each location, precedes the data tables.

In future it would be helpful to be provided with a station location map. This aids in determining the quantity of whole water to settle, and gives us a general idea of the taxa we will be encountering. Some samples have been preserved with too high a concentration of Lugol's solution. When the whole water samples are preserved, enough Lugol's should be added to give a light whiskey color to the water, approximately 3ml/liter. Plastic containers will absorb the preservative, and it is therefore good to re-use the bottles. Your sample containers are being returned to you for future use.

We are presently working on a program which will generate biomass (mg of dry weight/m^3) based on our cell counts. If you would be interested in this type of information in addition to #/ml, we will be able to provide it.

We have noticed several errors in the March, 1977 report. In the introductory section for Lake Erie, Microcystis flos-aquae cells are ~4.3μ in diameter, and M. minutissima cells are less than 1μ in size. Both are not ~1μ. In Table 4, Aphanizomenon flos-aquae, Oscillatoria animalis, and the filamentous blue-green 1.5μ in diameter should be expressed as filaments/ml. Microcystis flos-aquae and M. minutissima should be expressed as colonies/ml. We regret that we failed to notice these errors earlier.

Center for Lake Erie Area Research / Biological Sciences Bldg. / 484 West Twelfth Avenue / Columbus, Ohio 43210 / Phone (614) 422-8949

Also, in the Nemadji River species list, several Chrysophyte "species" were listed by number. Sp. 1 is possibly an encysted Chlamydomonas, Sp. 5 is a Chlamydomonas, and Sp. 3 is a unicellular green.

If there are any questions about either report, please contact us.

Sincerely,

Donna Larson
David Rathke

Donna Larson
David Rathke
Research Associates
Center for Lake Erie Area Research
484 West 12th Avenue
Columbus, Ohio 43210

L&R/dl
cc: C. E. Herdendorf

INTRODUCTION

Twenty samples from Lake Erie and Lake Michigan locations were examined for determination of algal abundance and species composition using the Utermohl technique. 10 ml of water were usually settled, and 50 random fields examined at 25x, a strip examined at 40x, and a half-chamber at 25x. Due to algal density and/or suspended sediment at some of the sites, 5 ml and in one instance 2 ml, of whole water were settled.

Identification to species was made whenever possible, using standard references. Numbers are expressed as cells /ml , with a few exceptions, which are noted in the following tables. The small centric diatoms were not identified to species, due to taxonomic difficulties. They were, however, placed into categories by size.

A recent change in taxonomic status has resulted in reassignment of a Coscinodiscus species to Actinocyclus normanii f. subsalsa.

LAKE MICHIGAN - MILWAUKEE, WISCONSIN

The four Milwaukee stations were similar in algal composition, with some exceptions. Station 12 had very low Chlorophyta and Cyanophyta populations in comparison with the other stations, and station 2 was also low in Chlorophyta. While stations 1, 2 and 12 were rich in Chrysophytes, this group was nearly absent from station 10.

Rhizoselenia (Bacillariophyta) and several species of Dinobryon (Chrysophyta) were abundant at this location (all stations). Many of the Rhizoselenia frustules were broken, and only cells containing plastids were enumerated. This may have led to an underestimation of the number of Rhizoselenia cells present. Dinobryon cells which had come out of their loricas were identifiable to genus, but not species. These loose Dinobryon cells were counted and included in the species list.

LAKE MICHIGAN Milwaukee, Wisconsin	COLLECTION SITE AND DATE			
	Special Station #1 2 meters July 13, 1977	Special Station #2 2 meters July 13, 1977	Station # 10 2 meters July 13, 1977	Station 12 2 meters July 13, 1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
CYANOPHYTA				
Anabaena planktonica			286	
Chroococcus limneticus			19	
Gomphosphaeria aponina	166	152		148
Merismopedia minima			1244	
Microcystis minutissima		5 colonies		
Oscillatoria limnetica	111			
Oscillatoria sp. 2μ	1160	1010	1219	114
Oscillatoria sp. 3μ	332	238		
Oscillatoria sp. 4-6μ	49		159	
Raphidiopsis mediterranea		35		
BLUE-GREEN CELLS	14	50	99	
CHLOROPHYTA				
Actinastrium Hantzchii			118	
Ankistrodesmus falcatus	73	9	466	71
A. falcatus var. setiformis			16	
Carteria sp.	18		3	
Chlamydomonas anglica	36		9	13
C. globosa	32		53	
Chlamydomonas sp. 14μ			37	
Closterium sp.				1
Coelastrum microporum			165	
Cosmarium depressum	1	1	1	1
C. incurvum	1	1		
Dictyosphaerium pulchellum		10	16	
Elaktothrix gelatinosa	20	8	53	3
Franceia Droescheri			6	
Kirchneriella lunaris			78	
K. obesa			187	
Micractinium pusillum			37	
Nephrocytium Agardhianum			25	

LAKE MICHIGAN Milwaukee, Wisconsin	COLLECTION SITE AND DATE			
	Special Station #1 2 meters July 13, 1977	Special Station #2 2 meters July 13, 1977	Station #10 2 meters July 13, 1977	Station 12 2 meters July 13, 1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
CHLOROPHYTA (CON'T.)				
Oocystis Borgei			31	
O. lacustris	13		37	20
O. parva	5			
Pediastrum Boryanum	3		12	
P. duplex			5	
P. simplex			6	
P. tetras var. tetraedon			7	
Pteromonas aculeata			12	
Scenedesmus abundans			6	
S. acuminatus	18		146	
S. bicaudatus	10	3	12	
S. quadricauda	45		488	10
S. quadricauda var. major			68	
Scenedesmus sp. (2-celled)	35	33	93	30
Shroederia Judayi	3	10		
S. setigera	3			
Sphaerocystis Shoeteri	5	5	27	
Staurastrum paradoxum			1	
Tetraedon trigonum			47	
T. trigonum var. gracile			28	
T. minimum			19	
Tetrastrum glabrum			47	
T. heteracanthum	10	10	44	10
T. staurogeniforme			25	
GREEN CELLS			49	
EUGLEOPHYTA				
Phacus sp.			12	
BACILLARIOPHYTA				
Asterionella formosa	134	43	106	97
Centric 3-4.3μ	105	20	67	
Centric 6.9μ		68		31
Centric 13-14μ	13			

LAKE MICHIGAN Milwaukee, Wisconsin	COLLECTION SITE AND DATE			
	Special Station #1 2 meters July 13, 1977	Special Station #2 2 meters July 13, 1977	Station #10 2 meters July 13, 1977	Station 12 2 meters July 13, 1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
BACILLARIOPHYTA (CON'T.)				
Coscinodiscus 14-19μ	3	3		
Cyclotella meneghiniana	137	20	1191	
Cyclotella 21-29μ	3	16		10
Diatoma elongata	30	25	264	22
Fragilaria crotonensis	48	187	945	15
Melosira granulata var. angustissima			226	
Navicula sp.	3	8	16	
Nitzschia acicularis			16	27
N. palea			9	
Nitzschia sp.			65	
Rhizoselenia eriensis	605	239	239	461
Stephanodiscus Niagarea			16	
Synedra acus var. angustissima	20	13		
Synedra ulna	109			15
S. ulna var. chaseana	43	10	59	22
Tabellaria fenestrata	106			8
CHRYSOPHYTA				
Bodo spora	205	642		220
Chromulina sp. 4.3μ	18	74		58
Chromulina sp. 2.μ	382	173		85
Chrysamoeba radians	15	3	3	
Chrysochromulina parva		5	9	40
Chrysococcus punctiformis	400			
Dinobryon bavaricum	5			
D. divergens	68	71	40	281
D. sociale	49	63		10
Dinobryon cells	1060	27		256
Ochromonas sp. 3μ	14	9		
Ochromonas sp. 8.6μ		14	13	45
Pseudokephyrion sp.	214	78		76
Salpingoeca sp.	264	15		76

LAKE MICHIGAN Milwaukee, Wisconsin	COLLECTION SITE AND DATE			
	Special Station #1 2 meters July 13, 1977	Special Station #2 2 meters July 13, 1977	Station #10 2 meters July 13, 1977	Station 12 2 meters July 13, 1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
PYRROPHYTA				
CRYPTOPHYCEAE				
Cryptomonas erosa	13	48	124	30
C. erosa var. reflexa			31	
C. ovata	3		3	
Katablepharis ovalis	209	41	22	18
Rhodomonas minuta	263	79	13	247
DINOPHYCEAE				
Ceratium hirundinella	1			1
Gymnodinium neglectum				1
G. ordinatum	1	1		
Peridinium aciculiferum		1		
Peridinium sp. 5	1			

SITES 1, 2 and 3

The Cyanophyta were abundant at all sites, and large and diverse populations of Chlorophyta were present. Bacillariophyta only occured in high concentrations in the August 18th samples. Chrysophyta and Pyrrophyta were abundant during both sampling periods at all three stations.

SITES 1 - 3	COLLECTION SITE AND DATE			
	Site 1 1 meter August 25,1977	Site 2 1 meter August 18,1977	Site 2 1 meter August 25,1977	Site 3 1 meter August 18,1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
CYANOPHYTA				
Anabaena planktonica		2087		1786
Anabaena spiroides		2762	650	2463
Aphanizomenon flos-aquae	1938	3544	247	2470
Aphanocapsa delicatissima		40 colonies		
Aphanothece clathrata	5 colonies			
Coelosphaerium Kuetzingianum	1356	2087		
C. Naegelianum	18			
Gomphosphaeria aponina			508	1960
Merismopedia minima		3296	238	12062
Microcystis aeruginosa		20 colonies		25 colonies
M. flos-aquae	15 colonies	50 colonies	3 colonies	
M. minutissima	5 colonies	81 colonies	2 colonies	327 colonies
Oscillatoria sp. 2μ		3680	202	7410
Oscillatoria sp. 4.3-5.7μ		3172		
Oscillatoria limnetica		10,247	588	10760
Raphidiopsis mediterranea		4690		1277
Blue green cells	114	173	136	136
CHLOROPHYTA				
Actinastrum Hantzschii var. fluviatile		242		402
Ankistrodesmus falcatus	13	202	90	75
A. falcatus var. mirabilis	5		27	
Carteria sp. 4-7μ	14	27		
Carteria sp. 7.3x11.5μ		61	10	
Carteria 27.6μ				25
Chlamydomonas anglica	5	10		23
C. globosa		9		
Chlamydomonas sp. 11.5-13μ	3	10	37	75
Chlamydomonas sp. 15.8μ		20		
Closterium aciculare	8		12	

SITES 1-3	COLLECTION SITE AND DATE			
	Site 1 1 meter August 25,1977	Site 2 1 meter August 18,1977	Site 2 1 meter August 25,1977	Site 3 1 meter August 18,1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
CHLOROPHYTA (CON'T.)				
Closterium sp. (299x23μ)	1			
Closterium sp. (84x9.2μ)		1	1	
Coelastrum microporum		81	62	151
C. reticulatum		161		317
Cosmarium biretum	1		1	
C. depressum	1		2	
C. incurvum		1		1
C. Kjelmani	5	1	1	
Cosmarium sp.7			1	
Crucigenia Lauterborni				201
Dictyosphaerium pulchellum		544	35	352
Elaktothrix gelatinosa		10		
Franceia Droescheri		20	3	
Golenkinia radiata		10		
Kirchneriella lunaris		101	20	326
Lagerheimia geneviensis	5	36		25
Micractinium pusillum		968	15	
Mougeotia sp.		40		25
Nephrocytium obesum	10			
Oocystis Borgei	10	111	22	101
O. lacustris	81	61	45	25
O. parva	20	81	30	327
O. submarina	10			
Pandorina morum		161	30	
Paradoxia multiseta	10	20		25
Pediastrum Boryanum	5	16	6	14
P. duplex	23	18	54	90
P. simplex	33	40	25	6
Quadrigula chodati	3	10		
Scenedesmus abundans		61		101
S. bicaudatus	30	81		151
S. bijugatatus	20		77	
S. denticulatus		40		101

SITES 1-3	COLLECTION SITE AND DATE			
	Site 1 1 meter August 25, 1977	Site 2 1 meter August 18,1977	Site 2 1 meter August 25,1977	Site 3 1 meter August 18,1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
CHLOROPHYTA (CON'T.)				
S. intermedius			40	
S. protuberens var. danubensis				101
S. quadricauda		554	60	603
Scenedesmus sp. (2-celled)		536	35	101
Shroederia Judayi	20	20	10	
S. setigera	10	30		
Sphaerocystis Schroeteri	267	81	37	50
Staurastrum chaetocerus				1
St. Dickiei var. maximum	1		1	
St. gracile		1		
St. longiradiatum	1		1	
St. paradoxum	3		5	
Tetraedon minimum		50	3	
T. triappendiculatum				91
Tetrastrum glabrum				101
T. heteracanthum				75
T. staurogeniforme		121		402
Green cells	142	389		522
EUGLENOPHYTA				
Euglena sp.		4		50
Phacus sp.		10		
BACILLARIOPHYTA				
Actinocyclus normanii f. subsalsa	25	131	62	276
Asterionella formosa	3			
Centric 4.3μ				50
Centric 5.7x8.6μ			13	1282
Centric 7.2-9μ		61		276
Centric 9-12μ				981

SITES 1-3	COLLECTION SITE AND DATE			
	Site 1 1 meter August 25,1977	Site 2 1 meter August 18,1977	Site 2 1 meter August 25,1977	Site 3 1 meter August 18,1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
BACILLARIOPHYTA (CON'T.)				
Centric 16-18μ		30		101
Cymatopleura solea				3
Fragilaria sp.		2255		
Fragilaria crotonensis			288	
Melosira islandica		534		
Melosira granulata		192	25	
M. granulata angustissima				151
Navicula sp.		141		101
Nitzschia acicularis		30	5	75
Nitzschia palea		10		
Nitzschia sp.				50
Rhizoselenia eriensis		10		
Skeletonema subsalsa		40		427
Stephanodiscus astraea		20		
St. niagarae	15		7	
CHRYSOPHYTA				
Bodo spora	441	9		23
Chromulina sp. 4.3μ	23	36	26	
Chromulina sp. 2μ	187	55	5	23
Chrysamoeba radians	3	1		
Chrysochromulina parva	5		40	
Chrysococcus radians	23	18		23
Chrysococcus punctiformis		64		
Erkenia subaequiciliata			112	
Pseudokephyrion sp.	9			
Salpingoeca sp.	58	40		50
Ochromonas sp. 8.7μ	5	10	90	
Ochromonas sp. 3μ	23			
Trachelomonas sp.				68

SITES 1-3	COLLECTION SITE AND DATE			
	Site 1 1 meter August 25,1977	Site 2 1 meter August 18,1977	Site 2 1 meter August 25,1977	Site 3 1 meter August 18,1977
TAXA	#/ml.	#/ml.	#/ml.	#/ml.
PYRROPHYTA				
CRYPTOPHYCEAE				
Cryptomonas erosa	23	151	124	101
C. erosa var. reflexa	25	141	52	201
Katablepharis ovalis	146	300	126	23
Rhodomonas minuta	565	718	888	647
DINOPHYCEAE				
Ceratium hirundinella	2	10	2	1
Diplosalis		1		
Glenodinium neglectum	1			8
Gymnodinium aeruginosum			1	
G. coronatum		2	1	
G. ordinatum	1	1	7	
G. inversum		1		
Peridinium polonicum		8	1	
Peridinium sp. 4	1			
Peridinium sp. 5		7	2	3
Peridinium 6				3

LAKE ERIE - PORT CLINTON,OHIO

Members of the Cyanophyta were the dominant algae at this location, and at stations 1 and 2 high cell numbers were primarily due to this group. Station 4 also had high populations of Chlorophyta as well as Bacillariophyta, primarily centrics. In contrast to other locations, Chrysophytes were nearly absent from the Port Clinton samples, and the Dinoflagellate Ceratium was unusually abundant.

LAKE ERIE Port Clinton, Ohio	COLLECTION SITE AND DATE		
	Station 1 1 meter July 20, 1977	Station 2 1 meter July 20, 1977	Station 3 1 meter July 20, 1977
TAXA	#/ml	#/ml	#/ml
CYANOPHYTA			
Anabaena planktonica			3,052
Anabaena spiroides	169		
Aphanizomenon flos-aquae	22,953	8573	10,661
Aphanocapsa delicatissima			51colonies
Aphanothece nidulans			81colonies
Chroococcus limneticus		20	242
Coelosphaerium Kutzingianum			5,171
Gomphosphaeria aponina			1,242
Merismopedia minima		40	13,484
Microcystis flos-aquae	40colonies	2colonies	20colonies
Microcystis minutissima			788colonies
Oscillatoria sp. 3μ			200
Oscillatoria sp. 4.3-5.8μ			2,262
Oscillatoria limnetica			101
Raphidiopsis mediterranea			654
Blue-green cells		523	682
CHLOROPHYTA			
Ankistrodesmus falcatus		3	20
A. falcatus var. mirabilis			20
Binuclearia sp.			40
Chlamydomonas anglica	5		
C. globosa	5		10
Chlamydomonas sp. 18μ		5	10
Coelastrum microporum	10		403
C. reticulatum		913	
Closterium venus var. major			1
Cosmarium biretum			1
C. depressum		1	1
C. incurvum			1

LAKE ERIE Port Clinton, Ohio	COLLECTION SITE AND DATE		
	Station 1 1 meter July 20, 1977	Station 2 1 meter July 20, 1977	Station 4 1 meter July 20, 1977
TAXA	#/ml	#/ml	#/ml
CHLOROPHYTA (CON'T.)			
Cosmarium Kjelmani	2	3	6
Cosmarium viride	1		
Cosmarium sp. 4	1		
Cosmarium sp. 5	1		
Cosmarium sp. 7		1	1
Crucigenia Lauterborni			121
C. rectangularis			1048
Dictyosphaerium pulchellum			202
Elactothrix gelatinosa			30
Franceia Droescheri		3	30
Kirchneriella lunaris			50
Lagerheimia geneviensis			18
Micractinium pusillum			242
Mougeotia sp.			30
Nephrocytium Agardhianum	5		
Oocystis Borgei	10	57	131
Oocystis crassa			61
O. lacustris	20	45	373
O. parva			252
Pandorina morum	35		
Paradoxia multiseta	8		
Pediastrum Boryanum			18
P. duplex	11	7	186
P. simplex	35	45	98
P. simplex var. duodenarium			14
Scenedesmus abundans			81
S. bicaudatis		10	202
S. intermedius var. baltonicus			81
S. quadricauda	10		171

LAKE ERIE Port Clinton, Ohio	COLLECTION SITE AND DATE		
	Station 1 1 meter July 20, 1977	Station 2 1 meter July 20, 1977	Station 4 1 meter July 20, 1977
TAXA	#/ml	#/ml	#/ml
CHLOROPHYTA (CON'T.)			
Scenedesmus spinosus			40
Scenedesmus sp. (2-celled)			161
Shroederia Judayi	33	50	91
S. setigera	8	7	10
Sphaerocystis Shroeteri	355	50	766
Staurastrum gracile	1		5
S. longiradiatum	1	2	8
S. paradoxum	3	2	
Tetraedon caudatum			18
Tetraedon trigonum			10
Tetrastrum glabrum			40
T. heteracanthum			81
Treubaria trigonum			
Green cells	5		181
BACILLARYOPHYTA			
Actinocyclus normanii f. subsalsa		12	444
Centric 9-10μ			181
Centric 23μ			20
Cyclotella 5-6.8μ			202
Cyclotella 16-18μ			131
Fragilaria crotonensis	139	7	10
Melosira granulata var. angustissima			121
Melosira islandica			302
Navicula sp.			10
Nitzschia acicularis			20
Nitzschia palea			20
Nitzschia sp.			20

LAKE ERIE Port Clinton, Ohio	COLLECTION SITE AND DATE		
	Station 1 1 meter July 20, 1977	Station 2 1 meter July 20, 1977	Station 4 1 meter July 20, 1977
TAXA	#/ml	#/ml	#/ml
BACILLARIOPHYTA (CON'T.)			
Skeletonema subsalsa			71
Synedra actinastroides			3
Synedra sp.			30
Stephanodiscus astraea		3	
CHRYSOPHYTA			
Bodo spora	3		
Chrysamoeba radians	3		
PYRROPHYTA			
CRYPTOPHYCEAE			
Cryptomonas erosa	48	134	202
C. erosa var. reflexa	5	32	30
C. ovata			10
Katablepharis ovalis	5		9
Rhodomonas minuta	18	32	246
DINOPHYCEAE			
Ceratium hirundinella	16	29	17
Gymnodinium sp.5			3
Peridinium polonicum		3	6
Peridinium sp. 5			1

LAKE ERIE - CHAGRIN RIVER, OHIO

This location was dominated by the Chlorophyta, with few members of the Cyanophyta or Bacillariophyta present. An exception was observed at Station 4, where Aphanizomenon was abundant.

The Cryptophyceae and Chrysophyta also made up a relatively large portion of the community.

LAKE ERIE Chagrin River, Ohio	COLLECTION SITE AND DATE		
	Station 1 1 meter July 18, 1977	Station 2 1 meter July 18, 1977	Station 4 1 meter July 18, 1977
TAXA	#/ml	#/ml	#/ml
CYANOPHYTA			
Anabaena planktonica		20	444
Anabaena spiroides	484	71	
Aphanozomenon flos-aquae		519	2135
Coelosphaerium Naegelianum		5	
Gomphosphaeria aponia		33	15
Oscillatoria sp. 4.3μ	119		
Blue green cells		64	
CHLOROPHYTA			
Ankistrodesmus falcatus			5
Carteria sp. 4.6-7μ		18	
Chlamydomonas globosa	79	15	2
Coelastrum microporum			67
C. reticulatum		3	
Cosmarium biretum	1		1
C. depressum	1		
C. Kjelmani		5	4
Cosmarium sp. 4	1		3
Cosmarium sp. 5		5	
Elactothrix gelatinosa	5		
Gleocystis gigas			55
Kirchneriella lunaris			5
Lagerheimia subsalsa	37		2
Nephrocytium Agardhianum	64	20	
Oocystis Borgei	27	13	20
O. lacustris	164	68	171
O. parva	89	43	52
Oedogonium sp.		78	
Pediastrum Boryanum	6		96
P. duplex			3
P. simplex			8
Scenedesmus acuminatus		5	

LAKE ERIE Chagrin River, Ohio	COLLECTION SITE AND DATE		
	Station 1 1 meter July 18, 1977	Station 2 1 meter July 18, 1977	Station 4 1 meter July 18, 1977
TAXA	#/ml	#/ml	#/ml
CHLOROPHYTA (CON'T)			
S. armatus var bicaudatus	20	20	
S. bijugatatus	747	129	112
S. quadricauda			20
S. quadricauda var. maximus			10
Scenedesmus sp.			5
Shroedoria Judayi	7	262	171
S. setigera		3	17
Spherocystis Schroeteri	1039	368	451
Staurastrum longiradiatum	3	3	3
Staurastrum paradoxum	2		1
Tetraedon minimum	7		
Green cells		13	
BACILLARIOPHYTA			
Cyclotella sp. 10μ			2
Fragilaria crotonensis		66	737
Tabellaria fenestrata		30	
CHRYSOPHYTA			
Bodo spora		27	
Chromulina sp. 4.3μ	72		
Chromulina sp. 2μ	5		116
Chrysochromulina parva	377	328	25
Chrysococcus punchformis		168	
Dinobryon divergens	563	199	82
Ochromonas sp. 3μ	85	14	144
Salpingoeca sp.	567	146	364
CRYPTOPHYCEAE			
Cryptomonas erosa	69	121	471
C. erosa var. reflexa	47	106	444
Cryptomonas reflexa			10
Katablepharis ovalis	27	105	
Rhodomonas minuta	595	249	1627

LAKE ERIE Chagrin River, Ohio	COLLECTION SITE AND DATE		
	Station 1 1 meter July 18, 1977	Station 2 1 meter July 18, 1977	Station 4 1 meter July 18, 1977
TAXA	#/ml	#/ml	#/ml
DINOPHYCEAE			
Ceratium hirundunella	2	3	1
Gymnodinium ordinatum		3	
Gymnodinium coronatum			3

Lake Erie - Cattaraguas Creek

Chlorophyta, Cyanophyta and Chrysophyta were abundant at site 1 with few Bacillariophyta present. In contrast, the Bacillariophyta were the only algae occurring in significant numbers at station 2. Algal populations were very low at this station, and there was an exceptionally high concentration of inorganic sediment.

LAKE ERIE Cattaraguas Creek, New York	COLLECTION SITE AND DATE	
	Site #1 1 meter August 30, 1977	Site #2 1 meter August 30, 1977
TAXA	#/ml.	#/ml.
CYANOPHYTA		
Anabaena planktonica	81	
Aphanizomenon flos-aquae	239	
Aphanothece clatherata	25 colonies	
Coelosphaerium Naegelianum	3 colonies	
Gomphosphaeria aponina	443	
Merismopoedia minima	1540	
Microcystis flos-aquae	5 colonies	
Microcystis minutissima	106 colonies	
Oscillatoria sp. 2μ	718	
Oscillatoria sp. 3μ	85	
Oscillatoria sp. 4.6μ		362
CHLOROPHYTA		
Ankistrodesmus falcatus	46	
Carteria sp.	5	
Chlamydomonas globosa	9	
Coelastrum microporum	139	22
C. reticulatum	50	
Cosmarium depressum	1	
Cosmarium sp. 5	1	
Elaktothrix gelatinosa	8	
Franceia Droescheri	3	
Kirchneriella lunaris	3	
Kirchneriella subsolitaria	35	
Lagerheimia geneviensis	3	
Micractinium pusillum	8	
Oocystis Borgei	8	22
O. lacustris	40	
O. parva	5	
Paradoxia multiseta	3	
Pediastrum Boryanum	3	
Pediastrum duplex var. clatheratum	81	

LAKE ERIE Cattaraguas Creek, New York	COLLECTION SITE AND DATE	
	Site #1 1 meter August 30, 1977	Site #2 1 meter August 30, 1977
TAXA	#/ml.	#/ml.
CHLOROPHYTA (CON'T.)		
Pediastrum simplex	307	
Scenedesmus abundans	10	
S. bicaudatus	20	
S. bijugatatus	20	
S. quadricauda	30	
Shroederia setigera	8	
Spherocystis Shroeteri	68	
Staurastrum longiradiatum	1	
S. Dickiei var. maximum	3	
Tetraedon minimum	3	
Tetrastrum staurogeniforme	10	
BACILLARIOPHYTA		
Centric 9.2μ	3	12
Cymbella sp.		25
Diatoma vulgare		
Fragilaria crotonensis	5	
Fragilaria sp.		25
Gyrosigma sp.		12
Navicula sp.	3	12
Nitzschia acicularis		12
Nitzschia sp.		149
CHRYSOPHYTA		
Chromulina glacialis	27	
Chrysococcus punctiformis	23	
C. radians	201	
Mallomonas tonsurata	3	
Ochromonas sp. 8.6μ	5	
Ochromonas sp. 3μ	68	

LAKE ERIE Cattaraguas Creek, New York	COLLECTION SITE AND DATE	
	Site #1 1 meter August 30, 1977	Site #2 1 meter August 30, 1977
TAXA	#/ml.	#/ml.
PYRROPHYTA		
CRYPTOPHYCEAE		
Cryptomonas erosa	24	12
Katablepharis ovalis	32	
Rhodomonas minuta	96	
DINOPHYCEAE		
Ceratium hirundinella	1	
Peridinium aciculiferum	1	
Peridinium sp. 4	1	

LAKE ERIE - PORT DOVER, ONTARIO

The Port Dover samples were nearly devoid of the Cyanophyta, Bacillariophyta and Dinophyceae. The community was predominantly composed of Chrysophyta and Cryptophyceae, with a few members of the Chlorophyta present. The July 8 sample contained large quantities of bacteria and detritus.

LAKE ERIE Port Dover, Ontario	COLLECTION SITE AND DATE	
	Surface sample Offshore 30' depth station July 8, 1977	Vertical series 6,4,1,0.5 meters July 9, 1977
TAXA	#/ml.	#/ml.
CYANOPHYTA		
Anabaena planktonica		42
Chroococcus limneticus	5	
CHLOROPHYTA		
Ankistrodesmus falcatus	41	20
Chlamydomonas globosa	2	
Cosmarium incurvum	1	
Kirchneriella lunaris	35	5
Lagerheimia geneviensis	2	
Lagerheimia subsalsa		2
Oocystis lacustrus	20	5
Pediastrum Boryanum		2
Pediastrum duplex	3	
Scenedesmus bijugatatus	30	
Scenedesmus sp		15
Scenedesmus quadricauda		10
Schroederia Judayi	5	
Sphaerocystis Schroeteri	45	288
Staurastrum paradoxum		1
Tetraedron minimum	5	
Green cells	86	
BACILLARIOPHYTA		
Cyclotella sp. 6μ	9	12
Nitzschia acicularis	10	
Tabellaria fenestrata		49
CHRYSOPHYTA		
Chromulina sp. 2μ	41	108
Chrysochromulina parva	1288	180
Dinobryon divergens	10	32

LAKE ERIE Port Dover, Ontario	COLLECTION SITE AND DATE	
	Surface sample offshore 30' depth station July 8, 1977	vertical series 6,4,1,0.5 meters July 9, 1977
TAXA	#/ml.	#/ml.
CHRYSOPHYTA (CON'T.)		
Ochromonas sp 3μ	14	54
Psuedokephyrion sp.	43	49
PYRROPHYTA		
CRYPTOPHYCEAE		
Cryptomonas erosa	5	45
C. erosa var. reflexa	55	
Rhodomonas minuta	649	382
Katablepharis ovalis	182	368
DINOPHYCEAE		
Glenodinium neglectum	1	
Gymnodinium coronatum		1

LAKE ERIE - GRAND RIVER, ONTARIO

Algal cell numbers were approximately 5 times higher at station 2 than at station 1 in the Grand River. Chlorophyta and Bacillariophyta were predominant, but numbers of Cryptophyceae and Chrysophyta were also high. This location (site 2) had the most diverse flora among the 20 samples.

LAKE ERIE Grand River, Ontario	COLLECTION SITE AND DATE	
	Site 1 1 meter August 31, 1977	Site 2 1 meter August 31, 1977
TAXA	#/ml.	#/ml.
CYANOPHYTA		
Anabaena spiroides	30	
Aphanizomenon flos-aquae		1080
Aphanothece clatheratum		10 colonies
Chroococcus limneticus	17	
Coelosphaerium Kuetzianum	1 colony	
Gloeocystis gigas	7	
Gomphosphaeria aponina		181
Merismpedia minutissima	427	2218
Microcystis minima		30 colonies
Oscillatoria limnetica		
Oscillatoria sp. 4.3μ	485	959
Blue green cells	198	54
CHLOROPHYTA		
Actinastrum hantzschii var. fluviatile		30
Ankistrodesmus falcatus	39	404
Binuclearia sp.		423
Carteria sp.	12	30
Chlamydomonas anglica		127
Chlamydomonas globosa		61
Chlamydomonas sp. 11.5 μ	58	60
Chlamydomonas 17.3 μ		10
Coelastrum cambricum var. intermedium		61
Coelastrum microporum	40	1008
Coelastrum reticulatum	40	
Cosmarium depressum	1	
C. kjellmani		1
Cosmarium sp. 4	2	
Cosmarium sp. 5	1	

LAKE ERIE Grand River, Ontario	COLLECTION SITE AND DATE	
	Site 1 1 meter August 31, 1977	Site 2 1 meter August 31, 1977
TAXA	#/ml.	#/ml.
CHLOROPHYTA (CON'T.)		
Cosmarium sp. 8	1	
Crucigenia fenestrata		40
C. rectangularis		242
C. tetrapedia		40
Dictyosphaerium pulchellum		393
Elactothrix gelatinosa		50
Franceia Droescheri		30
Gloeocystis gigas	7	
Kirchneriella lunaris	10	323
K. subsolitaria		222
Lagerheimia geneviensis		1037
L. subsalsa		20
Micractinium pusillum	25	131
Nephrocytium Agardhianum	20	
Oocystis Borgei	10	161
O. crassa	3	
O. lacustris	12	
O. parva		131
Pandorina morum		323
Pediastrum Boryanum	22	91
P. duplex var. clathratum	5	162
P. simplex	134	32
P. simplex var. duodenarium		16
P. tetras var. tetraedon	4	1
Quadrigula pfitzeri	112	
Scenedesmus abundans		40
S. acuminatus		212
S. acutus		50
S. arcuatus		474
S. bic		81
S. bijugatatus	25	101
S. denticula		40

LAKE ERIE Grand River Ontario	COLLECTION SITE AND DATE	
	Site 1 1 meter August 31, 1977	Site 2 1 meter August 31, 1977
TAXA	#/ml.	#/ml.
S. protuberans var. danubianus		81
S. quadricauda	40	333
S. quadricauda var. major		161
Scenedesmus sp. (2-celled)		81
Selenastrum gracile		91
Shroederia Judayi	30	30
S. setigera		10
Sphaerocystis	89	1079
Staurastrum longiradiatum	2	1
Tetraedon caudatum		50
Tetraedon minimum	3	50
T. trigonum		30
Tetrastrum glabrum		40
T. staurogeniforme	10	393
Treubaria trigonum		10
Green cells		1994
EUGLENOPHYTA		
Euglena sp.		20
Phacus sp.		9
BACILLARIOPHYTA		
Actinocyclus normanii f. subsalsa	15	20
Asterionella formosa		71
Centric 3-5.7μ		1920
Centric 7.2μ	7	2339
Centric 15.8 x 17.3μ		313
Cyclotella sp. 6μ		302
Cyclotella 8.6-11.5μ	77	655
Fragilaria crotonensis	181	
Fragilaria sp.		272
Gyrosigma sp.		10

LAKE ERIE Grand River Ontario	COLLECTION SITE AND DATE	
	Site 1 1 meter August 31, 1977	Site 2 1 meter August 31, 1977
TAXA	#/ml.	#/ml.
BACILLARIOPHYTA (CON'T.)		
Melosira granulata var. angustissima		71
Navicula sp.		20
Nitzschia acicularis		10
Nitzschia palea		20
Skeletonema subsalsa	156	635
Synedra radians	1	
Tabellaria flocculosa	2	
CHRYSOPHYTA		
Bodo spora	382	136
Chromulina sp. 4.3μ	211	236
Chromulina sp. 2 μ		290
Chrysamoeba radians		1
Chrysochromulina parva	148	9
Chrysococcus radians	67	82
Dinobryon divergens		9
Erkenia subaequiciliata	54	
Pseudokephyrion sp.	3	9
Mallomonas		81
Ochromonas sp. 8.7μ	85	9
Ochromonas sp. 3μ		255
Salpingoeca sp.	9	855
Trachelomonas sp.		10
PYRROPHYTA		
CRYPTOPHYCEAE		
Cryptomonas erosa	97	675
C. erosa var. reflexa	84	101
Kalablepharis ovalis	198	864
Rhodomonas minuta	1295	1364

LAKE ERIE Grand River, Ontario	COLLECTION SITE AND DATE	
	Site 1 1 meter August 31, 1977	Site 2 1 meter August 31, 1977
TAXA	#/ml.	#/ml.
DINOPHYCEAE		
Ceratium hirundinella	1	4
C. ordinatum	1	6
Gymnodinium coronatum		1
Peridinium aciculiferum		1
Peridinium sp. 4	5	1
Peridinium sp. 5		

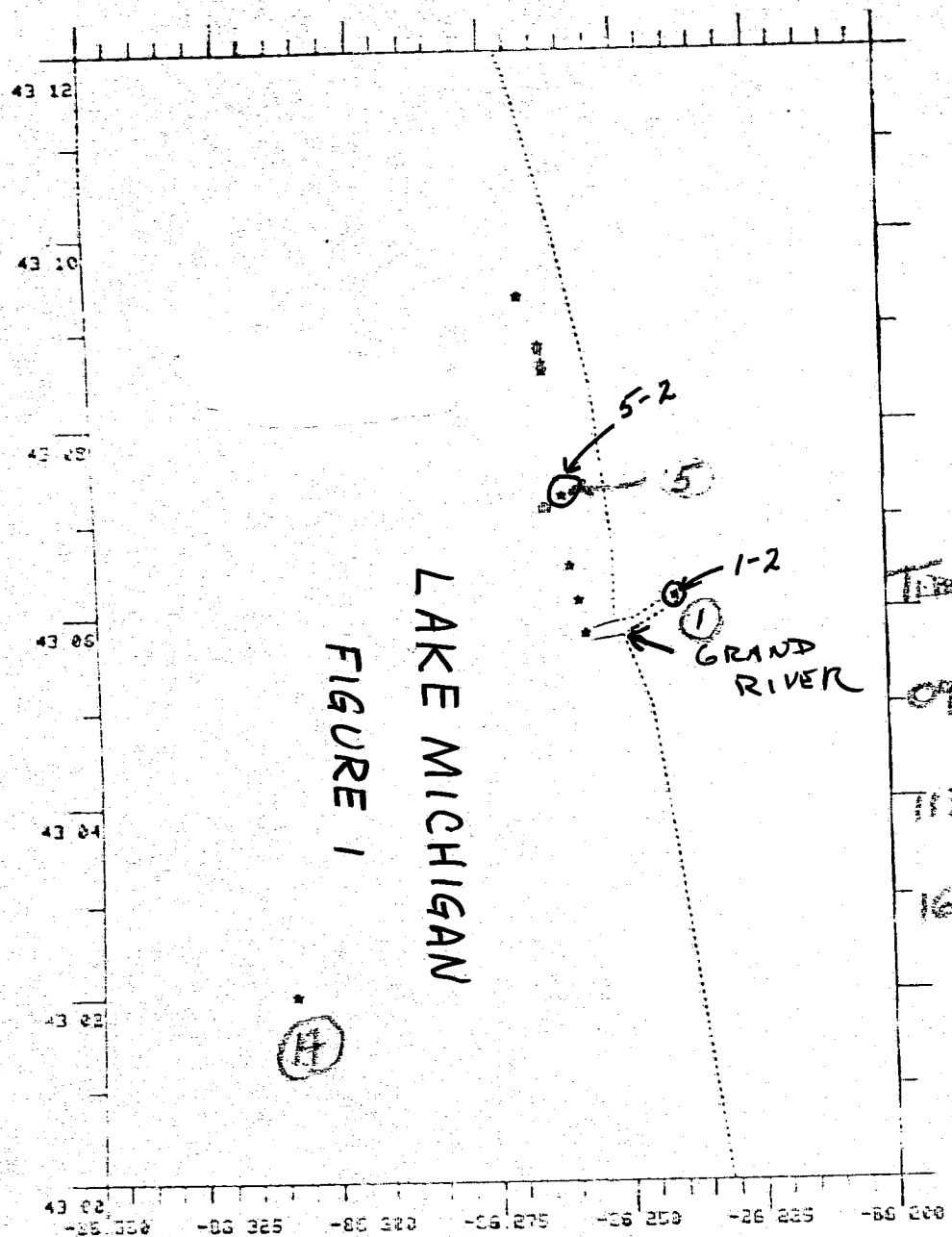


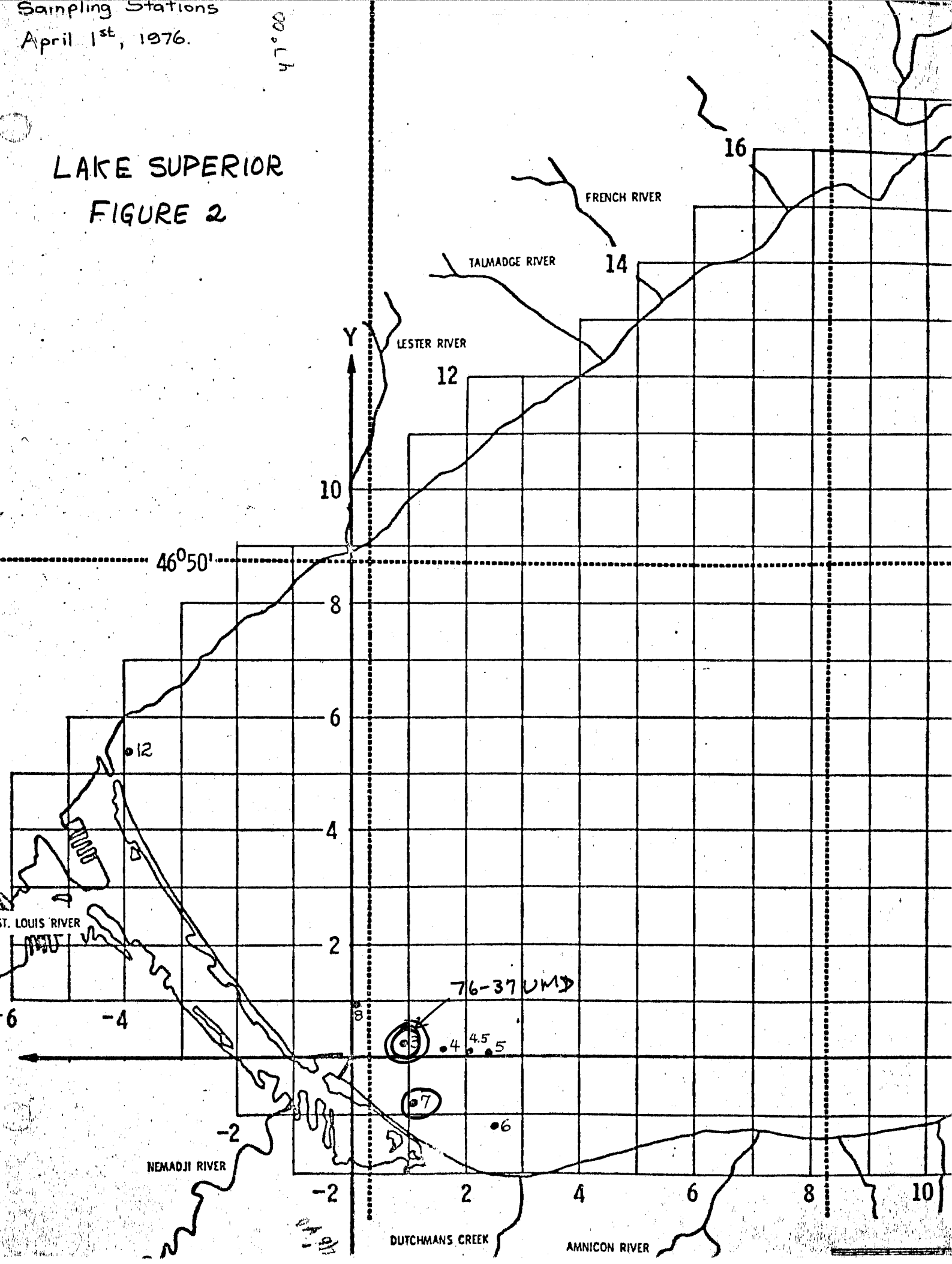
FIGURE 1

March 23
NASA Cruise 2
1603

Time	Station		
0900	1	River [illegible]	
1130	5	43° 04.35′	86° 15.66′
1630	4	43° 01.2′	86° 18.8′

Sampling Stations
April 1st, 1976.

LAKE SUPERIOR
FIGURE 2

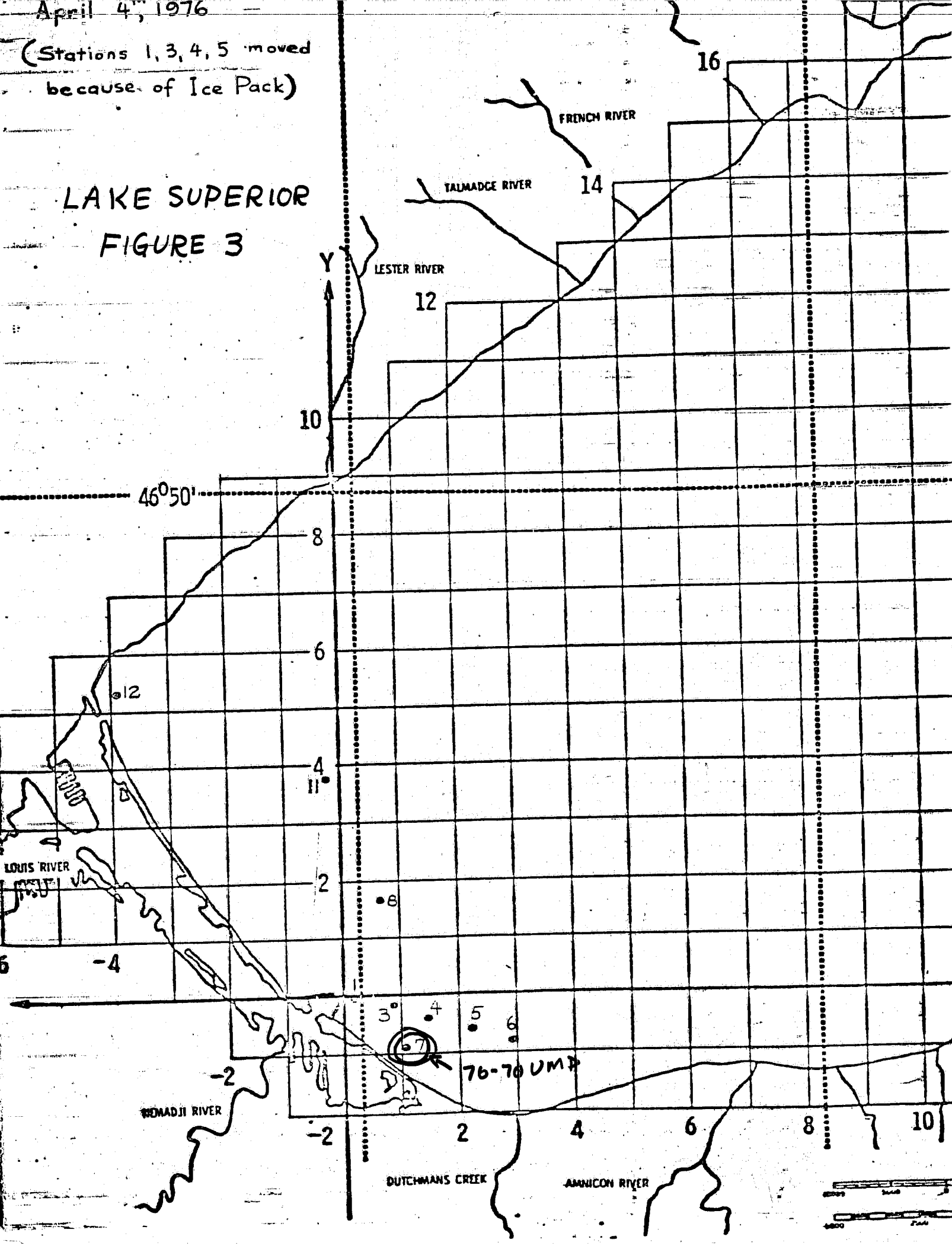


April 4, 1976

(Stations 1, 3, 4, 5 moved because of Ice Pack)

LAKE SUPERIOR

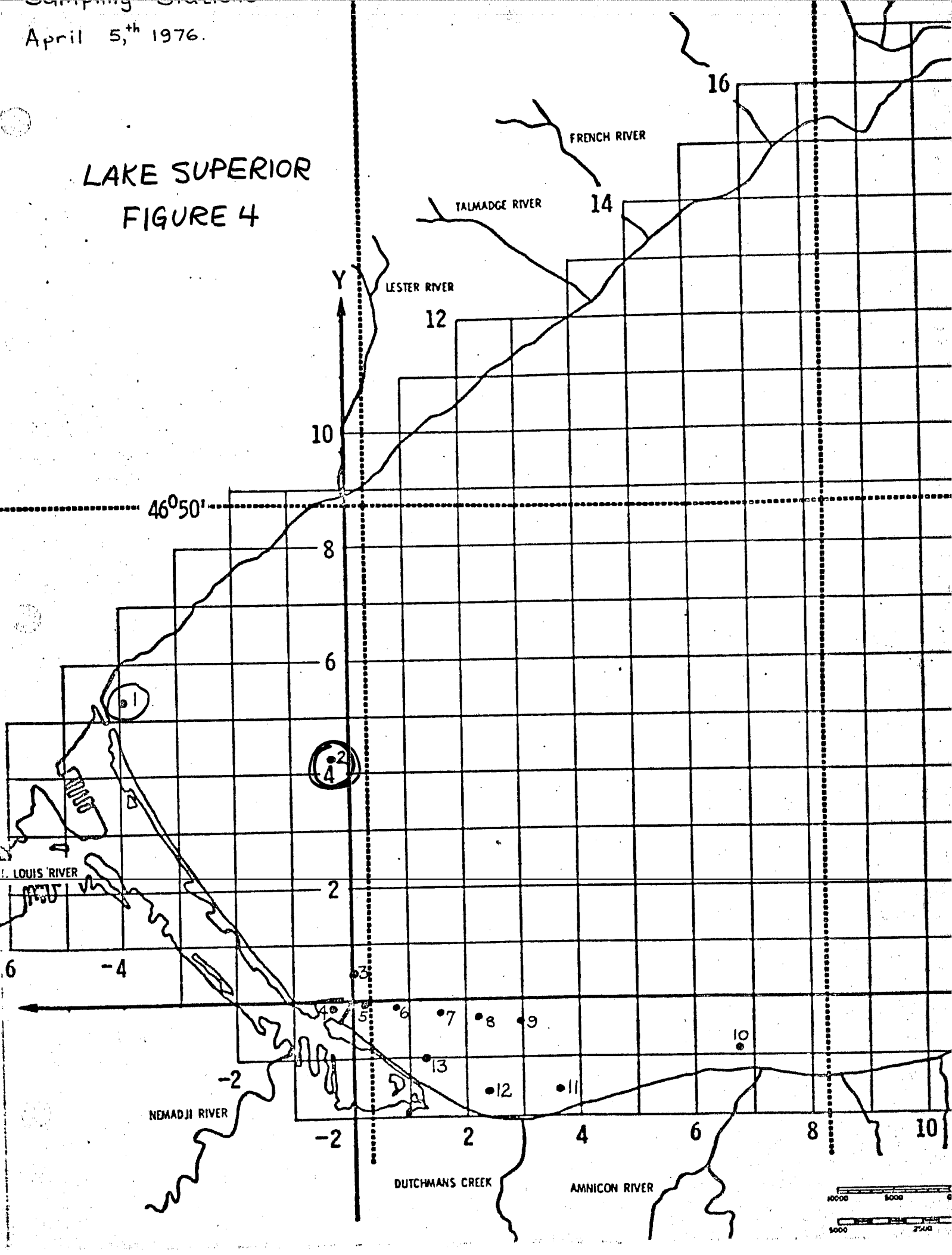
FIGURE 3



Sampling Stations

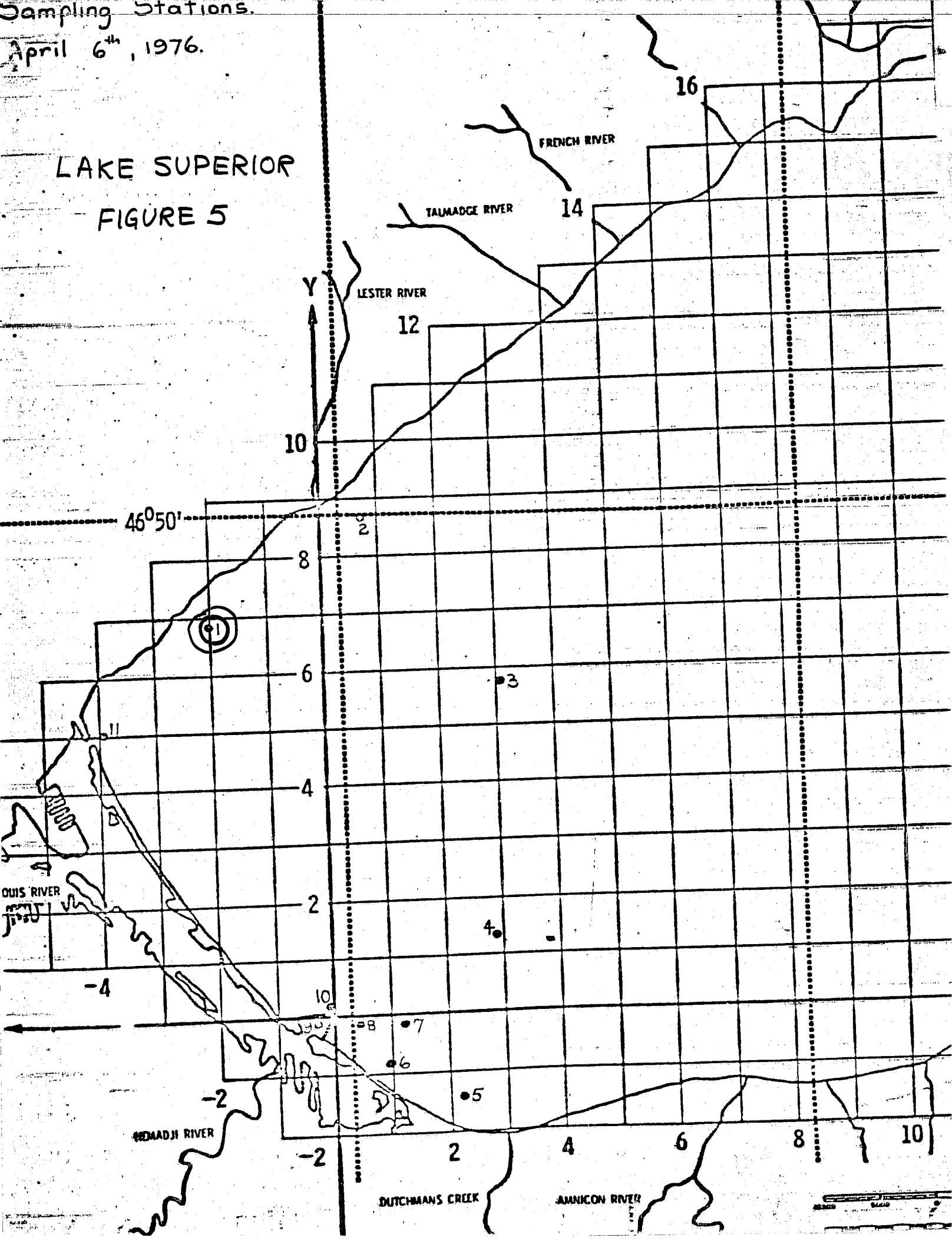
April 5,th 1976.

LAKE SUPERIOR
FIGURE 4



Sampling Stations.
April 6th, 1976.

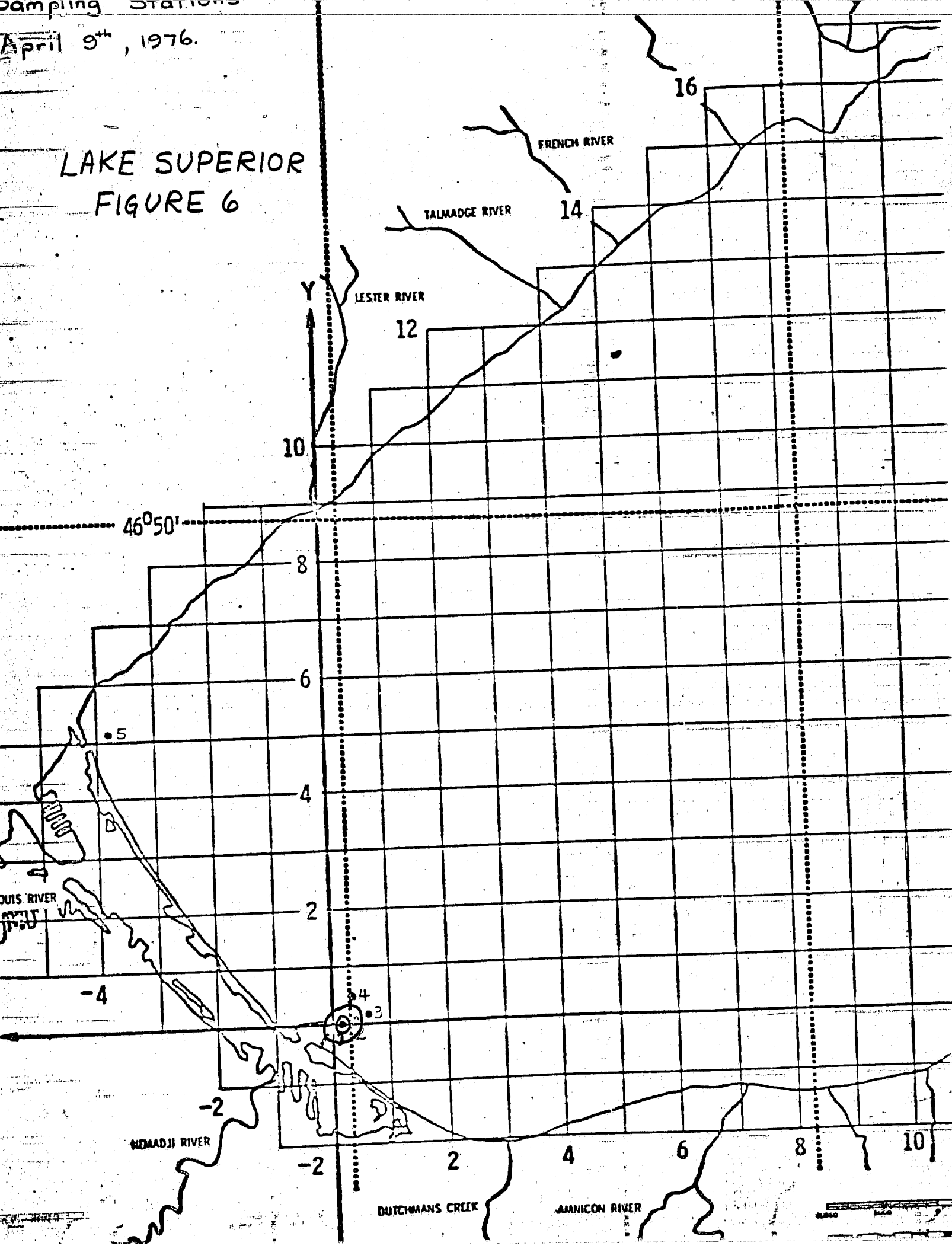
LAKE SUPERIOR
FIGURE 5

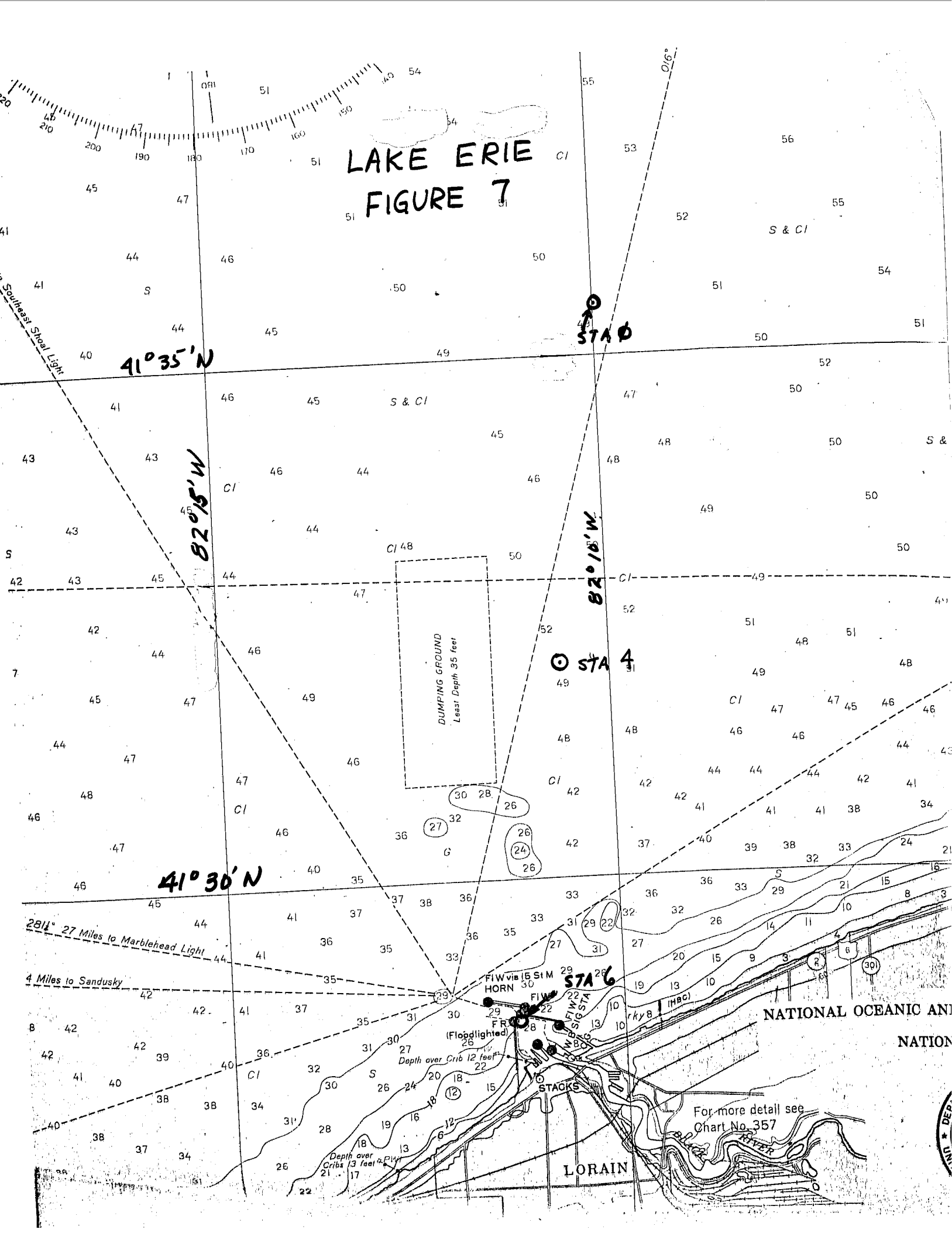


Sampling Stations

April 9th, 1976.

LAKE SUPERIOR
FIGURE 6




LAKE ERIE
FIGURE 7
STA 0
STA 4
STA 6
41°35'N
41°30'N
82°15'W
82°10'W
DUMPING GROUND
Least Depth 35 feet
Southeast Shoal Light
281° 27 Miles to Marblehead Light
4 Miles to Sandusky
Fl W vis 15 St M
HORN
Fl W
Fl W SIG STA
(Floodlighted)
Depth over Crib 12 feet
STACKS
Depth over Cribs 13 feet
LORAIN
For more detail see Chart No. 357
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