VOGTLE ELECTRIC GENERATING PLANT
SURVEY OF THE PLANKTON COMMUNITY OF THE SAVANNAH RIVER, BURKE COUNTY, GEORGIA, FROM JANUARY, 1981, TO SEPTEMBER, 1981
OPERATING LICENSE STAGE ENVIRONMENTAL REPORT
TECHNICAL DOCUMENT

TANYA D. COLLINS
PRINCIPAL INVESTIGATOR

GEORGIA POWER COMPANY
ENVIRONMENTAL AFFAIRS CENTER

FEBRUARY, 1983

VEGP - OLSER

TABLE OF CONTENTS

	Page
LIST OF TABLES	ii
LIST OF FIGURES	iii
INTRODUCTION	1
METHODS	2
RESULTS AND DISCUSSION	4
CONCLUSIONS	7
REFERENCES	9
TABLES	11
FIGURES	19

LIST OF TABLES

		Page
1.	Phytoplankton Taxa in the Savannah River Between River Miles 150.6 and 151.2	11
2.	Number of Taxa of Major Phytoplankton Groups for Each Station	12
3.	Densities (Organisms Per Liter) of Major Phytoplankton Taxa for Each Station	13
4.	Percent Composition of Major Phytoplankton Taxa for Each Station	14
5.	Zooplankton Taxa in the Savannah River Between River Miles 150.6 and 151.2	15
6.	Number of Taxa of Major Zooplankton Groups for Each Station	16
7.	Densities (Organisms Per Liter) of Major Zooplankton Taxa for Each Station	17
8.	Percent Composition of Major Zooplankton Taxa for Each Station	18

VEGP - OLSER

LIST OF FIGURES

		Page
1.	Location of VEGP Plankton Survey Stations	19
2.	Plankton Densities and River Velocities for January, 1981	20
3.	Plankton Densities and River Velocities for April, 1981	21
4.	Plankton Densities and River Velocities for June, 1981	22
5.	Plankton Densities and River Velocities for September, 1981	23
6.	Zooplankton Densities and River Velocities for January, 1981	24
7.	Zooplankton Densities and River Velocities for April, 1981	25
8.	Zooplankton Densities and River Velocities for June, 1981	26
9.	Zooplankton Densities and River Velocities for September, 1981	27

INTRODUCTION

Construction of the Vogtle Electric Generating Plant (VEGP) began in June, 1974, and was discontinued in September, 1974, as a result of unfavorable economic conditions. Construction resumed in January of 1977 with excavation activities beginning in February. The plant site is approximately 3169 acres and located in Burke County, the southwest side of the Savannah River, a natural boundary between Georgia and South Carolina. The site is at river mile 150.9 across from the Savannah River Plant (SRP) operated by E. I. DuPont DeNemours and Company for the U.S. Department of Energy. The plant site is approximately 26 miles south-southeast of Augusta, Georgia. The site is located in the coastal plain, which is characterized by sandy or sandy loam soil with rolling hills and mixed pine-hardwood association. Since the onset of construction, approximately 1391 acres of the site have been cleared for plant construction.

The original plans proposed a generating plant consisting of four units, but construction of two units has been cancelled. The plant will employ two pressurized water reactors producing 1160 MW each. Unit 1 is scheduled to go into service in March, 1987, and Unit 2 in September, 1988. The exhaust steam will be cooled by a closed-cycle cooling system employing natural draft cooling towers using make-up water from the Savannah River. Low volume waste and blowdown from both cooling towers will ultimately be discharged back into the river.

The Savannah River below Augusta, Georgia, and above the VEGP site receives wastewater discharges from municipalities and industries that add organic wastes, nutrients, metals, and other trace contaminants. Stream classification near the VEGP is listed as "Fishing".[1] The river near the plant site is typical of large southeastern coastal plain rivers except that a dredge channel is maintained by the Corps of Engineers for barge traffic. The biological community of the river is similar to that of other large southeastern rivers, but has been affected by man's influence on the river. The impoundment of the river above Augusta, Georgia, has reduced the transport of sediments and allochthonous particulate organic material, and the dredging of the channel has reduced the natural shallow areas and backwaters that would normally support a diverse flora and fauna. Studies on the Savannah River flora and fauna have been conducted periodically since 1951 and were detailed in Patrick, et al.,[2] Academy of Natural Sciences of Philadelphia,[3][4] and Matthews.[5]

Georgia Power Company was required by Chapter 2.2 of the U.S. Nuclear Regulatory Commission Regulatory Guide 4.2, Revision 2, 1976, to conduct a biological study to describe the flora and fauna in the vicinity of the site, their habits, and distribution. The study should also identify organisms defined to be "important" because of commerical or recreational value, threatened or endangered status, effects on other "important" species, or being a biological indicator of radionuclides in the environment. In addition, food chains and other interspecies relationships were to be identified.

In the aquatic community, phytoplankton and zooplankton serve an important function as a basic food source for many animals. Phytoplankton serves an equally important function as a primary producer of energy and oxygen through the photosynthesis process. Certain algae, such as some blue-green phytoplankton, contribute essential nitrogenous compounds to the environment. A study of the plankton community of the Savannah River near the VEGP was conducted between January, 1981, and September, 1981.

METHODS

Plankton samples were collected quarterly from six station locations in the Savannah River between river miles 150.6 and 151.2 near the VEGP site (figure 1). Two stations were located 0.3 mile upstream of the site; two stations were located at the intake; and two stations were located 0.3 mile downstream of the site. Stations were located approximately 40 feet from the east or west bank.

A standard plankton net with a mouth diameter of 4.5 in. was used for collection of all plankton samples. The net frame and cod end collecting jar were equipped with No. 20 cloth with a mesh size of approximately 76 microns.

Plankton samples were collected at each station by suspending the net in the river to approximately 1.5 ft depth for ten minutes. The concentrated sample in the net was transferred to a labeled sample jar and preserved with four percent formalin. Subsurface sampling was sufficient since no significant differences in the plankton population could be expected throughout the water column in this area of the river due to depth and velocity which facilitates complete mixing.[6] Air and water temperature, water velocity, pH, conductivity, dissolved oxygen, light penetration, and sampling duration were recorded for each station.

Field samples were returned to the Georgia Power Company (GPC) Environmental Center for laboratory processing, identification, and enumeration.

In the laboratory, each sample was transferred to a graduated cylinder. If the sample volume was less than 200 ml, distilled water was added to bring the volume up to 200 ml. If the sample volume was greater than 200 ml, the sample was left undisturbed for at least 24 hours to allow the plankton to settle. The excess was decanted off by means of a suction tube.

Phytoplankton and zooplankton counts were made from a measured Sedgewick-Rafter (S-R) counting chamber. Diatom identifications were made from permanent slides. A compound microscope equipped with a calibrated Whipple grid ocular micrometer was used for all identifications and enumerations.

Phytoplankton enumeration and identification was made by examining a one ml aliquot sample in the S-R counting chamber with a compound microscope at 200X. Two strips, the width of a Whipple grid and length of the counting chamber, were examined. All phytoplankton falling on or within the image of the grid were enumerated and identified to the lowest practical taxon. Diatoms were identified only as centrics or pennates. The scientific names and numbers of phytoplankton for each station were recorded on phytoplankton laboratory sheets.

Diatom identifications were made from permanent slides prepared according to Weber.[7] Random strips of slides from each station were examined at 200X. All diatoms encountered during 45 minutes of scanning were identified to the lowest practical taxon and were recorded on laboratory sheets. Keys used for phytoplankton and diatom identification were Palmer,[6] Needham,[8] Prescott,[9, 10] Vinyard,[11] Ward and Whipple[12] and Weber[13].

Zooplankton identifications were made by examining a one ml aliquot sample in the S-R counting cell at 100X. Ten strips the width of a Whipple grid and length of the S-R counting chamber were scanned. All zooplankton falling on or within the image of the grid were identified to the lowest practical taxon. Keys used to identify zooplankton were: Ward and Whipple,[12] Barnes,[14] and Pennak.[15] The scientific names and numbers of zooplankton were recorded on laboratory sheets.

Phytoplankton and zooplankton data were converted to number of organisms per liter as follows:

$$\text{Number of organisms per ml of sample} = \frac{C \times 1000\ mm^3}{L \times W \times D \times S}$$

Where:

C = Number of organisms counted
L = Length of strip, mm (length of S-R chamber)
W = Width of strip, mm (width of Whipple grid)
D = Depth of strip, mm (depth of S-R chamber)
S = Number of strips counted

The number of organisms per ml of sample was multiplied by the volume of the sample to obtain the total number of organisms in the sample. The total number of organisms was divided by the total volume of water filtered to obtain the number of organisms per liter.

The percent composition of the major taxonomic groups of phytoplankton and zooplankton was determined by dividing each taxon's density by the total density at a station and multiplying by 100. A list of all diatom taxa present at the station was compiled.

RESULTS AND DISCUSSION

I. Phytoplankton

A total of 105 phytoplankton taxa were identified from samples collected in 1981 (table 1). A taxon is defined as the lowest level to which an organism could be identified. The number of taxa of each major group were: Chrysophyta, 61; Chlorophyta, 22; Cyanophyta, 15; Rhodophyta, 1; Euglenophyta, 1; and Pyrrophyta, 1. These numbers may not represent an accurate appraisal of the number of phytoplankton taxa present since many identifications were only to generic or major taxonomic levels. Four hundred species of phytoplankton and periphyton were identified in the Savannah River between river miles 123 and 162 from 1959 to 1962 by the Academy of Natural Sciences in Philadelphia (ANSP).[2]

Table 2 lists the number of taxa of the major groups found at each station for each quarter. There were no large fluctuations in the number of taxa for any quarter. There was some variation in the number of taxa among stations during a sample period.

Phytoplankton taxa occurring in at least two-thirds of the total samples collected in 1981 were considered common to the area. Common taxa were: Chrysophyta, Melosira spp., Surirella spp., and Pinnularia spp.; Chlorophyta, an unidentified unicell; Cyanophyta, Oscillatoria spp., Lyngba spp., and an unidentified blue-green filament. The diatom, Melosira spp. "A", appeared in every sample. Melosira spp. "B" occurred in all samples but one. Melosira spp. was the most common phytoplankton.

The average density of phytoplankton per liter for each quarter was: January, 532; April, 452; June, 347; and September, 274. The density of phytoplankton is usually expected to be the greatest during the spring.[6] The greatest density, however, occurred in January. This could result from many factors. Chrysophytes have been reported to increase during the colder months, and diatoms accounted for 80 percent of the January sample.[11] Water discharge from upstream reservoirs, as measured at USGS river gauging station 02197320 near Jackson, South Carolina, was greater during the January survey (8120 ft^3/sec) than during the April (6330 ft^3/sec), June (5680 ft^3/sec), or September (5390 ft^3/sec) survey. This increase in water discharge could be responsible for a flush of inocula from streams and lakes feeding into the river.[12][16][17] During periods of high water, more individuals are carried downstream. This number, however, will decrease in time even if the water level remains high.[17]

The average density per liter varied from station to station within a sampling period. The greatest difference occurred at Station 150.9-1 for all sampling periods except January. The density at this station was much greater than at any of the other five stations. During April, June, and September, the water velocity at the station was less than at the other stations. This lower velocity could allow a greater

phytoplankton population to become established due to decreased turbulence. Areas of low velocity usually exhibit greater plankton populations.[6][16] In January, the water velocity was more consistent between stations. This inverse relationship between water velocity and plankton densities is evident in figures 2 through 5.

Table 3 lists the density of phytoplankton per liter for each major group at each station. Chrysophyta represented the majority of phytoplankton collected in each sampling period. Cyanophyta was second, except in June. Chlorophyta followed with the third greatest density. Chlorophyta exhibited a peak density in June, which is common during the warmer months.[6] This peak resulted from an increase in the number of Scenedesmus spp. and Staurastrum spp. Increases in Staurastrum spp. during the summer is very common in waters where the algae flora is predominantly the cyanophyte-diatom type.[9] Other density studies have been done on the Savannah River. Differences in sampling design and station locations make it impossible to make specific comparisons. However, some general observations can be noted. These studies showed considerable patchiness in the distribution of phytoplankton. The greatest number of organisms were found where the current was slow and the water was less turbid.[2]

The percent composition of each major group for each station during each quarter is shown in table 4. Percent composition remained fairly consistent throughout the sampling period with the exception of an increase in Chlorophyta in June. The percent composition of major taxa varied among stations during a sampling period. This may have resulted from normal sampling variability or patchiness in distribution.

In 1981, diatoms comprised approximately 71 percent of the total number of phytoplankton with Melosira spp., a centric diatom, the most abundant. Melosira spp. was one of the most abundant phytoplankton in ANSP studies from 1959 to 1962 and in 1968.[18] Most studies conducted on large rivers have documented centric diatoms as the primary phytoplankton.[6][16]

The phylum Chlorophyta, comprising 11 percent of the total phytoplankton, generally had an even distribution of taxa with the exception of an increase of Staurastrum spp. and Scenedesmus spp. in June. Oscillatoria spp., Lyngba spp., and an unidentified blue-green filament comprised the greatest percentage of Cyanophyta, which represented 14 percent of all phytoplankton. Euglenophyta was represented by a single genus, Euglena spp. Compsopogon spp. was the only Rhodophyta identified. The dinoflagllate, Ceratium spp., was the only Pyrrophyta identified.

A literature review of studies done on the effects of power plant entrainment on phytoplankton and zooplankton was conducted by Electric Power Research Institute (EPRI) in 1976. Most of the studies reviewed indicated that changes in plankton standing stocks, viability, and/or productivity may be detectable in the immediate area of the discharge plume, but that the effects outside the discharge plume are difficult to detect. There was little indication that entrainment greatly affects

phytoplankton species composition in the receiving body of water. The small amount of information found on the effects of chlorination on the distribution of phytoplankton in the receiving body of water indicated that chlorination tends to reduce phytoplankton standing stock and production.[19]

II. Zooplankton

A total of 32 zooplankton taxa were identified from samples collected in 1981 (Table 5). The number of taxa in each major group was: Protozoa, 7; Rotifera, 12; Copepoda, 3; Ostracoda, 1; Cladocera, 1; other Crustacea, 1; and miscellaneous, 7. These numbers may not represent an accurate appraisal of the species of zooplankton present, since many identifications were made only to generic or major taxonomic levels and many soft-bodied forms were destroyed by the formalin preservative used. In studies conducted by the ANSP, 40 species of rotifers, 10 species of crustaceans, and 440 species of protozoa have been identified in the Savannah River between river miles 123 and 162 from 1959 to 1962.[2]

Table 6 shows the number of taxa of the major groups found at each station for each quarter. No sampling period had a large fluctuation in total number of taxa. There was only a slight variation in the number of taxa between stations during any quarter.

Zooplankton taxa occurring in at least two-thirds of the samples collected in 1981 were considered common to the area studied. Common taxa were Rotifera, Keratella spp,; Protozoans, Rhizopodea; Vorticella spp., and other cilates. Rhizopods occurred in all but two samples and cilates occurred in all but four samples. These two Protozoan groups were the most common zooplankton present. The average density of zooplankton per liter for each quarter were: January, 4; April, 6; June, 4; and September, 3. Such low densities made it impossible to correlate the densities to any seasonal changes. Protozoan exhibited the greatest average density followed by rotifers.

Table 7 lists the density of zooplankton per liter for each major group at each station. The density per liter varied among stations within a sampling period. The greatest difference occurred at Station 150.9-1 for all sampling periods except January. The density at this station was consistently greater for April, June, and September. This increase in zooplankton parallels the increase in phytoplankton densities at this station for the same sampling periods. The lower velocity and decreased turbulence could have resulted in a greater phytoplankton and zooplankton population (figures 6 through 9). Zooplankton are usually reduced in number in swift waters and any input from upstream inlets usually declines rapidly downstream.[16] The velocity was not reduced at Station 150.9-1 during January.

Other density studies done on the Savannah River have shown similar densities of rotifers, copepod, copepod nauplii, and cladocerans.[18] Differences in sampling design and station locations made it impossible to make specific comparisons.

Table 8 shows the percent composition of the major groups for each station in 1981. The percent composition was fairly consistent throughout the sampling period. Protozoans represented approximately 61 percent of the total number of zooplankton; rotifers comprised about 18 percent; Crustacea, 10 percent; and other miscellaneous phyla, 10 percent.

Rotifers are expected to be the primary zooplankton present in large rivers.[6][16] Protozoans, however, represented the largest percentage of zooplankton in 1981. The predominant protozoan was the ciliate, Vorticella spp., which is generally considered an attached sessile organism and may have been scuffed up from the bottom and carried along with the drift. All microscopic organisms retained by the plankton net were included in this study.

There was an increase in the percentage of rotifers in June and a slight decrease in September. These variations were not due to an increase or decrease in any particular species.

All major zooplankton phyla were represented in the 1981 samples; however, the densities were low. Similar numbers of rotifers, copepods, and crustacean nauplii were also observed in the 1959 to 1962 studies.[18]

In a literature review of studies conducted on power plant entrainment of phytoplankton and zooplankton, it was indicated that the distribution of zooplankton in time and space was highly variable. Differences in mean abundance or biomass among stations were often found to be statistically insignificant; however, differences among sampling dates were significant. Trends in spatial distribution were also apparent in stations near the plant and stations farther away. The factors cited as responsible for these differences include discharge of organisms using inner-plant structures as substratum, mixing, and turbulence associated with the intake and discharge of relatively large amounts of water; and entrainment mortality. These effects varied among taxon, site, and season. In short, these effects do appear detectable, but the exact cause may be taxon, site, and season specific. Both composition and seasonal cycles of abundance tended to be similar among preoperational and operational years. Limited information on the effects of chlorination suggests abundance and viability in the discharge plume are reduced to a greater extent at times of chlorination.[19]

CONCLUSIONS

The study conducted by GPC has shown a plankton population dominated by the typical constituents of large rivers. Centric diatoms dominate the phytoplankton assemblage. Rotifers predominated over other zooplankton with the exception of the protozoans. The protozoans were dominated by the ciliate, Vorticella spp., which generally is not considered planktonic. Corbicula spp. was the only biological indicator of radionuclides identified in plankton samples collected in 1981. No species identified were considered important because of their uniqueness, recreational, or commercial "importance."

All major groups of phytoplankton and zooplankton were represented in 1981. There seemed to be variation in the distribution and density of plankton in relation to current velocity and water discharge from upstream reservoirs.

Station operation at the VEGP may cause changes in plankton standing stocks, viability, and/or productivity within the immediate area of the discharge plume, but effects outside the discharge plume are expected to be insignificant.

REFERENCES

1. Environmental Protection Division, Water Quality Monitoring Data for Georgia Streams, Department of Natural Resources, Atlanta, Georgia, 1981.

2. Patricks, R., Cairns, J., and Roback, S. S., "An Ecosystematic study of the Fauna and Flora of the Savannah River," Proceedings of the Academy of Natural Sciences of Philadelphia 118, Philadelphia, Pennsylvania, pp 109-407, 1967.

3. Academy of Natural Sciences of Philadelphia, Summary of Studies on the Savannah River 1951-1970 for E. I. DuPont DeNemours and Company, Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, 1970.

4. Academy of Natural Sciences of Philadelphia, Summary Reports of Savannah River Cursory Surveys for E. I. DuPont DeNemours and Company 1961-1972, 1974, and 1977, Academy of Natural Sciences of Philadelphia, Philadelphia, Pennsylvania, 1978.

5. Matthews, R. A., Biological Surveys on the Savannah River in the Vicinity of the Savannah River Plant (1951-1976), E. I. DuPont DeNemours and Company, Savannah River Laboratory, Aiken, South Carolina, 1982.

6. Palmer, C. M., Algae and Water Pollution, EPA-600/9-77-036, U.S. Environmental Protection Agency, December 1977.

7. Weber, C. I., Methods of Collections and Analysis of Plankton and Periphyton Samples in the Water Pollution Surveillance System, U.S. Department of the Interior, June 1970.

8. Needham, J. G. and Needham, P. R., A Guide to the Study of Freshwater Biology, Holden-Day, Inc., San Francisco, California, 1962.

9. Prescott, G. W., Algae of the Western Great Lakes Area, Wm. C. Brown Publishers, Dubuque, Iowa, 1962.

10. Prescott, G. W., How to Know the Freshwater Algae, Wm. C. Brown Publishers, Dubuque, Iowa, 1970.

11. Vineyard, W. C., Diatoms of North America, Mad River Press, Inc., Eureka, California, 1979.

12. Ward, H. B. and Whipple, G. C., Freshwater Biology, John Wiley and Sons, Inc., New York, 1959.

13. Weber, C. I., A Guide to Common Diatoms at Water Pollution Surveillance Systems Stations, U.S. Environmental Protection Agency, Cincinnati, Ohio, 1971

REFERENCES (Con't.)

14. Barnes, R. D., Invertebrate Zoology, W. B. Saunders Co., Philadelphia, Pennsylvania, 1963.

15. Pennak, R. W., Freshwater Invertebrates of the United States, Ronald Press Company, New York, 1953.

16. Whitton, B. A., ed., River Ecology, Vol 2, University of California Press, Berkeley and Los Angeles, California, pp 81-105, 155-169, 1975.

17. Hynes, H. B., The Ecology of Running Waters, University of Toronto Press, pp 94-111, 1970.

18. Georgia Power Company, "Alvin W. Vogtle Nuclear Plant Environmental Report," Vol 1, Georgia Power Company, Atlanta, Georgia, pp 2.7-101-2.7-104, August 1, 1972.

19. Lawler, Matusky and Skelly Engineers, "Ecosystem Effects of Phytoplankton and Zooplankton Entrainment," Electric Power Research Institute, EA-1038 Research Project 876, Palo Alto, California, April 1979.

TABLE 1

PHYTOPLANKTON TAXA IN THE SAVANNAH RIVER
BETWEEN RIVER MILES 150.6 AND 151.2

CHLOROPHYTA (Green Algae)
- Chlamydomonas spp.
- Kirchneriella spp.
- Dictyosphaerium spp.
- Actinastrum spp.
- Scenedesmus spp.
- Hydrodictyon spp.
- Pediastrum spp.
- Ulothrix spp.
- Stigeoclonium spp.
- Oedogonium spp.
- Cladophora spp.
- Mougotia spp.
- Spirogyra spp.
- Desmidiaceae
- Closterium spp.
- Cosmarium spp.
- Staurastrum spp.
- Characeace
- Unidentified taxa (4)

CYANOPHYTA (Blue-Green Algae)
- Coelosphaerium spp.
- Merismopedium spp.
- Microcystis spp.
- Oscillatoriales spp.
- Lyngba sp. "A"
- Lyngba sp. "B"
- Oscillatoria sp. "A"
- Oscillatoria sp. "B"
- Anabaena spp.
- Nostoc spp.
- Gloetrichia spp.
- Unidentified taxa (4)

EUGLENOPHYTA
- Euglena spp.

RHODOPHYTA (Red Algae)
- Compsopogon spp.

PYRROPHYTA (Dinoflagellates)
- Ceratium spp.

CHRYSOPHYTA (Yellow or Brown Algae)
- Coscinodiscus spp.
- Melosira sp. "A"
- Melosira sp. "B"
- Biddulphia spp.
- Terpsinoe spp.
- Stephanodiscus spp.
- Asterionella formosa
- Cocconeis spp.
- Eunotia spp.
- Surirella spp.
- Fragilaria spp.
- Navicula spp.
- Tabellaria spp.
- Pinnularia spp.
- Stauroneis spp.
- Gyrosigma spp.
- Unidentified pennates (44)
- Unidentified centrics (1)

MISCELLANEOUS
- Unidentified phytoplankton taxa (4)

TABLE 2

NUMBER OF TAXA OF MAJOR PHYTOPLANKTON GROUPS FOR EACH STATION

	Station						Total No. of Different Taxa
	150.6-1	150.6-3	150.9-1	150.9-3	151.2-1	151.2-3	
January, 1981							
Chlorophyta	3	4	5	4	4	3	10
Cyanophyta	5	7	6	4	8	5	9
Euglenophyta	0	1	1	1	1	0	1
Rhodophyta	0	0	0	0	0	1	1
Chrysophyta	23	14	9	14	14	11	16
Pyrrophyta	1	1	0	0	0	0	1
Miscellaneous	1	2	2	1	1	1	2
Total	33	29	23	24	28	22	40
April, 1981							
Chlorophyta	8	6	5	6	5	5	12
Cyanophyta	6	7	6	5	5	6	9
Euglenophyta	0	1	0	0	0	0	1
Rhodophyta	1	0	0	0	1	0	1
Chrysophyta	6	7	4	6	6	6	9
Pyrrophyta	0	0	0	0	0	0	0
Miscellaneous	2	2	2	2	2	2	2
Total	23	23	17	19	19	19	34
June, 1981							
Chlorophyta	7	6	8	6	9	8	17
Cyanophyta	5	3	4	5	2	3	7
Euglenophyta	0	1	1	0	0	1	1
Rhodophyta	1	0	0	1	1	1	1
Chrysophyta	5	5	5	5	6	6	7
Pyrrophyta	0	0	0	0	0	0	0
Miscellaneous	2	2	2	0	2	1	3
Total	20	17	20	17	20	20	36
September, 1981							
Chlorophyta	10	6	5	6	5	2	15
Cyanophyta	5	5	2	6	6	5	8
Euglenophyta	0	0	0	0	0	0	0
Rhodophyta	1	1	1	1	1	1	1
Chrysophyta	9	6	5	5	4	6	8
Pyrrophyta	0	0	0	0	0	0	0
Miscellaneous	1	1	0	2	2	2	2
Total	26	19	13	20	18	16	34

TABLE 3

DENSITIES (ORGANISMS PER LITER) OF MAJOR PHYTOPLANKTON TAXA FOR EACH STATION

	Station						Average Density for
	150.6-1	150.6-3	150.9-1	150.9-3	151.2-1	151.2-3	all Stations
January, 1981							
Chlorophyta	6.08	20.05	9.80	10.33	7.49	6.61	10
Cyanophyta	69.91	69.57	83.89	67.18	114.91	83.33	81
Euglenophyta	-	2.36	1.09	2.07	1.25	-	1
Rhodophyta	-	-	-	-	-	1.32	<1
Chrysophyta	340.43	442.20	343.17	310.04	577.02	560.85	429
Pyrrophyta	1.01	1.18	-	-	-	-	<1
Miscellaneous	8.11	16.51	9.80	4.13	5.00	13.23	9
Total	425.53	551.87	447.76	393.75	705.67	665.34	532
April, 1981							
Chlorophyta	24.65	24.53	36.09	21.16	23.20	15.48	24
Cyanophyta	34.73	77.92	93.83	75.40	62.27	73.81	70
Euglenophyta	-	1.44	-	-	-	-	<1
Rhodophyta	1.12	-	-	-	4.88	-	1
Chrysophyta	281.23	337.66	546.74	292.33	269.84	315.48	341
Pyrrophyta	-	-	-	-	-	-	-
Miscellaneous	13.45	20.20	14.44	14.55	17.09	19.05	16
Total	355.18	461.76	691.10	403.44	377.29	423.81	452
June, 1981							
Chlorophyta	61.25	40.40	234.13	64.67	93.21	99.68	99
Cyanophyta	22.41	10.10	234.13	8.23	6.08	16.61	50
Euglenophyta	-	1.44	3.97	-	-	1.38	1
Rhodophyta	1.40	-	-	1.18	1.01	6.92	2
Chrysophyta	142.86	154.40	317.46	79.95	116.51	91.37	150
Pyrrophyta	-	-	-	-	-	-	-
Miscellaneous	9.80	7.22	27.78	-	8.11	8.31	10
Total	236.69	238.10	892.86	188.12	267.48	261.65	347
September, 1981							
Chlorophyta	16.57	17.84	58.62	11.44	14.42	2.29	20
Cyanophyta	30.12	82.52	29.31	25.17	29.95	22.93	37
Euglenophyta	-	-	-	-	-	-	-
Rhodophyta	3.01	4.46	-	1.14	-	6.88	3
Chrysophyta	227.40	124.89	476.31	124.73	136.46	130.68	203
Pyrrophyta	-	-	-	-	-	-	-
Miscellaneous	15.06	6.69	21.98	3.43	14.42	5.73	11
Total	289.15	236.40	586.22	165.92	195.25	168.51	274

TABLE 4

PERCENT COMPOSITION OF MAJOR PHYTOPLANKTON TAXA FOR EACH STATION

	Station						Average
	150.6-1	150.6-3	150.9-1	150.9-3	151.2-1	151.2-3	Percent
January, 1981							
Chlorophyta	1	3	2	2	1	1	2
Cyanophyta	16	13	19	17	16	13	16
Euglenophyta	-	<1	<1	<1	<1	-	<1
Rhodophyta	-	-	-	-	-	<1	<1
Chrysophyta	80	80	77	79	82	84	80
Pyrrophyta	<1	<1	-	-	-	-	<1
Miscellaneous	2	2	2	1	<1	2	2
April, 1981							
Chlorophyta	7	5	5	5	6	4	5
Cyanophyta	10	17	14	19	16	17	16
Euglenophyta	-	<1	-	-	-	-	<1
Rhodophyta	<1	-	-	-	1	-	<1
Chrysophyta	79	73	79	72	72	74	75
Pyrrophyta	-	-	-	-	-	-	-
Miscellaneous	4	4	2	4	5	4	4
June, 1981							
Chlorophyta	26	17	26	34	35	38	29
Cyanophyta	9	4	26	4	2	6	9
Euglenophyta	-	<1	<1	-	-	<1	<1
Rhodophyta	<1	-	-	<1	<1	3	<1
Chrysophyta	60	75	44	54	59	49	57
Pyrrophyta	-	-	-	-	-	-	-
Miscellaneous	4	3	3	-	3	3	3
September, 1981							
Chlorophyta	6	8	10	7	7	1	7
Cyanophyta	9	35	5	15	15	14	16
Euglenophyta	-	-	-	-	-	-	-
Rhodophyta	1	2	-	<1	-	4	1
Chrysophyta	79	53	81	75	70	77	73
Pyrrophyta	-	-	-	-	-	-	-
Miscellaneous	5	3	4	2	7	3	4

TABLE 5

ZOOPLANKTON TAXA IN THE SAVANNAH RIVER
BETWEEN RIVER MILES 150.6 and 151.2

PROTOZOA
- Mastigophora
  - Rhizopodea (3 taxa)
  - Actinopodea
- Ciliatea
  - *Vorticella* spp.

ROTIFERA
- *Keratella* spp.
- Unidentified Rotifers (11 taxa)

CRUSTACEA
- Copepoda
  - Cyclopoida
  - Nauplii
- Ostracoda
- Cladocera
- Unidentified Crustacean

MISCELLANEOUS
- Hydroida
- Nematoda
- Tardigrada
- Annelida
- Insecta
- Gastropoda
- Pelecypoda
  - *Corbicula* sp.

TABLE 6

NUMBER OF TAXA OF MAJOR ZOOPLANKTON GROUPS FOR EACH STATION

	Station						Total No. of Different Taxa
	150.6-1	150.6-3	150.9-1	150.9-3	151.2-1	151.2-3	
January, 1981							
Protozoa	3	3	4	3	4	3	5
Rotifera	3	4	4	1	3	2	5
Crustacea	-	-	-	-	-	-	-
Copepoda	1	1	2	1	1	2	2
Branchipoda	-	-	-	-	-	1	1
Ostracoda	-	-	-	-	1	1	1
Miscellaneous	3	1	1	3	3	3	5
Total	10	9	11	8	12	12	19
April, 1981							
Protozoa	5	3	3	3	4	4	5
Rotifera	4	3	3	5	3	4	9
Crustacea	-	-	-	-	-	-	-
Copepoda	2	3	1	1	3	2	3
Branchipoda	-	1	-	-	-	-	1
Ostracoda	-	-	1	-	-	-	1
Miscellaneous	3	3	3	3	1	3	6
Total	14	13	11	12	11	13	25
June, 1981							
Protozoa	4	4	3	5	3	4	6
Rotifera	5	3	4	3	4	3	10
Crustacea	-	-	-	-	-	-	-
Copepoda	1	-	1	1	2	-	2
Branchipoda	-	-	1	-	-	-	1
Ostracoda	-	-	-	-	-	-	-
Miscellaneous	2	1	-	1	1	2	3
Total	12	8	9	10	10	9	22
September, 1981							
Protozoa	3	1	3	4	4	4	4
Rotifera	3	2	1	1	-	1	6
Crustacea	-	-	-	-	-	-	-
Copepoda	2	1	-	1	1	1	3
Branchipoda	-	-	-	-	-	-	-
Ostracoda	-	-	-	-	-	1	1
Miscellaneous	3	1	1	2	4	1	7
Total	11	5	5	8	9	8	21

TABLE 7

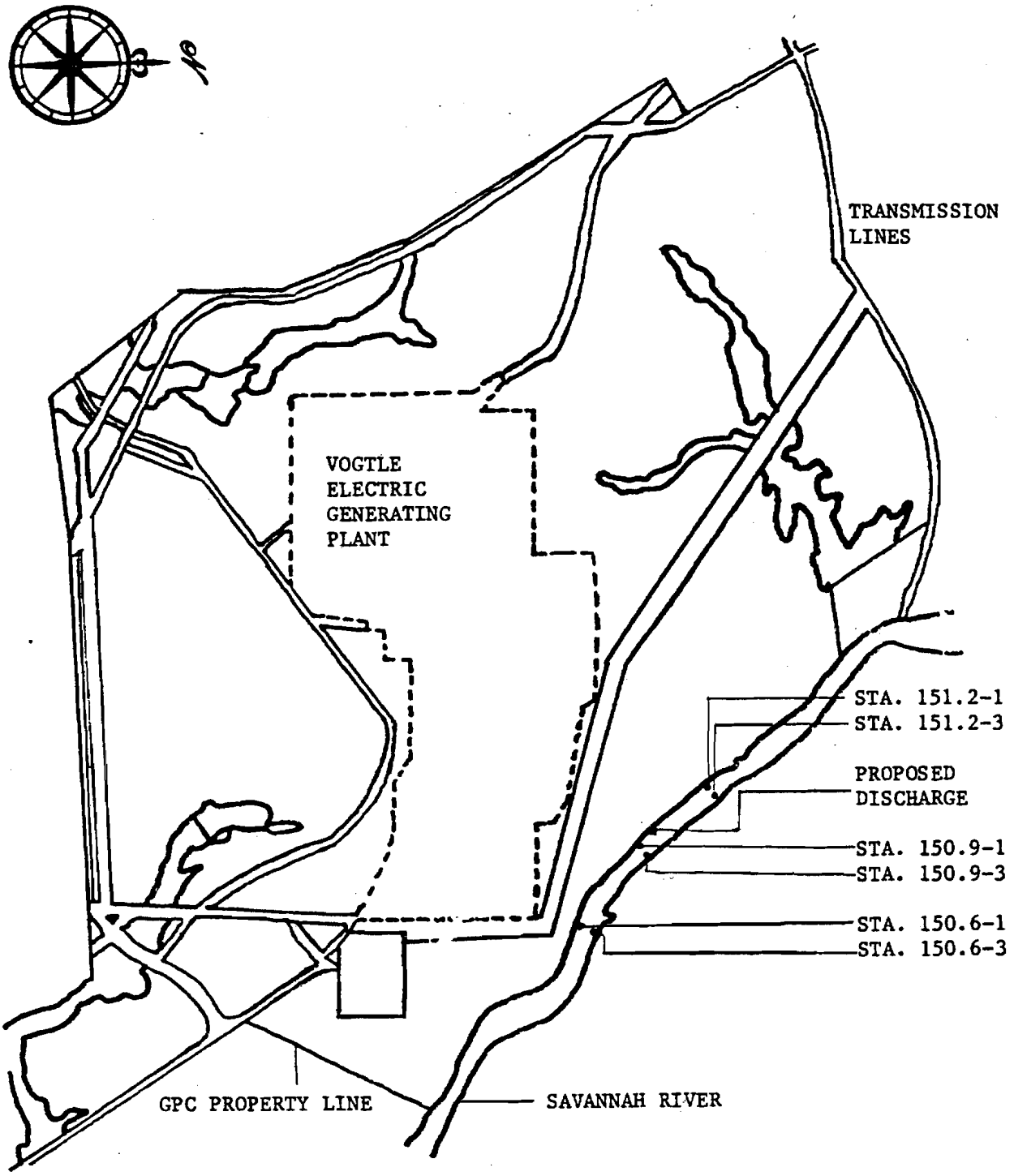
DENSITIES (ORGANISMS PER LITER) OF MAJOR ZOOPLANKTON TAXA FOR EACH STATION

	Station						Average Density for all Stations
	150.6-1	150.6-3	150.9-1	150.9-3	151.2-1	151.2-3	
January, 1981							
Protozoa	2.73	2.71	2.29	1.96	2.37	2.52	2
Rotifera	0.71	1.06	0.44	0.41	0.87	0.26	1
Crustacea	-	-	-	-	-	-	-
Copepoda	0.20	0.47	0.65	0.10	0.37	0.66	<1
Branchipoda	-	-	-	-	-	0.40	<1
Ostracoda	-	-	-	-	0.12	0.13	<1
Miscellaneous	0.30	0.35	0.11	0.42	0.49	0.65	<1
Total	3.85	4.60	3.49	2.89	4.25	4.63	4
April, 1981							
Protozoa	3.47	3.90	5.05	4.36	4.88	3.57	4
Rotifera	1.34	0.43	1.44	0.93	0.98	0.71	1
Crustacea	-	-	-	-	-	-	-
Copepoda	0.22	0.43	0.54	0.53	0.73	0.48	<1
Branchipoda	-	0.14	-	-	0.12	-	<1
Ostracoda	-	-	0.18	-	-	-	<1
Miscellaneous	0.33	0.57	0.54	0.39	0.24	0.36	<1
Total	5.38	5.48	7.76	6.22	6.96	5.12	6
June, 1981							
Protozoa	1.82	2.30	4.36	1.30	1.10	1.80	2
Rotifera	0.98	0.87	2.38	0.59	0.71	0.69	1
Crustacea	-	-	-	-	-	0.14	<1
Copepoda	0.42	-	0.40	0.35	0.20	-	<1
Branchipoda	-	-	0.40	-	-	-	<1
Ostracoda	-	-	-	-	-	-	-
Miscellaneous	0.28	0.29	-	0.24	0.10	0.28	<1
Total	3.50	3.46	7.54	2.47	2.13	2.91	4
September, 1981							
Protozoa	1.65	0.69	5.13	0.92	1.49	1.55	2
Rotifera	0.60	0.45	0.73	0.34	0.34	0.22	<1
Crustacea	-	-	-	-	-	-	-
Copepoda	0.45	0.22	-	0.11	0.23	0.33	<1
Branchipoda	-	-	-	-	-	-	-
Ostracoda	0.60	-	-	-	0.11	-	<1
Miscellaneous	0.45	0.44	0.73	0.22	0.34	0.44	<1
Total	3.76	1.78	6.60	1.60	2.52	2.55	3

TABLE 8

PERCENT COMPOSITION OF MAJOR ZOOPLANKTON TAXA FOR EACH STATION

	Station						Average
	150.6-1	150.6-3	150.9-1	150.9-3	151.2-1	151.2-3	Percent
January, 1981							
Protozoa	68	59	66	68	56	54	62
Rotifera	18	23	13	14	20	6	16
Crustacea	-	-	-	-	-	-	-
Copepoda	5	10	19	3	9	14	10
Branchipoda	-	-	-	-	-	-	-
Ostracoda	-	-	-	-	-	-	-
Miscellaneous	8	8	3	14	12	15	10
April, 1981							
Protozoa	64	71	65	69	70	70	68
Rotifera	25	8	19	15	14	14	16
Crustacea	-	-	-	-	-	-	-
Copepoda	4	8	7	9	10	9	8
Branchipoda	-	3	-	-	2	-	1
Ostracoda	-	-	2	-	-	-	<1
Miscellaneous	6	11	6	6	3	6	6
June, 1981							
Protozoa	52	66	58	53	52	62	57
Rotifera	28	25	32	24	33	24	28
Crustacea	-	-	-	-	-	5	1
Copepoda	12	-	5	10	9	-	6
Branchipoda	-	-	5	-	-	-	1
Ostracoda	-	-	-	-	-	-	-
Miscellaneous	8	8	-	10	5	10	7
September, 1981							
Protozoa	44	39	77	58	59	61	56
Rotifera	16	25	11	21	13	9	13
Crustacea	-	12	-	-	-	-	2
Copepoda	12	-	-	7	9	13	7
Branchipoda	-	-	-	-	-	-	-
Ostracoda	16	-	-	-	4	-	3
Miscellaneous	12	24	11	14	13	17	15



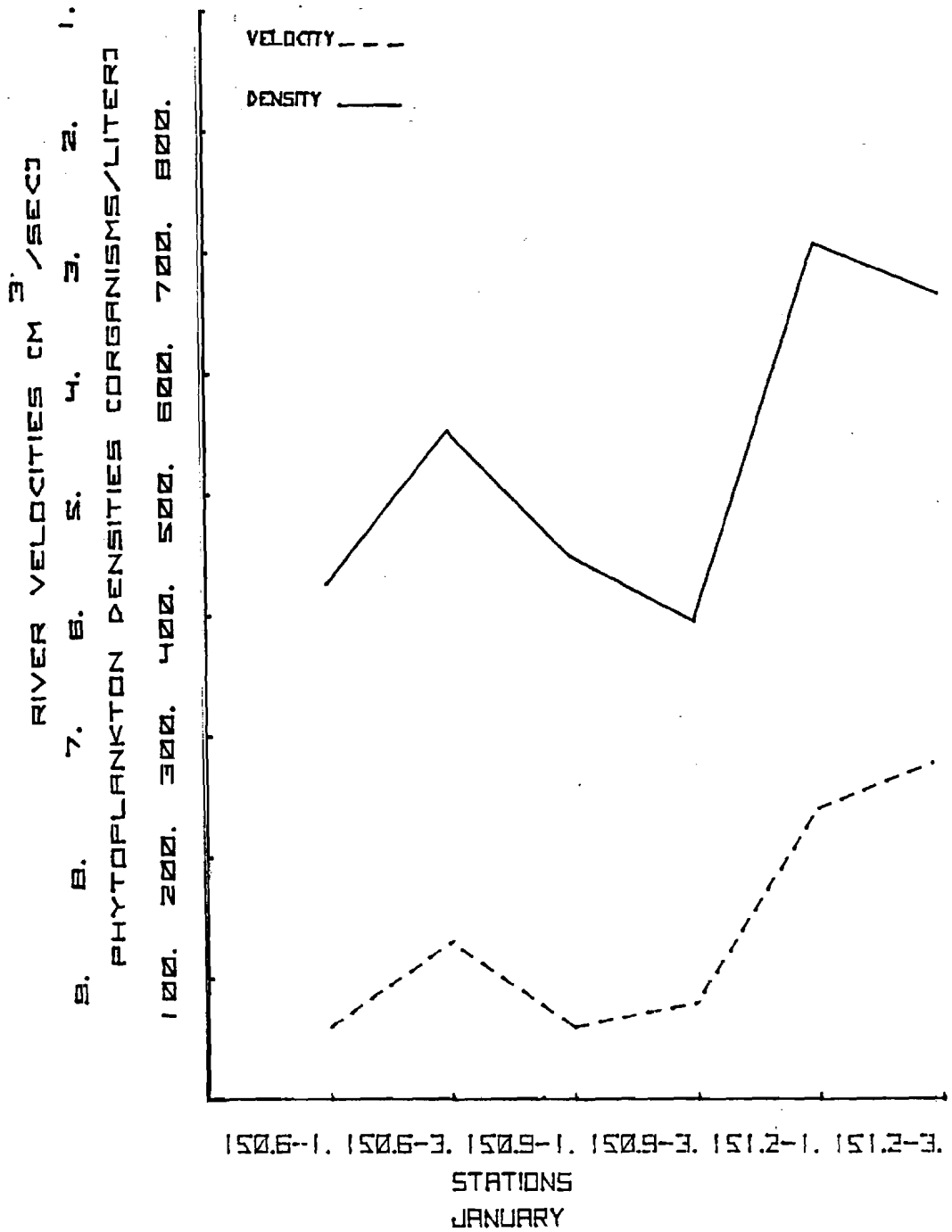
Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

LOCATION OF VEGP PLANKTON SURVEY STATIONS

FIGURE 1

433-9



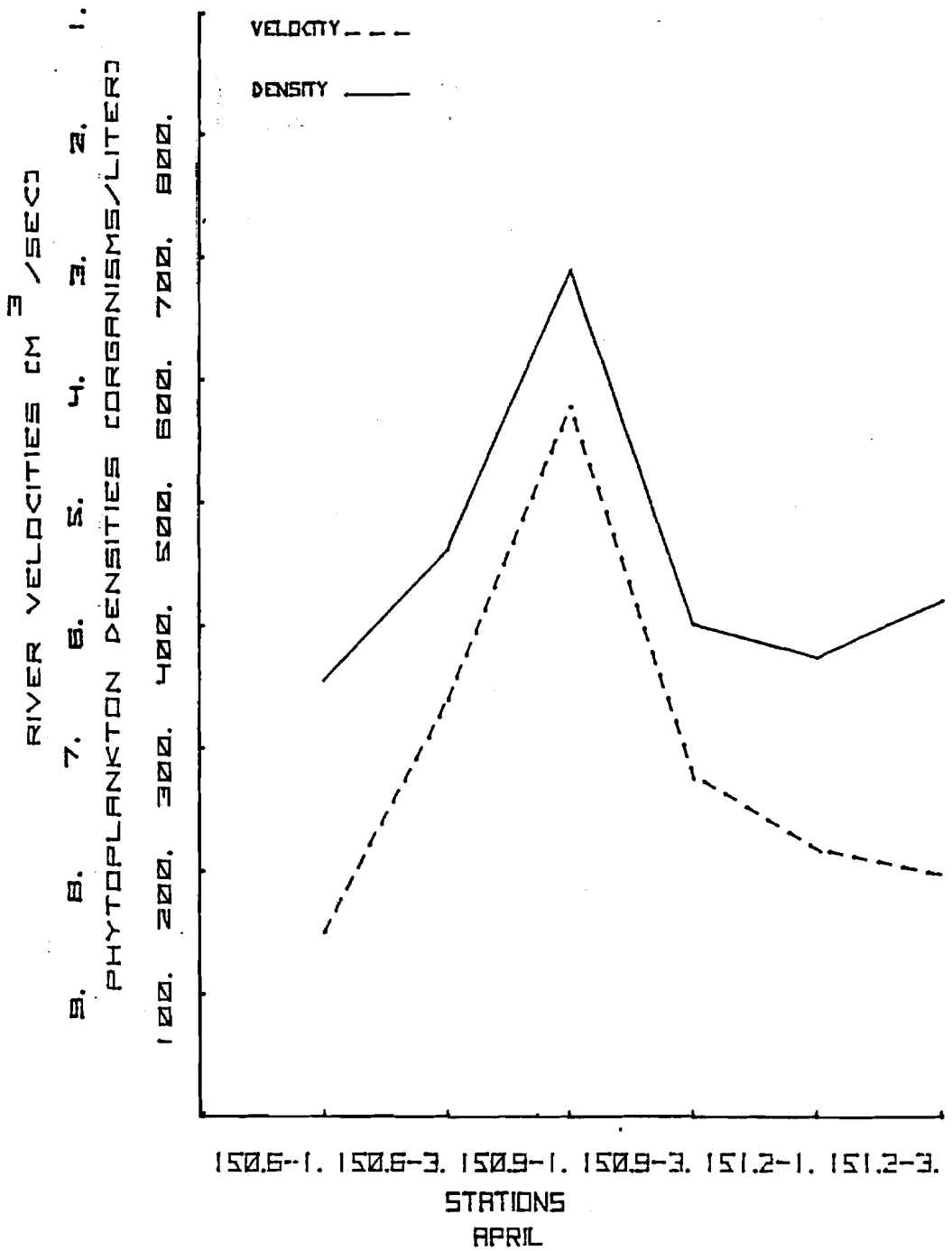
Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

PHYTOPLANKTON DENSITIES AND RIVER VELOCITIES FOR JANUARY 1981

FIGURE 2

433-9



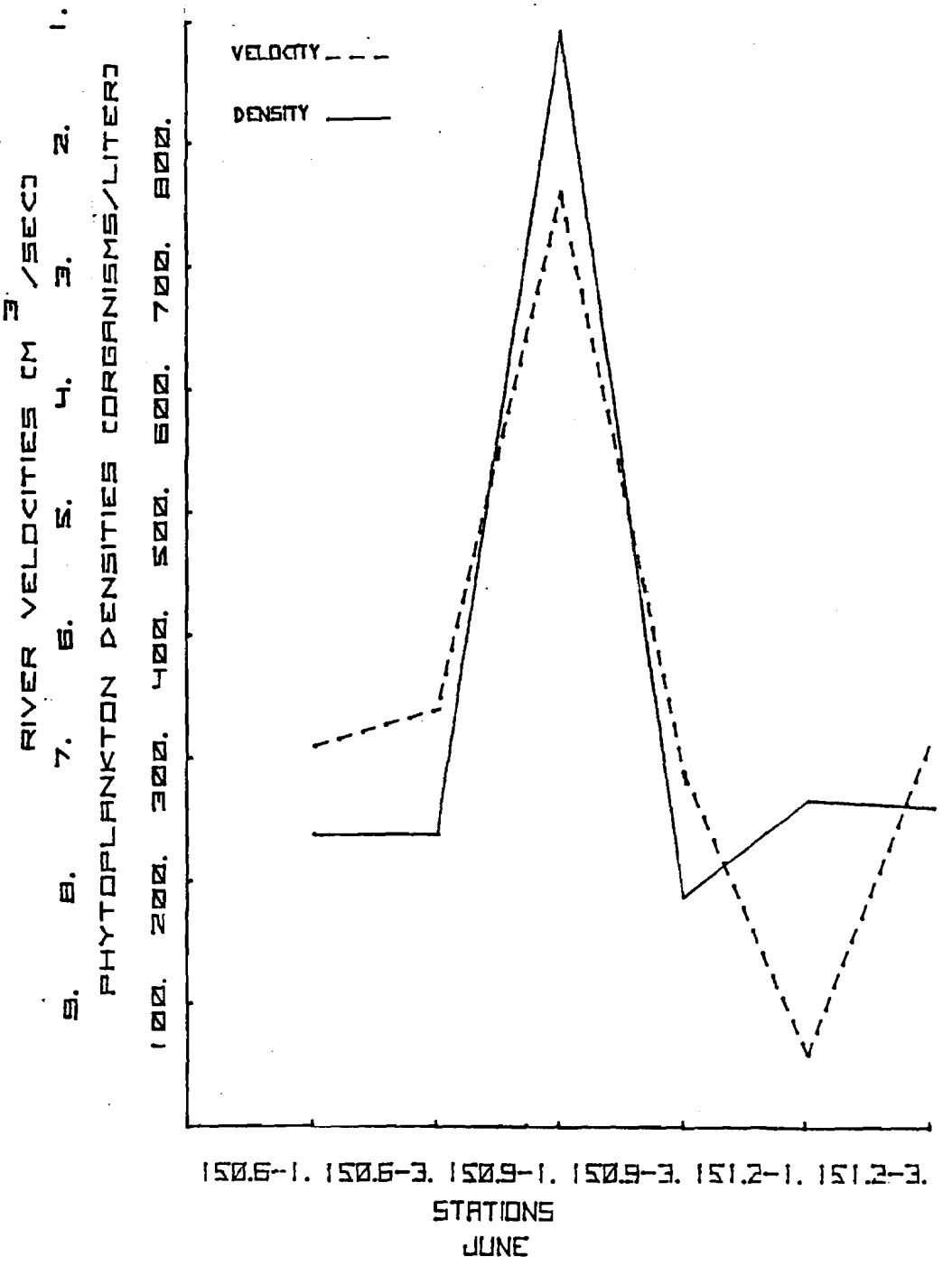
Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

PHYTOPLANKTON DENSITIES AND RIVER VELOCITIES FOR APRIL 1981

FIGURE 3

433-9



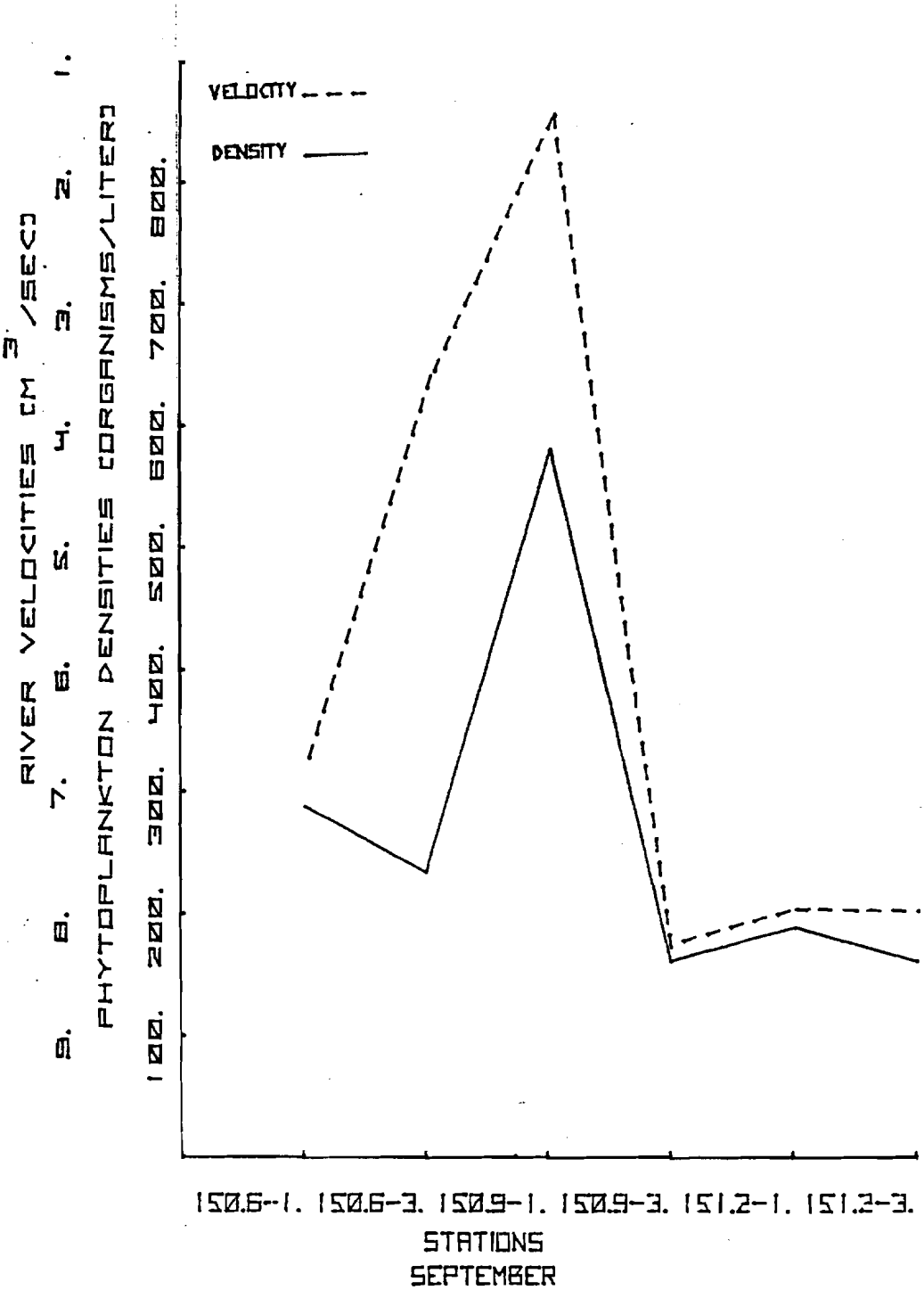
Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

PHYTOPLANKTON DENSITIES AND RIVER VELOCITIES FOR JUNE 1981

FIGURE 4

433-9



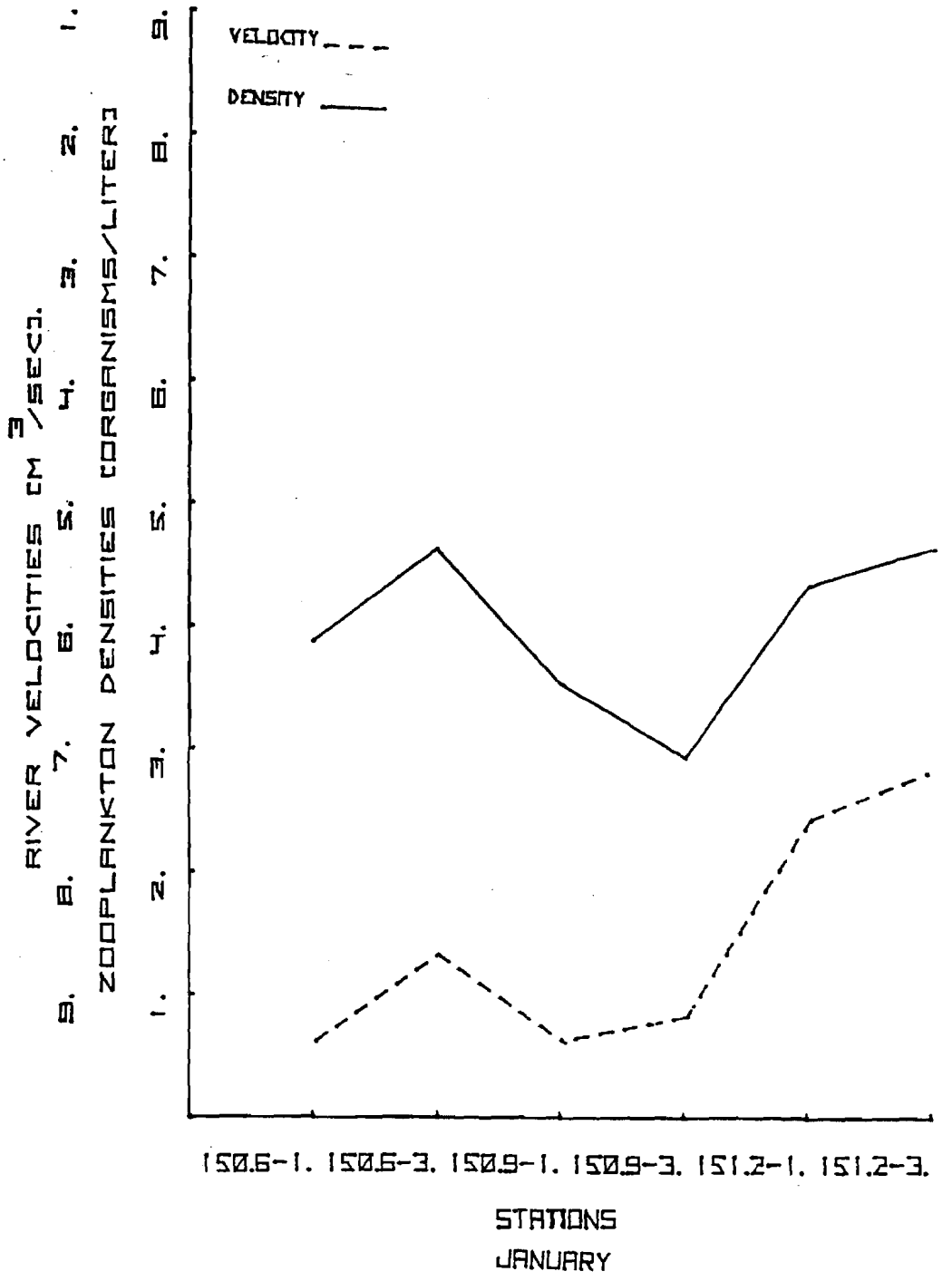
Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

PHYTOPLANKTON DENSITIES AND RIVER VELOCITIES FOR SEPTEMBER 1981

FIGURE 5

433-9



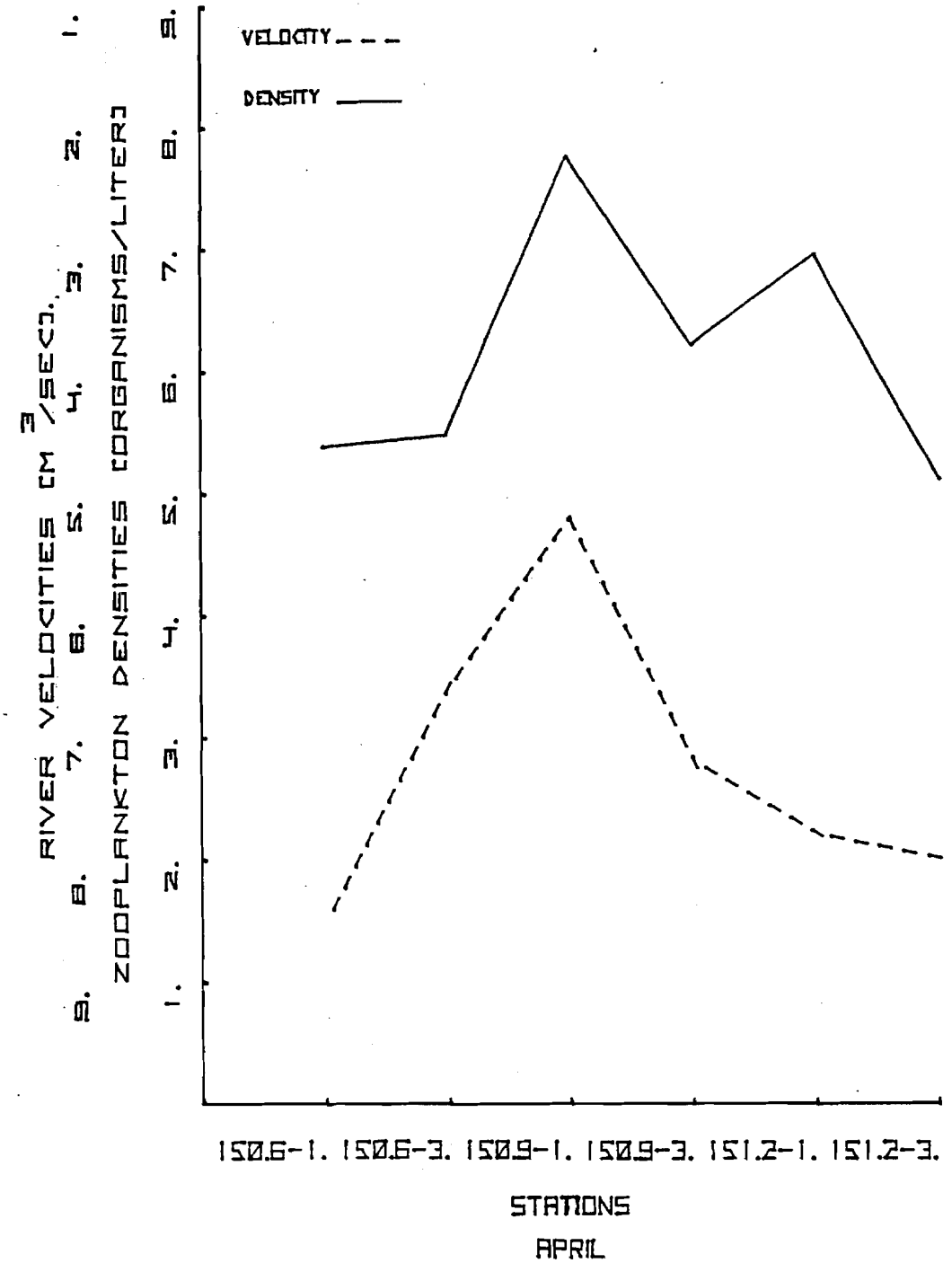
Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

ZOOPLANKTON DENSITIES AND RIVER VELOCITIES FOR JANUARY 1981

FIGURE 6

433-9



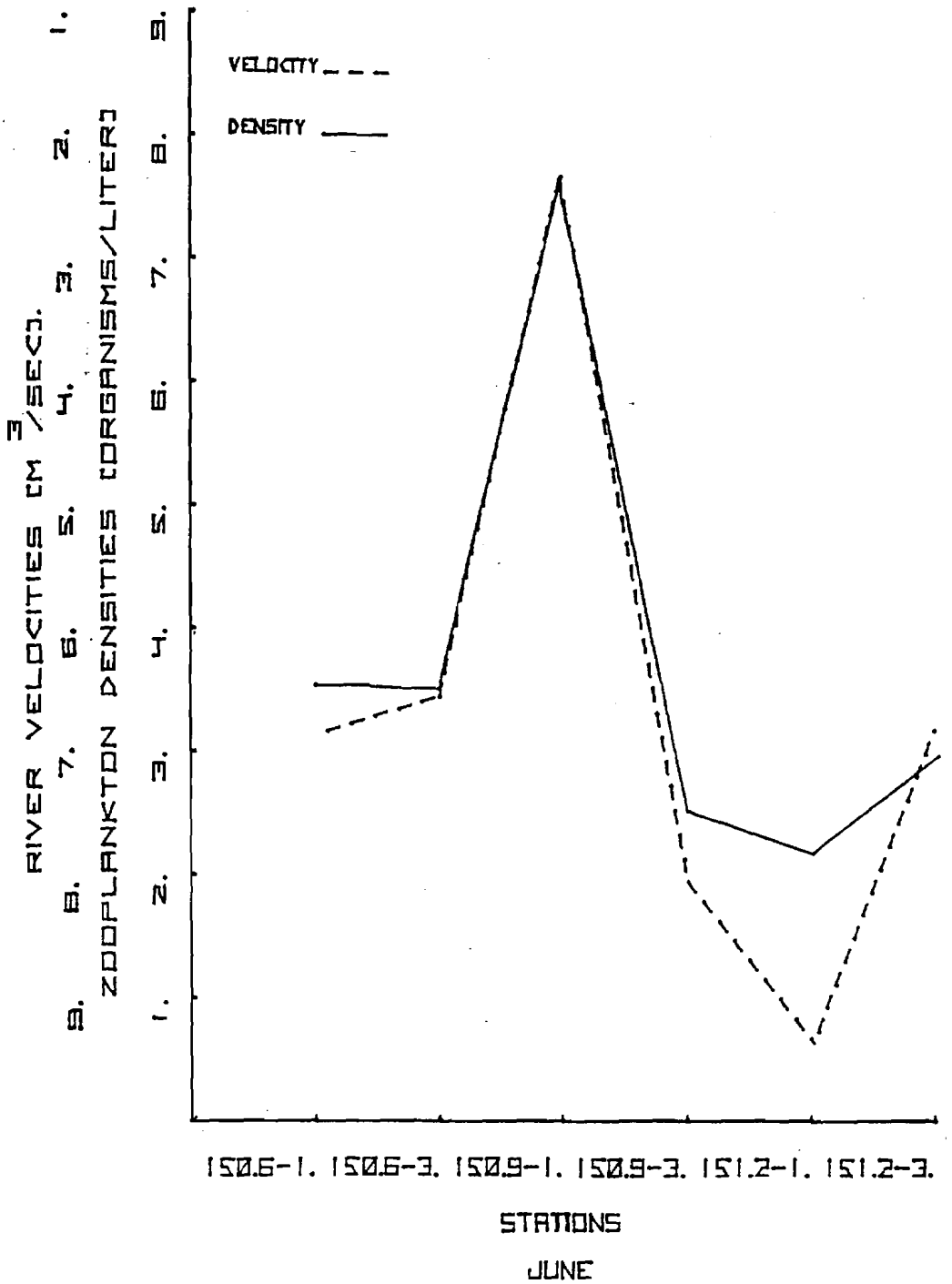
Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

ZOOPLANKTON DENSITIES AND
RIVER VELOCITIES FOR
APRIL 1981

FIGURE 7

433-9



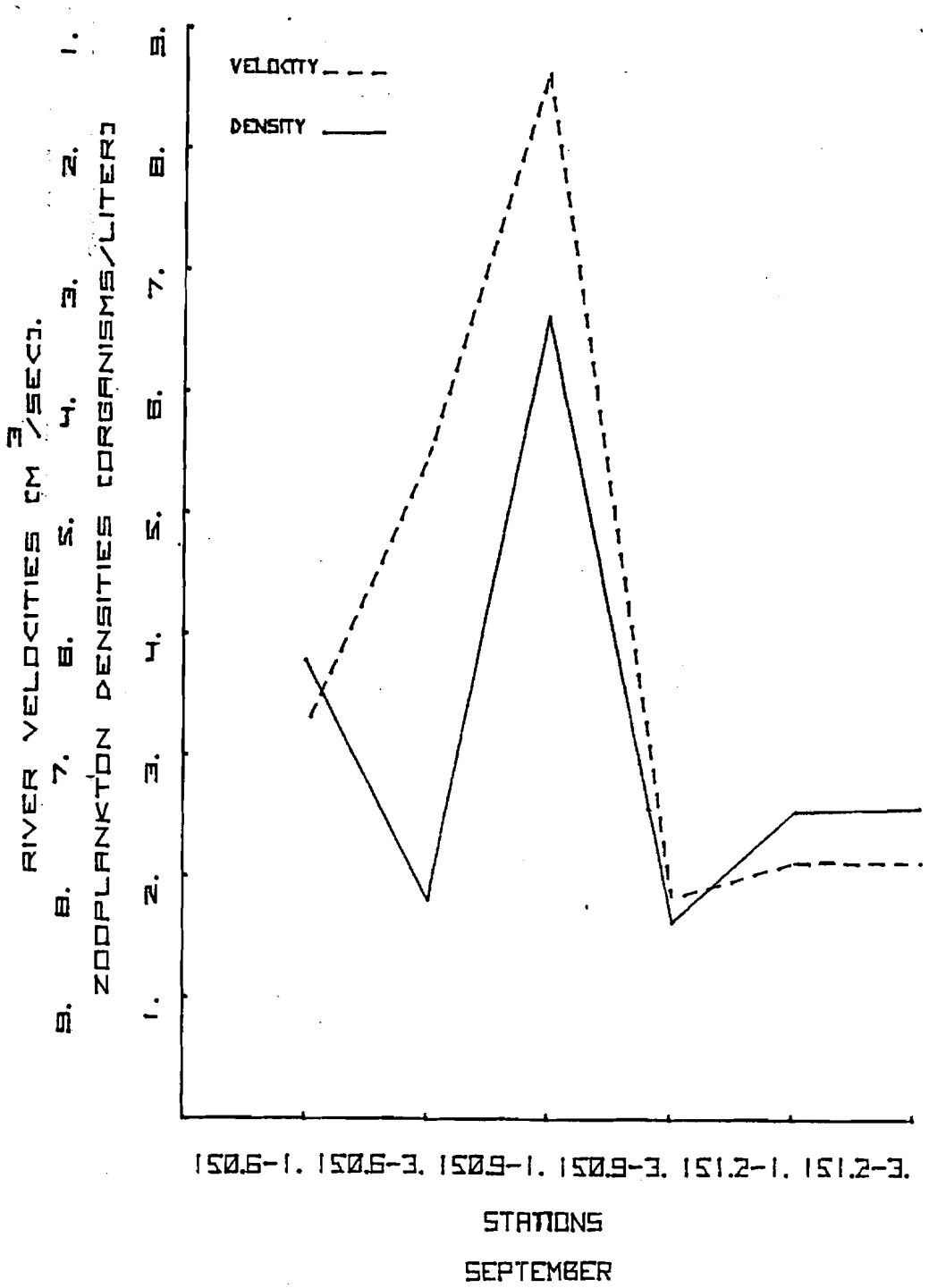
Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

ZOOPLANKTON DENSITIES AND RIVER VELOCITIES FOR JUNE 1981

FIGURE 8

433-9



Georgia Power

VOGTLE
ELECTRIC GENERATING PLANT
UNIT 1 AND UNIT 2

ZOOPLANKTON DENSITIES AND RIVER VELOCITIES FOR SEPTEMBER 1981

FIGURE 9

433-9