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WATER QUALITY CHARACTERISTICS OF THE LOWER KISSIMMEE RIVER BASIN, FLORIDA

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by

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Water Chemistry Division
RESOURCE PLANNING DEPARTMENT
South Florida Water Management District
West Palm Beach, Florida

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INTRODUCTION

The lower Kissimmee River (C-38) has received a great deal of attention in recent years, primarily as a result of its dominance of the Lake Okeechobee watershed coupled with major modifications of the river itself. Studies devoted to the river prior to 1966 were primarily concerned with evaluations into means of improving the flood control capabilities of both the Upper and Lower Kissimmee River Basins. After channelization of the river in 1971, attention has been redirected to the environmental consequences of the channelization and flood control modifications.

Selected water quality monitoring of the river, primarily for a few physical and major ionic parameters, was begun in 1954 by the United States Geological Survey (USGS). A more intensive sampling program was undertaken from 1971 to 1973 by the USGS, in cooperation with the South Florida Water Management District (SFWMD), (Lamonds 1975). In 1973 the SFWMD began a large scale long term synoptic water quality monitoring effort of the river and its tributaries. In addition, the SFWMD has conducted a broad spectrum of other environmental studies of the Kissimmee River, including an assessment of water level fluctuations in the lower Kissimmee River valley (Goodrick and Milleson 1974), environmental studies in the Chandler Slough marsh (Federico et al. 1978), and floodplain vegetation mapping (Milleson et al. 1980).

The predecessor of the Florida Department of Environmental Regulation, the Department of Pollution Control, has also conducted several studies in the Kissimmee River basin in 1974-1975 as part of the Special Project to Prevent the Eutrophication of Lake Okeechobee. These studies included water quality surveys (Federico and Brezonik 1975), limiting nutrient determinations (Jones et al. 1975), aquatic vertebrate fauna surveys (Yerger 1975), and a study of precipitation regimes (Echternacht 1975).

The purpose of this report is to document the findings of the SFWMD's aforementioned synoptic water quality monitoring program of the lower Kissimmee River. This represents the first long term comprehensive water quality study of the lower Kissimmee River which includes the C-38 channel, the major tributaries, and an assessment of pool loadings and runoff characteristics.

SUMMARY AND CONCLUSIONS

The lower Kissimmee River was sampled at 31 locations on approximately a monthly frequency from June 1973 to December 1978 for the purposes of: (1) establishing a comprehensive water quality characterization data base for C-38 and its tributaries, (2) determining the water quality effects of tributary inputs on C-38, (3) examining seasonal water quality variations in C-38 and its tributaries, (4) identifying those water quality parameters which display substantial variation within the C-38 basin, and (5) determining material loads at the water control structures.

Water chemistry and field data were collected immediately above and below the six water control structures (S-65 through S-65E) at a point approximately halfway between each structure, and at the mouth of the 15 major tributaries.

The major results obtained from this study were:

1. Phosphorus was the water quality component which displayed the greatest variation.
   (a) The mean wet season total and ortho phosphorus concentrations in the tributaries ranged from 0.026 to 0.253 mg/L and from 0.003 to 0.187 mg/L, respectively. The Pool D and E tributaries (Chandler Slough, Yates Marsh, and Maple River) had the highest phosphorus levels. Ice Cream Slough (Pool A) had the lowest levels of phosphorus.
   (b) Phosphorus concentrations in C-38 increased in a downstream direction but were usually below that found in rainfall until S-65C (Pools A, B, and C). A substantial increase in

phosphorus levels occurred downstream of S-65C as a result of Pool D and E tributary inflows. The mean total phosphorus concentration increased from 0.032 mg/L at S-65 to 0.092 mg/L at S-65E.

(c) Total nitrogen, chloride, sodium, potassium, magnesium, silica, sulfate, alkalinity, turbidity, and pH showed little net change from S-65 to S-65E especially in relation to their low levels. Inorganic nitrogen, calcium, color, and specific conductance increased slightly. Daytime dissolved oxygen concentrations decreased approximately 1 mg/L on the average from S-65 to S-65E.

(d) Five of the 15 tributaries had mean total phosphorus concentrations less than rainfall while nine had lower mean ortho phosphorus concentrations.

2. C-38 and its tributaries contained relatively soft, poorly buffered water consisting of low levels of chloride, sodium, potassium, calcium, magnesium, silica, sulfate, bicarbonate, and turbidity. Color levels were high throughout the basin. Mean daytime dissolved oxygen concentrations were usually moderately low to low during periods of flow.

3. Seasonal variations were noted for most of the water quality parameters. Phosphorus concentrations increased sharply during the beginning of the wet season. Chloride, sodium, potassium, calcium, magnesium, silica, sulfate, alkalinity, dissolved oxygen, and pH all tended to be lower during the wet season. Temporal variability in nitrogen could not be related to any consistent seasonal phenomenon.

4. There was no consistently increasing or decreasing change in any of the water quality parameters measured from 1973 to 1978.
5. The mean annual discharge for S-65E from 1974 to 1978 was 978,897 acre-feet which transported an average of 109.6 tonnes of phosphorus, 1660 tonnes of nitrogen, and 22,544 tonnes of chloride. Tributary inputs downstream of S-65 accounted for approximately 51 percent of the flow, 78 percent of the phosphorus, 44 percent of the nitrogen, and 46 percent of the chloride released past S-65E.
6. Cumulative nitrogen loads, discharge, and drainage basin area increased linearly from S-65 to S-65E while phosphorus and chloride loads increased exponentially.
7. Net runoff rates and flow weighted concentrations for total nitrogen and discharge among the five pools remained fairly constant when compared to total phosphrous and chloride which experienced a 4 to 15 fold increase in a downstream direction.
8. In general, the more intensive agricultural land use practices (especially in Pools D and E) resulted in higher phosphorus and chloride concentrations in C-38,but had little effect on the other water quality parameters.
9. During the dry season (November to April), there was little difference between the surface and bottom levels of ortho phosphorus, total phosphorus, inorganic nitrogen, total nitrogen,and organic nitrogen in the C-38 channel. However, during the wet season (May to October) the bottom concentrations of ortho phosphorus, total phosphorus,and inorganic nitrogen were substantially higher than the surface concentration. These wet season differences between surface and bottom concentrations generally decreased in a

downstream direction. Bottom levels of specific conductance, chloride, and turbidity were slightly higher than surface levels during both the wet and dry season. Dissolved oxygen concentrations were higher at the surface than at the bottom.

10. In general, the lower the flow rate the larger the gradient change with depth in specific conductance, temperature, and dissolved oxygen. At flow rates greater than 6,000 acre-feet/day the water column in C-38 was usually well mixed with respect to specific conductance, temperature, and dissolved oxygen. However, even at very low flows there were occasions when the water column was well mixed vertically.

DESCRIPTION OF STUDY AREA

History

Lake Okeechobee is the focal point of the water storage system for south Florida. The lake receives surface inflows from nine major basins (Figure 1) the largest of which is the Kissimmee River basin. The Kissimmee River basin covers approximately 5,473 sq. km (2,113 sq. mi) and stretches from the southern portion of the City of Orlando to the northwestern shore of Lake Okeechobee. Hydrologically the basin can be divided into two sections, the Upper and Lower Kissimmee River Basins. The Upper Kissimmee River Basin extends from Orlando to Lake Kissimmee (3,644 sq. km). Historically, drainage patterns in the upper basin involved local storage of runoff in a series of 14 major lakes. These major lakes and numerous smaller ones were not directly connected in their native state; however, during flood conditions their waters frequently overflowed and traveled down the series of lakes to Lake Kissimmee. The Lower Kissimmee River Basin begins at the outflow from Lake Kissimmee which serves as the origin of the Kissimmee River. Prior to 1965 the Kissimmee River meandered about 158 km (98 miles) to Lake Okeechobee (1,829 sq. km). In this natural state the Lower Kissimmee River Basin experienced cyclic flooding in a broad wetlands floodplain which reached a mile across.

Hamilton Disston was the first to alter drainage patterns in the Kissimmee basin. During the 1880's he excavated channels between the major lakes in the upper basin. Congressional Acts authorized in 1937, 1939, and 1946 directed that studies be conducted on regulating the Kissimmee River and its tributaries. In 1948, as a result of these and other studies, the Congress created the Central and Southern Florida

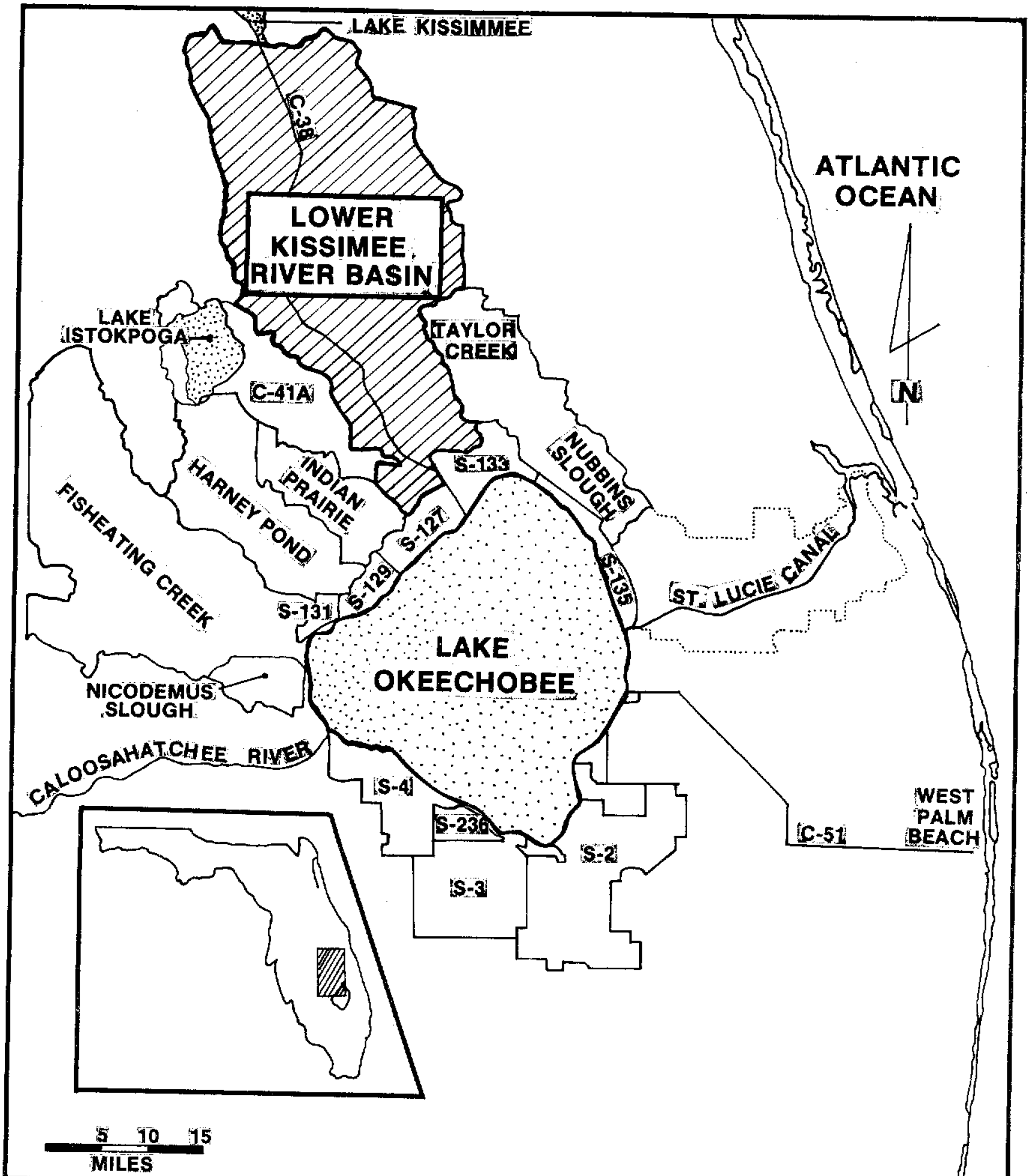


FIGURE 1. LOCATION OF THE LOWER KISSIMMEE RIVER BASIN IN THE LAKE OKEECHOBEE WATERSHED

NOTE: Areas designated by dashed lines contribute only small amounts of water at irregular intervals.

Flood Control District (FCD) in Florida. The FCD was charged with operating the Central and Southern Florida Flood Control Project (CSFFCP) as built by the U.S. Army Corps of Engineers. It was the responsibility of the FCD and the CSFFCP to provide food protection, sufficient water supply, prevent salt water intrusion, encourage agricultural and urban development, and preserve fish and wildlife. A major part of the CSFFCP was to relieve flooding in the Upper Kissimmee River Basin. This was to be accomplished by increasing flood storage in the upper basin lakes by increasing the capability of moving surplus flood waters rapidly from the basin. These objectives were accomplished by increased channelization between the major lakes in the upper basin and by construction of a channel connecting Lake Kissimmee with Lake Okeechobee. Improved channelization in the upper basin lakes began in the early 1960's, with eight water control structures and sixteen canals presently completed. The channelization of the Kissimmee River (C-38) and construction of the control structures began in 1966 and was completed in 1971. Six control structures are employed on C-38 to control water elevation in the canal and to regulate the flows originating in both the upper and lower basin. These six structures step the water down in approximately 2 m (6 foot) intervals and consequently act as dams, replacing the natural slope of the river with five flat pools arranged in stairstep fashion. The water level within each pool remains relatively uniform except that the marshes in the northern end are usually drained and the ones in the southern end are usually flooded. The five pools are named A through E with pool A being upstream of S-65A, Pool B being upstream of S-65B, etc.

Land Use

Milleson et al. (1980) have documented the vegetation communities that inhabit the present floodplain since the construction and operation of the C-38 system. Figures 2 and 3 present their conceptualized cross-sections of the Kissimmee River floodplain.

There are 15 major tributaries which discharge into C-38 (Table 1). These tributaries drain approximately 75 percent of the C-38 basin. Land use in these tributaries is presented in Table 2. In general, the land use activities intensify in a downstream direction. The upper pool tributaries are approximately equally dominated by native rangeland and improved pasture, while the lower pools (C, D, and E) are dominated completely by improved pasture. In addition, the lower pools (especially D and E) are more intensively improved, via large series of ditches, than is the improved pasture in the upper pools (Huber and Heaney, 1975). Pools D and E also contain five dairy operations.

Rainfall

Table 3 presents the average annual rainfall prior to this study and the annual rainfall during this study at five locations in the Lower Kissimmee River Basin. Based upon the existing period of record the annual rainfall from S-65 to S-65C during the study was slightly above average (2 to 29%), while at S-65D and S-65E the annual rainfall was below average (14 to 21%). On a basinwide basis this study was conducted during a period when the total annual rainfall was about equal to the average annual period of record rainfall.

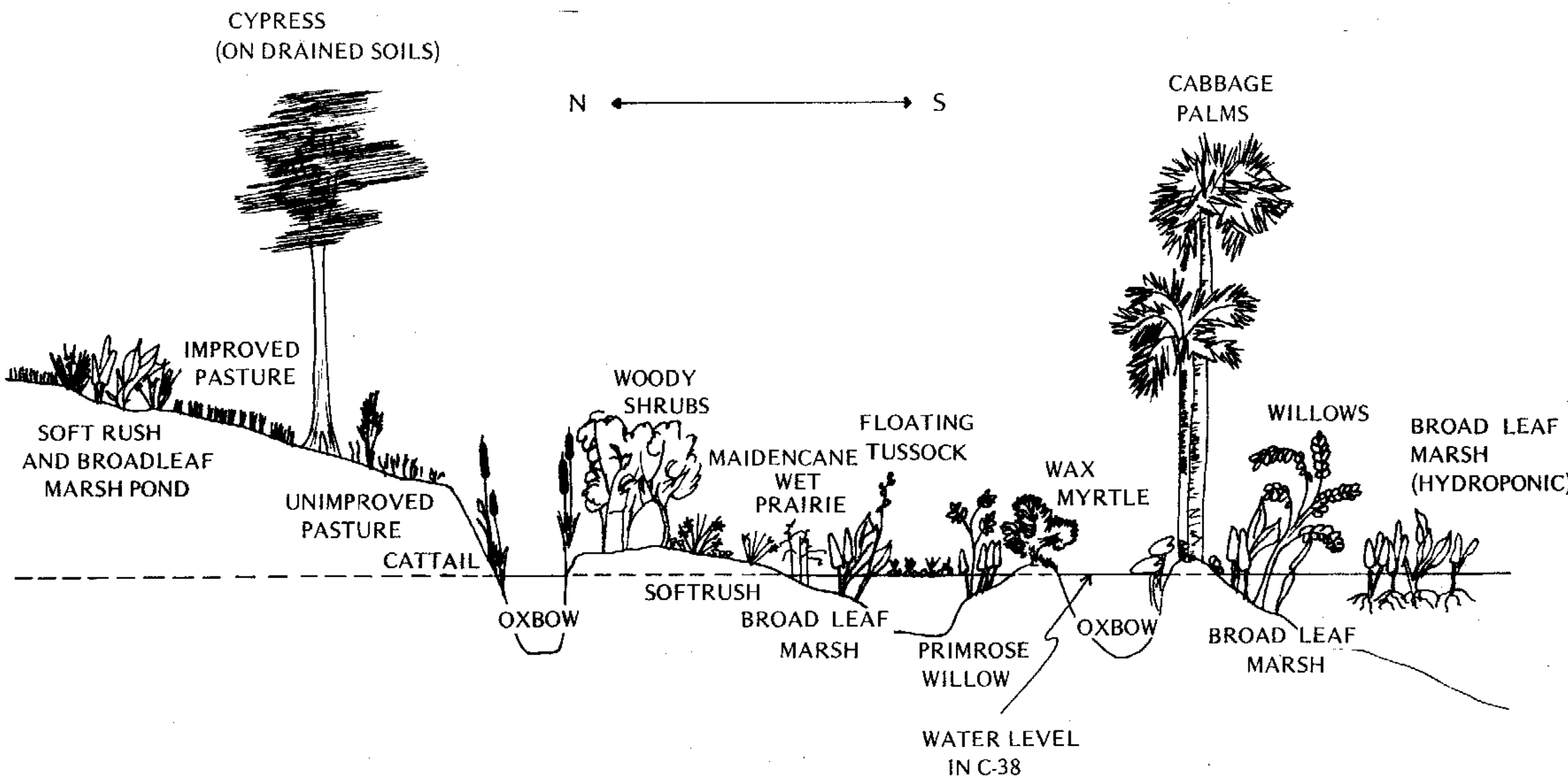


FIGURE 2: CONCEPTUAL CROSS-SECTION (NORTH TO SOUTH) THROUGH A KISSIMMEE RIVER IMPOUNDMENT (POOL), ILLUSTRATING GENERAL RELATIONSHIPS AMONG SOME OF THE PLANT COMMUNITIES AND COMMON SPECIES.

(from Milleson et al 1980)

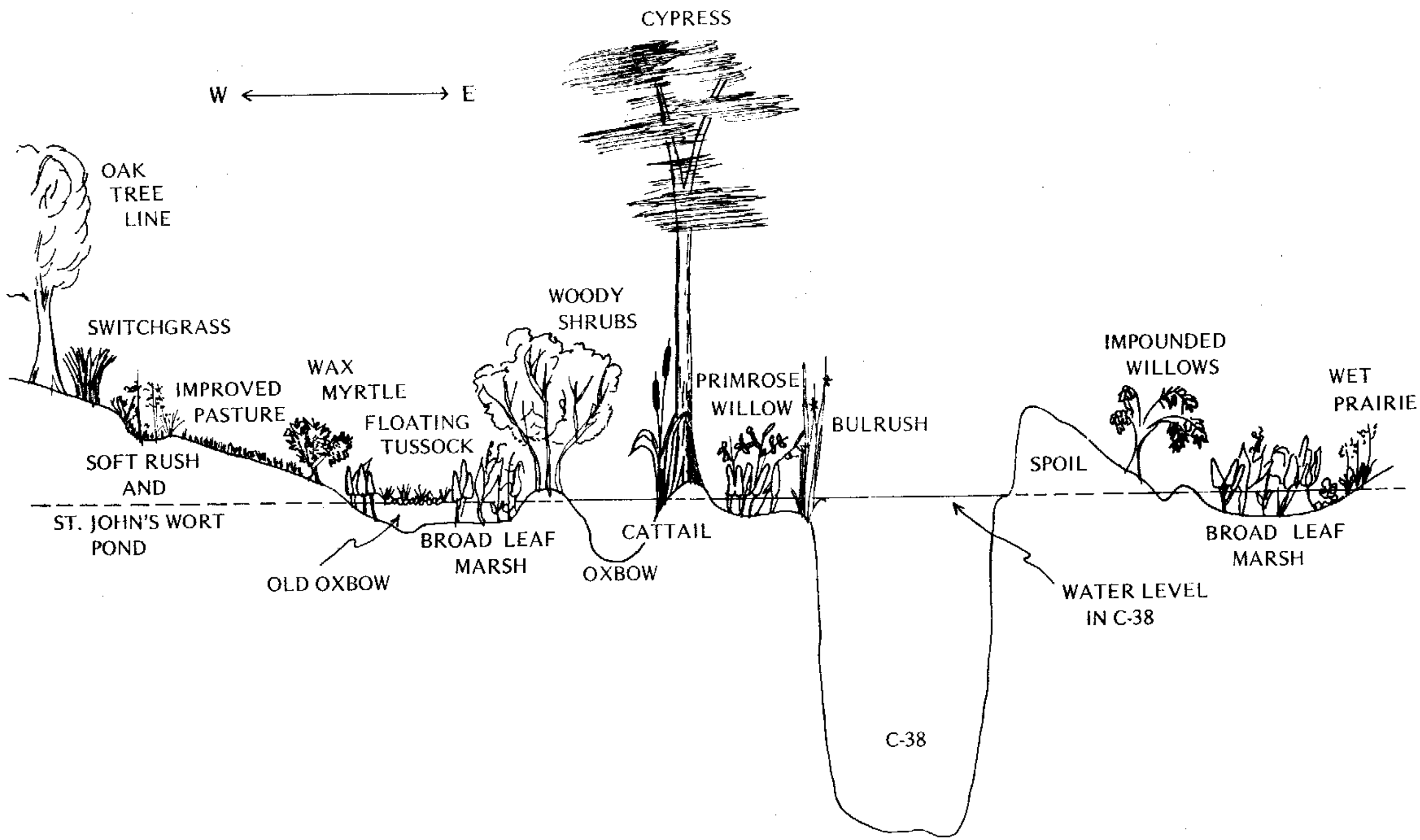


FIGURE 3: CONCEPTUAL CROSS-SECTION (WEST TO EAST) THROUGH THE KISSIMMEE RIVER FLOODPLAIN ILLUSTRATING GENERAL RELATIONSHIPS AMONG SOME OF THE PLANT COMMUNITIES AND COMMON SPECIES.

(from Milleson et al. 1980)

TABLE 1. DRAINAGE BASIN AREAS OF TRIBUTARIES TO C-38

Pool	Tributary	Drainage Area (km2)	% of Pool Drainage Area
A		447.1	100
	* Buttermilk Slough	13.0	2.9
	* Ice Cream Slough	173.5	38.8
	* Blanket Bay Slough	81.2	18.2
	* Bay Hammock	15.5	3.5
	* Skeeter Slough	20.3	4.5
	* Armstrong Slough	58.1	13.0
	* River Ranch South	12.4	2.8
	Unnamed Tributaries	73.1	16.3
B		575.1	100
	* Pine Island/Seven Mile Slough	316.2	55.
	* Duck Slough	17.2	3.0
	* Tick Island Slough	57.3	10.0
	Unnamed Tributaries	184.5	32.0
C		219.7	100
	* Starvation Slough	23.7	10.8
	* Oak Creek	53.9	24.5
	Unnamed Tributaries	142.2	64.7
D		498.9	100
	* Chandler Slough	392.6	78.7
	Unnamed Tributaries	101.8	20.3
E		171.5	100
	* Yates Marsh	115.1	67.1
	* Maple River	56.4	32.9

* indicates tributary runoff was sampled

TABLE 2. 1979 LAND USE IN THE LOWER KISSIMMEE RIVER (C-38) TRIBUTARY BASINS

Tributary	Land Use[1/] Relative Abundance
Pool A	
Buttermilk Slough	Agriculture >> Rangeland > Swamp
Ice Cream Slough	Rangeland >> Forest > Agriculture ≅ Wetlands
Blanket Bay Slough	Agriculture > Rangeland > Wetland
Bay Hammock Slough	Agriculture >> Wetland
Skeeter Slough	Agriculture >> Rangeland
Armstrong Slough	Agriculture >> Rangeland > Wetland
River Ranch South	Rangeland >> Agriculture Urban > Forest
Pool B	
Pine Island/Seven Mile Slough	Rangeland >> Wetland > Agriculture
Duck Slough	Rangeland >> Wetland
Tick Island Slough	Rangeland >> Wetland > Forest > Agriculture
Pool C	
Starvation Slough	Agriculture > Wetland > Rangeland > Forest
Oak Creek	Agriculture[2/] ≅ Rangeland > Wetland
Pool D	
Chandler Slough	Agriculture[2/] >> Urban > Wetland > Rangeland
Pool E	
Yates Marsh	Agriculture >> Rangeland > Wetland > Forest > Urban
Maple River	Agriculture[2/] >> Wetlands > Rangeland

[1/] Prepared by U.S. Army Corps of Engineers by Booz-Allen and Hamilton, Inc. and Earth Satellite Corp. (1980)

[2/] Includes one dairy operation

[3/] Includes two dairy operations

TABLE 3. COMPARISON OF STUDY PERIOD RAINFALL TO PERIOD OF RECORD

	Period of Record		This Study - Total Annual Rainfall						Study Period	
	Time Period	Avg. Annual Rainfall	1973	1974	1975	1976	1977	1978	Annual Avg. (1973-78)	% Difference
S-65	1965-72	45.8	53.4	71.5	33.1	53.0	31.3	53.4	59.3	29%
S-65A	1965-72	41.4	54.6	52.1	45.9	51.0	35.2	58.3	47.7	15%
S-65C	1966-72	46.2	47.4	32.6	43.4	54.3	44.3	-	47.3	2%
S-65D	1965-72	45.5	49.7	42.0	32.9	37.0	30.4	37.7	36.0	-21%
S-65E	1974-72	47.2	53.4	47.4	37.0	33.7	36.6	36.7	40.8	-14%
	Avg.	45.2							46.2	2%

Units: in inches

PROGRAM DESIGN AND OBJECTIVES

Purpose and Scope

The lower Kissimmee River/C-38 sampling program was designed as a long term synoptic monitoring effort which was conducted from June 1973 through December 1978. The sampling program had two main objectives:

1. Monitor the quality of the major tributary inflows to C-38.
2. Monitor the quality of water along the length of C-38.

The data generated by this sampling program was used to:

1. Establish a comprehensive water quality characterization data base for C-38 and its tributaries.
2. Determine the water quality effects of tributary inputs on C-38.
3. Examine seasonal variation in water quality parameters in C-38 and its tributaries.
4. Identify those water quality parameters which displayed substantial variation within the C-38 basin.
5. Determine water control structure and pool material loads.

The area, scope, and sampling frequency of the program varied during the study; however, the aforementioned objectives remained consistent. The 15 major inflows to C-38 were monitored at the mouth of the tributaries. The location of the tributary stations are shown in Figure 4. The monitoring of C-38 was conducted by establishing sampling stations immediately above and below the six water control structures and at a point approximately midway between each structure (Figure 5). All the stations in this study were sampled on an approximately monthly frequency (Table 4).

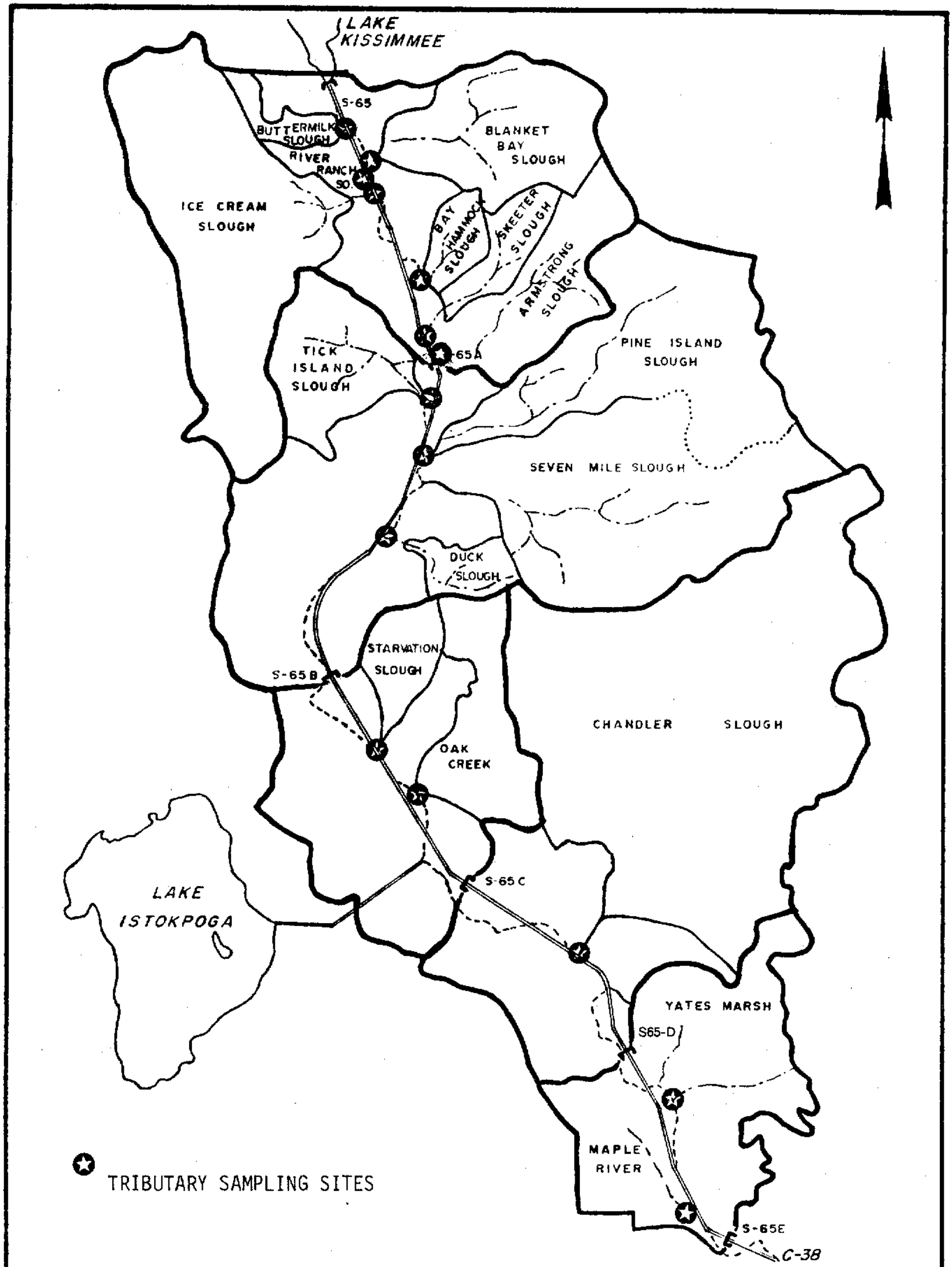


FIGURE 4 LOCATION OF LOWER KISSIMMEE RIVER (C-38) TRIBUTARY SAMPLING SITES

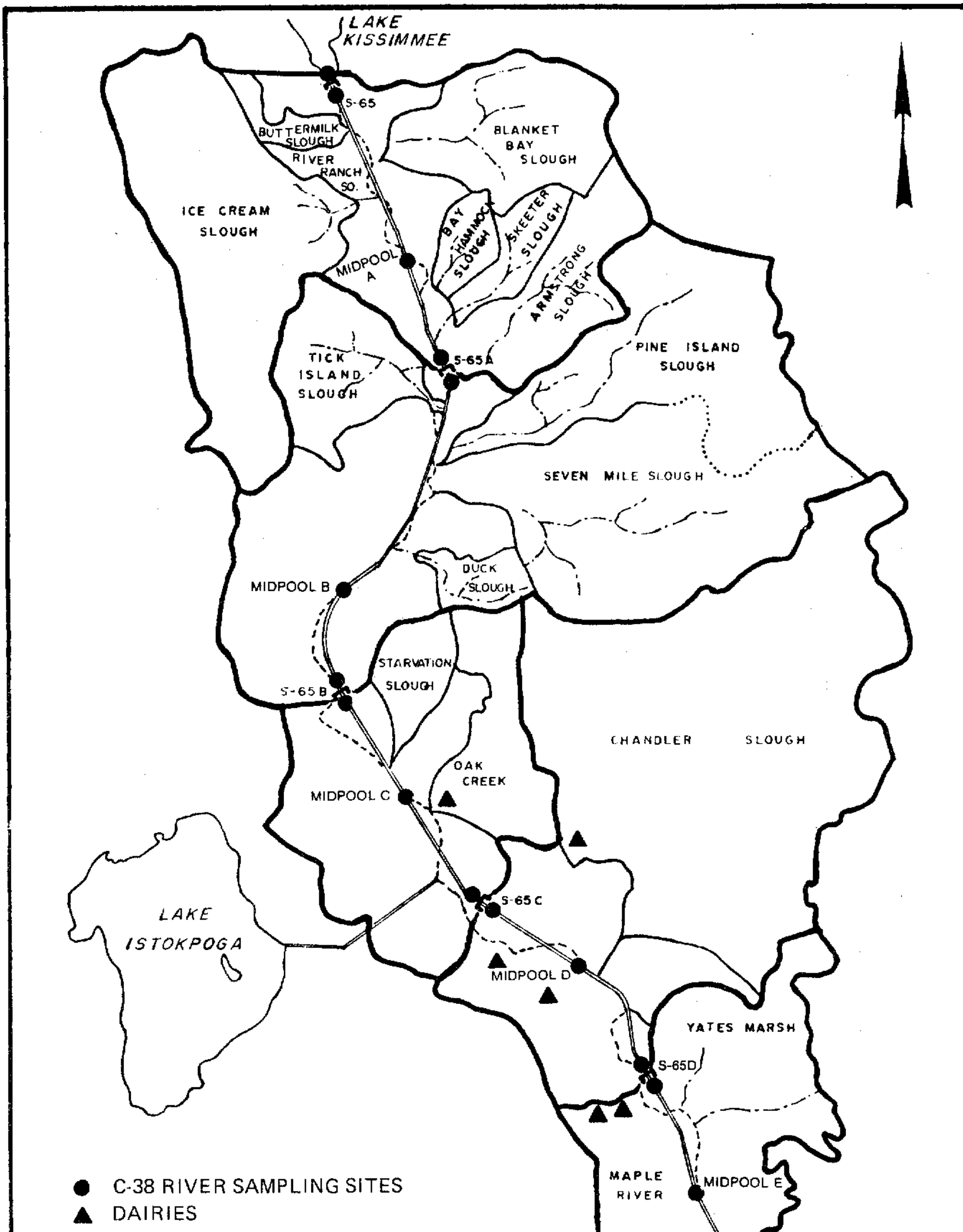


FIGURE 5 LOCATION OF C-38 RIVER SAMPLING SITES

TABLE 4. GRAB SAMPLING REGIME FOR THE LOWER KISSIMMEE RIVER VALLEY

	1973							1974												1975											
	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Buttermilk Slough				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Ice Cream Slough				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Blanket Bay Slough				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Bay Hammock Slough				X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Skeeter Slough				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Armstrong Slough					X	X	X	X	X	X	X	X	X	X	X	X	X	X													
River Ranch South						X	X	X	X	X	X	X	X	X	X	X	X	X							X	X	X	X	X		
Pine Island/Seven Mile Sl	X		X	X	X								X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Duck Slough				X	X			X	X	X	X	X	X	X	X	X	X	X													
Tick Island Slough				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Starvation Slough					X	X	X	X	X	X	X	X	X	X	X	X	X														
Oak Creek						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		
Chandler Slough				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Yates Marsh					X	X	X	X	X	X	X	X	X	X	X	X	X	X													
Maple River	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X													
C-38*	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		

*includes S65, S65A, S65B, S65C, S65D, S65E
Midpool A, B, C, D, E

X = denotes sample collection

TABLE 4. (CONTINUED)

	1976												1977												1978											
	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Buttermilk Slough		X			X	X	X	X	X	X		X	X		X		X		X	X	X		X		X		X		X	X	X	X	X	X	X	X
Ice Cream Slough		X			X	X	X	X	X	X		X	X		X		X		X		X		X		X		X		X	X	X	X	X	X	X	X
Blanket Bay Sl		X			X	X	X	X	X	X		X	X						X	X	X		X		X		X		X	X	X	X	X	X	X	X
Bay Hammock Sl		X			X	X	X	X	X	X		X	X						X		X		X		X		X		X	X	X	X	X	X	X	X
Skeeter Slough		X			X	X	X	X	X	X		X	X				X		X		X		X		X		X		X	X	X	X	X	X	X	X
Armstrong Slough																																				
River Ranch So.		X			X	X	X	X	X	X		X	X				X		X		X		X		X		X		X	X	X	X	X	X	X	X
Pine Island/ Seven Mile Sl		X			X	X	X	X	X	X		X	X		X		X		X		X		X		X		X		X	X	X	X	X	X	X	X
Duck Slough																																				
Tick Island Sl		X			X	X	X	X	X	X		X	X		X		X		X		X		X		X		X		X	X	X	X	X	X	X	X
Starvation Sl						X	X	X	X	X		X	X		X		X		X		X			X	X				X	X	X	X	X	X	X	
Oak Creek		X						X	X	X		X	X				X		X		X			X	X		X		X	X	X	X	X	X	X	
Chandler Sl		X			X	X	X	X	X	X		X	X		X		X		X		X		X		X		X			X	X	X	X	X	X	X
Yates Marsh																																				
Maple River					X	X	X	X	X	X		X	X		X		X		X		X			X			X		X	X	X	X	X	X	X	X
C-38*		X			X	X	X	X	X	X		X	X						X		X		X		X		X		X	X	X	X	X	X	X	X

*includes S65, S65A, S65B, S65C, S65D, S65E,
Midpool A, B, C, D, E

Sampling and Analytical Methods

Water samples were collected using a 2.2 liter PVC Niskin type sampler. Tributary samples were collected at the surface (0.5 m). Stations located immediately upstream and downstream of the six water control structures were sampled at 2.0 m. The five mid-pool stations were sampled at 2.0 m and at one meter above the bottom. Those samples collected for dissolved nutrients and major ion analysis were filtered in the field through a 0.45 micron Nucleopore$^{(R)}$ membrane filter. Unfiltered aliquots were collected for total nutrient analysis. All samples were stored in polyethylene bottles, on ice in the dark, until they were transported back to the laboratory. In the laboratory the samples were kept at 4°C, in the dark, prior to analysis. Analyses for routine water quality parameters commenced within one week of sample collection.

Laboratory analysis of the water samples included the following parameter groups:

1. General characteristics: color, turbidity, and total and dissolved organic carbon
2. Nutrients: nitrite, nitrate, ammonia, total Kjeldahl nitrogen, ortho phosphorus, total phosphorus, and silica.
3. Major ions: Na^+, K^+, Ca^{++}, Mg^{++}, Cl^-, $SO_4^=$, and alkalinity (primarily HCO_3^- and $CO_3^=$)

The analytical chemistry methods used in this study were either recommended or approved by the Environmental Protection Agency or the American Public Health Association (Table 5).

Field data (dissolved oxygen, temperature, specific conductivity, and pH) were collected simultaneously with the water samples at 2.0 m intervals using a Hydrolab Surveyor II$^{(R)}$.

TABLE 5. ANALYTICAL METHODS

AutoAnalyzer II Method

Determination	Method	Range	Sensitivity	Detection Limit
Alkalinity	Colorimetric Automated Methyl Orange, Technicon AA II Method #111-71W, modified EPA Method #310.2	0-5.0 meq/l	0.1 meq/l	0.1 meq/l
Ammonia	Colorimetric Automated Phenate, Technicon AA II Method #154-71W, modified EPA Method #350.1	0-0.50 mg/l	0.01 mg/l	0.01 mg/l
Chloride	Colorimetric Automated Ferricyanide, Technicon AA II Method #99-70W, modified EPA Method, #325.2	0-200.0 mg/l	2.0 mg/l	4.0 mg/l
Nitrite	Colorimetric Automated Diazotization with Sulfanilamide and coupling with N- (1 naphthyl) ethylenediamine dihydrochloride, Technicon colorimetric, automated AA II Method #120-70W, modified EPA Method #353.2	0-0.200 mg/l	0.002 mg/l	0.004 mg/l
Nitrate	Same as nitrite with Cadmium Reduction Column. Technicon AA II Method #100-70W, modified EPA Method #353.2	0-0.200 mg/l	0.002 mg/l	0.004 mg/l
Total Kjeldahl Nitrogen	Colorimetric, Semi-automated Block Digestor, Technicon AA II Method #376-75W, 334-74A, modified EPA Method #351.2	0-10.0 mg/l	0.1 mg/l	0.20 mg/l
Ortho Phosphate	Colorimetric, Automated, Phosphomolybdenum Blue Complex with Ascorbic Acid Reduction, Technicon AA II Method #155-71W, modified EPA Method #365.1	0-0.10 mg/l	0.001 mg/l	0.002 mg/l
Total Phosphate	Colorimetric, Semi-automated Persulfate Digestion followed by same method as Ortho Phosphate Technicon AA II Method #155-71W, modified EPA Method #365.1	0-0.10 mg/l	0.001 mg/l	0.002 mg/l

Table 5 (Continued)

Determination	Method	Range	Sensitivity	Detection Limit
Silicates	Colorimetric, Automated Ascorbic Acid Reduction of Silicomolybdate Complex, Technicon AA II Method #105-71W	0-20.0 mg/l	0.20 mg/l	0.40 mg/l
Sulfate	Colorimetric, Automated Methylthymol Blue, Technicon AA II Method #118-71W, modified EPA Method #375.2	0-250.0 mg/l	5.0 mg/l	5.0 mg/l
Total Iron	Colorimetric, Semi-automated, Hydrochloric Acid Digestion modified Standard Methods 13th Ed., pp 192, 1971, followed by Total Dissolved Iron Determination	0-1.0 mg/l	0.02 mg/l	0.02 mg/l

Physical Parameters

Determination	Method	Range	Detection Range
Turbidity	Nephelometric, Standard Methods #214A, 14th Ed., pp 132, 1975, EPA Method #180.1	0-1,000 N.T.U.	2% of scale used
Color	Colorimetric, modified Standard Method #204A, 14th Ed., pp 64, 1975 (modified as per N.C.A.S.I. Technical Bulletin #253) modified EPA Method #110.2	0-500 mg/l as platinum in platinum-cobalt solution	1.0 mg/l

Metals - Major Cation

Atomic Abosrption

Determination	Method	Range	Detection Range
Sodium	Atomic Absorption Direct Aspiration with Dual Capillary System (DCS), EPA Method #273.1	0-150 mg/l	As calculated from absorbance
Potassium	Atomic Absorption Direct Aspiration with Dual Capillary System (DCS), EPA Method #258.1	0-10 mg/l	As calculated from absorbance

Table 5 (Continued)

Atomic Absorption (Continued)

Determination	Method	Range	Detection Range
Calcium	Atomic Absorption Direct Aspiration with Dual Capillary System (DCS), Samples are treated with LA_2O_3/HCl with DCS, EPA Method #215.1	0-150 mg/l	As calculated from absorbance
Magnesium	Atomic Absorption Direct Aspiration with Dual Capillary System (DCS), Same Treatment as calcium, EPA Method #242.1	0-40 mg/l	As calculated from absorbance

Evaluation Methodology

The data gathered during this 5½ year monitoring study will be evaluated in four sections. As a general guide, only those parameters which displayed substantial variations between stations or distinct seasonal trends will be emphasized. The first section will present and discuss the water quality data collected for the tributaries. Included will be a discussion of seasonal trends and qualitative land use influences. The second section will present and discuss the water quality along the main C-38 channel, including surface and bottom comparisons. The influence of tributary inputs will be qualitatively evaluated as they affect the receiving waters of C-38. Seasonal trends will also be discussed. The third section will address material loadings at each of the six water control structures. The fourth section will compare the data collected from this study with published historical data collected along the lower Kissimmee River.

Mean values and ranges presented in the discussion of tributary water quality and its impact on C-38, along with the water quality characterization of C-38, were calculated using "wet season" data only. For purposes of this report the "wet season" is defined as May 1 through October 31. The majority of the rainfall occurs during this period as evidenced by the rainfall patterns displayed in Figures 6 through 10. This in turn causes and accounts for the vast majority of the flow in both the tributaries and C-38. Approximately 75 percent of the total annual flow at the six water control structures occurs during this wet season period. During the remaining dry months, there is essentially no tributary flow and only minimal flow past the six water control structures along C-38. When the tributaries are not flowing, the tributary samples collected represent only the backwaters

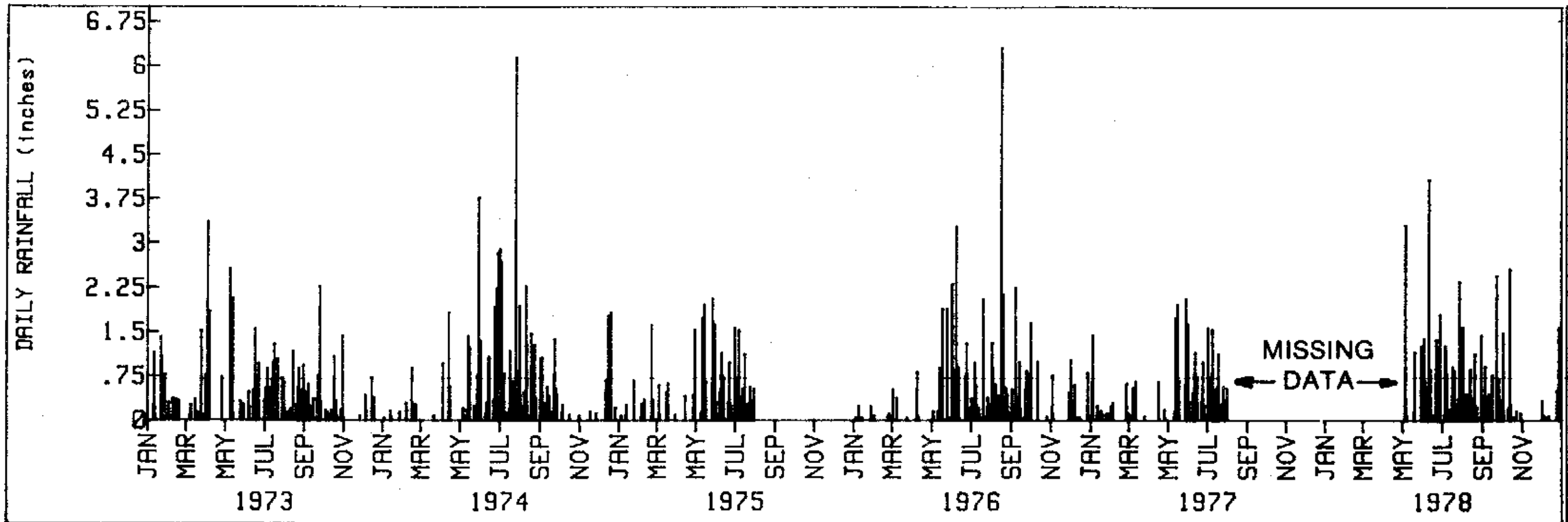


FIGURE 6 DAILY RAINFALL AT S-65

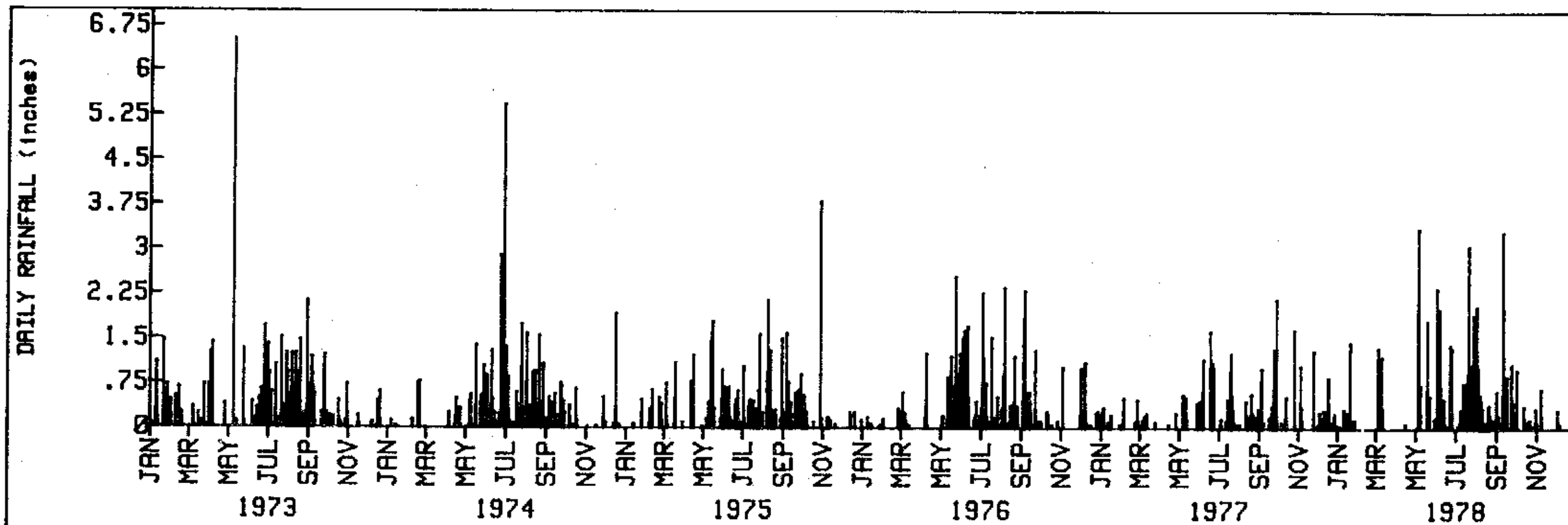


FIGURE 7 DAILY RAINFALL AT S-65A

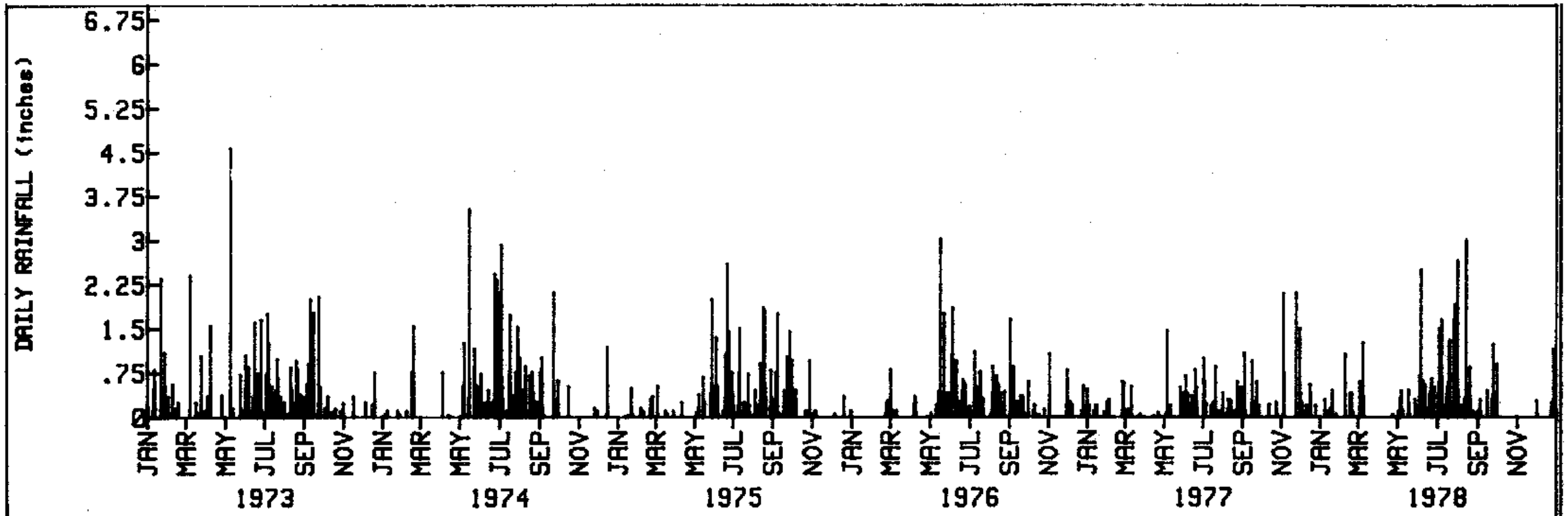


FIGURE 8 DAILY RAINFALL AT S-65B

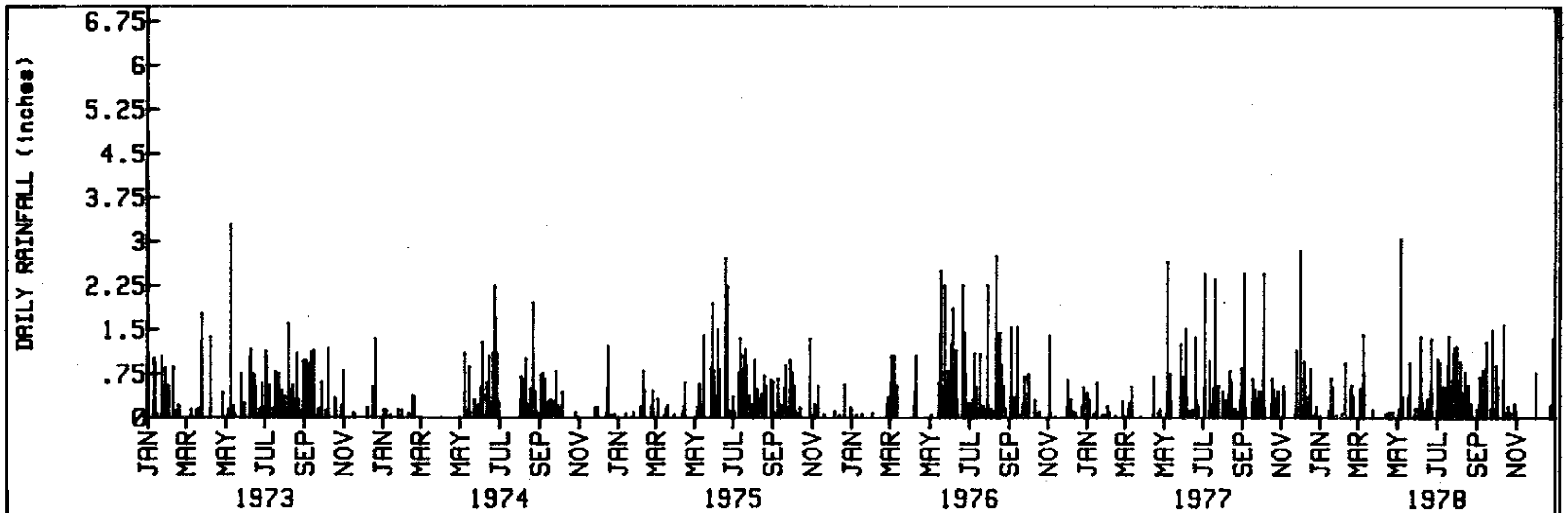


FIGURE 9 DAILY RAINFALL AT S-65C

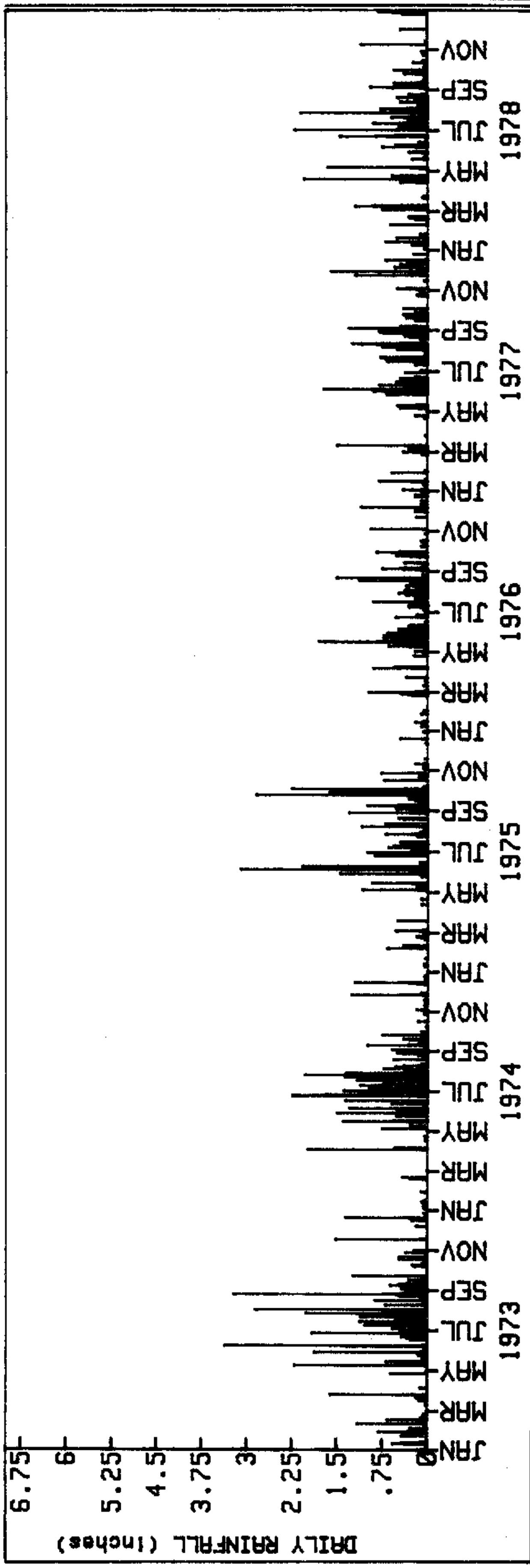


FIGURE 10 DAILY RAINFALL AT S-65E

of C-38 and are not representative of the tributary's quality. The wet season data, therefore, represents the quality of water in the lower Kissimmee River valley when the system is most "active".

Rainwater Quality Collection Methodology

The quality of rainfall in the C-38 basin was measured by using a bulk precipitation collector located near the City of Okeechobee, Florida. The rainwater collection apparatus consisted of a 20 cm funnel covered by a screen (1 mm mesh). The collection vessel was a 1 liter bottle. A crown was placed around the edge of the screen in order to reduce perching and subsequent contamination by bird droppings. All of the collection equipment was constructed of plastic except for the housing which was constructed of wood. The collector was mounted 1 m above ground level, in the open, in order to prevent ground splash and drip contamination. The rainwater collector was serviced daily during weekdays. Daily samples (if any) were frozen into biweekly composites.

TRIBUTARY WATER QUALITY CHARACTERISTICS

The foregoing section entitled, "Program Design and Objectives" outlines the sampling regime and parametric coverage for the 15 major sloughs which are tributary to C-38. Summary tables (mean, minimum, maximum, and standard deviation) of wet and dry season water chemistry data for each tributary are presented in Appendices A and B. The raw data is available upon request. This section will focus on a discussion of seasonal trends and on the major similarities and differences in water quality between the tributaries. Seasonal fluctuations were noted, to varying degress, for most of the water quality parameters. Selected time series graphs are presented in this section. Graphs for all tributaries are located in Appendix C. Phosphorus variations displayed the most distinct seasonal pattern. Peaks in phosphorus concentrations were usually measured at the beginning of the wet season as part of a "first flush" phenomenon (Figures 11 and 12, also Figure C-1 in Appendix C). The initial rains at the beginning of the wet season flush out the previous season's growth which decayed and mineralized during the winter (Federico et al, 1978). The magnitude of the increase in phosphorus levels associated with the peaks varied substantially with the relative variation being greatest in the tributaries with the highest phosphorus concentrations. Generally, the Pool D and E tributaries (Chandler Slough, Yates Marsh, and Maple River) displayed the largest variation and most distinct seasonal trend with peaks ranging above 0.5 mg/L. Ice Cream Slough (Pool A) had the smallest variation in phosphorus concentrations and displayed virtually no seasonal trend.

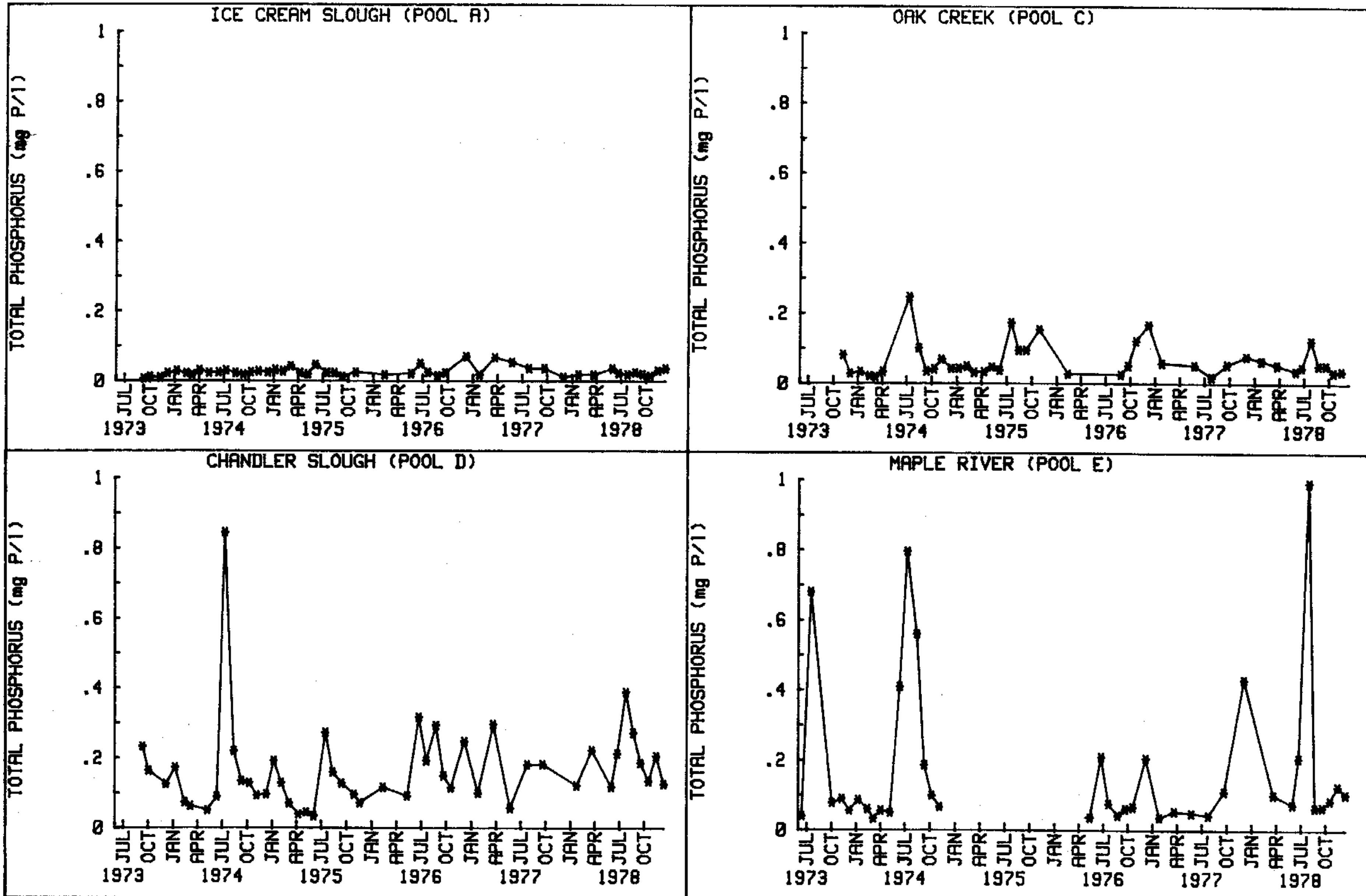


FIGURE 11 TOTAL PHOSPHORUS VERSUS TIME FOR SELECTED C-38 TRIBUTARIES

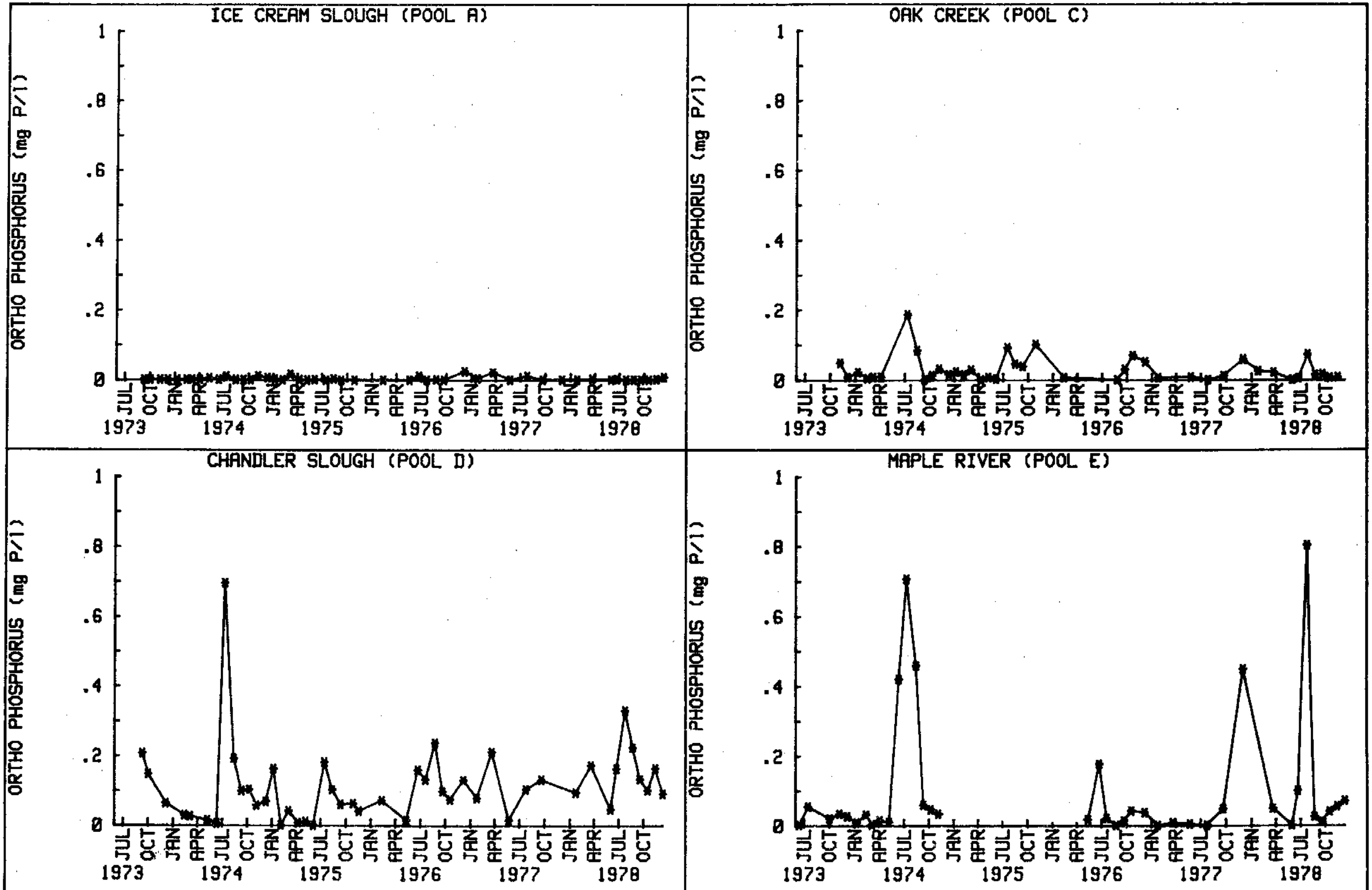


FIGURE 12 ORTHO PHOSPHORUS VERSUS TIME FOR SELECTED C-38 TRIBUTARIES

Daytime dissolved oxygen also displayed distinct seasonal fluctuations (Figure 13 and Figure C-2 in Appendix C). The low values occurred during the wet season (May to October) and were usually less than 2 mg/L, while the high values occurred during the dry season and were usually greater than 7 mg/L. The range and degree of fluctuations were fairly consistent among all tributaries.

The major cations and anions displayed only small seasonal variations. The seasonal variation in chloride (Figure 14 and Figure C-3 in Appendix C) was representative of the other cations and anions. In general, the lower chloride concentrations occurred during the wet season. This relationship was in response to the diluting effect of low ionic strength rainwater (Table 6). The direct effect of rainwater on tributary water quality was evident in the pH. The pH of rainfall is generally considered to be acidic (Brezonik et al. 1980). In response to acidic rainfall, the tributary pH is lower during the wet season than during the dry season (Figure 15 and Figure C-4 in Appendix C). Noticeable changes in the pH on a seasonal basis is indicative of the low buffering capacity of many of the tributaries (Figure 15) and Figure C-4 in Appendix C (mean alkalinity ranged from 0.2 to 0.7 meq/L). There were no seasonal trends evident for nitrogen (Figure C-5 and C-6 in Appendix C).

Since there were differences between wet and dry season concentrations, and since the wet season (May through October) was more representative of tributary water quality due to larger tributary flows, further comparisons of tributary quality will be based on wet season data only.

Table 7 presents a ranked comparison of selected mean wet season water quality characteristics for the C-38 tributaries. The ranking was based upon phosphorus because the mean total and ortho phosphorus

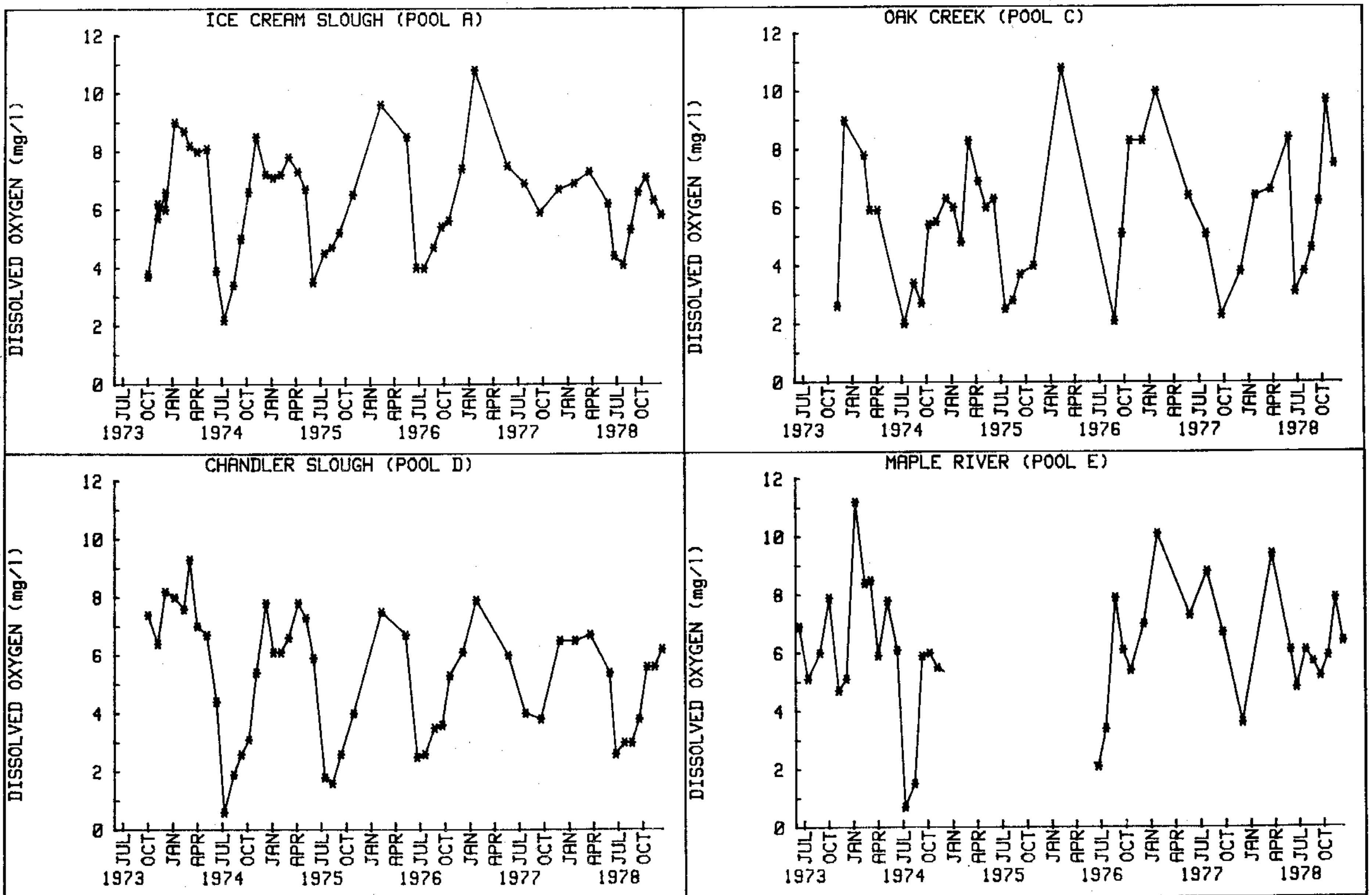


FIGURE 13 DISSOLVED OXYGEN VERSUS TIME FOR SELECTED C-38 TRIBUTARIES

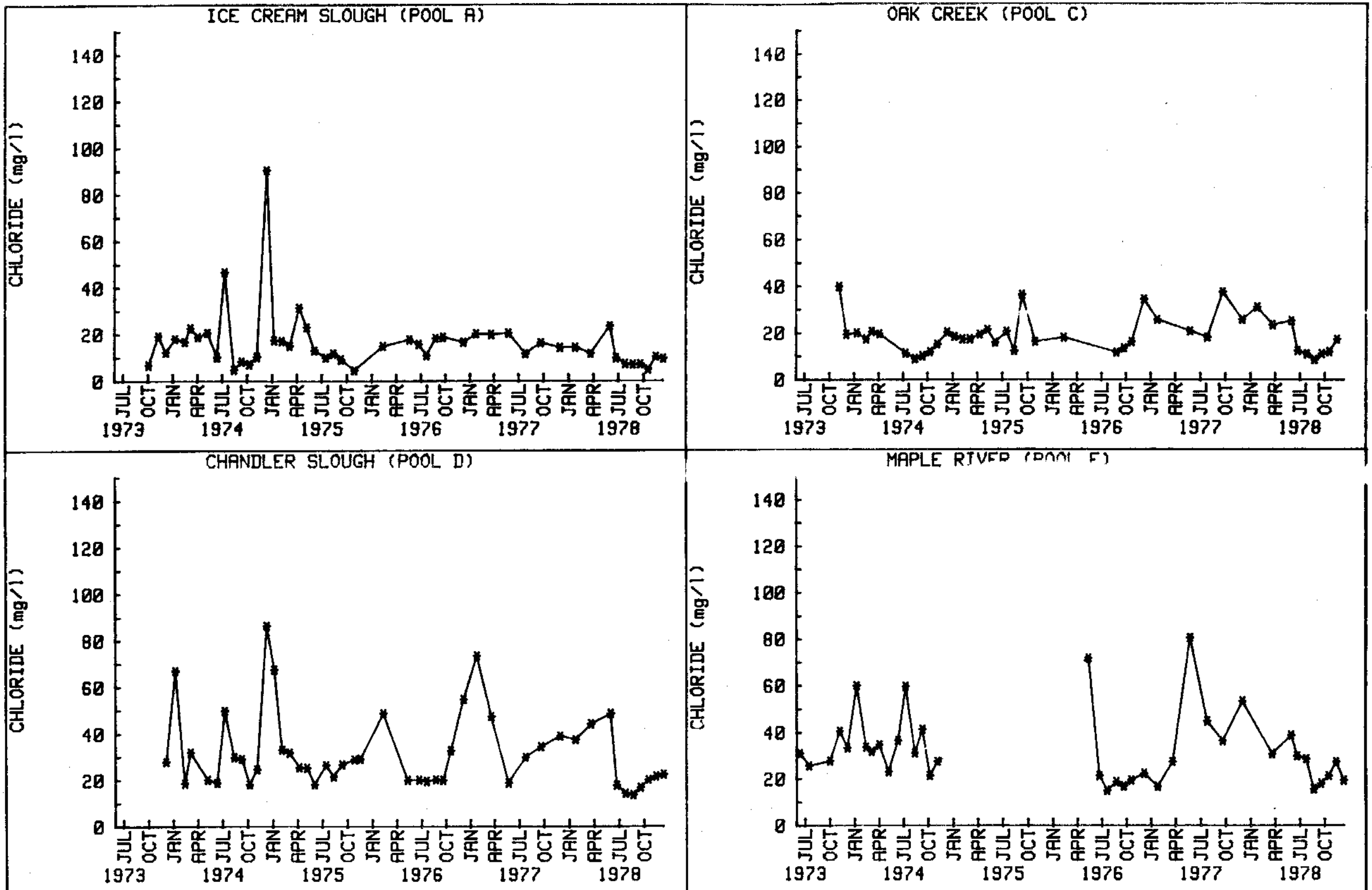


FIGURE 14 CHLORIDE VERSUS TIME FOR SELECTED C-38 TRIBUTARIES

TABLE 6. SUMMARY OF SELECTED WATER CHEMISTRY PARAMETERS FOR RAINFALL*

Parameter**	Number of Samples	Mean	Min.	Max.	Std. Dev.
Ortho-P	62	0.045	0.002	0.277	0.061
Total P	57	0.064	0.005	0.343	0.082
NO_2	65	0.008	0.004	0.173	0.022
NO_3	65	0.258	0.057	0.658	0.144
NH_4	62	0.34	0.03	2.62	0.40
TKN	48	0.82	0.13	2.70	0.56
Total N	47	1.08	0.21	3.06	0.60
Na	64	2.12	0.08	6.31	1.29
K	64	0.46	0.08	2.30	0.50
Ca	41	2.66	0.24	4.01	2.66
Mg	35	0.75	0.20	0.97	0.18
Cl	32	4.6	4.0	8.7	
SO_4	31	7.4	5.0	17.0	2.7
Alkalinity (meq/L)	36	0.15	0.07	1.43	0.23
Hardness (as $CaCO_3$)	35	9.5	3.0	12.6	2.6
Total Fe	28	0.06	0.02	0.43	0.08
Total Diss. Fe	56	0.03	0.02	0.08	0.01

* Period of record: November 1974 - October 1978

Collection site: SFWMD Okeechobee Field Station located near Okeechobee City, Florida

** mg/L unless otherwise indicated.

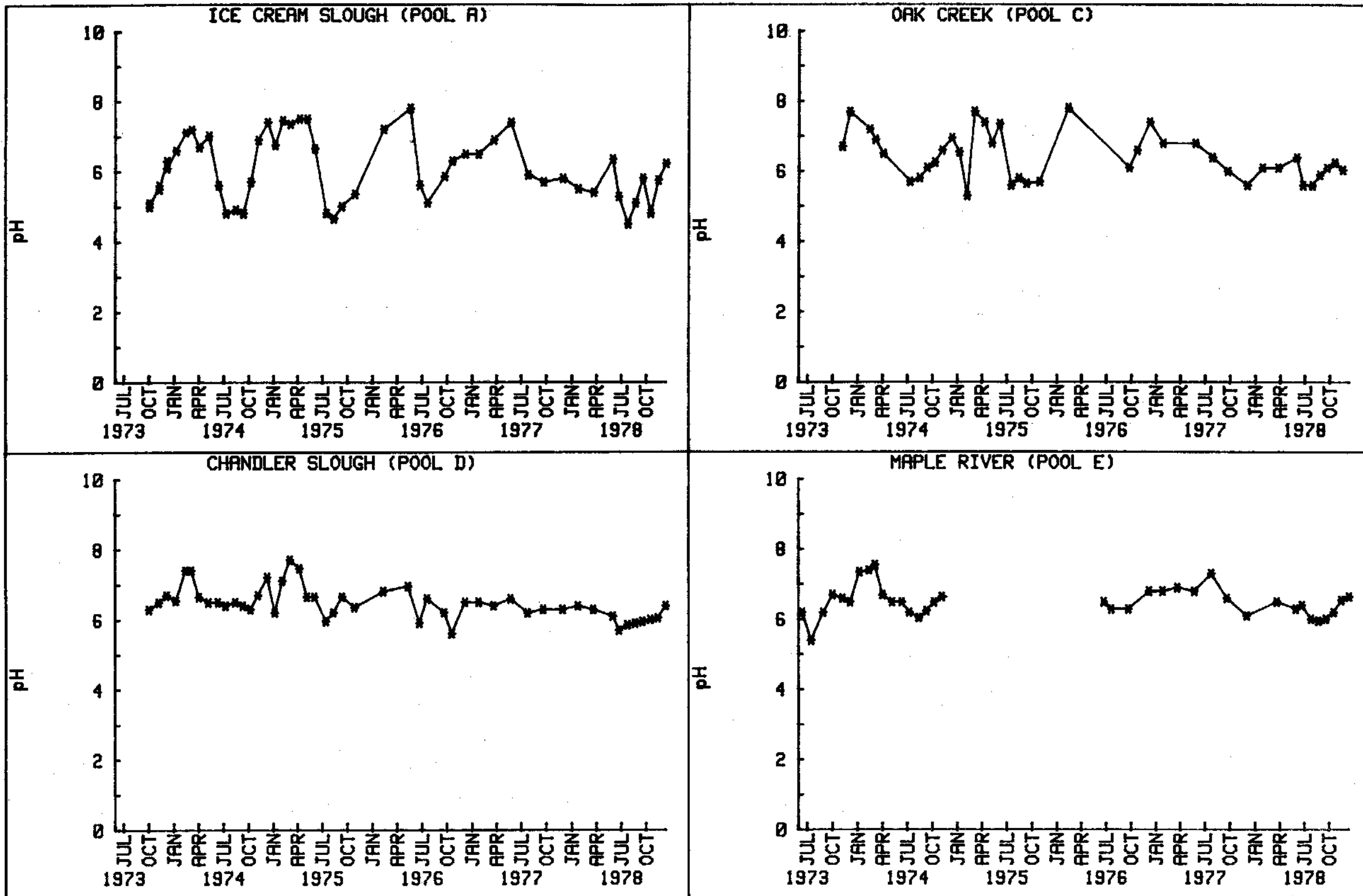


FIGURE 15 pH VERSUS TIME FOR SELECTED C-38 TRIBUTARIES

TABLE 7. MEAN WET SEASON WATER QUALITY CHARACTERISTICS FOR C-38 TRIBUTARIES[3/]

Tributary	Concentration[1/] TP	OP	TN	NO_3	NO_2	NH_4	Cond	Cl	DO
Chandler Slough (D)[2/]	.253	.187	1.69	.058	.006	.03	165	23.0	4.1
Yates Marsh (E)	.215	.154	1.55	.034	.008	.10	162	27.1	4.6
Maple River (E)	.212	.129	1.45	.028	.006	.04	197	32.3	5.7
Duck Slough (B)	.197	.093	1.62	.009	.006	.05	91	12.9	3.7
Armstrong Slough (A)	.128	.079	1.65	.008	.006	.05	115	20.2	4.6
Blanket Bay Slough (A)	.120	.071	1.85	.022	.007	.04	110	17.0	4.2
Oak Creek (C)	.073	.034	1.59	.032	.008	.04	128	18.6	4.7
Skeeter Slough (A)	.073	.031	1.33	.008	.005	.03	190	29.6	3.0
Buttermilk Slough (A)	.064	.015	1.82	.057	.009	.06	139	17.9	3.5
River Ranch South (A)	.051	.013	1.31	.031	.005	.04	144	17.0	4.0
Bay Hammock Slough (A)	.043	.007	1.39	.023	.006	.05	105	16.2	5.2
Starvation Slough (C)	.033	.007	1.57	.020	.008	.09	149	14.0	3.8
Pine Island Slough (B)	.030	.004	1.30	.030	.006	.03	110	19.3	5.1
Tick Island Slough (B)	.028	.003	1.27	.027	.006	.05	112	14.4	5.8
Ice Cream Slough (A)	.026	.003	1.20	.017	.006	.04	77	13.5	5.3

1/ All concentrations in mg/L except conductivity which is in μmhos/cm

2/ ( ) - denotes Pool location

3/ Date range : May through October, 1973-1978

TABLE 7. (Continued)

Triburary	Na	K	Ca	Mg	SiO_2	SO_4	Alk	pH	Turb	Color
	Concentration[1/]									
Chandler Slough (D)[2/]	12.1	2.1	12.5	3.1	4.7	7.4	0.5	6.3	3.0	183
Yates Marsh (E)	12.1	2.1	12.1	3.2	5.9	9.8	0.6	6.5	5.2	-
Maple River (E)	17.3	1.9	15.5	4.5	3.8	12.8	0.6	6.3	2.6	98
Duck Slough (B)	8.1	0.7	7.2	2.1	3.3	8.5	0.3	6.0	1.8	-
Armstrong Slough (A)	11.1	2.2	8.4	3.3	4.9	8.0	0.5	6.3	4.5	-
Blanket Bay Slough (A)	8.0	1.5	8.9	2.2	4.5	10.6	0.4	6.1	2.7	163
Oak Creek (C)	10.2	1.0	10.0	2.8	3.3	11.3	0.3	6.2	1.9	159
Skeeter Slough (A)	13.0	1.3	12.7	4.2	5.0	11.1	0.7	6.2	2.7	114
Buttermilk Slough (A)	9.5	1.0	14.1	3.1	5.1	12.6	0.5	6.2	3.0	153
River Ranch South (A)	9.4	1.1	12.2	2.9	4.4	11.5	0.5	6.2	3.7	112
Bay Hammock Slough (A)	8.8	1.2	9.0	2.5	3.8	10.7	0.4	6.2	3.9	129
Starvation Slough (C)	8.3	0.8	13.3	2.3	3.7	12.4	0.4	6.2	2.9	127
Pine Island Slough (B)	7.2	0.5	6.2	1.8	4.3	8.0	0.2	6.0	3.9	167
Tick Island Slough (B)	8.8	0.7	10.2	2.1	3.5	11.1	0.4	6.1	3.1	167
Ice Cream Slough (A)	6.5	0.5	5.9	1.5	3.0	8.8	0.3	5.7	3.8	162

1/ All concentrations in mg/L except alkalinity (meq/l); pH; turbidity (NTU); Color (Pt units)

2/ ( ) denotes Pool locations

concentrations displayed the largest variation of any water chemistry parameter among the tributaries. There was almost a tenfold difference in the mean total phosphorus range and over a sixtyfold difference in the mean ortho phosphorus range. At the high extreme, Chandler Slough had a mean total phosphorus concentration of 0.253 mg/L. At the low extreme, Ice Cream Slough had a mean total phosphorus concentration of 0.026 mg/L. The difference was even greater in the ortho phosphorus concentrations with Chandler Slough averaging 0.187 mg/L and Ice Cream Slough averaging only 0.003 mg/L. Ortho phosphorus accounted for 74 percent of the total phosphorus concentration at Chandler Slough but accounted for only 12 percent at Ice Cream Slough. In comparison, mean total nitrogen concentrations were low and displayed little variation among the tributaries, ranging from 1.20 mg/L at Ice Cream Slough (Pool A) to 1.85 mg/L at Blanket Bay Slough (Pool A). The inorganic nitrogen species were also low and again demonstrated little variation among the tributaries. Nitrate ranged from 0.017 mg/L (Ice Cream Slough) to 0.058 mg/L (Chandler Slough), while nitrite ranged from 0.005 mg/L (Skeeter Slough and River Ranch South) to only 0.009 mg/L (Buttermilk Slough). Pine Island, Skeeter, and Chandler Sloughs had the lowest mean ammonia concentration (0.03 mg/L) and Yates Marsh had the highest concentration (0.10 mg/L). All of these nitrogen levels can be considered to be relatively low.

The major ions (chloride, sodium, potassium, calcium, magnesium, silica, sulfate, and alkalinity) displayed only small variations among the tributaries, especially in relation to their low concentrations.

Potassium displayed a fourfold range between Ice Cream Slough (0.5 mg/L) and Armstrong Slough (2.2 mg/L); however, these mean concentrations are low. The mean pH ranged only 0.6 pH units between Ice Cream Slough (5.7) and Armstrong Slough (6.3). Mean turbidity levels were very low and ranged from 1.9 NTU at Oak Creek to 5.2 NTU at Yates Marsh. Color levels were high in all the tributaries with Maple River having the lowest mean level (98 Pt units) and Chandler Slough having the highest mean level (183 Pt units).

The mean daytime dissolved oxygen concentrations were highest at Tick Island (5.8 mg/L) and lowest in Skeeter Slough (3.0 mg/L).

C-38 WATER QUALITY CHARACTERISTICS

General Characteristics and Tributary Influence

A summary of the mean wet season water quality characteristics for the six C-38 water control structures from S-65 through S-65E is presented in Table 8. In general, the mean concentrations of nitrogen, chloride, sodium, potassium, calcium, magnesium, silica, sulfate, and alkalinity were low. Turbidity levels were very low. Conductivity and daytime dissolved oxygen levels were moderately low. Color was moderately high. The pH remained slightly acidic. The concentrations of the major cations and anions (chloride, sodium, potassium, calcium, magnesium) decreased slightly in a downstream direction from S-65 to S-65C. From S-65C to S-65E the concentrations increased to a level equal to or slightly above those initially entering C-38 upstream of S-65 from Lake Okeechobee. Chloride remained the dominant anion throughout C-38 (41 to 44 percent) (Table 9). Sodium was the dominant cation at S-65 and S-65A (39 to 40 percent). However, from S-65B to S-65E calcium became the dominant cation (43 percent), although sodium still accounted for a large percentage (36 percent) of the total cation composition. These small changes indicate that the integrated effect of the tributaries, taken as a group, had little net influence on the quality of water along C-38 with respect to these parameters. This trend is displayed graphically for chloride in Figure 16. The decreasing chloride concentration in Pools A, B, and C was the result of lower levels of chloride entering C-38 via Ice Cream, Bay Hammock, Tick Island, Blanket Bay, and River Ranch South Sloughs. Although Buttermilk, Skeeter, Armstrong, and Pine Island/Seven Mile Sloughs had chloride concentrations higher than

TABLE 8. MEAN WET SEASON[1/] WATER CHEMISTRY DATA FOR S-65 STRUCTURES (UPSTREAM) FROM 1973 THROUGH 1978

Parameter [2/]	S65	S65A	S65B	S65C	S65D	S65E
Total P	.032	.038	.041	.043	.071	.092
Ortho P	.003	.008	.010	.011	.032	.053
Total N	1.37	1.34	1.32	1.33	1.40	1.31
NO_3	.027	.022	.025	.025	.036	.047
NO_2	.005	.006	.007	.007	.022	.011
NH_4	.04	.07	.08	.09	.08	.09
Cl	18.0	17.1	15.4	15.6	17.8	19.1
Na	11.2	10.6	9.3	9.3	10.0	11.5
K	1.4	1.3	1.1	1.1	1.3	1.4
Ca	9.1	9.1	9.7	9.4	10.4	12.0
Mg	3.2	3.0	2.8	2.8	2.9	3.2
SiO_2	2.8	3.3	3.3	3.1	3.4	3.5
SO_4	11.9	11.4	11.8	11.0	10.2	12.3
Alkalinity (meq/l)	.40	.45	.42	.45	.46	.51
Turbidity (NTU)	4.8	3.8	3.1	2.8	3.2	3.2
Color (Pt)	61	119	123	108	118	99
Cond. (μmhos/cm)	134	136	127	139	146	149
pH	6.5	6.3	6.2	6.3	6.3	6.4
Diss. Oxygen	5.8	4.8	4.3	3.8	4.8	4.6

1/ Wet Season: May 1st through October 31

2/ All parameters in mg/L unless otherwise noted

TABLE 9. ANION/CATION COMPOSITION AT S-65 STRUCTURES

	S-65		S-65A		S-65B		S-65C		S-65D		S-65E	
Anion	meq/L	%	meq/L	%	meq/L	%	meq/L	%	meq/L	%	meq/L	%
Cl	.51	44%	.48	41%	.43	39%	.44	40%	.5	43%	.54	41%
Alkalinity	.40	34%	.45	38%	.42	38%	.45	41%	.46	39%	.51	39%
SO_4	.25	22%	.24	20%	.24	22%	.22	20%	.21	18%	.26	20%
	1.16		1.17		1.09		1.11		1.17		1.31	
Cation												
Na	.49	40%	.46	39%	.40	35%	.40	36%	.44	36%	.50	36%
Ca	.45	36%	.45	38%	.48	42%	.47	42%	.52	42%	.60	43%
Mg	.26	21%	.24	20%	.23	20%	.23	20%	.24	20%	.26	19%
K	.04	3%	.03	2.5%	.02	1.7%	.028	2.5%	.03	2.4%	.04	2%
	1.24		1.18		1.14		1.128		1.23		1.40	

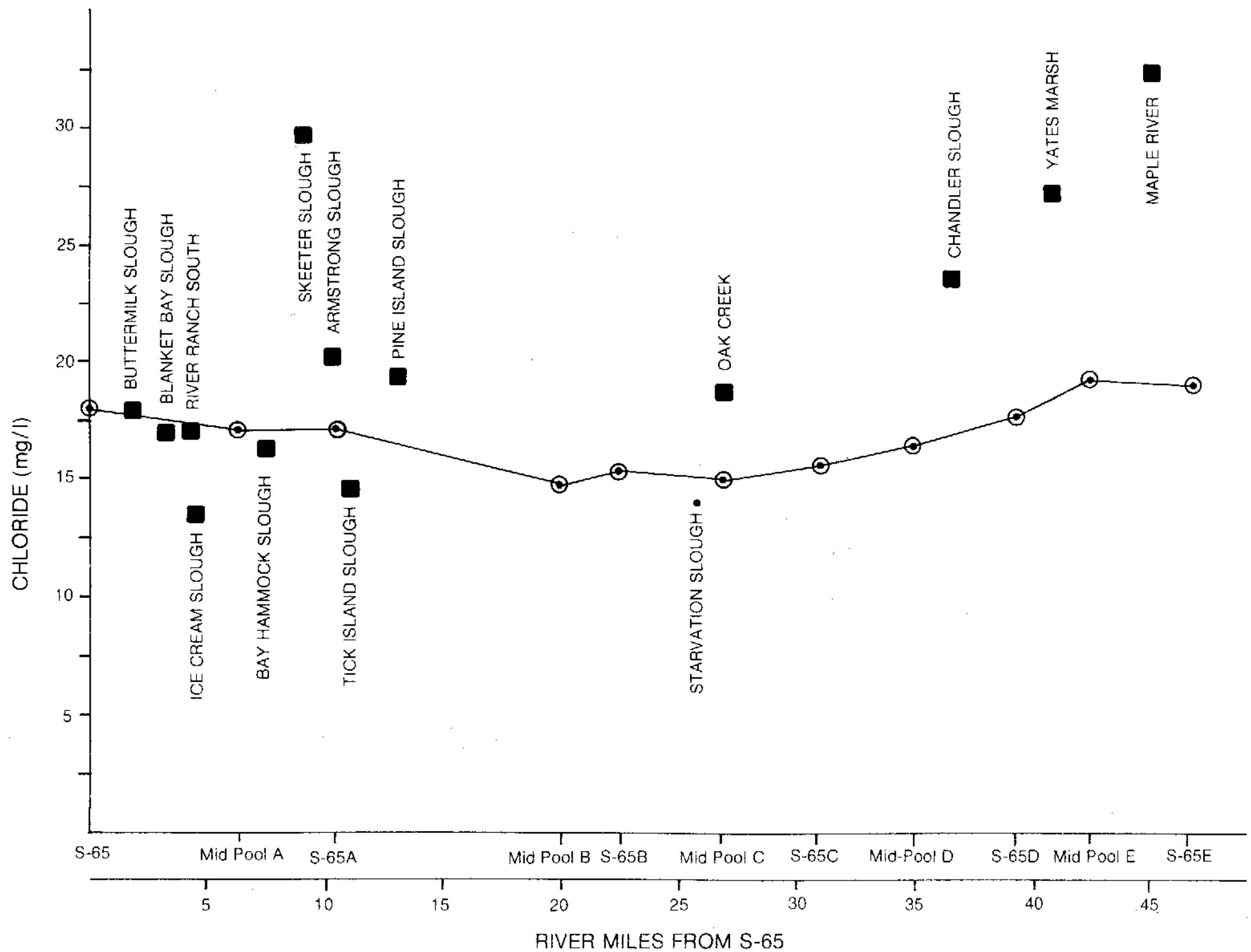


FIGURE 16 MEAN WET SEASON CHLORIDE CONCENTRATIONS ALONG C-38 (1973-78)

C-38, their combined discharge was apparently not sufficient to offset the dilution effect of the other tributaries. Downstream of S-65C the increase in chloride levels was the result of elevated concentrations entering via Yates Marsh, Oak Creek, Chandler Slough, and Maple River. Silicate, sulfate, alkalinity, and conductivity displayed a similar though less evident trend with the increase in the upper pools not as pronounced. The elevated ion concentrations in the latter three tributaries located in Pools D and E could be partially the result of several dairies located in these basins (Figure 5). As part of normal dairy management, groundwater is used both as barnwash and to clean the cows prior to milking.

There were distinct temporal patterns in the levels of the major cations and anions along C-38. The typical pattern was for the lower levels of the major ions to occur during discharge, with the majority of the discharge occurring during the summer. Figures 17 and 18 display this relationship for specific conductance at S-65 and S-65E. These patterns are representative of the seasonal variability in the other major ions. The dilution effect of low ionic strength rainwater (Table 6) appear to be a causative factor responsible for these temporal patterns.

The high color levels associated with the Pool A and B tributaries resulted in a rapid elevation in color from S-65 to S-65B (Figure 19). The color decreased in Pool C even though Starvation Slough and Oak Creek had higher color levels than C-38. However, these two sloughs account for only 35 percent of the Pool C drainage basin and may not be characteristic of the color in the remaining 65 percent of the pool basin. The very high color levels measured in Chandler Slough again caused the color in C-38 (Pool D) to increase. The lower color levels in the Pool E tributaries caused a reduction in color in this segment of C-38. The net effect of the tributary input along C-38, with respect to color, was to increase the mean wet season levels from 61 at S-65 to 99 Pt color units at S-65E.

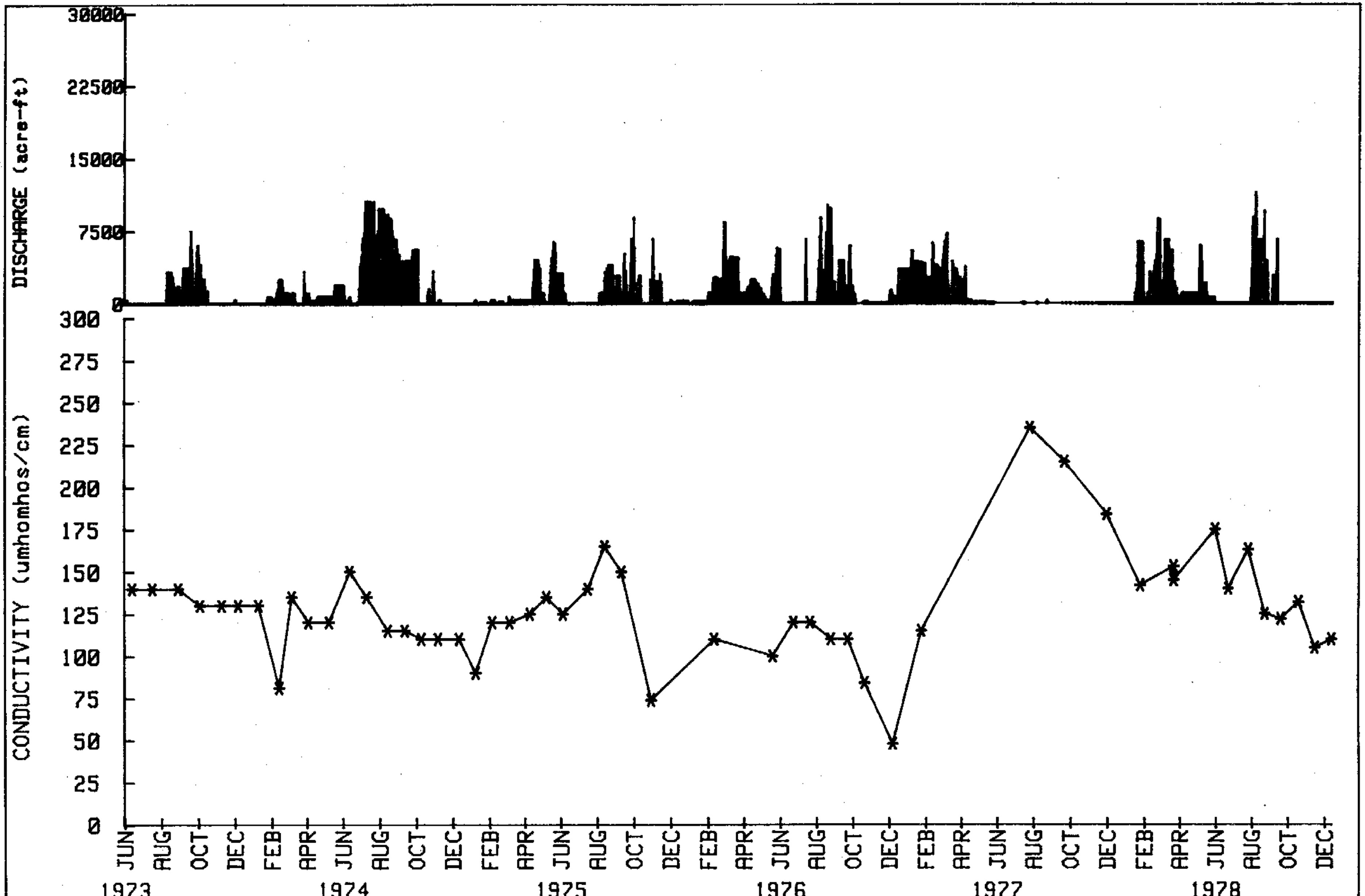


FIGURE 17 CONDUCTIVITY AND DISCHARGE VERSUS TIME UPSTREAM OF S-65 (LAKE KISSIMMEE)

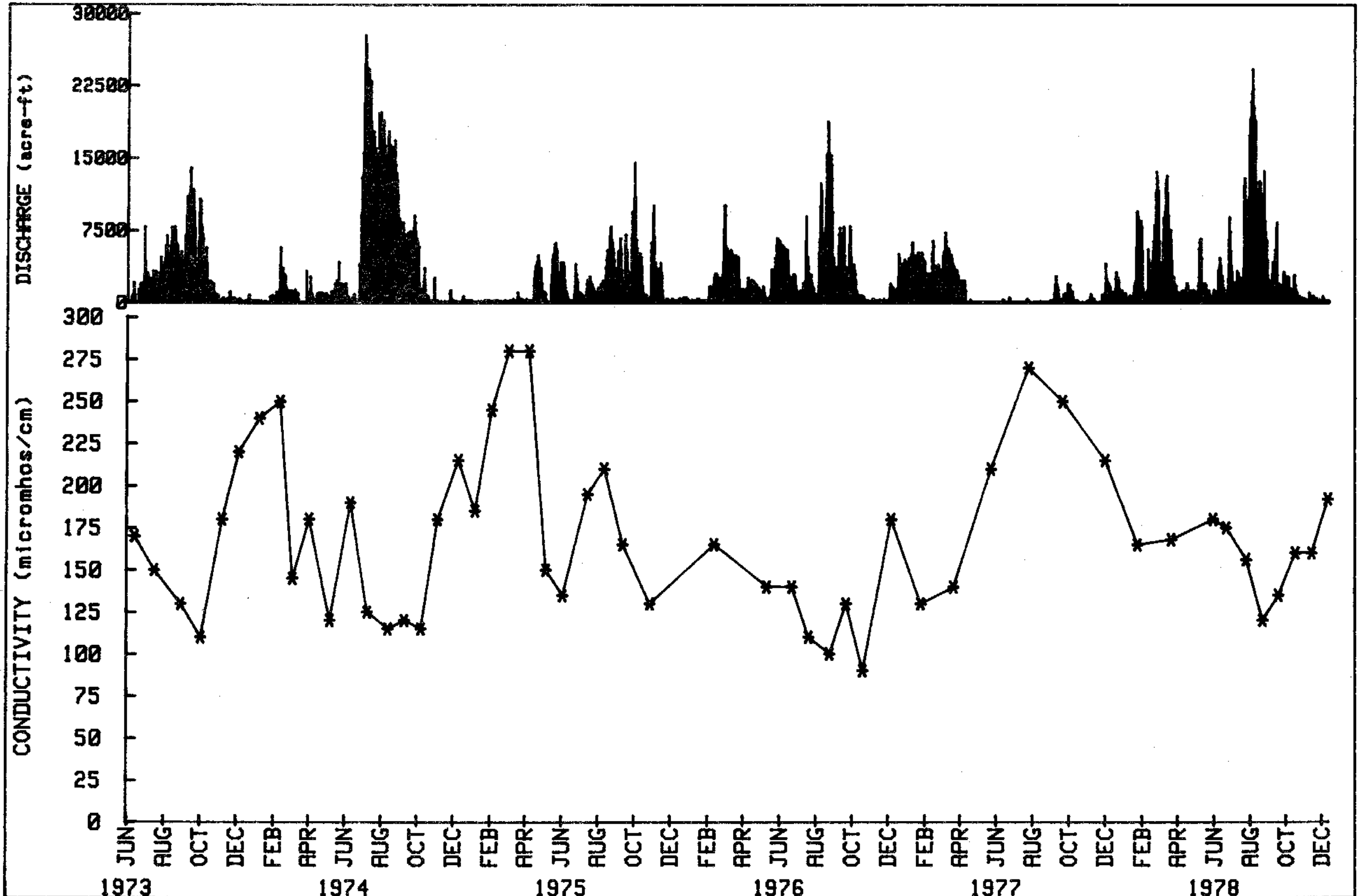


FIGURE 18 CONDUCTIVITY AND DISCHARGE VERSUS TIME UPSTREAM OF S-65E

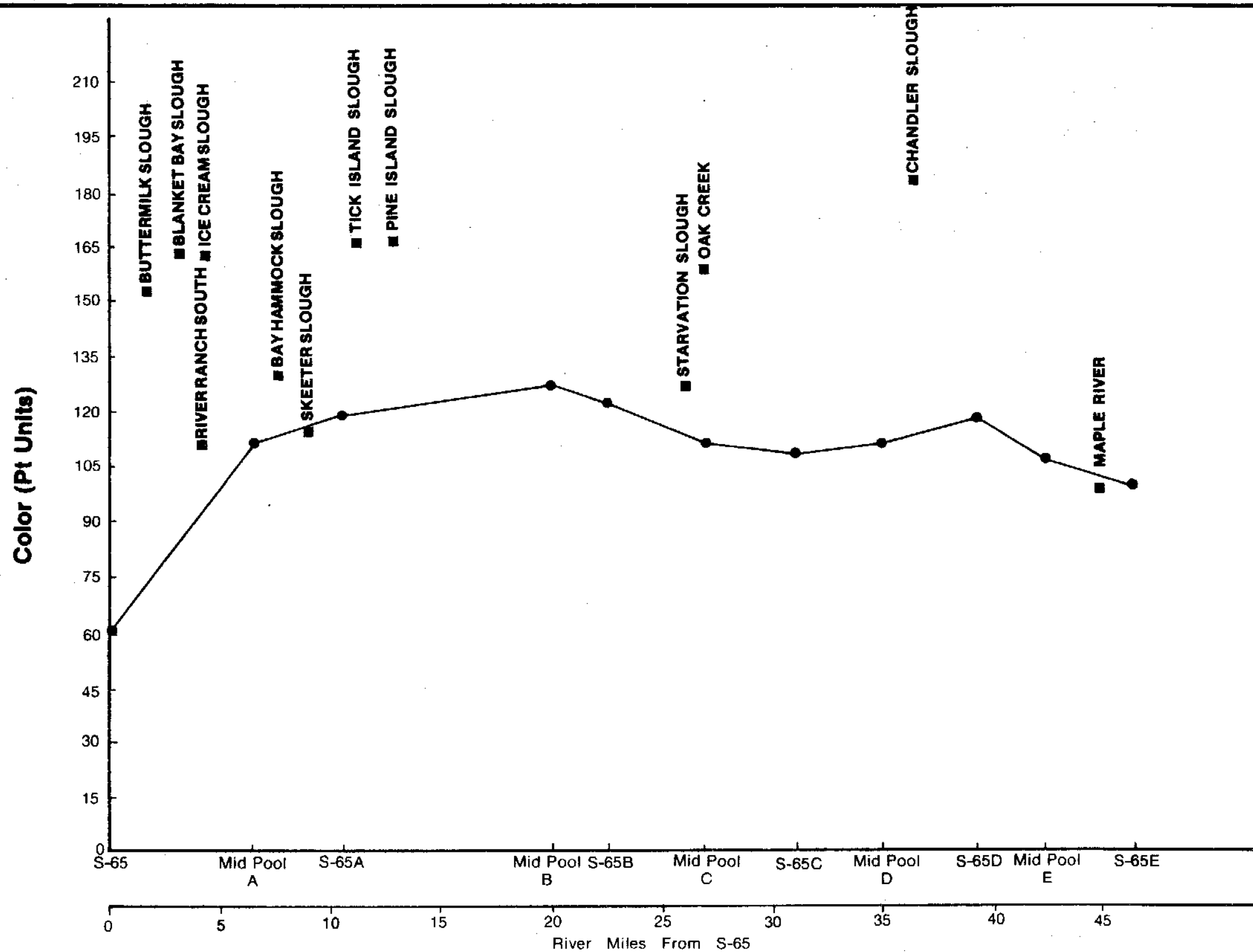


FIGURE 19 **MEAN WET SEASON COLOR LEVELS ALONG C-38 (1973-1978)**

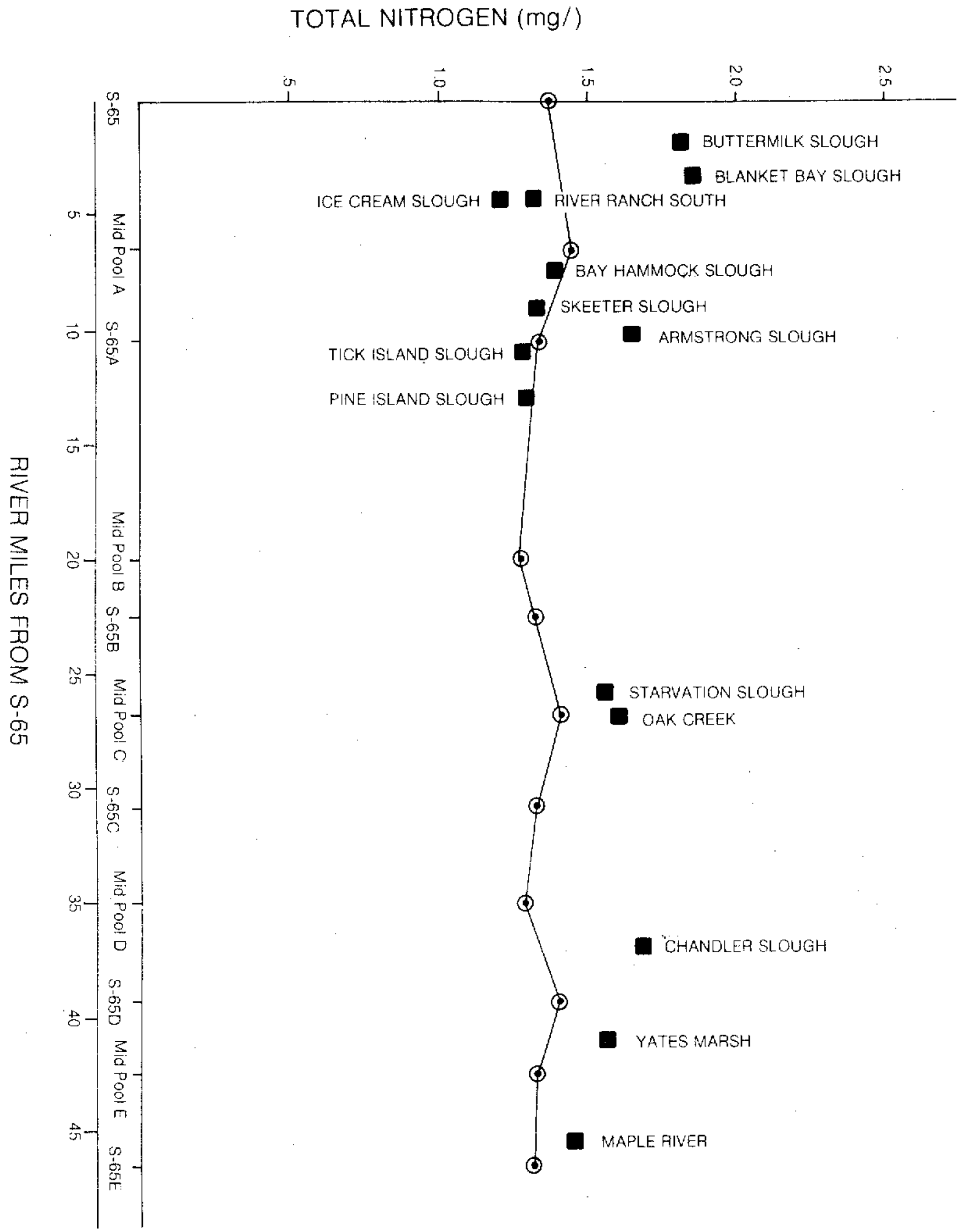


FIGURE 20 MEAN WET SEASON TOTAL NITROGEN CONCENTRATIONS ALONG C-38 (1973-78)

Turbidity levels were very low throughout C-38 with the mean level at S-65E (3.2 NTU) being slightly less than at S-65 (4.8 NTU).

Daytime dissolved oxygen concentrations were at moderate to low levels along C-38 and generally decreased in a downstream direction. The mean wet season concentration upstream of S-65 was 5.8 mg/L as compared to a mean value of 4.6 mg/L upstream of S-65E.

Although mean total nitrogen (Figure 20) concentrations remained very stable along the length of C-38 (Table 8), mean inorganic nitrogen concentrations increased 50 percent from S-65 to S-65E. Ammonia levels increased slightly from 0.04 mg/L at S-65 to 0.07 mg/L at S-65A and subsequently remained relatively constant down the remainder of channel. Nitrate and nitrite concentrations were fairly constant from S-65 to S-65C but increased slightly in Pools D and E.

Ortho and total phosphorus levels were increased substantially from S-65 to S-65E. Figures 21 through 26 present a time series display of total and ortho phosphorus and discharge upstream of the six main water control structures along C-38. Several major trends are evident from these graphs:

1. There appears to be no major change in the phosphorus concentrations at the six water control structures from 1973 to 1978.
2. Peak phosphorus levels were frequently associated with peak discharges which usually occurred at the beginning of the wet season (June - July). This relationship was more evident at S65D and E than at S65, S65A, B, and C and was probably a result of the "first flush" phenomenon observed for the tributaries.
3. The temporal variability in phosphorus concentrations increased in a downstream direction from S65 to S65E, with S65D and E displaying the largest variability. This increased variability at S65D and E was the result of the large phosphorus variability of the Pool D and E tributaries (Chandler Slough, Maple River, and

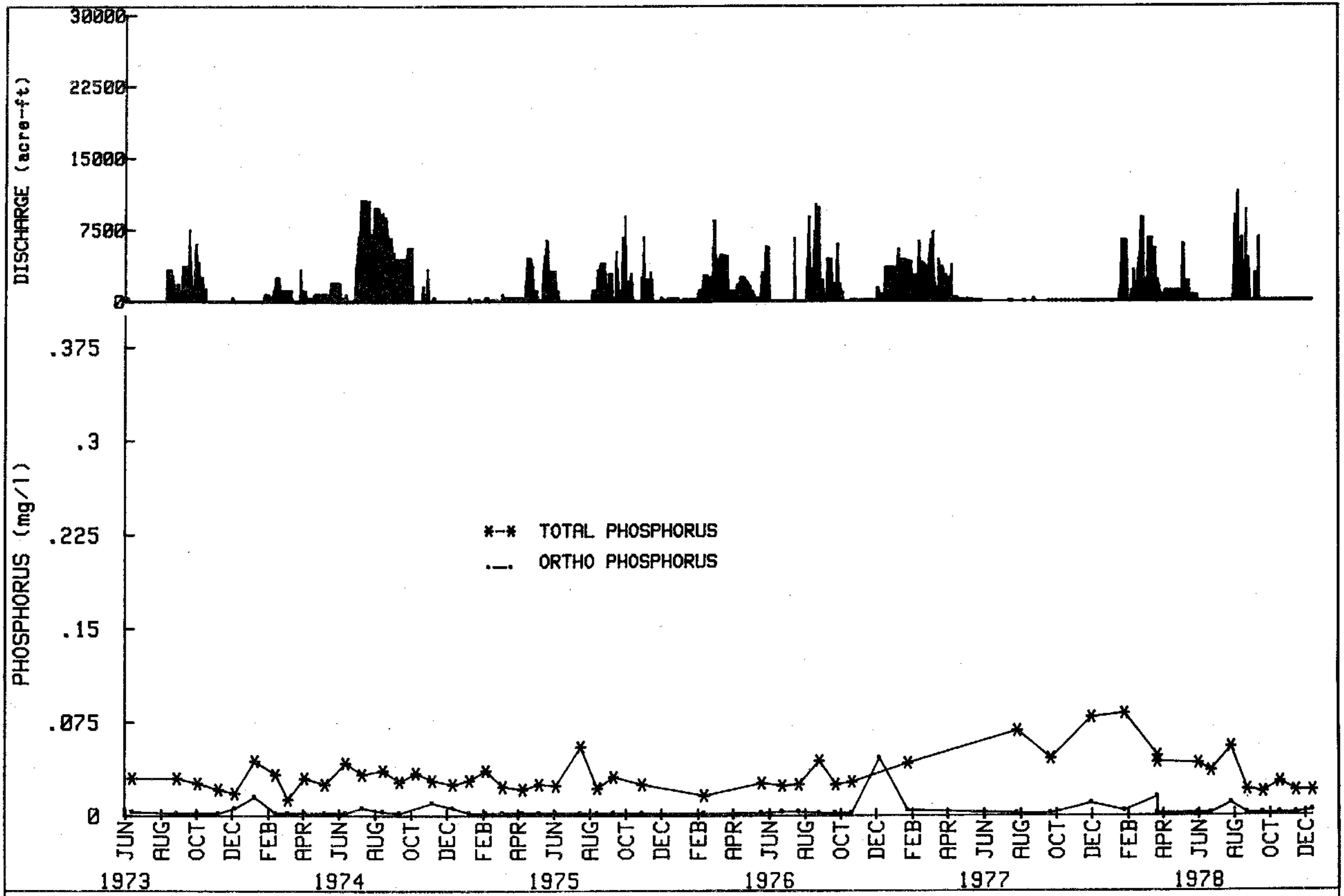


FIGURE 21 PHOSPHORUS AND DISCHARGE VERSUS TIME UPSTREAM OF S-65

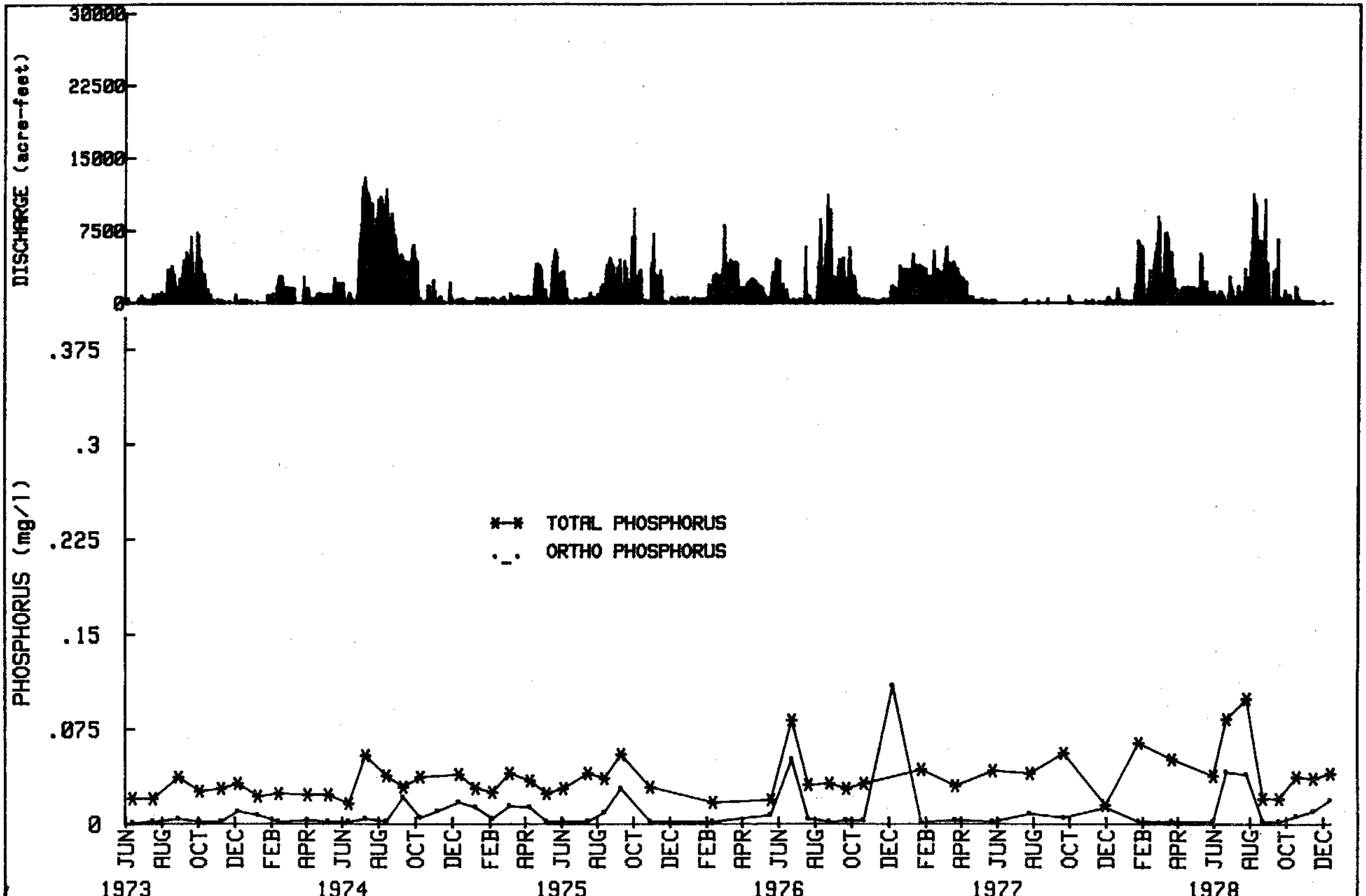


FIGURE 22 PHOSPHORUS AND DISCHARGE VERSUS TIME UPSTREAM OF S-65A

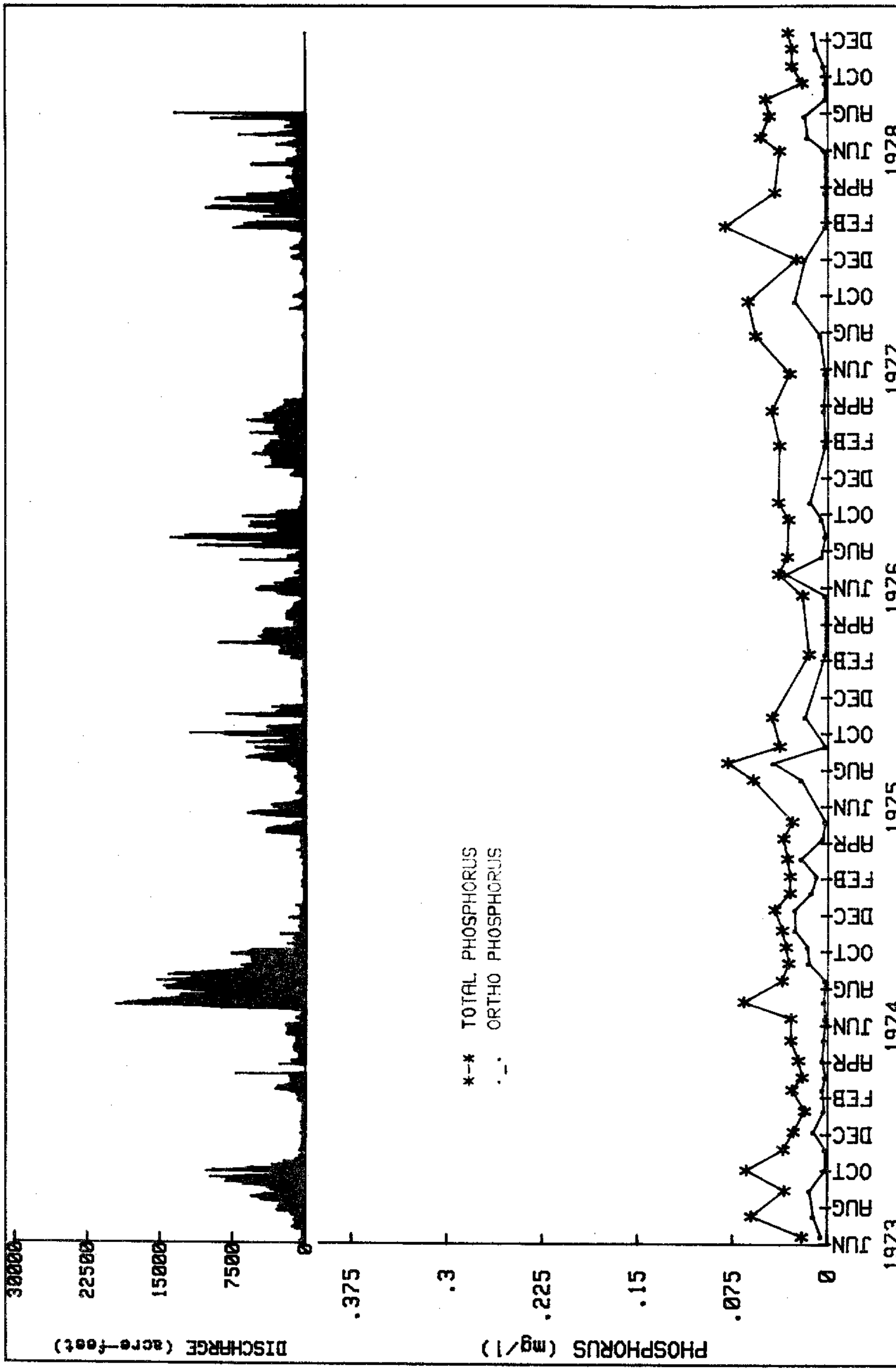


FIGURE 23 PHOSPHORUS AND DISCHARGE VERSUS TIME UPSTREAM OF S-65B

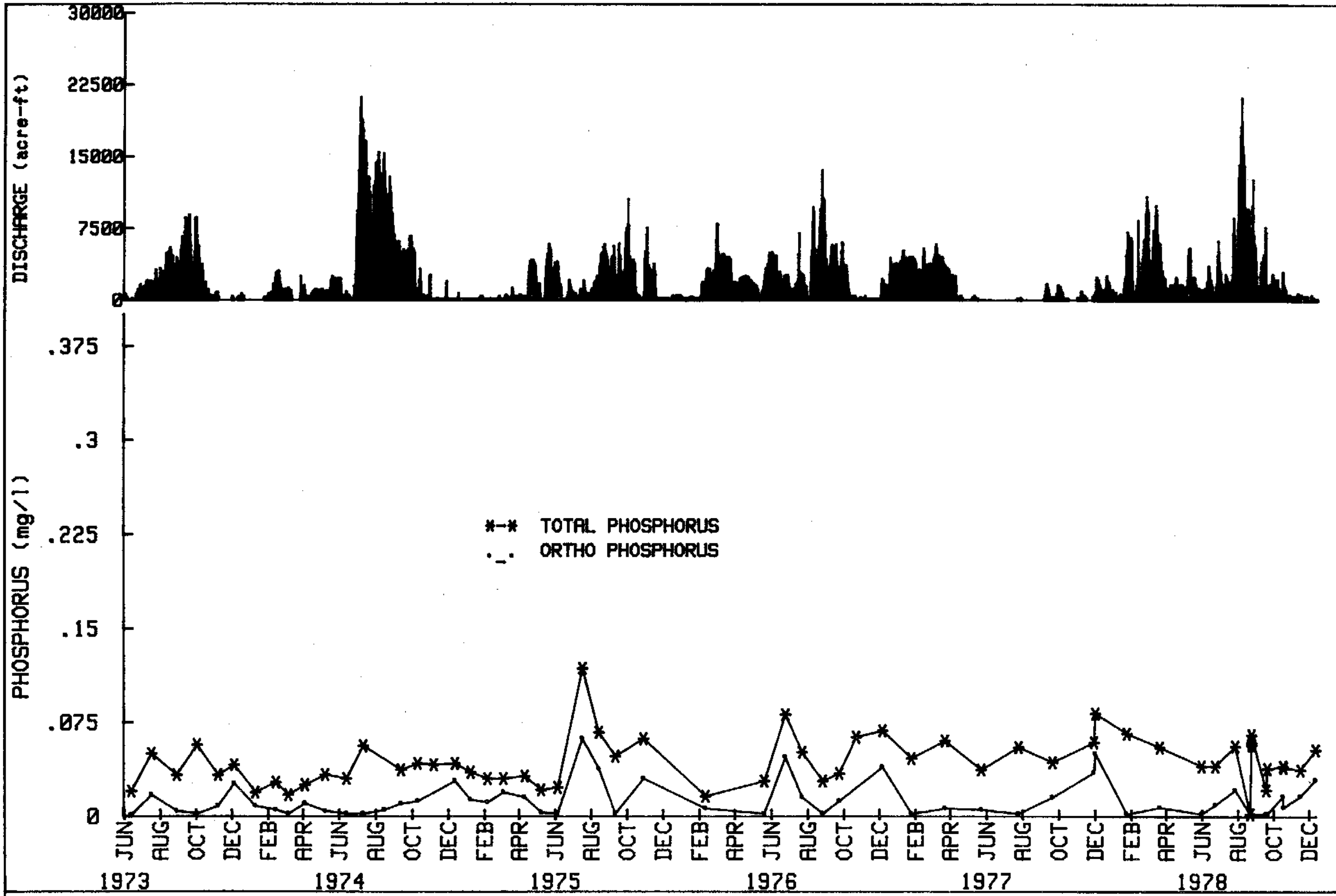


FIGURE 24 PHOSPHORUS AND DISCHARGE VERSUS TIME UPSTREAM OF S-65C

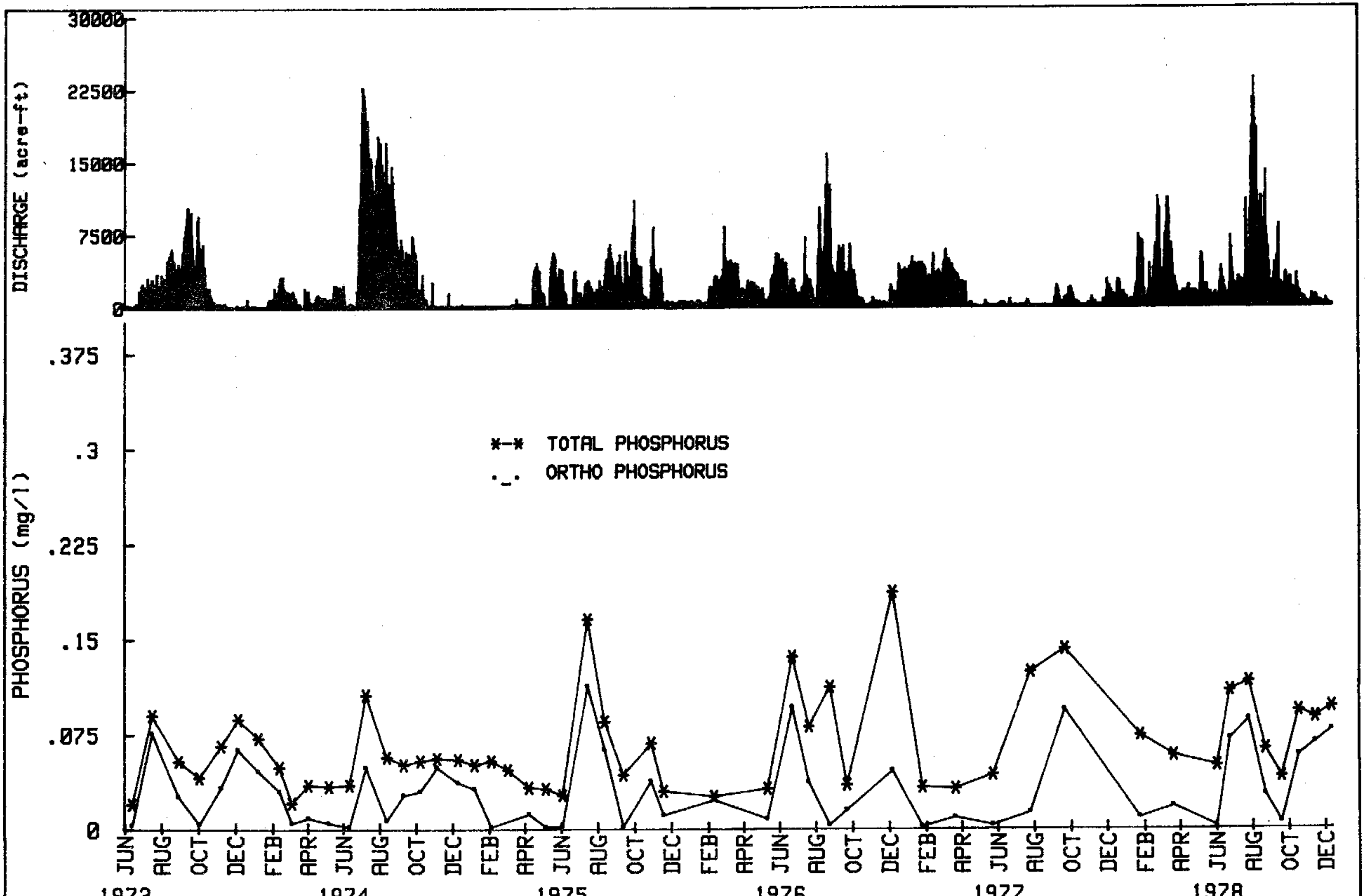


FIGURE 25 PHOSPHORUS AND DISCHARGE VERSUS TIME UPSTREAM OF S-65D

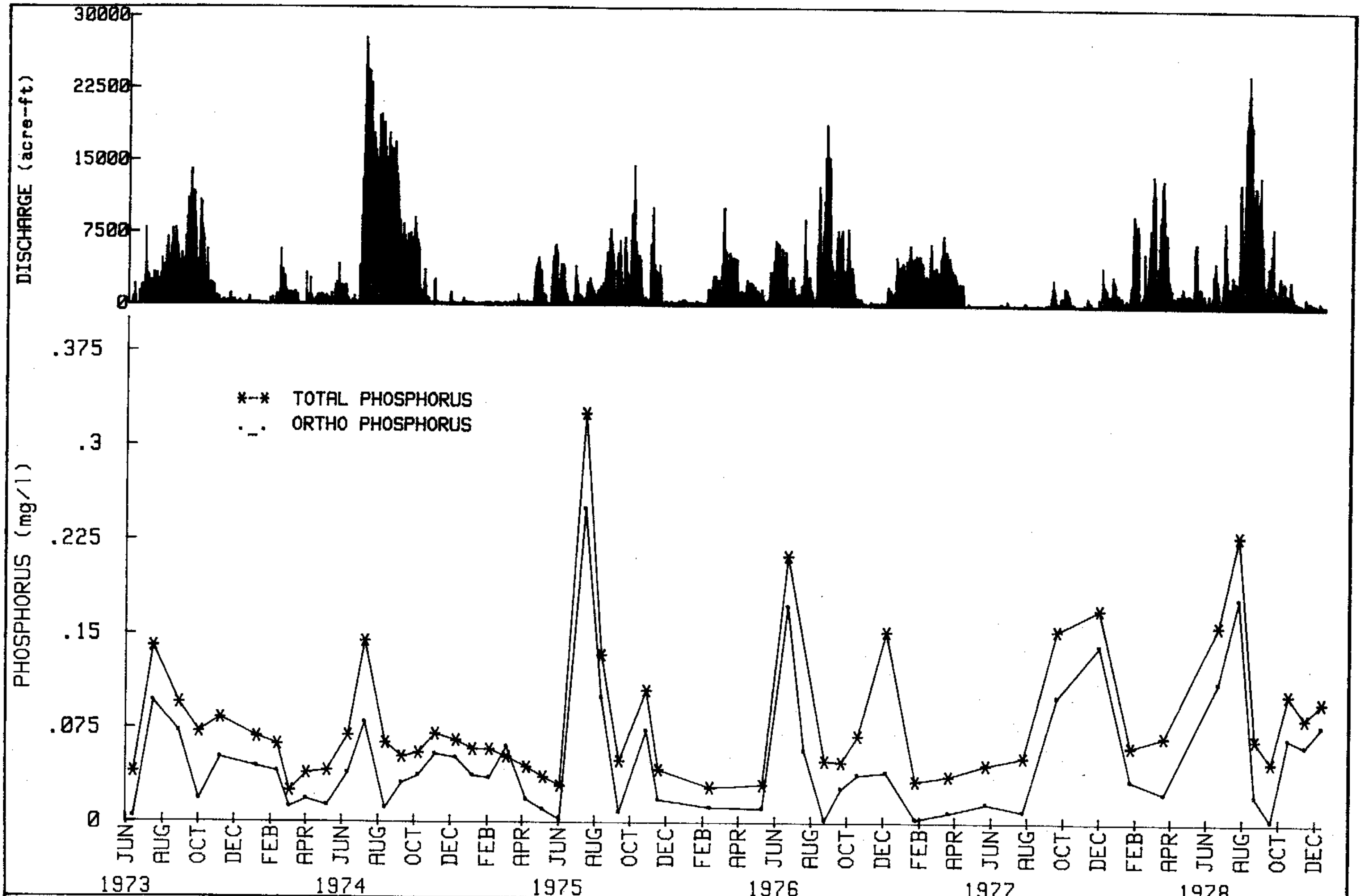


FIGURE 26 PHOSPHORUS AND DISCHARGE VERSUS TIME UPSTREAM OF S-65E

Yates Marsh).

Mean wet season total phosphorus concentrations exhibited a general increasing trend along C-38 from 0.032 mg/L at S-65 to 0.092 mg/L at S-65E. The rate of increase, however, was not uniform through all five pools (Figure 27). Along the upper 65 percent of C-38 (Pools A, B, and C) mean phosphorus levels were consistently low and increased only 0.012 mg/L from S-65 (0.032 mg/L) to S65C (0.044 mg/L). These levels were less than the average total phosphorus concentration of 0.064 mg/L measured in rainfall in the City of Okeechobee (Table 6). The increase in phosphorus levels that were measured along C-38 occurred in the lower two segments (Pools D and E) which experienced more than a doubling in the average wet season concentration from 0.044 mg/L (S65C) to 0.092 mg/L (S65E).

The quality of surface water entering the C-38 system from Lake Kissimmee and from the river's tributaries accounts for the differences in the quality of water found in Pools A - C from that found in Pools D and E. Pools A - C generally received water containing lower phosphorus concentrations than did Pools D and E. The water entering Pool A from Lake Kissimmee through S65 was relatively low in phosphorus. The average wet season concentration in Lake Kissimmee immediately upstream of S65 from 1973 through 1978 was 0.032 mg/L P/L with discrete values ranging from 0.019 to 0.068 mg/L P/L (Appendix A). The dissolved inorganic ortho phosphorus fraction averaged less than 10 percent (0.003 mg/L) of this total. In addition, of the 11 major sloughs which in turn drain 68 percent of Pools A - C watershed (Table 1) four of them, Ice Cream, Tick Island, Pine Island, and Starvation Sloughs had average phosphorus concentrations ranging from 0.026 to 0.033 mg/L which was less than that of the river itself between S65 and S65C. These four sloughs carry runoff from 56 percent (570.7 sq km) of Pools A, B, and C watershed and drain predominantly unimproved pasture (Table 2). Runoff from

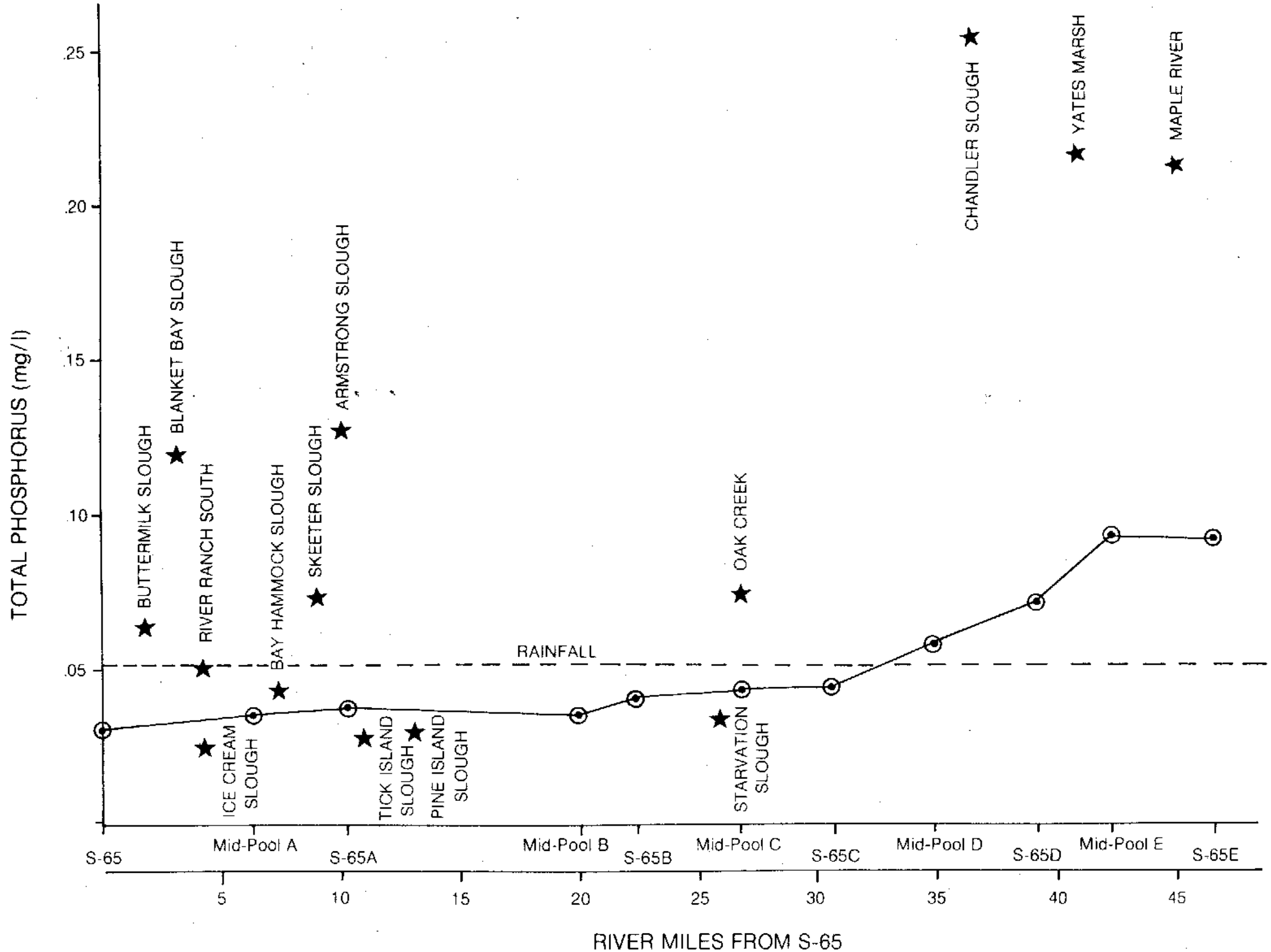


FIGURE 27 MEAN WET SEASON TOTAL PHOSPHORUS CONCENTRATES ALONG C-38 (1973- 1978)

these four areas would tend to improve the quality of water in the river through a dilution effect. Comparatively, the remaining seven sloughs had higher mean phosphorus concentrations (0.043 to 0.120 mg/L) than this section of the river. The majority of the land use in these sloughs is improved and ditched improved pasture. However, since only 25 percent (254.4 sq. km) of Pools A - C watersheds are drained by these seven sloughs, the impact on the river in terms of elevated phosphorus concentrations was apparently minimal.

The major increase in total phosphorus levels that occurred along C-38 in Pools D and E was a result of the inflow from three major tributaries: Chandler Slough, Yates Marsh, and Maple River. These three tributaries had average wet season total phosphorus concentrations of 0.253, 0.212, and 0.215 mg/L, respectively, which was five times higher than the concentration of phosphorus entering Pool D through S65C. The substantial impact of these three tributaries on the phosphorus levels between S65C and S65E is a function of these high phosphorus concentrations and the large percentage (85%) of Pools D and E watersheds which are drained by the tributaries. The land use in these three tributaries is dominated by ditched improved pasture. There are also two dairies located in the Maple River watershed and one dairy in the Chandler Slough watershed. These dairies can serve as a source of phosphorus since the feed is spiked with phosphorus which served to enhance calcium uptake.

The change in total phosphorus from S65 to S65E was mainly a function of changes in ortho phosphorus (Figure 28). The fraction of the total phosphorus not present in the ortho form remained relatively constant along C-38 increasing only 0.010 mg/L (from 0.029 at S65 to 0.039 mg/L

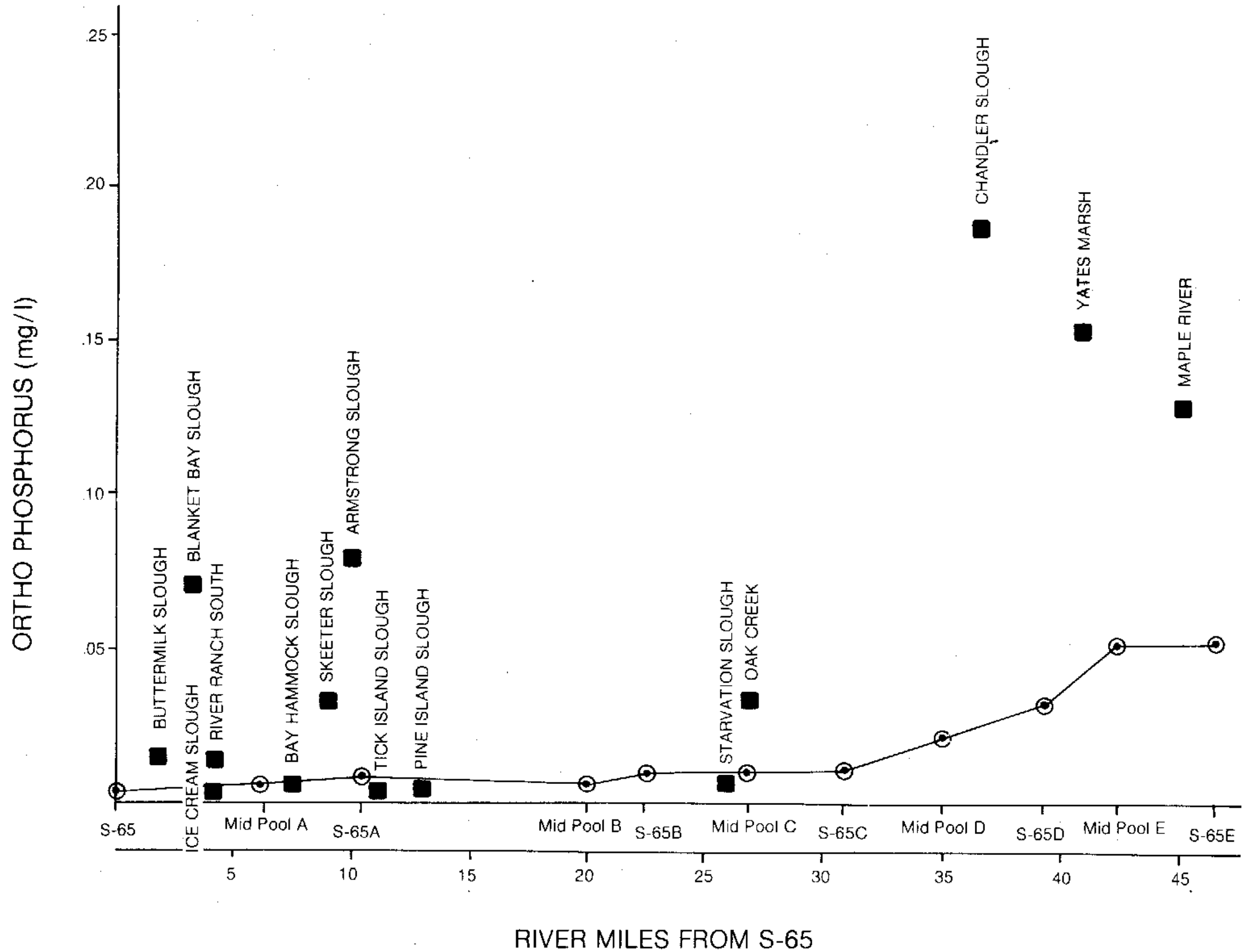


FIGURE 28 MEAN WET SEASON ORTHO PHOSPHORUS CONCENTRATIONS ALONG C-C-38 (1973-78)

at S65E) while ortho phosphorus levels correspondly increased 0.050 mg/L. Ortho phosphorus accounted for only 9 percent of the mean total phosphorus level at S65 but accounted for 58 percent of the total at S65E.

The above described trends are compatible with and complement the water quality trends presented for the tributaries. The tributaries had similar and characteristically low levels of all parameters except total and ortho phosphorus. The quality of water along C-38 reflects the influence of these tributaries by also having low levels of all parameters except phosphorus. Areas of increased phosphorus levels along C-38 corresponded to areas downstream of the tributaries which displayed the highest phosphorus concentrations.

Surface-Bottom Comparisons along C-38

The depth of the C-38 channel, typically 6 to 8 m, is sufficient enough to provide an opportunity for the establishment of water quality gradients. The magnitude of these gradients was evaluated by comparing water chemistry data collected at 2.0 m below the surface and at 1.0 m above the bottom at the five mid-Pool stations (Figure 5). Hereafter these two sampling depths will be identified as surface and bottom, respectively. Since the degree to which the surface and bottom samples may differ is a function of the flow in the channel, the comparison of surface and bottom data was examined on a seasonal basis. The wet season (May 1 through October 31) represents the period when 75 percent of the total annual flow occurs along C-38 and a period of higher temperatures. The dry season (November 1 to April 30) represents a period of minimal flow and lower temperatures.

Table 10 presents a comparison of surface and bottom average phosphorus and nitrogen levels during both the wet and dry seasons. During the dry season there was little difference between the surface and bottom levels of ortho phosphorus, total phosphorus, inorganic nitrogen, total nitrogen, and organic nitrogen. However, during the wet season the bottom concentrations of ortho phosphorus, total phosphorus, and inorganic nitrogen were substantially higher than the surface concentrations. The differences between the surface and bottom concentrations were largest at the mid-pool A and B stations and generally decreased in a downstream direction (Figures 29 through 32). The smallest differences usually occurred at the mid-pool E location. The increasing downstream trend in wet season surface phosphorus levels previously displayed in Figures 27 and 28 was also apparent in the bottom concentrations. Bottom inorganic nitrogen concentrations,

TABLE 10. COMPARISON BETWEEN C-38 MID-POOL SURFACE AND BOTTOM AVERAGE CONCENTRATIONS OF PHOSPHORUS AND NITROGEN

Mid Pool	Wet Season Surface [1]	Wet Season Bottom [2]	Dry Season Surface	Dry Season Bottom
Ortho P (mg/L)				
A	.006	.025	.007	.006
B	.007	.023	.008	.010
C	.010	.019	.014	.014
D	.022	.030	.022	.023
E	.052	.059	.036	.034
Avg.	.019	.031	.017	.017
Total P (mg/L)				
A	.035	.056	.032	.036
B	.034	.055	.035	.040
C	.043	.047	.038	.038
D	.058	.072	.052	.065
E	.091	.100	.068	.063
Avg.	.052	.066	.045	.048
Inorganic N (mg/L)				
A	.08	.42	.13	.15
B	.12	.29	.15	.17
C	.13	.17	.20	.16
D	.12	.16	.23	.26
E	.14	.16	.26	.27
Avg.	.12	.24	.19	.20
Total N (mg/L)				
A	1.46	1.62	1.23	1.32
B	1.27	1.53	1.25	1.24
C	1.42	1.40	1.23	1.18
D	1.29	1.35	1.31	1.26
E	1.30	1.35	1.29	1.27
Avg.	1.35	1.45	1.26	1.25
Organic N (mg/L)				
A	1.35	1.26	1.11	1.18
B	1.16	1.24	1.10	1.07
C	1.27	1.20	1.03	1.03
D	1.17	1.18	1.08	1.00
E	1.16	1.19	1.02	1.00
Avg.	1.22	1.21	1.07	1.06

1/ Surface sample taken at 2.0 m (May to October, 1973-1978)

2/ Bottom sample taken 1 m from bottom (usually 6 - 8 m) (November to April, 1973-1978)

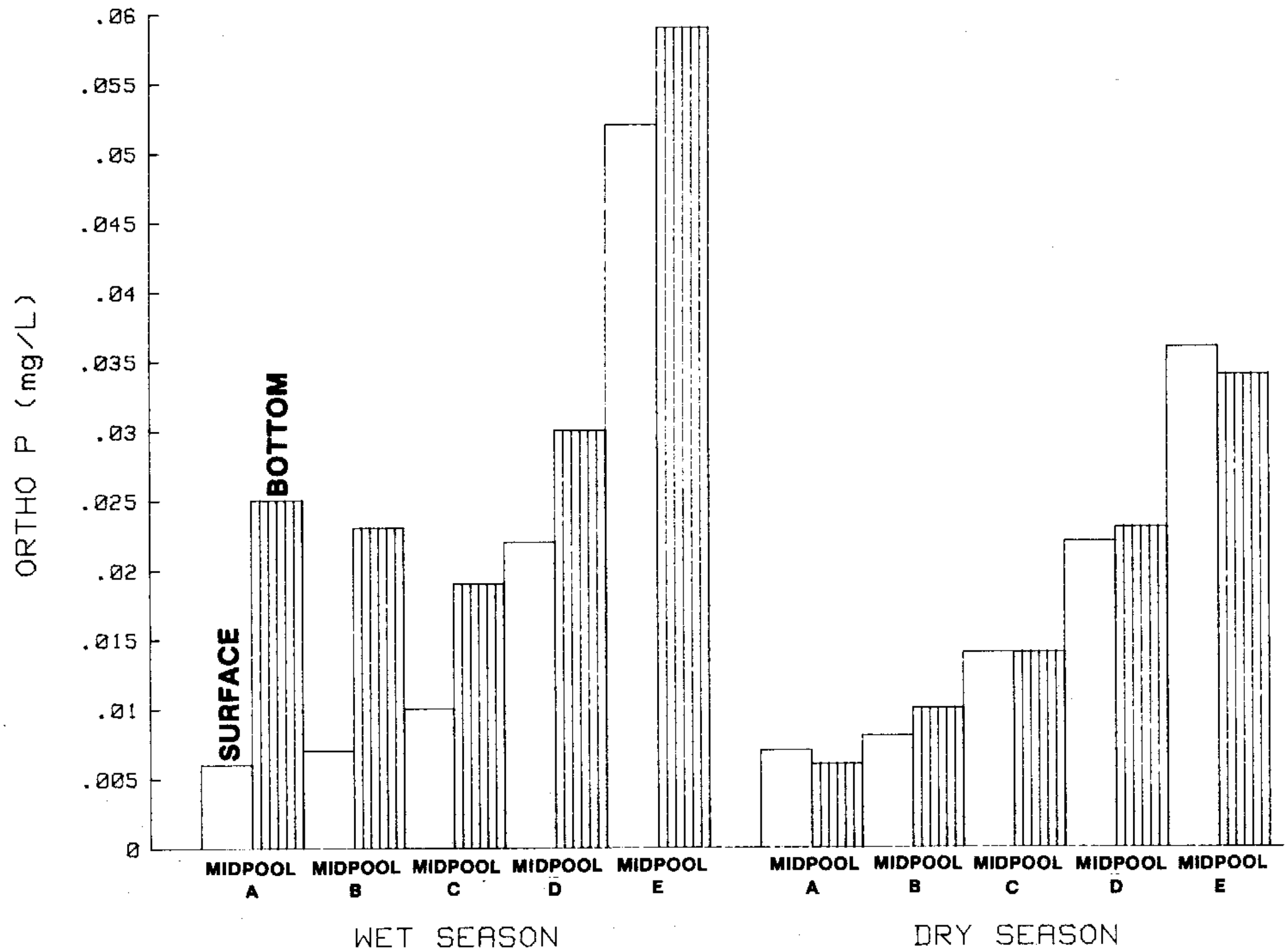


FIGURE 29 C-38 MIDPOOL ORTHO PHOSPHORUS SURFACE-BOTTOM COMPARISON

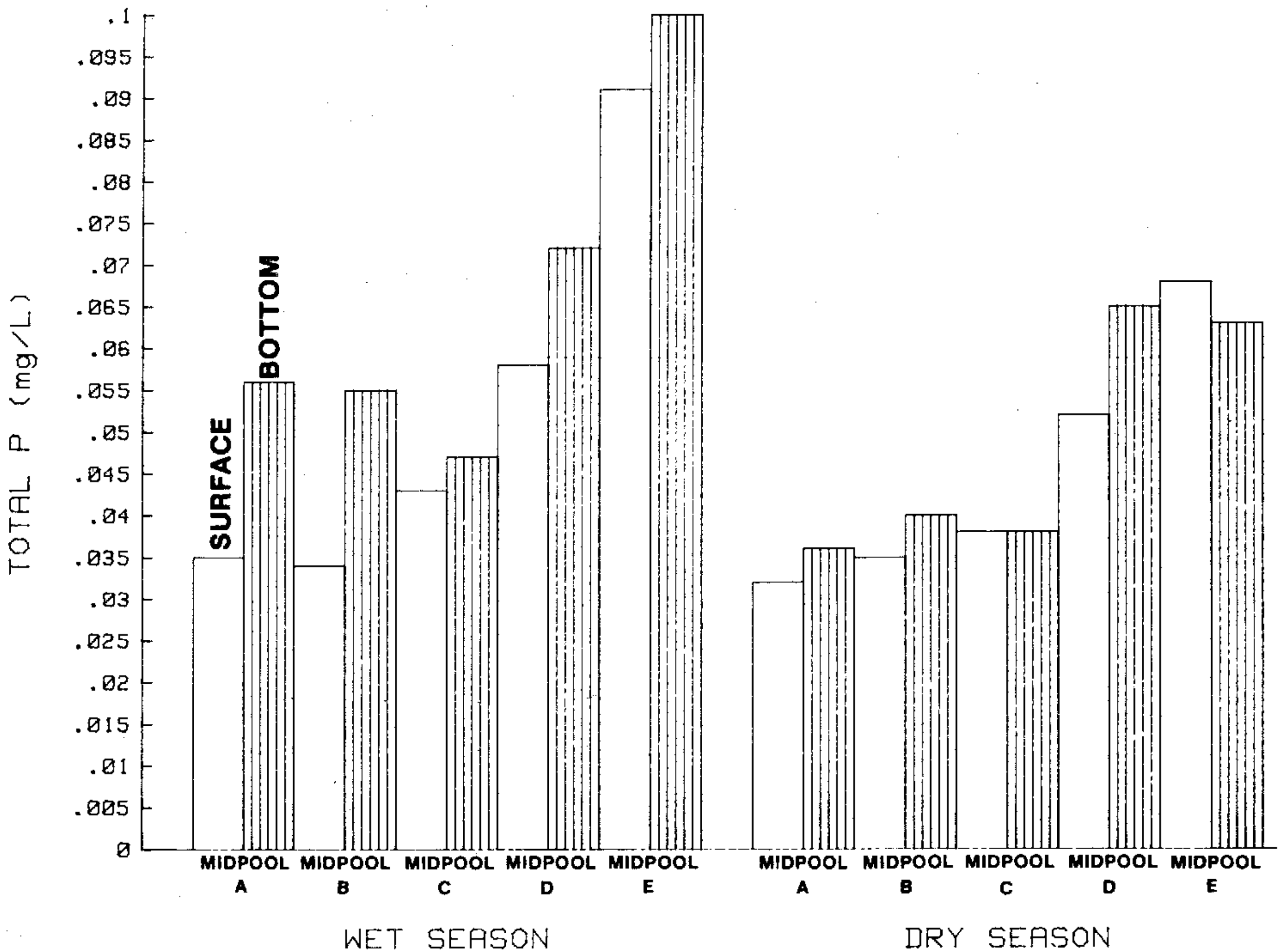


FIGURE 30 **C-38 MIDPOOL TOTAL PHOSPHORUS SURFACE-BOTTOM COMPARISON**

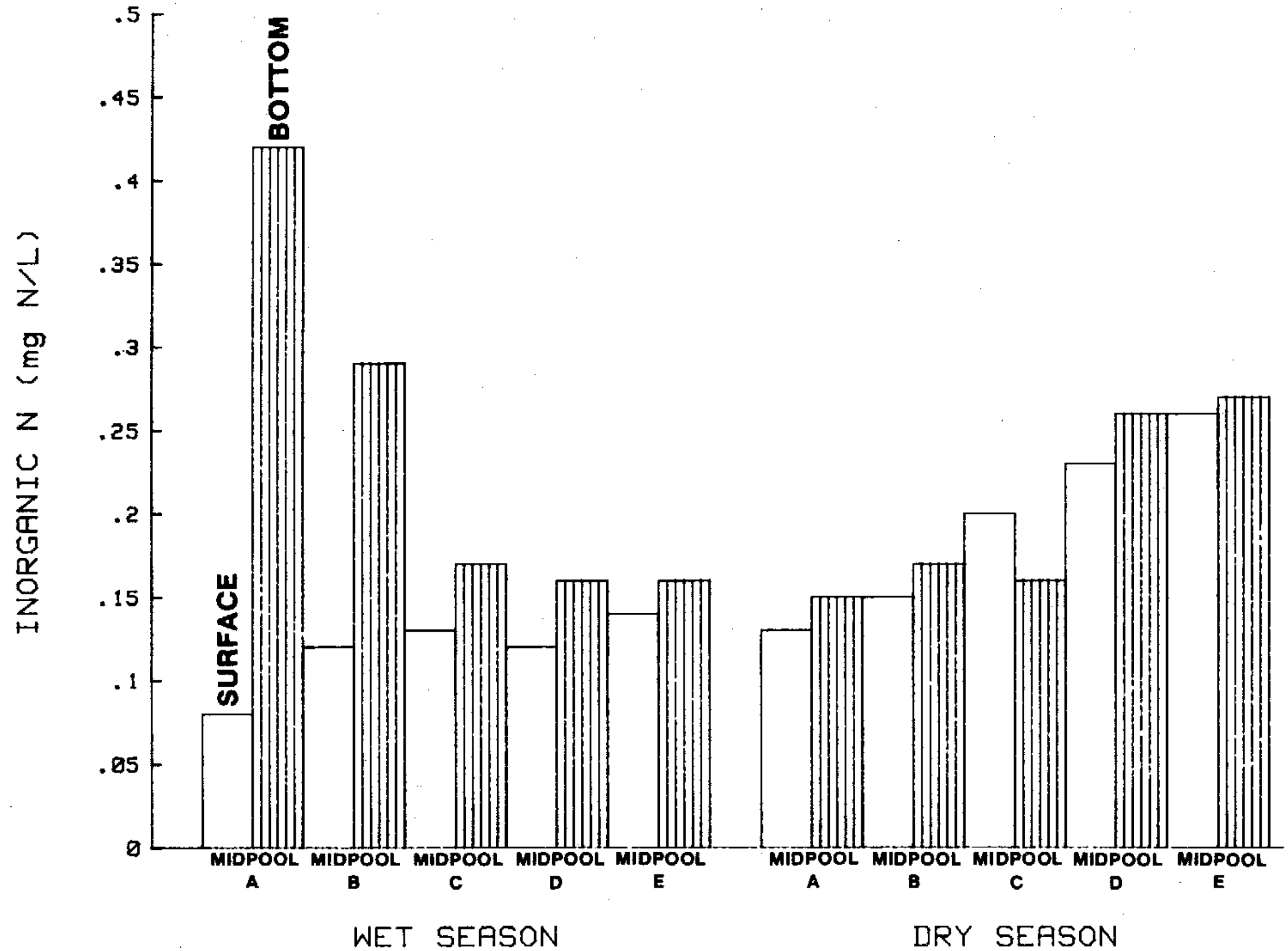


FIGURE 31 C-38 MIDPOOL INORGANIC NITROGEN SURFACE-BOTTOM COMPARISON

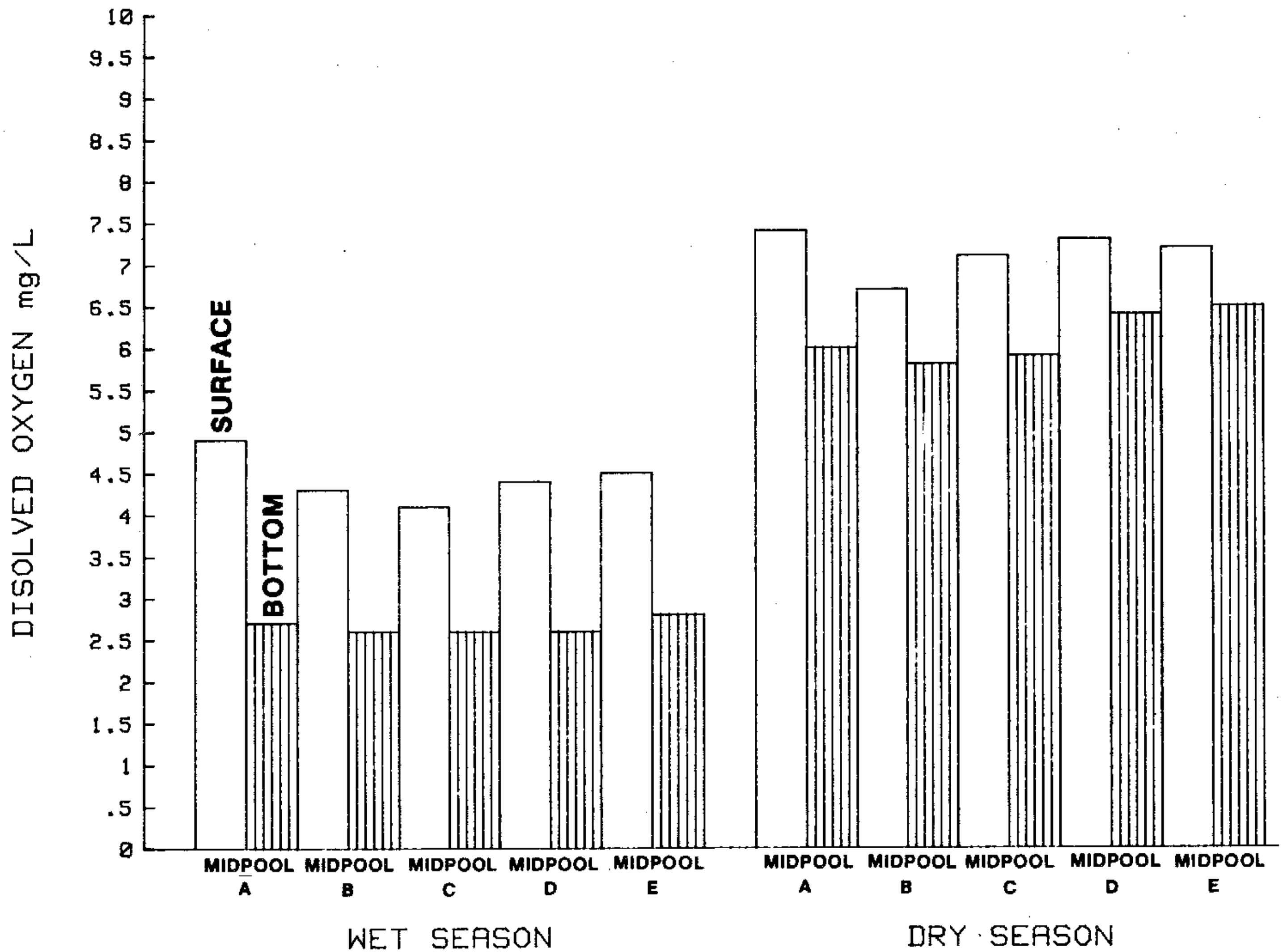


FIGURE 32 C-38 MIDPOOL DISSOLVED OXYGEN SURFACE-BOTTOM COMPARISON

however, decreased substantially in a downstream direction during the wet season but increased downstream during the dry season (Table 10 and Figure 31).

Organic nitrogen did not show any substantial differences between the wet season surface and bottom data. Since approximately 90 percent of the total nitrogen is compared to the organic fractions, the differences between the surface and bottom total nitrogen levels were also small.

Bottom levels of specific conductance, chloride, and turbidity were slightly higher than surface levels during both the wet and dry season (Table 11). In addition, dry season levels of specific conductance and chloride were higher than wet season levels at both the surface and bottom. This is consistent with the discharge related pattern and wet season trends established at the six water control structures and the tributaries.

Dissolved oxygen displayed a different trend (Table 11). Dissolved oxygen concentrations were higher at the surface than at the bottom. This difference was greater during the wet season than during the dry season. The wet season dissolved oxygen levels were also lower than the dry season levels at both the surface and bottom. Decreased oxygen solubility at higher summertime temperatures may partially account for this trend. This seasonal trend is similar to that previously documented for the six water control structures and the tributaries.

TABLE 11. COMPARISON BETWEEN C-38 MID-POOL SURFACE AND BOTTOM AVERAGE LEVELS OF DISSOLVED OXYGEN, TURBIDITY, SPECIFIC CONDUCTIVITY AND CHLORIDE

	Wet Season		Dry Season	
Mid-Pool	Surface[1/]	Bottom[2/]	Surface	Bottom
Dissolved Oxygen (mg/L)				
A	4.9	2.7	7.4	6.0
B	4.3	2.6	6.7	5.8
C	4.1	2.6	7.1	6.4
D	4.4	2.6	7.3	6.4
E	4.5	2.8	7.2	6.5
Avg.	4.4	2.7	7.1	6.1
Turbidity (NTU)				
A	3.8	4.3	2.7	4.0
B	3.6	4.9	2.2	3.0
C	2.6	3.5	2.2	5.2
D	3.2	4.2	1.9	4.0
E	3.4	6.4	1.6	1.8
Avg.	3.3	4.7	2.1	3.6
Specific Conductivity (μmhos/cm)				
A	132	141	131	135
B	126	131	140	147
C	134	138	146	153
D	137	145	161	168
E	145	155	177	187
Avg.	135	142	151	158
Chloride (mg/L)				
A	17.1	17.0	17.3	20.7
B	14.9	16.4	17.2	20.0
C	15.0	15.6	17.1	19.0
D	16.6	16.9	19.9	23.4
E	19.2	20.4	20.6	22.2
Avg.	16.6	17.3	18.4	21.1

1/ Surface sample collected at 2.0 m (May to October, 1973 to 1978)

2/ Bottom sample collected at 1.0 m above bottom (usually 6-8 m) (November to April 1973 to 1978)

Depth Profiles along C-38

The trends described in the surface-bottom comparison for dissolved oxygen and specific conductivity can be examined in greater detail from depth profiles taken on individual sampling dates. Depth profiles were measured for four field parameters: specific conductance, pH, daytime dissolved oxygen, and temperature. Percent saturation of dissolved oxygen was calculated from this information. Profile measurements were taken above and below each water control structure and at the five mid-pool stations. Four individual case studies were selected for discussion. Site selection was restricted to the mid-pool stations since they are probably most representative of the majority of the river. Two wet season cases were chosen; one during a high rate of flow (July 9 - 11, 1974) and one during a low rate of flow (July 25 - 27, 1977). The other two cases were in the dry season, with one also during a high rate of flow (February 10 - 12, 1976) and one during a low rate of flow (January 8 - 10, 1974). Table 12 presents the daily discharge along C-38 for these four cases. These cases represent the widest range of hydrologic conditions at the time of sampling and, as such, represent the extreme conditions with respect to depth profiles. The depth profiles for the other 47 sampling dates generally represented transition profiles between these extremes.

During periods of high discharge along C-38, the water column is effectively vertically mixed with respect to specific conductance, pH, dissolved oxygen, and temperature. Specifically, the wet season high flow case of July 9 - 11, 1974 represented a flow condition (approximately 10,000 to 25,000 acre-feet/day) which approached the maximum measured

TABLE 12. FLOW RATES DURING DEPTH PROFILES

Case	Sampling Date	Daily Discharge During Sampling (acre-feet)										
		S-65		S-65A		S-65B		S-65C		S-65D		S-65E
Wet season	July 9, 1974	10,534		12,502		15,884		14,941	D	20,667	D	23,958
High flow	10	10,534	A[1/]	11,771	B	15,482		14,115		18,127		24,156
	11	10,534		11,359		15,674	C	15,494		17,074		19,800
Wet Season	July 25, 1977	0		0		238		198	D	57	D	2
Low flow	26	0	A	0	B	150	C	218		105		4
	27	0		0		79		129		123		2
Dry season	Feb. 10, 1976	2,138		2,370		2,085		2,255	D	2,130		1,911
High flow	11	2,673	A	2,823	B	2,637	C	3,063		2,903		2,653
	12	2,673		2,822		2,643		3,287		3,200	E	2,970
Dry season	Jan. 8, 1974	2		0		174		0	D	75	E	4
Low flow	9	4	A	0	B	174	C	0		63		55
	10	2		0		174		0		55		113
Max. daily discharge during study		11,405 8/9/78		11,963 7/4/74		19,499 7/4/74		21,162 7/5/74		23,560 8/3/78		27,720 7/4/74

1/ indicates date mid-pool depth profile was taken (i.e. mid-pool A profile measured on July 10, 1974) during the study (Table 12). When the discharge rate was greater than 11,000 acre-feet/day (mid-pools B, C, D and E) there were virtually no profile gradients (Figures 33b, c, d, e). At a flow rate of 10,500 acre-feet/day (mid-pool A, Figure 33a) only temperature in the top 1 m at mid-pool A displayed a significant gradient.

As the flow rate decreased, profile gradients began to be established. The February 10 - 12, 1976 dry season high flow case represented a period when discharges ranged between approximately 2,000 and 3,200 acre-feet/day. At these lower flow rates, small gradients were established in the upper 2 m for temperature (0.5 to 1.0°C/m decline), dissolved oxygen (0.2 to 0.5 mg/L per M decline), and specific conductance (0 to 10 μmhos/cm per m increase) (Figure 34 a - e). Percent saturation decreased proportionally to the temperature and dissolved oxygen. There was no gradient in the pH values. Below 2 m the rate of change of the gradients was substantially less.

At minimal flow rates along C-38 (0 to 300 acre-feet/day), large profile gradients were established for dissolved oxygen, temperature, and percent saturation. These large gradients occurred during both the wet season (July 25 - 27, 1977) and the dry season (January 8 - 10, 1974). The pattern of the depth profile varied depending upon season and location. During the wet season case, decreases in dissolved oxygen concentrations were usually more abrupt and the bottom depths usually approached anoxic conditions (Figure 35 a - e). The rate of decline during the July 1977 case ranged up to 3 mg/L per m. The percent saturation paralleled the dissolved oxygen profile and ranged from 110 percent to less than 1 percent in a single profile (Figure 35 a,b). Temperature gradients in July 1977 decreased 2 to 7°C in a relatively smooth uniform pattern (Figure 35 a-e).

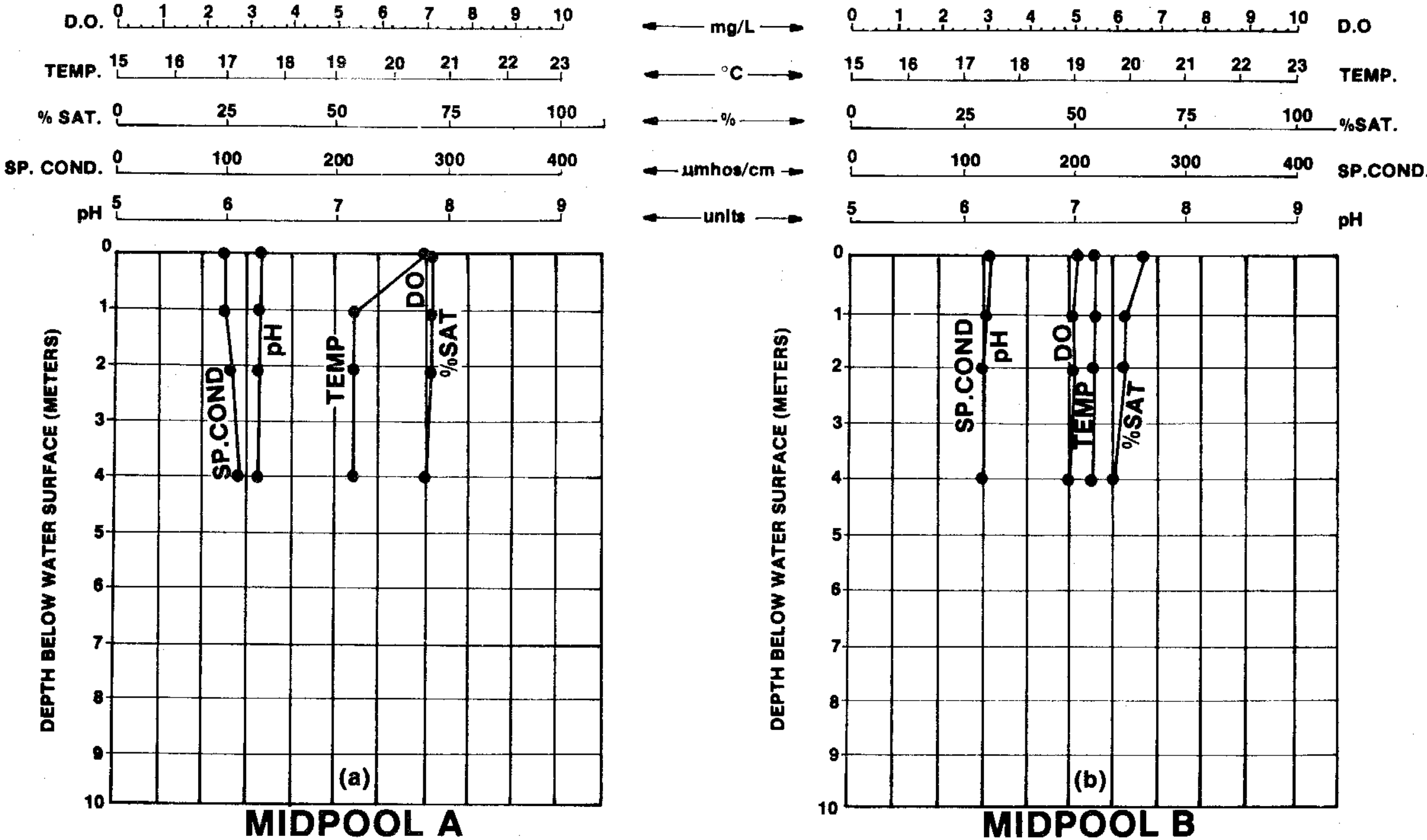


FIGURE 33 FIELD PARAMETER DEPTH PROFILES ALONG C-38 ON JULY 9-11, 1974

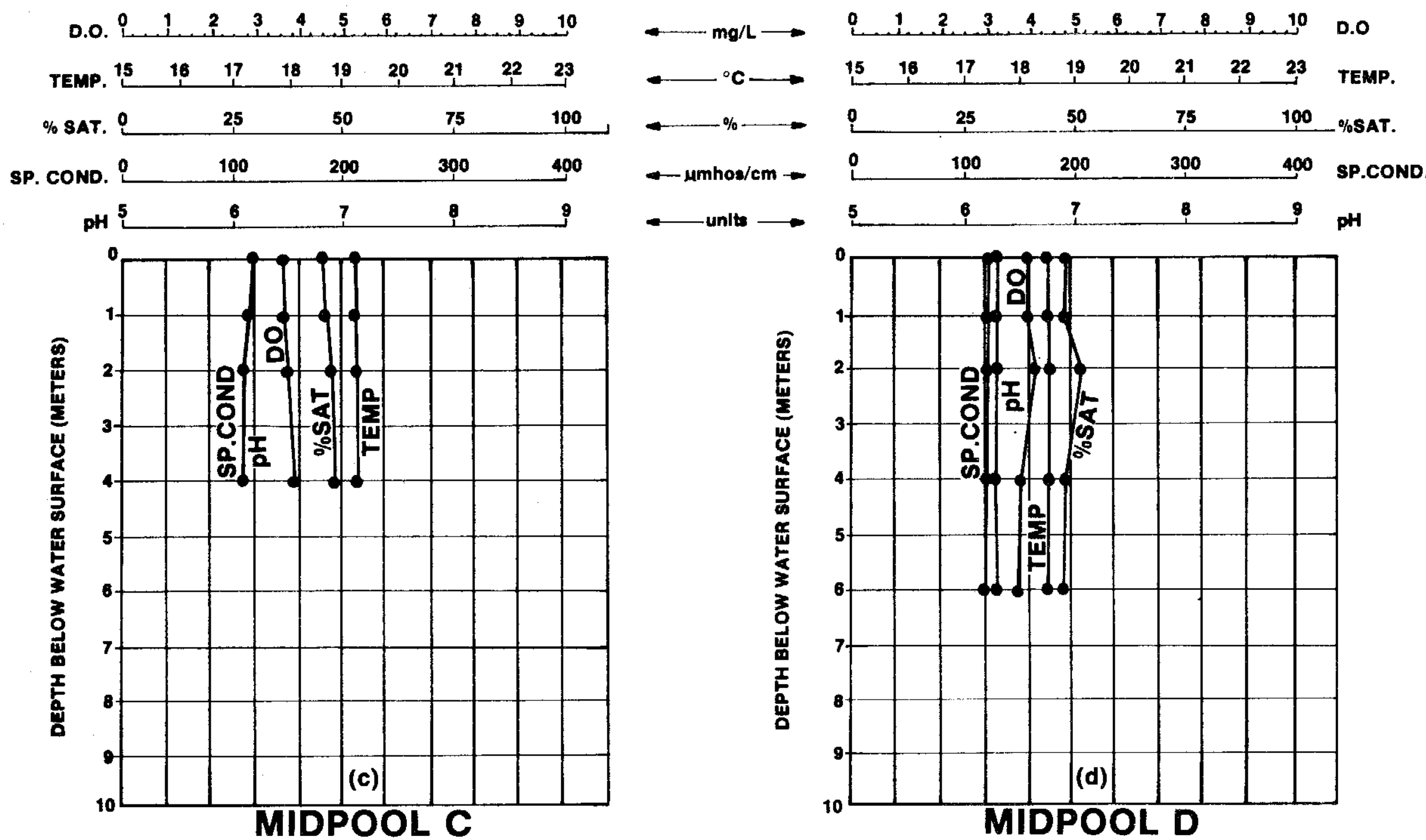


FIGURE 33 (continued)

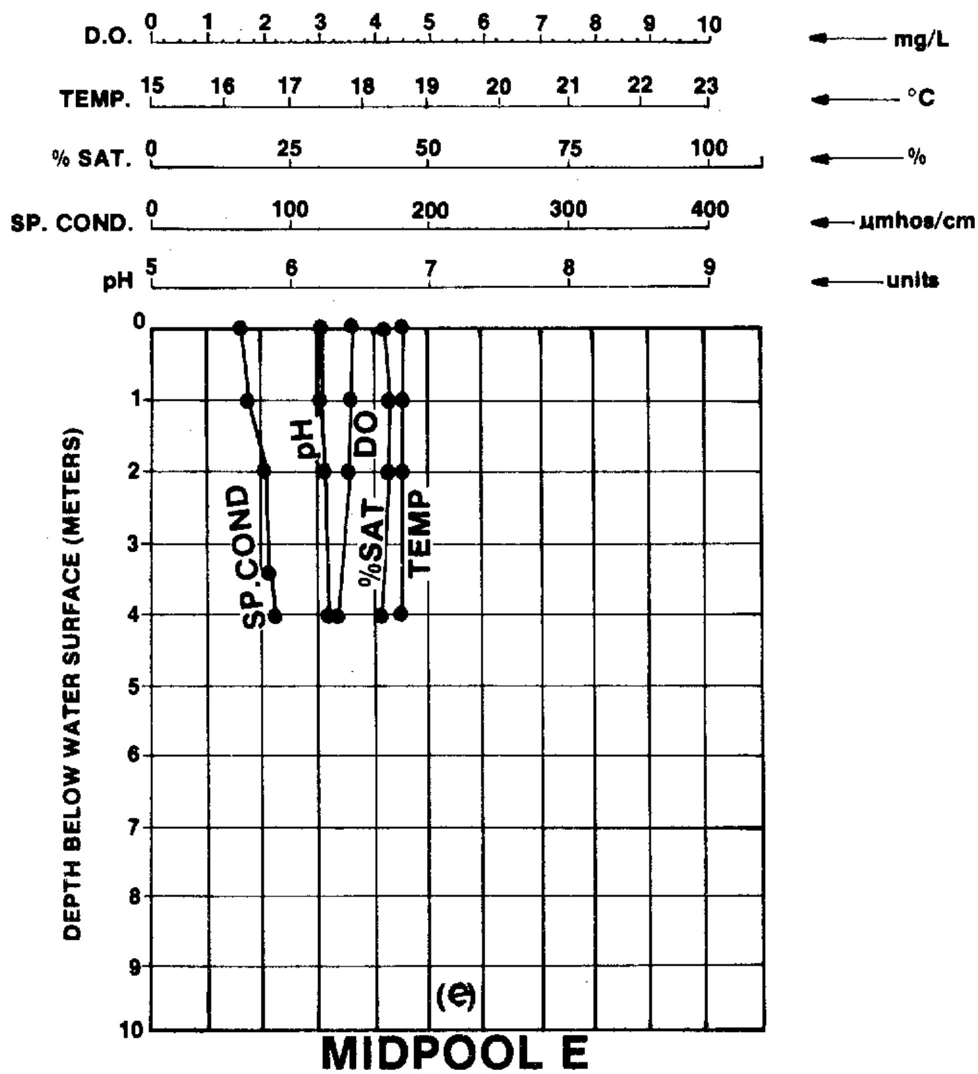


FIGURE 33 (continued)

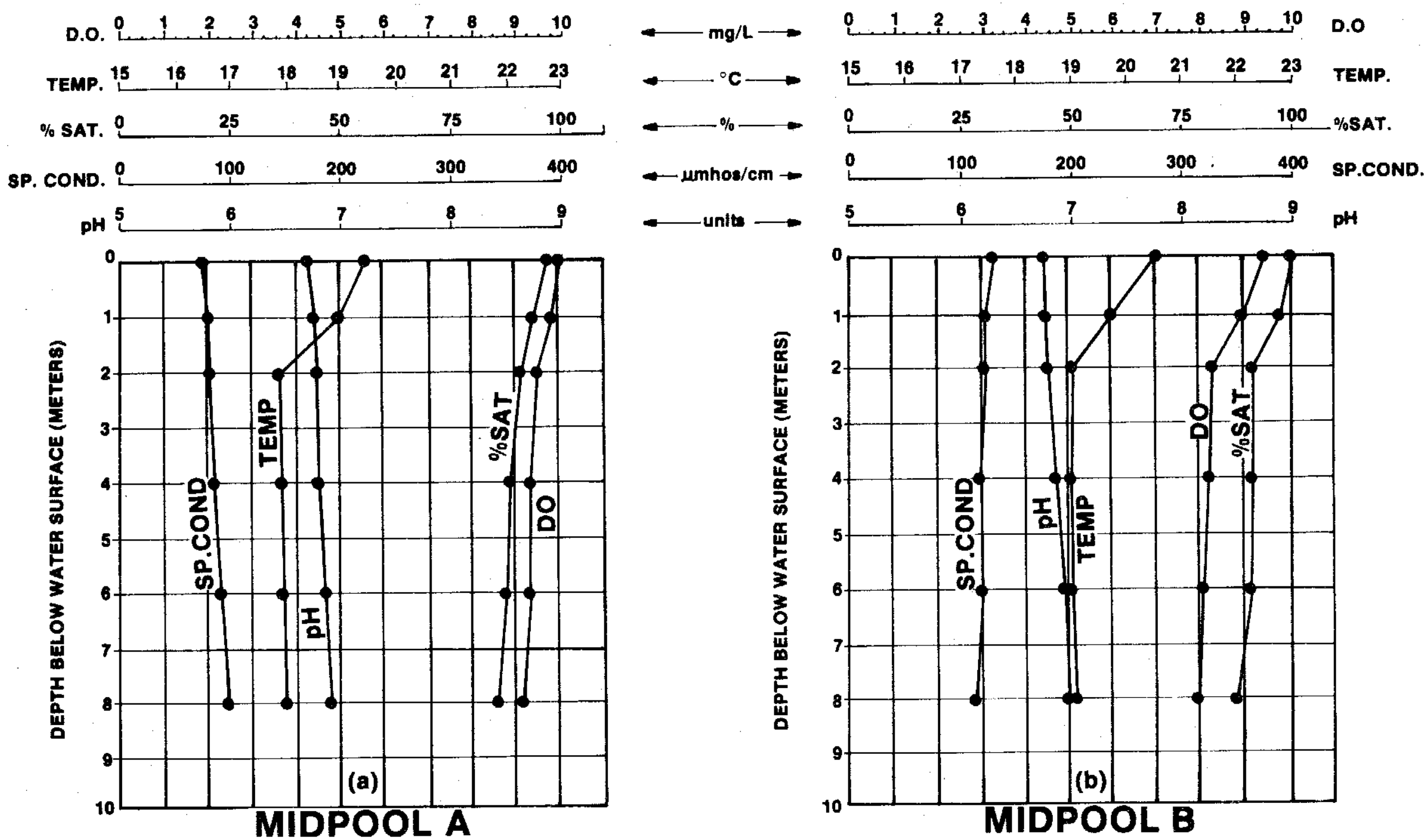


FIGURE 34 FIELD PARAMETER DEPTH PROFILES ALONG C-38 ON FEBRUARY 10-12, 1976

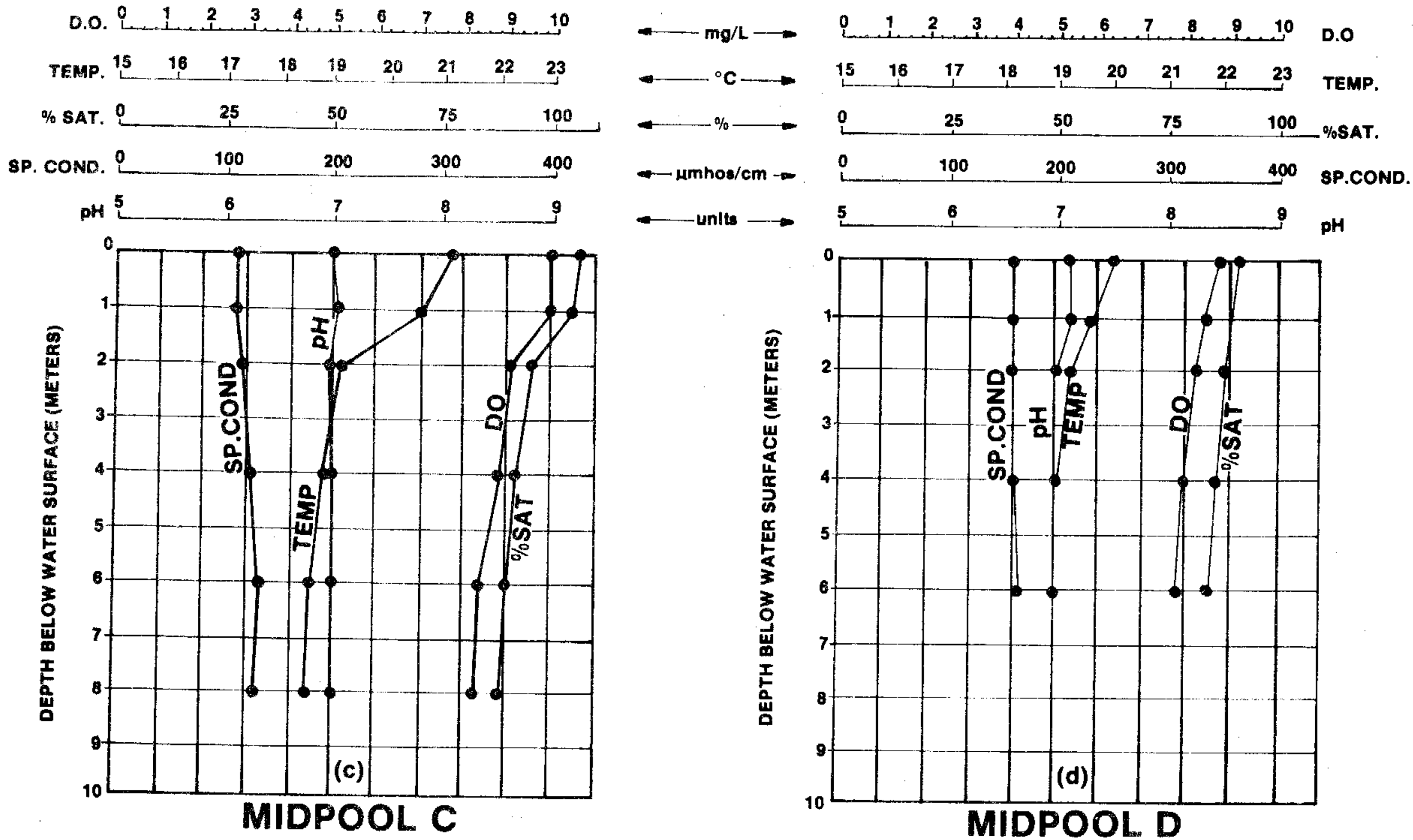


FIGURE 34 (continued)

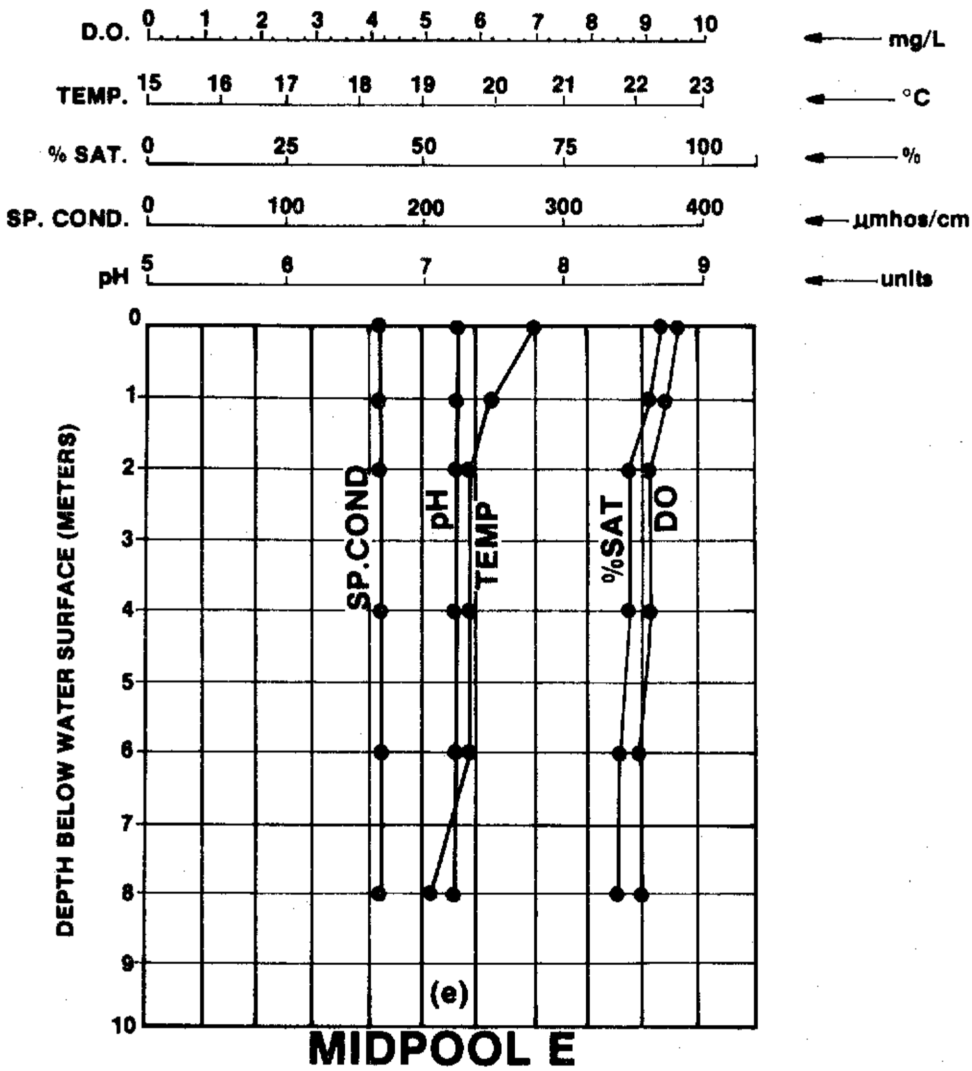


FIGURE 34 (continued)

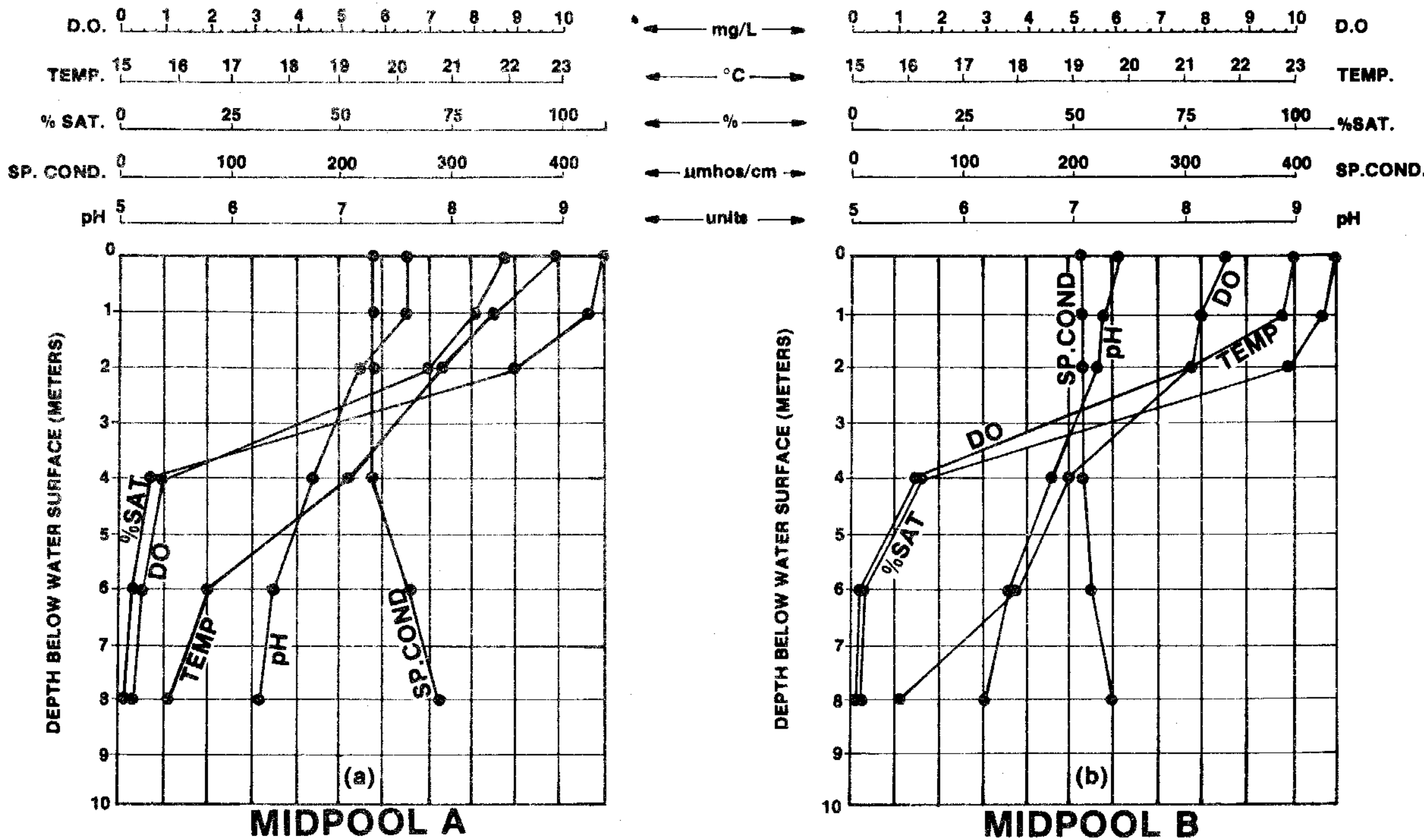


FIGURE 35 PARAMETER FIELD DEPTH PROFILES ALONG C-38 ON JULY 25-27, 1977

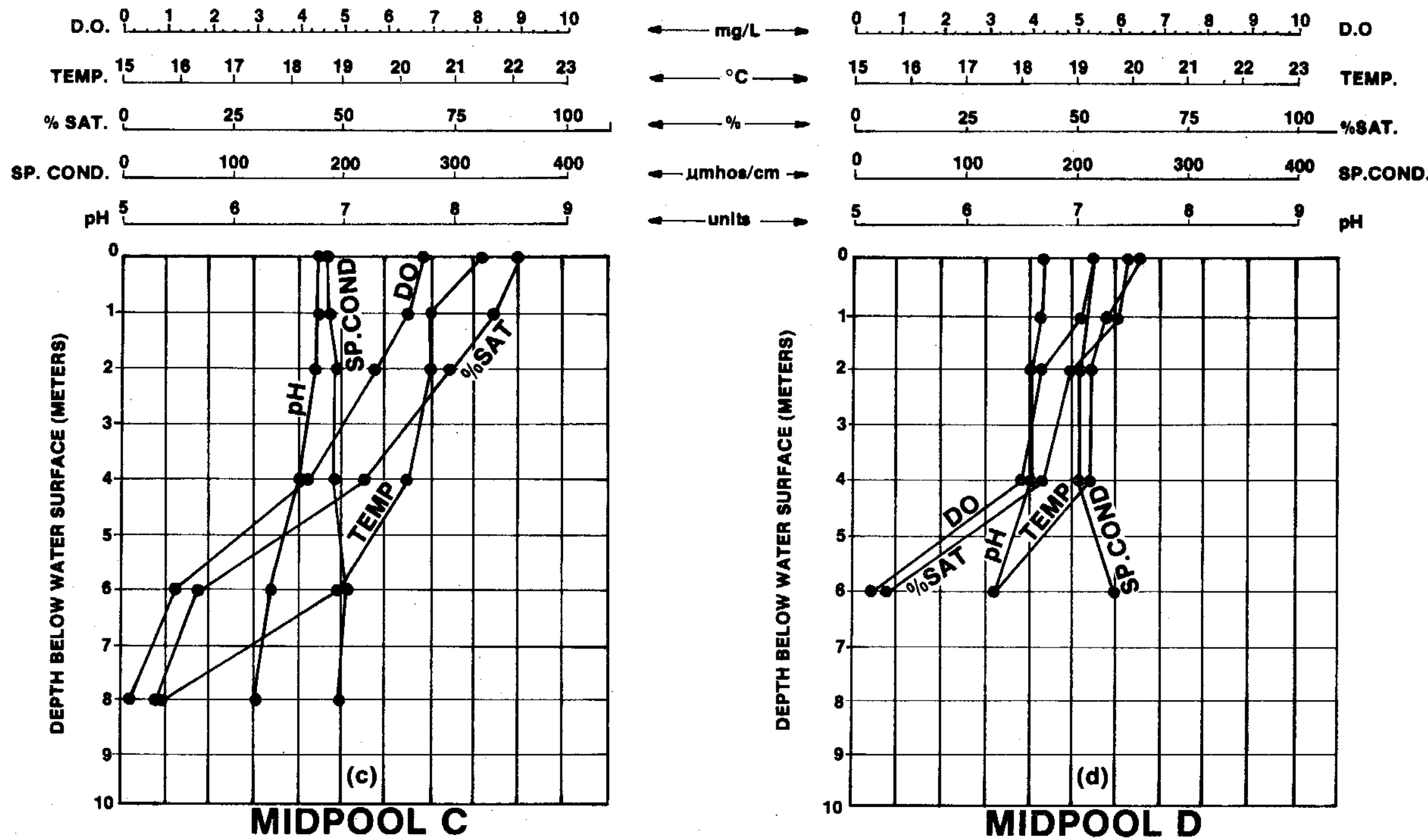


FIGURE 35 (continued)

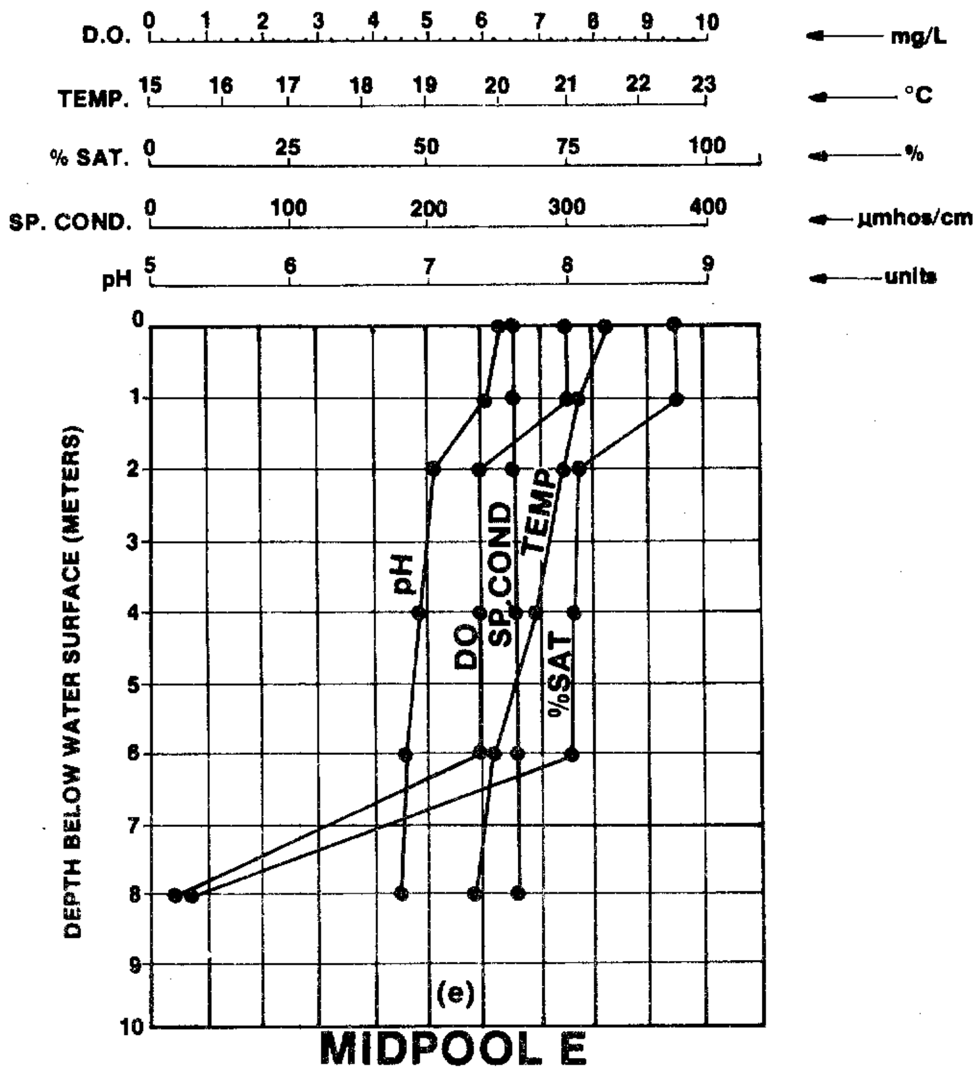


FIGURE 35 (continued)

The pH and specific conductance profiles also displayed gradients. The pH decreased 0.5 to 1 units from top to bottom at the 5 mid-pool stations. The profile gradient for specific conductance was largest at mid-pools A and B, increasing from 30 to 50 μmhos/cm from surface to bottom (Figure 35 a,b). This increasing conductivity gradient became less distinct at mid-pools C and D (Figure 35 c, d) and was non-existent at mid-pool E (Figure 35e).

Depth profiles for the dry season low flow case (January 8 - 10, 1974) were generally less pronounced. Increases in specific conductance were lower, ranging from 0 to 30 μmhos/cm from surface to bottom (Figure 36 a - e). The decreases in pH were also lower, ranging from 0.2 to 0.5 units. Althoagh there were substantial decreases in dissolved oxygen from the surface to bottom, the bottom concentrations did not decline below 3.0 mg/L. In addition, the dissolved oxygen profiles appeared to parallel the temperature profiles. This was in contrast with the wet season case where the bottom dissolved oxygen concentrations were below 1.0 mg/L and where the correlation between temperature and dissolved oxygen was not as well defined.

Figure 37 summarizes the average rate of change versus flow for each depth profile measured at the five mid-pool stations. These values were calculated by subtracting the surface and bottom values for each profile and dividing the difference by the maximum depth. In general, the lower the flow rate the larger the gradient change, although even at very low flows there were occasions when the water column was well mixed. At flow rates greater than 6,000 acre-feet per day the water column in C-38 was usually well mixed with few profile gradients occurring in specific conductance, temperature, dissolved oxygen, and percent saturation.

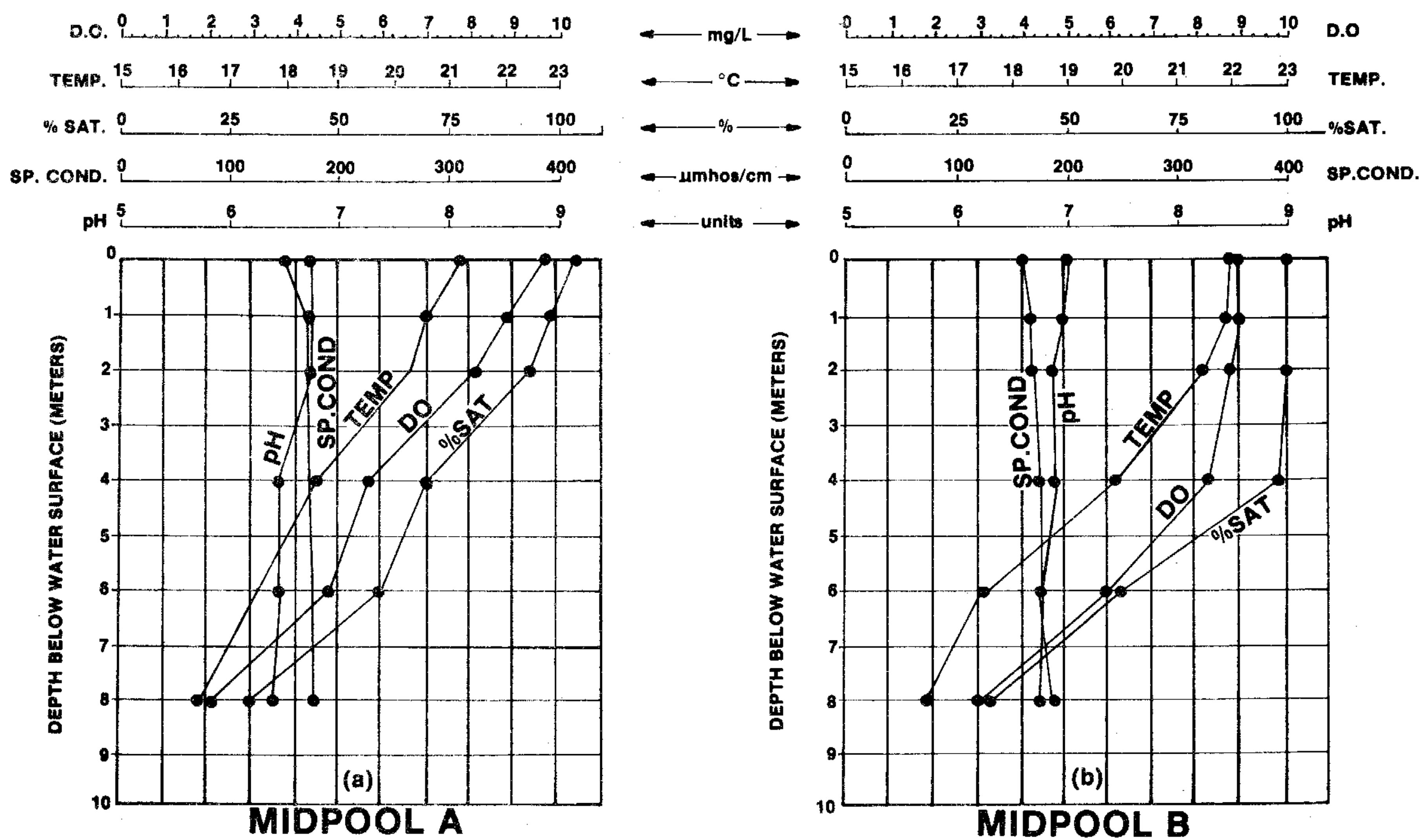


FIGURE 36 FIELD PARAMETER DEPTH PROFILES ALONG C-38 ON JANUARY 8-10, 1974

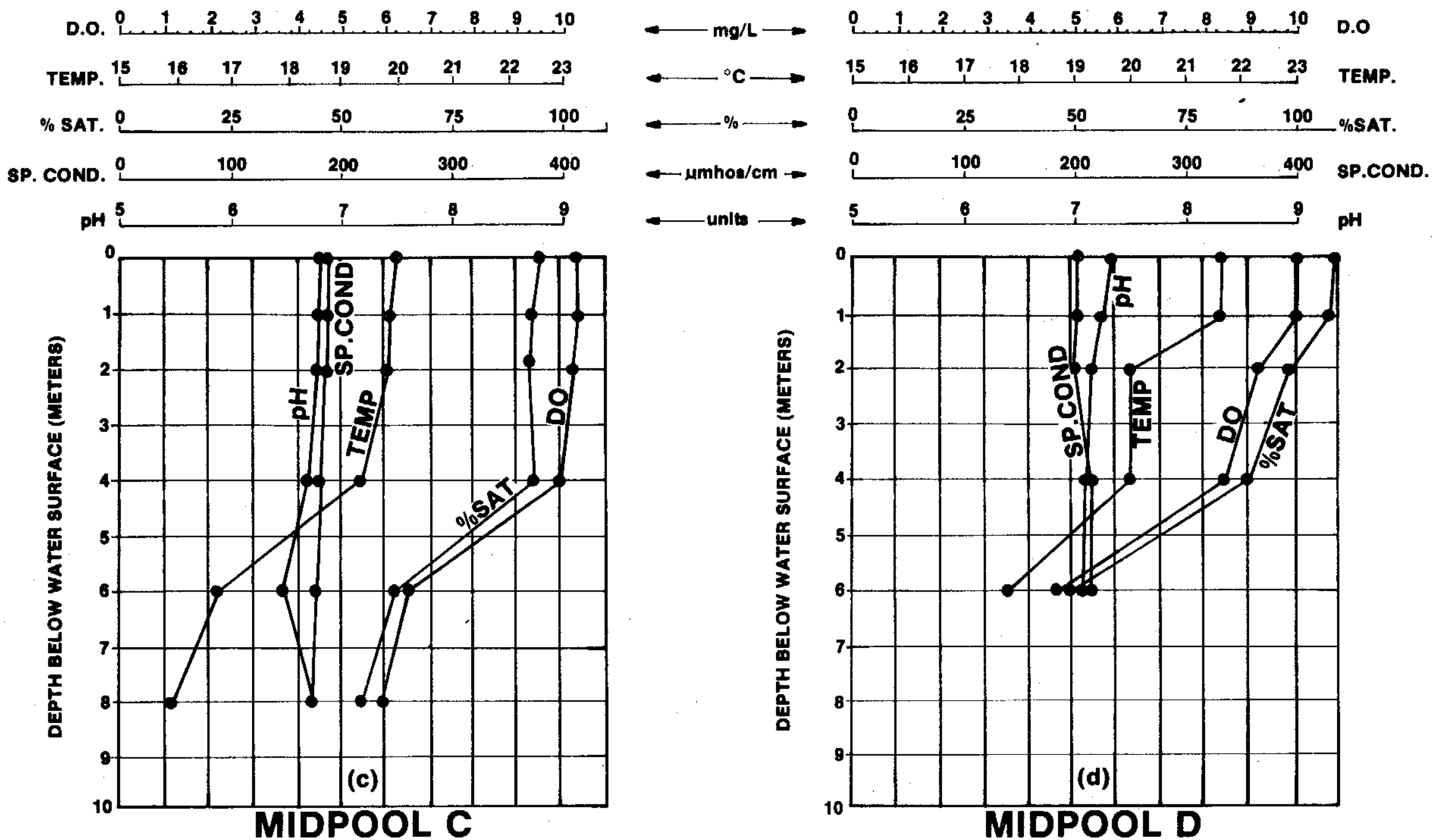


FIGURE 36 (continued)

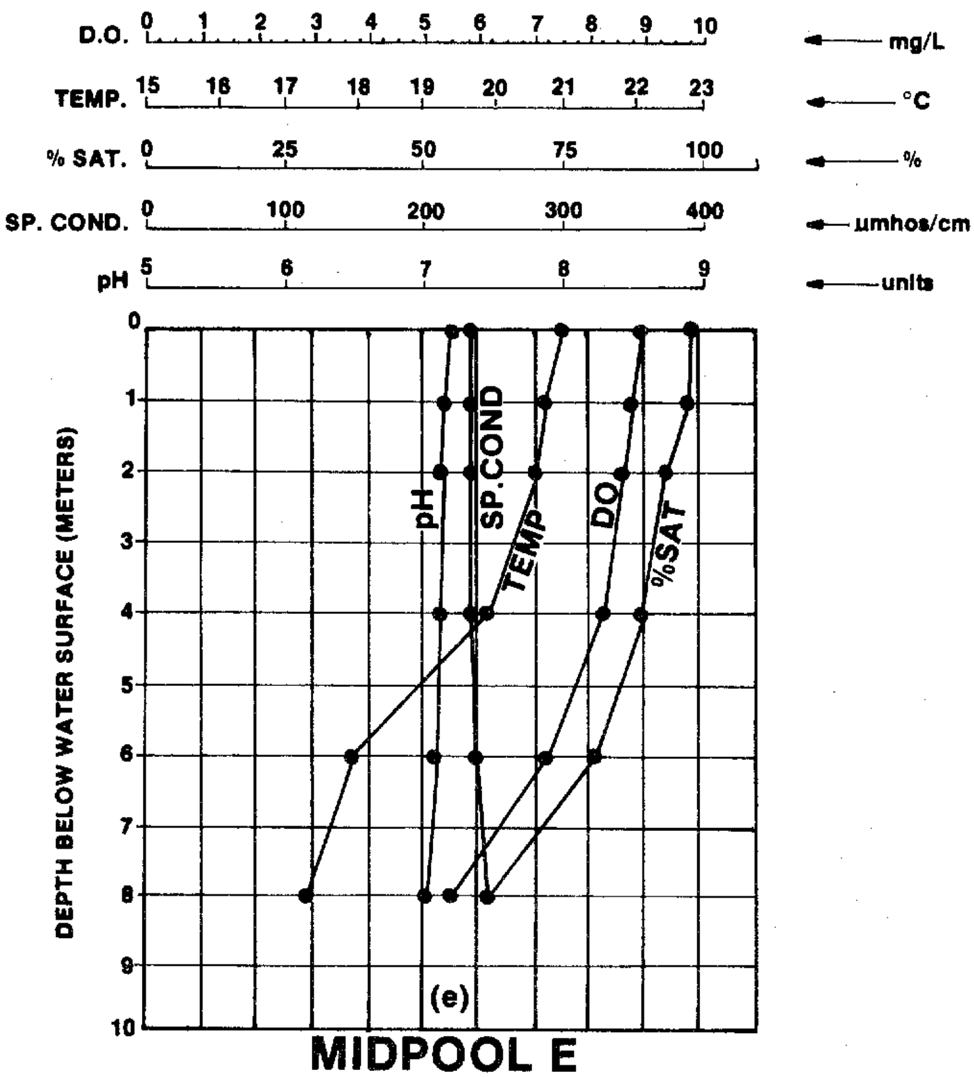


FIGURE 36 (continued)

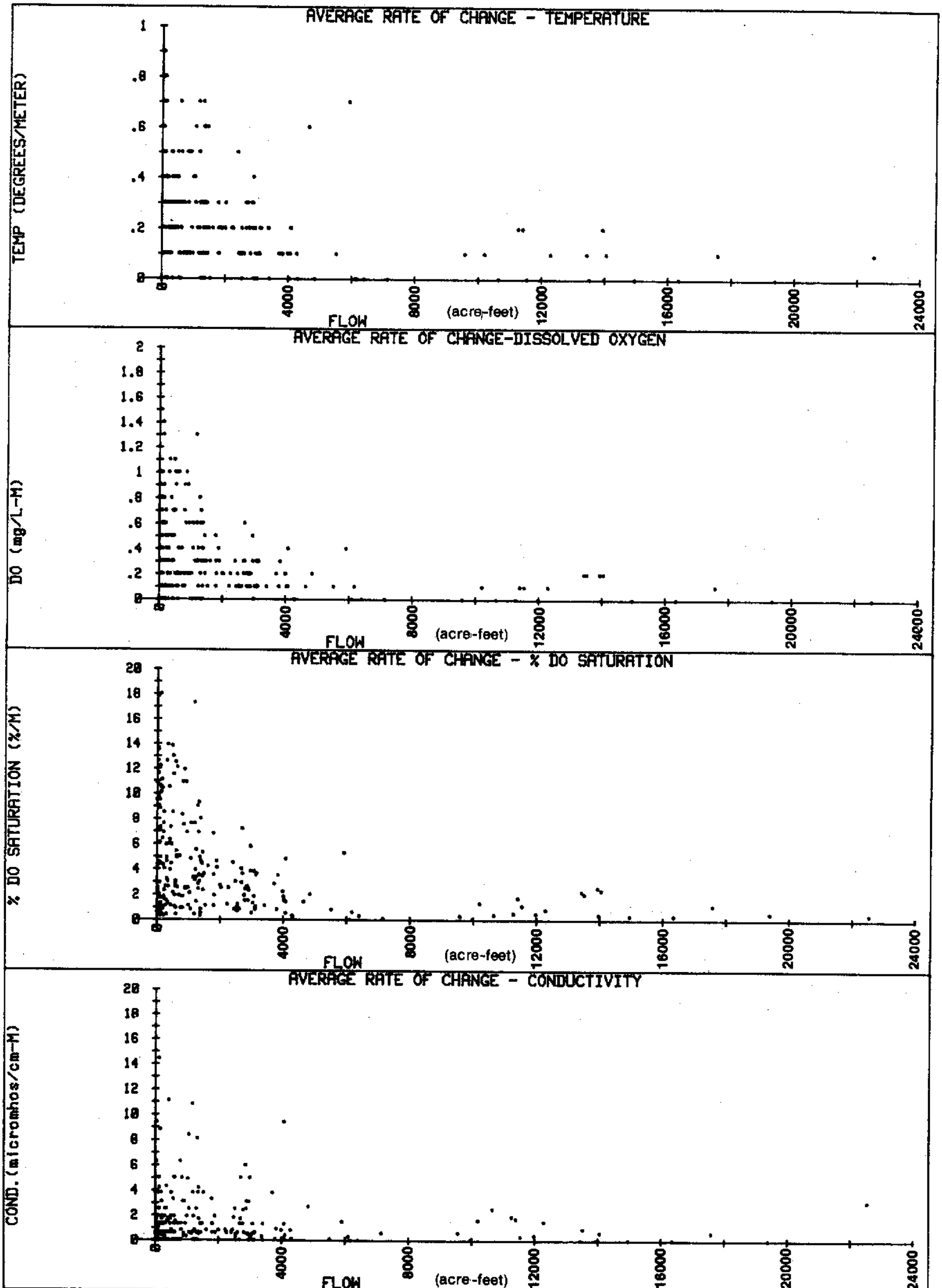


FIGURE 37 AVERAGE RATE OF CHANGE IN DEPTH PROFILES AT MIDPOOLS

As indicated in Table 13, flow rates greater than 6,000 acre-feet per day occurred from 5 to 13 percent of the time, with the frequency increasing in a downstream direction. Below flow rates of 4,000 acre-feet per day there was a sharp increase in the frequency of profile gradients with large changes in values.

TABLE 13. FREQUENCY OF OCCURRENCE FOR DAILY DISCHARGE ALONG C-38 FROM JUNE 1973 TO DECEMBER 1978.

Range Daily Discharge (acre-feet) Min. - Max.	Percent Relative Frequency S-65	S-65A	S-65B	S-65C	S-65D	S-65E
0	13	17	1	11	.7	1.8
1 - 100	32	3	14	9	5.4	14
100 - 200	3.3	9.3	10	6.1	14	11
200 - 300	2.7	7.4	6.1	3.4	5.9	4.5
300 - 400	5.2	5.0	6.8	5.1	4.6	3.5
400 - 500	.5	4.2	4.8	3.8	4.1	3.1
500 - 600	.1	4.9	3.0	2.2	2.2	2.1
600 - 700	3.3	1.7	2.1	2.4	1.9	2.9
700 - 800	1.4	1.4	2.0	1.4	2.4	1.2
800 - 900	.4	2.1	2.8	1.5	2.0	1.8
900 - 1000	.6	1.6	2.2	1.7	1.8	2.6

TABLE 13. (Continued)

Daily Discharge (acre-feet)		Percent Relative Frequency					
Min.	Max.	S65	S65A	S65B	S65C	S65D	S65E
0	1,000	63	57	55	48	45	48
1,000 -	2,000	11	13	15	15	16	14
2,000 -	3,000	7	9	8	10	11	9
3,000 -	4,000	6	8	6	8	8	6
4,000 -	5,000	5	6	4	7	7	6
5,000 -	6,000	3	2	4	4	4	4
6,000 -	7,000	2	2	2	2	2	3
7,000 -	8,000	1	1	1	1	1	2
8,000 -	9,000	1	1	0.8	1	0.8	1
9,000 -	10,000	1	1	0.8	1	0.7	0.8
10,000 -	11,000	1	1	0.6	1	0.8	0.8
11,000 -	12,000	1	0.4	0.5	0.5	0.7	0.6
12,000 -	13,000		0.1	0.8	0.5	0.8	0.6
13,000 -	14,000			0.7	0.5	0.3	0.5
14,000 -	15,000			0.2	0.4	0.2	0.6
15,000 -	16,000			0.3	0.2	0.4	0.4
16,000 -	17,000			0.1	0.1	0.3	0.5
17,000 -	18,000			0.2	0.1	0.2	0.3
18,000 -	19,000			0.2	0.2	0.2	0.5
19,000 -	20,000			0.04	0	0.1	0.2
20,000 -	21,000				0	0.1	0.1
21,000 -	22,000				0.1	0.3	0.04
22,000 -	23,000					0.1	0.1
23,000 -	24,000					0.04	0.04
24,000 -	25,000						0.3
25,000 -	26,000						0
26,000 -	27,000						0.04
27,000 -	28,000						0.04

C-38 MATERIAL LOADS

Presentation and discussion of material loads along C-38 will be restricted to phosphorus, nitrogen, and chloride. Phosphorus and nitrogen are included because of their importance in the eutrophication process, especially in relation to Lake Okeechobee. Chloride is included as a representative conservative parameter. Material loadings were calculated by averaging chronologically successive chemistry data points (collected at a depth of 2 m) and multiplying this average by the daily flows within the time period bounded by the two data points.

Figures 38 to 41 present the total annual discharge, phosphorus, nitrogen, and chloride loads for the six S-65 structures from 1974 to 1978. In general the smaller the discharge, the smaller the corresponding material load. However for each year, the phosphorus and chloride loads were proportionately greater with respect to discharges at S-65D and E than at S-65, A, B, and C. This trend is more evident when the four year mean annual loads for each structure (Table 14) are plotted versus river miles from S-65 (Figure 42). This graphical display of the cumulative material loads shows an exponential increase in the mass of phosphorus and chloride along C-38 with the greatest increase occurring downstream of S-65C. Cumulative and nitrogen load increased only linearly. The cumulative increase in the total drainage area was also only a linear function. These relationships indicate that the phosphorus and chloride loads contributed by Pools A, B, and C were proportionally less than their relative contribution of water and drainage basin area. Pools A, B, and C accounted for a total of 68 percent of the flow to C-38 south of S-65 while contributing only 24 percent of the total phosphorus loads

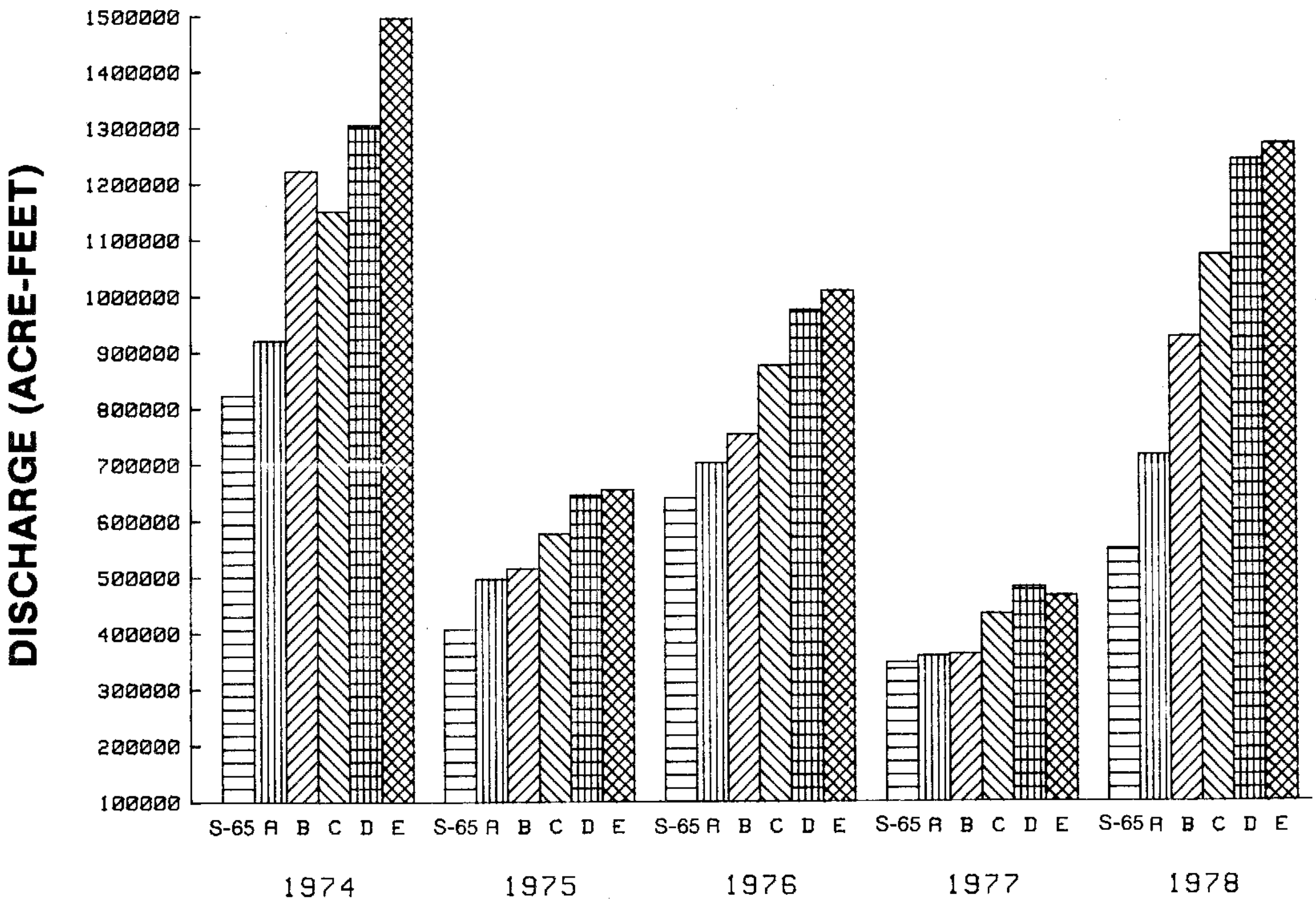


FIGURE 38 ANNUAL DISCHARGE AT S-65 STRUCTURES FROM 1974 to 1978

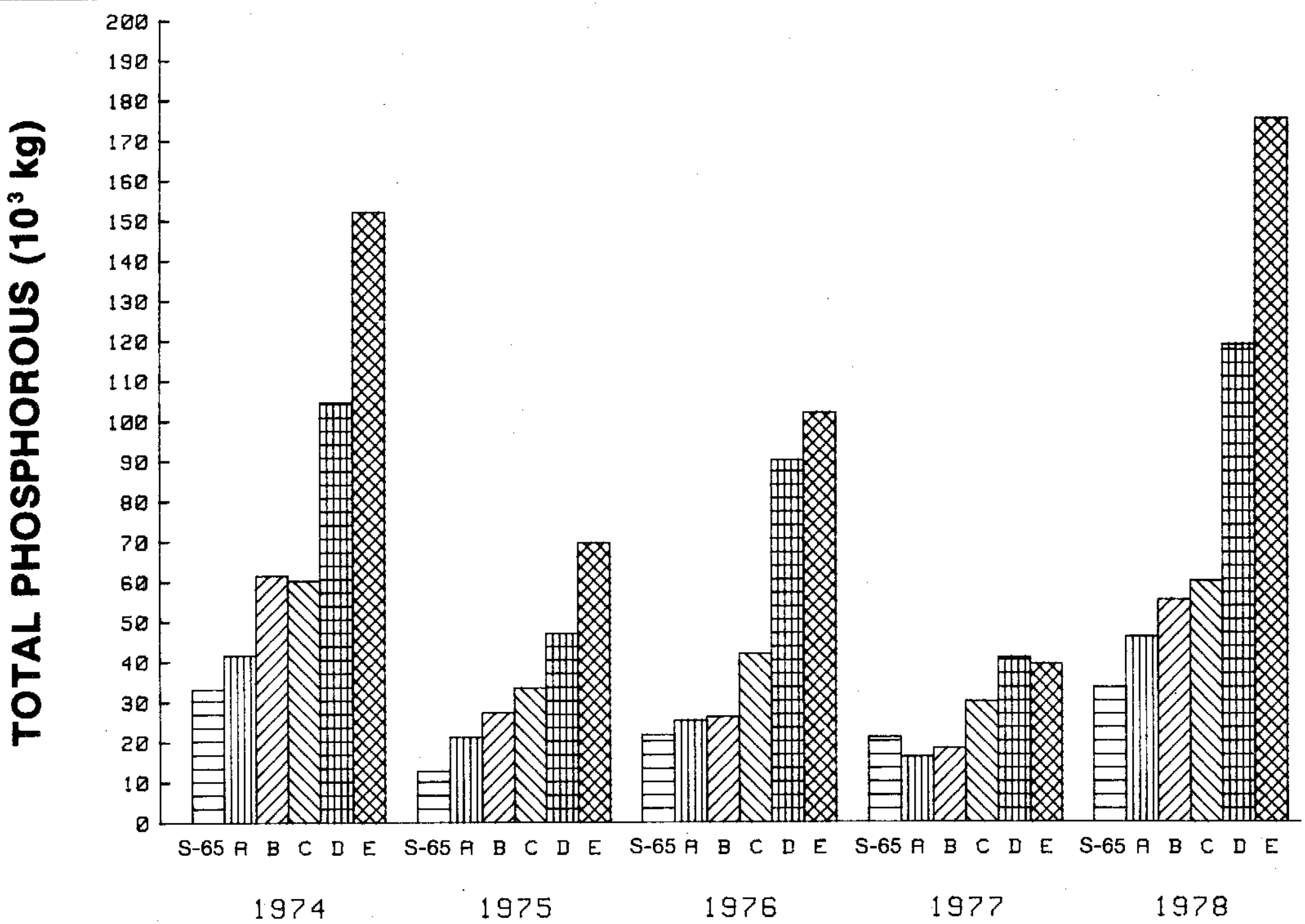


FIGURE 39 ANNUAL PHOSPHORUS LOADS AT S-65 STRUCTURES FROM 1974 to 1978

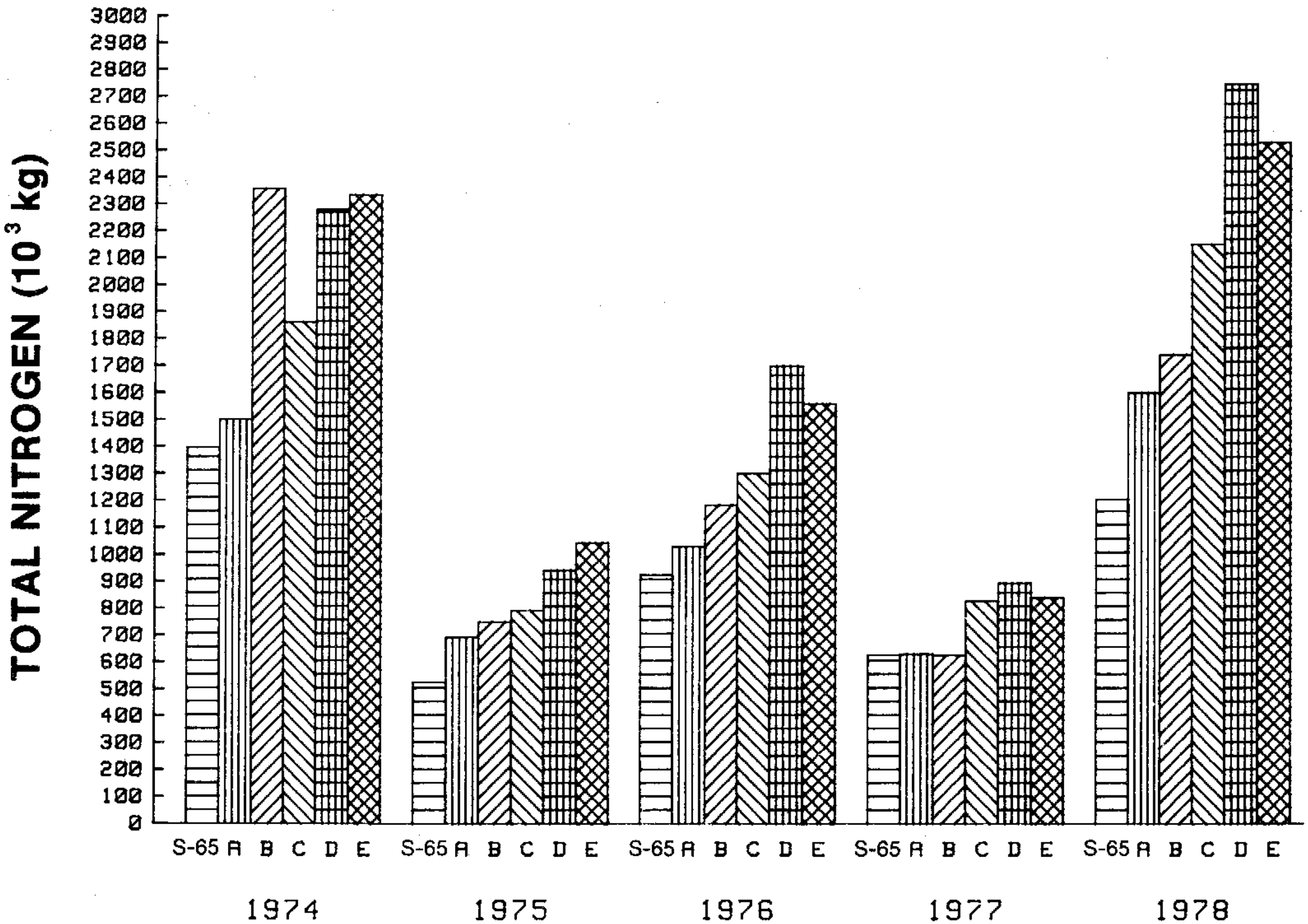


FIGURE 40 ANNUAL NITROGEN LOADS AT S-65 STRUCTURES FROM 1974 to 1978

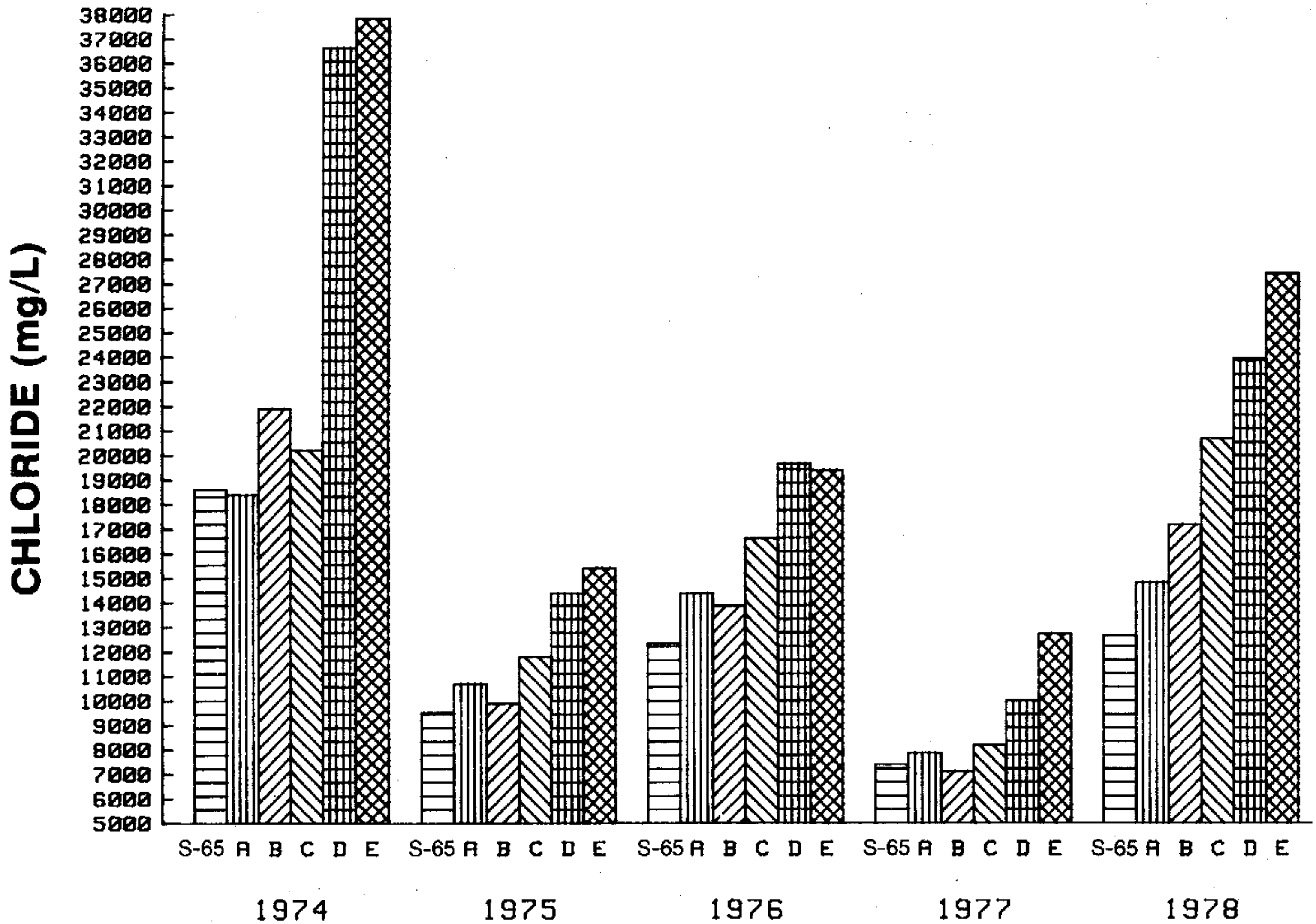


FIGURE 41 ANNUAL CHLORIDE LOADS AT S-65 STRUCTURES FROM 1974 to 1978

TABLE 14. MEAN ANNUAL DISCHARGE AND MATERIAL LOADS FOR C-38 STRUCTURES*

STRUCTURE LOADS

	Discharge (acre-feet)	Load (10^3 kg) Total Phosphorus	Total Nitrogen	Chloride
S65	484,523	24.4	934	12,093
S65A	638,296	30.0	1089	13,215
S65B	755,644	37.7	1329	13,980
S65C	821,450	44.9	1385	15,486
S65D	929,282	80.3	1711	20,908
S65E	978,897	109.6	1660	22,544

NET POOL CONTRIBUTIONS**

	Discharge (acre-feet)	Total Phosphorus	Total Nitrogen	Chloride
Pool A	153,773 (31%)	5.6 (7%)	155 (21%)	1,122 (11%)
Pool B	117,238 (24%)	7.7 (9%)	240 (33%)	765 (7%)
Pool C	65,806 (13%)	7.2 (8%)	56 (8%)	1,506 (14%)
Pool D	107,832 (22%)	35.4 (42%)	326 (45%)	5,422 (52%)
Pool E	49,615 (10%)	29.3 (34%)	-51 (-7%)	1,636 (16%)
Total	494,374	85.2	726	10,451

* Period of record: January 1974 - December 1978

** Net Pool Contribution = downstream structure load - upstream structure load

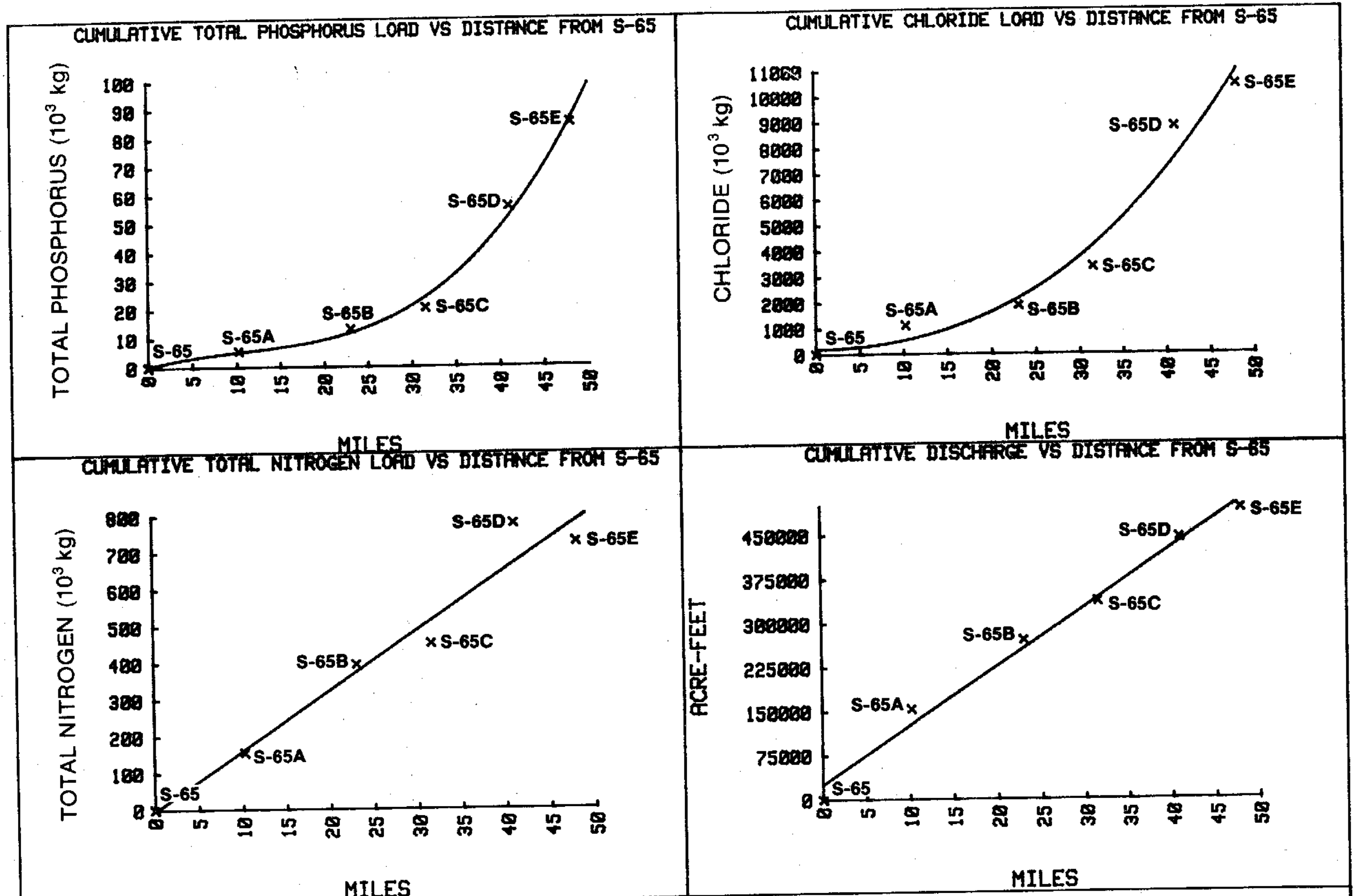
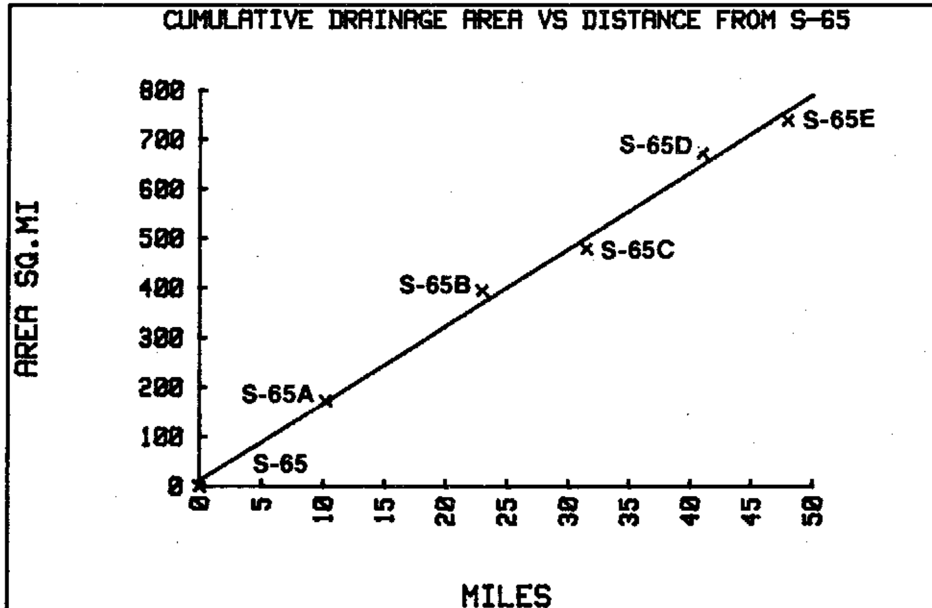


FIGURE 42 CUMULATIVE MATERIAL LOADS, DISCHARGE, AND DRAINAGE AREA ALONG C-38



Regression Equations:

Cumulative TP_{load} = $0.24 + 0.78\ D - 0.04\ D^2 + 0.001\ D^3$ $r^2 = 0.995$

Cumulative Cl_{load} = $211.5 + 1.93\ D + 2.66 D^2 + 0.04\ D^3$ $r^2 = 0.969$

Cumulative TN_{load} = $-2.72 + 16.40\ D$ $r^2 = 0.959$

Cumulative Discharge = $26101.3 + 10044.9\ D$ $r^2 = 0.990$

Cumulative Drainage Area = $11.54 + 15.54\ D$ $r^2 = 0.995$

Where: D = distance (in miles) from S-65

TP, Cl, and TN loads are in tonnes

Discharge is in acre-feet

Drainage area is in square miles

FIGURE 42 (continued). CUMULATIVE MATERIAL LOADS, DISCHARGE, AND DRAINAGE AREA ALONG C-38 and 32 percent of the chloride load (Table 14).

The contribution of phosphorus and chloride from Pools D and E, however, were proportionally greater than their relative contribution of water and drainage area. Pools D and E accounted for 22 and 10 percent of the flow to C-38, respectively, while contributing 42 and 34 percent of the total phosphorus load,and 52 and 16 percent of the chloride load (Table 14).

Table 15 presents a breakdown of the net runoff rates for water, total phosphorus, total nitrogen and chloride for each pool. The different land uses in each pool had apparently little effect on the total amount of runoff and total nitrogen which entered C-38. The runoff (in feet) remained fairly constant, ranging from 0.82 feet (Pool B) to 1.39 (Pool A). Since these runoff rates were based upon the differences between the down-stream structure discharge and the upstream structure discharge, they represent the net surface and subsurface inflow (if any) to the pool. However, these figures don't account for the time it takes a given quantity of water to reach C-38 from the pool basin. The net runoff rate for nitrogen also remained fairly constant, ranging from 1.03 kg/acre (Pool C) to 2.64 lbs/acre (Pool D). The net runoff rate for Pool E could not be calculated since there was a calculated net loss of nitrogen from the pool.

Land use did have a substantial impact on the phosphorus net runoff rates. The net runoff for phosphorus increased over an order of magnitude from 0.05 kg/acre in Pool A to 0.69 kg/acre in Pool E as the land use intensified in a downstream direction. The runoff rate for chloride increased similarly to phosphorus, although not as dramatically or con-sistently. The chloride runoff rate for the lower intensity land uses (Pools A, B, and C) was lower than the rate for the higher intensity

TABLE 15. NET RUNOFF RATES FOR C-38 POOLS*

	Discharge (feet)	Total Phosphorus (kg/acre)	Total Nitrogen (kg/acre)	Chloride (kg/acre)
Pool A	1.39	.05	1.40	10.2
Pool B	.82	.05	1.69	5.4
Pool C	1.21	.13	1.03	27.8
Pool D	.87	.29	2.64	44.0
Pool E	1.17	.69	-	38.6

* Period of Record: 1974-1978

land uses which included five dairy operations (Pools D and E).

Similar relationships were evident when flow weighted pool concentrations were compared. The flow weighted phosphorus concentrations in Pool A, B, and C tributaries were 0.030, 0.053, and 0.089 mg/L, respectively (Table 16). However, for the intensively utilized basins (Pools D and E) the flow weighted phosphorus concentrations in the tributaries were 5 to 10 times higher at 0.266 and 0.479 mg/L, respectively. The flow weighted chloride concentrations also showed marked increases in Pools D and E (40.8 and 26.7 mg/L, respectively). The flow weighted total nitrogen concentrations presented in Table 16 were relatively constant, ranging from 1.37 mg/L (S-65C) to 1.56 mg/L (S-65).

In summary, the more intensive agricultural practices in Pools D and E appear to have little effect on the total (surface and subsurface) runoff rate for water and nitrogen, a moderate effect on the runoff rate for chloride, and a substantial effect on the phosphorus runoff rate. These trends appear plausible since the more intensive land uses in the C-38 basin usually involve ditching which allows the runoff to reach C-38 faster than a more natural drainage pattern. This shortened hydraulic residence time would not appreciably alter the total quantity of water leaving the basin (as the water runoff rates indicate); however, it would substantially reduce the contact time available for biological assimilation and physical adsorption of the phosphorus and thereby increase the phosphorus runoff rate. The chloride runoff rate also tends to be higher in the pools where intensive dairy operations are located. Groundwater, which is characteristically higher in chloride, is used in normal dairy management for barnwashing and cleansing of dairy cattle prior to milking. The variations in total nitrogen runoff rates could not be related to land use practices.

TABLE 16. FLOW WEIGHTED CONCENTRATIONS OF SELECTED PARAMETERS ALONG C-38*

	Structure Concentrations Concentration (mg/L)		
	Total Phosphorus	Total Nitrogen	Chloride
S65	0.041	1.56	20.2
S65A	0.038	1.38	16.8
S65B	0.040	1.43	15.0
S65C	0.070	1.37	15.3
S65D	0.091	1.49	18.2
S65E	0.091	1.38	18.7
	Pool Tributary Concentrations		
Pool A	0.030	0.82	5.9
Pool B	0.053	1.66	5.3
Pool C	0.089	0.09	18.6
Pool D	0.266	2.45	40.8
Pool E	0.479	-	26.7

* Period of record 1974-1978

** Calculated from data presented in Table 14

CHAPTER VII

PREVIOUS WATER QUALITY STUDIES

This report represents the only long term (5½ year) comprehensive water quality study of C-38 and its tributaries. Three other previous major water quality studies have been conducted and reported on the Lower Kissimmee River although their objectives were different from this report. The first was conducted by the United States Geological Survey from July 1971 to June 1973 and was reported by Lammonds (1975). This USGS report focused attention on the main C-38 channel in an effort to determine the quality of water, nutrient loads, and seasonal and discharge related variations along C-38. Tributary input was not directly measured for considered in the study. The major conclusions of Lammond's report were similar to some presented in this study. Lammonds reported a similar trend of increasing phosphorus concentrations (three-fold) from S-65 to S-65E. The average total phosphorus concentration at S-65E was 0.08 mg/L from July 1971 to June 1973 which was similar to the average of 0.092 mg/L reported in this study. Nitrogen levels were also similar between the two studies. Similar trends of increasing calcium and bicarbonate levels in a downstream direction were also observed. The percent contributions of water, nitrogen, and phosphorus at S-65 and S-65E were also in close agreement. There were some relatively small differences in the loads reported for S-65A through S-65D. However, the Lammond's study did not base the loads on actual discharge measurements, as did this study. Lammond instead relied upon discharge estimations based upon Pool drainage area ratios and average increases between S-65 and S-65E. Pesticide and trace metal scans and sediment analysis reported by Lammond were not performed in this study.

The second major study involved a survey of water quality in the Kissimmee-Okeechobee watershed conducted by Federico and Brezonik (1975) under the auspices of the "Special Project to Prevent the Eutrophication of Lake Okeechobee". The Federico and Brezonik study involved the sampling of 96 stations in the Kissimmee River-Taylor Creek/Nubbin Slough basins. These stations were sampled four times during 1974, twice during low flow and twice during high flow conditions. Of the 96 stations, 48 were located in the Lower Kissimmee River Basin. Site selection was predominantly at the mouth of tributaries and in the oxbows receiving tributary runoff. The basic conclusions presented by Federico and Brezonik were similar to this study. Ice Cream Slough had the best water quality and Chandler Slough had the worst. Water quality was generally poorer during periods of flow as was the case in this study.

Huber et al. 1976, conducted the last major study of environmental conditions in the Kissimmee River Basin. Their study focused upon management alternatives in the basin (i.e., storage/treatment systems) and the transition of the Basin from a status typified by natural vegetation with low intensity agriculture to one increasingly characterized by intensive agriculture and urbanization. The data used for their quantity/quality models were supplied by the SFWMD. The quality data was the same as the 1973 data presented in this report. Their general conclusions were: (1) total phosphorus concentrations increased as drainage densities increased; (2) lakes, swamps and marshes, and reservoirs acted as storage/treatment devices because of attenuation of both flood peaks and pollutant concentrations; (3) significant peak flow attentuation was accomplished when at least 15 percent of the surface area remained as lakes or marshes; and (4) the most significant reduction in detention times appears to be caused by upland drainage, since average travel times in C-38 were not reduced from the pre-channelized conditions.

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APPENDIX A

MEAN WET SEASON CONCENTRATIONS FOR
C-38 TRIBUTARIES

All units in mg/L except:

alkalinity	-	meq/L
pH	-	standard units
conductivity	-	μmhos/cm
turbidity	-	NTU
color	-	Pt units

Phosphorus is as P
Nitrogen is as N

WET SEASON DATA FOR C-38 AND TRIBUTARIES
MAY 1 ST THRU OCT 31 : 1973 - 1978

S-65 UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	33	0.032	0.011	0.019	0.068
OPO4	32	0.002	0.002	0.002	0.010
TN	31	1.367	0.340	0.970	2.060
NO3	30	0.027	0.063	0.004	0.342
NO2	32	0.005	0.002	0.002	0.010
NH4	33	0.038	0.056	0.010	0.320
TKN	33	1.336	0.326	0.950	2.050
CL	33	17.967	4.012	11.900	28.100
NA	25	11.185	2.610	4.400	16.000
K	24	1.439	0.509	0.200	2.300
CA	22	9.098	4.081	5.000	18.540
MG	22	3.215	0.624	2.390	4.600
SIO2	30	2.830	1.298	0.800	7.500
SO4	22	11.864	11.008	3.000	57.800
ALK	26	0.398	0.209	0.100	1.000
'DORGC	2	11.150	9.546	4.400	17.900
TOTORGC	6	13.950	2.018	11.100	16.000
DO	90	5.828	1.585	1.300	8.900
PH	87	6.549	0.517	5.500	7.900
COND	90	133.511	32.824	73.000	235.000
TURB	14	4.829	2.341	1.700	9.400
COLOR	8	60.625	31.076	31.000	132.000

S-65 DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	31	0.040	0.023	0.018	0.107
OPO4	31	0.007	0.010	0.002	0.046
TN	27	1.363	0.389	0.990	2.630
NO3	26	0.020	0.028	0.004	0.122
NO2	30	0.005	0.002	0.004	0.011
NH4	31	0.050	0.046	0.010	0.190
TKN	30	1.322	0.386	0.810	2.630
CL	30	18.070	5.839	11.900	42.200
NA	22	10.905	2.439	4.400	15.000
K	21	1.407	0.476	0.180	2.280
CA	20	9.528	4.034	5.200	18.870
MG	20	3.279	0.684	2.390	4.570
SIO2	27	2.511	0.954	0.800	4.500
SO4	23	9.683	4.106	3.000	20.200
ALK	28	0.451	0.219	0.100	1.180
TDORGC	3	29.867	20.358	12.800	52.400
TOTORGC	6	16.117	4.072	12.400	24.000
DO	92	5.843	1.632	1.000	8.300
PH	90	6.587	0.552	5.550	8.200
COND	93	135.968	30.336	84.000	235.000
TURB	14	4.107	2.184	1.100	7.900
COLOR	8	70.875	39.708	49.000	168.000

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S-65A UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	31	0.038	0.020	0.016	0.099
OPO4	31	0.009	0.013	0.001	0.051
TN	29	1.341	0.395	0.780	2.730
NO3	28	0.022	0.032	0.001	0.117
NO2	30	0.006	0.003	0.004	0.018
NH4	31	0.066	0.076	0.010	0.270
TKN	31	1.305	0.390	0.770	2.730
CL	30	17.077	4.171	8.900	25.400
NA	23	14.701	19.729	3.050	104.180
K	22	1.334	0.480	0.170	2.280
CA	20	9.128	4.467	5.200	18.520
MG	20	2.982	0.858	1.080	4.600
SIO2	28	3.275	1.557	1.000	9.000
SO4	23	11.443	7.072	3.000	40.200
ALK	27	0.449	0.190	0.100	0.820
TDORGC	3	28.133	13.149	17.400	42.800
TOTORGC	6	15.317	3.845	11.500	21.700
DO	91	4.754	1.933	1.000	8.400
PH	85	6.346	0.598	5.200	8.100
COND	91	135.868	33.546	82.000	235.000
TURB	14	3.793	2.643	0.600	9.500
COLOR	8	119.375	64.049	50.000	232.000

S65A DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	30	0.043	0.024	0.020	0.097
OPO4	30	0.008	0.013	0.002	0.047
TN	26	1.312	0.306	0.930	1.840
NO3	26	0.039	0.054	0.004	0.179
NO2	29	0.007	0.005	0.004	0.028
NH4	30	0.088	0.087	0.010	0.340
TKN	30	1.260	0.297	0.820	1.830
CL	30	18.037	6.525	8.900	43.100
NA	22	10.245	2.542	3.050	14.850
K	21	1.314	0.484	0.170	2.340
CA	19	9.608	4.350	4.730	18.380
MG	19	2.839	0.728	1.040	4.060
SIO2	27	3.122	1.124	1.000	4.800
SO4	22	10.155	3.417	3.000	16.100
ALK	26	0.428	0.195	0.100	0.880
TDORGC	4	25.700	11.590	14.800	42.000
TOTORGC	6	15.300	2.983	11.100	17.900
DO	91	4.607	1.889	1.700	11.000
PH	85	6.349	0.620	5.250	8.000
COND	88	134.477	34.239	48.000	215.000
TURB	14	4.229	2.170	1.600	9.200
COLOR	8	129.375	66.990	52.000	225.000

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S-65B UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	30	0.041	0.016	0.020	0.079
OPO4	31	0.010	0.010	0.002	0.043
TN	28	1.317	0.321	0.710	2.210
NO3	27	0.025	0.033	0.004	0.117
NO2	29	0.007	0.004	0.004	0.022
NH4	31	0.083	0.076	0.010	0.300
TKN	31	1.273	0.307	0.710	2.170
CL	31	15.423	3.750	8.200	24.500
NA	23	9.348	2.325	3.240	14.000
K	22	1.111	0.526	0.080	2.180
CA	20	9.715	3.530	5.930	18.540
MG	20	2.828	0.918	1.080	4.600
SIO2	27	3.315	1.260	1.000	6.100
SO4	23	11.752	6.171	3.000	35.200
ALK	27	0.422	0.192	0.100	0.900
TDORGC	3	27.467	15.368	13.000	43.600
TOTORGC	6	14.600	3.174	9.500	18.800
DO	88	4.339	2.020	0.500	9.000
PH	80	6.197	0.637	4.500	7.500
COND	85	127.035	33.432	75.000	210.000
TURB	14	3.114	2.063	0.500	7.200
COLOR	8	122.875	73.513	53.000	232.000

S-65B DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	30	0.043	0.021	0.017	0.103
OPO4	30	0.012	0.016	0.002	0.073
TN	27	1.336	0.405	0.630	2.560
NO3	26	0.036	0.046	0.004	0.189
NO2	29	0.007	0.004	0.004	0.020
NH4	30	0.084	0.084	0.010	0.290
TKN	30	1.275	0.389	0.630	2.510
CL	29	15.224	3.516	8.000	23.700
NA	22	15.650	29.411	3.240	147.000
K	21	1.530	2.300	0.110	11.300
CA	20	11.532	9.863	5.400	51.200
MG	19	2.689	0.770	1.080	4.100
SIO2	26	2.962	1.269	0.900	5.100
SO4	22	10.582	3.624	3.000	16.000
ALK	27	0.435	0.207	0.130	1.070
TDORGC	4	22.950	14.142	9.200	42.100
TOTORGC	6	15.417	4.098	9.300	19.700
DO	87	4.185	2.016	0.700	9.700
PH	81	6.291	0.665	4.500	7.600
COND	84	129.655	33.148	55.000	195.000
TURB	14	3.307	2.668	0.500	9.100
COLOR	8	115.000	65.131	55.000	200.000

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	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
S-65C UPSTREAM	TPO4	33	0.044	0.021	0.002	0.118
	OPO4	33	0.011	0.014	0.001	0.062
	TN	33	1.332	0.507	0.710	3.340
	NO3	32	0.025	0.033	0.004	0.110
	NO2	33	0.007	0.005	0.004	0.022
	NH4	34	0.091	0.082	0.010	0.320
	TKN	34	1.300	0.499	0.710	3.300
	CL	34	15.571	3.613	9.000	25.000
	NA	24	9.335	2.038	4.560	13.000
	K	23	1.134	0.418	0.130	2.000
	CA	21	9.412	3.009	5.980	16.520
	MG	21	2.829	0.713	1.560	4.400
	SIO2	29	3.090	1.171	0.800	5.100
	SO4	25	11.004	3.372	3.000	16.100
	ALK	30	0.445	0.176	0.120	0.840
	TDORGC	4	22.625	13.522	10.500	41.600
	TOTORGC	9	16.067	9.566	5.600	37.700
	DO	100	3.753	1.790	0.500	7.700
	PH	94	6.265	0.538	5.400	7.450
	COND	97	139.278	40.639	90.000	310.000
	TURB	17	2.753	1.542	0.700	5.500
	COLOR	11	108.364	44.318	53.000	208.000

	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
S-65C DOWNSTREAM	TPO4	28	0.055	0.025	0.017	0.111
	OPO4	28	0.018	0.017	0.002	0.057
	TN	26	1.394	0.435	0.740	2.660
	NO3	26	0.061	0.116	0.001	0.572
	NO2	28	0.006	0.004	0.004	0.019
	NH4	28	0.101	0.073	0.010	0.270
	TKN	28	1.306	0.425	0.740	2.580
	CL	29	16.586	3.681	7.300	24.700
	NA	21	9.830	2.386	4.890	15.000
	K	20	1.210	0.473	0.260	2.200
	CA	18	10.398	4.516	4.310	18.520
	MG	18	2.687	0.863	1.260	4.280
	SIO2	27	3.252	1.315	0.800	5.200
	SO4	21	12.424	12.835	3.000	66.500
	ALK	23	0.503	0.190	0.100	0.830
	TDORGC	3	28.467	16.070	11.600	43.600
	TOTORGC	3	16.100	2.163	13.700	17.900
	DO	82	3.998	2.160	1.100	8.200
	PH	80	6.256	0.748	3.500	7.500
	COND	82	134.134	36.695	12.000	220.000
	TURB	11	4.864	5.428	0.700	18.000
	COLOR	5	111.000	46.610	61.000	169.000

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	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
S-65D UPSTREAM	TPO4	31	0.071	0.039	0.020	0.166
	OPO4	31	0.032	0.034	0.002	0.113
	TN	30	1.399	0.442	0.790	2.690
	NO3	29	0.036	0.059	0.001	0.237
	NO2	31	0.022	0.082	0.004	0.463
	NH4	31	0.083	0.066	0.010	0.280
	TKN	31	1.345	0.434	0.760	2.680
	CL	30	17.763	4.750	8.700	34.800
	NA	23	10.049	2.625	4.070	15.660
	K	22	1.303	0.489	0.130	2.330
	CA	20	10.447	2.938	5.930	16.850
	MG	20	2.865	0.728	1.690	4.200
	SIO2	27	3.411	1.346	0.600	5.500
	SO4	23	10.239	6.140	3.000	34.400
	ALK	27	0.461	0.191	0.100	0.740
	TDORGC	3	29.000	17.359	13.400	47.700
	TOTORGC	6	14.817	3.494	8.800	18.000
	DO	91	4.752	2.152	1.800	10.000
	PH	86	6.343	0.538	5.400	7.900
	COND	91	146.275	35.451	78.000	240.000
	TURB	13	3.192	2.097	0.700	7.200
	COLOR	8	118.875	39.055	68.000	188.000
S-65D DOWNSTREAM	TPO4	30	0.085	0.046	0.026	0.213
	OPO4	30	0.040	0.038	0.002	0.127
	TN	29	1.428	0.409	0.770	2.550
	NO3	29	0.044	0.057	0.001	0.237
	NO2	30	0.009	0.010	0.004	0.050
	NH4	30	0.094	0.061	0.010	0.270
	TKN	30	1.367	0.423	0.770	2.540
	CL	30	19.950	8.332	9.100	53.900
	NA	22	10.358	2.789	4.070	16.170
	K	21	1.336	0.516	0.140	2.370
	CA	20	10.930	3.412	6.260	18.030
	MG	20	3.100	0.943	1.780	4.770
	SIO2	27	3.256	1.351	1.000	5.600
	SO4	23	12.448	11.999	3.000	64.200
	ALK	26	0.486	0.194	0.100	0.830
	TDORGC	3	18.633	8.188	9.200	23.900
	TOTORGC	6	14.900	2.543	11.500	18.700
	DO	91	4.405	2.158	1.200	9.800
	PH	85	6.343	0.619	4.900	7.800
	COND	91	149.560	35.062	95.000	250.000
	TURB	14	3.950	3.667	1.000	14.000
	COLOR	8	111.375	41.775	60.000	195.000

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S-65E DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	30	0.098	0.070	0.036	0.333
OPO4	30	0.054	0.060	0.002	0.269
TN	30	1.338	0.356	0.900	2.630
NO3	30	0.051	0.072	0.004	0.331
NO2	30	0.011	0.011	0.004	0.048
NH4	30	0.100	0.078	0.010	0.270
TKN	30	1.281	0.365	0.820	2.620
CL	30	23.210	13.939	11.500	78.100
NA	22	13.148	8.341	5.880	44.730
K	21	1.538	0.673	0.120	3.290
CA	20	12.991	6.212	7.400	32.600
MG	20	3.648	2.154	2.030	11.170
SIO2	27	3.378	1.338	1.100	6.000
SO4	23	12.709	7.323	3.000	38.600
ALK	27	0.509	0.280	0.100	1.190
TDORGC	3	27.200	14.552	12.800	41.900
TOTORGC	6	14.967	3.093	10.100	17.700
DO	84	4.961	2.167	1.900	12.200
PH	78	6.455	0.665	5.350	8.600
COND	84	170.679	84.882	90.000	510.000
TURB	14	3.550	2.645	0.700	9.600
COLOR	8	104.875	46.113	42.000	199.000

S-65E UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	30	0.092	0.069	0.029	0.325
OPO4	31	0.054	0.060	0.002	0.249
TN	30	1.308	0.279	0.740	2.190
NO3	29	0.047	0.076	0.004	0.323
NO2	31	0.011	0.016	0.004	0.089
NH4	31	0.095	0.076	0.010	0.270
TKN	31	1.246	0.294	0.740	2.190
CL	31	19.068	5.804	12.100	34.800
NA	22	11.515	3.600	5.720	19.480
K	21	1.420	0.558	0.120	2.490
CA	19	11.999	3.708	7.300	20.540
MG	19	3.223	1.005	1.910	5.190
SIO2	28	3.489	1.535	1.000	6.600
SO4	23	12.283	9.082	3.000	49.100
ALK	27	0.506	0.225	0.100	1.110
TDORGC	3	25.400	19.582	6.500	45.600
TOTORGC	6	14.383	2.137	12.200	17.700
DO	91	4.641	2.115	1.700	10.200
PH	85	6.429	0.528	5.200	8.400
COND	91	149.132	43.680	78.000	270.000
TURB	14	3.243	1.935	0.900	6.700
COLOR	8	99.375	46.736	50.000	195.000

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MID-POOL A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	30	0.035	0.018	0.017	0.092
OPO4	30	0.006	0.012	0.002	0.053
TN	28	1.453	0.597	0.880	3.700
NO3	27	0.023	0.031	0.004	0.127
NO2	29	0.005	0.002	0.004	0.013
NH4	30	0.051	0.063	0.010	0.230
TKN	30	1.406	0.590	0.870	3.700
CL	30	17.053	8.251	6.100	53.500
NA	23	10.192	2.604	3.050	15.660
K	21	1.234	0.437	0.190	1.910
CA	20	9.665	4.786	4.960	20.180
MG	21	2.939	0.979	0.780	4.770
SIO2	27	2.656	0.992	0.800	4.400
SO4	23	10.674	5.513	3.000	26.300
ALK	27	0.457	0.247	0.100	1.190
TDORGC	3	30.933	16.508	15.900	48.600
TOTORGC	6	17.700	8.290	11.100	33.300
DO	92	5.367	1.659	2.200	8.400
PH	89	6.368	0.622	5.150	7.700
COND	92	131.065	36.543	80.000	230.000
TURB	14	3.757	2.279	1.100	8.200
COLOR	8	111.125	66.711	57.000	236.000

MID-POOL B

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	30	0.035	0.016	0.007	0.078
OPO4	30	0.007	0.010	0.002	0.050
TN	27	1.271	0.273	0.840	1.930
NO3	27	0.034	0.040	0.001	0.135
NO2	29	0.007	0.004	0.004	0.020
NH4	30	0.079	0.080	0.010	0.290
TKN	30	1.241	0.275	0.840	1.930
CL	30	14.923	3.374	8.000	22.300
NA	22	9.313	2.582	3.050	15.350
K	21	1.135	0.619	0.080	2.580
CA	20	9.920	4.273	5.510	19.380
MG	20	2.748	0.843	1.040	4.400
SIO2	26	2.908	1.026	1.000	5.000
SO4	23	10.478	3.900	3.000	20.000
ALK	27	0.400	0.189	0.100	0.780
TDORGC	3	21.700	7.715	12.900	27.300
TOTORGC	6	14.867	4.373	9.300	20.500
DO	89	4.692	1.968	0.400	8.700
PH	82	6.254	0.658	4.600	7.700
COND	89	125.034	33.711	73.000	210.000
TURB	14	3.364	2.299	0.400	8.700
COLOR	8	127.875	78.202	59.000	242.000

WET SEASON DATA FOR C-38 AND TRIBUTARIES
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MID-POOL C

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	28	0.043	0.018	0.022	0.086
OPO4	28	0.010	0.013	0.002	0.045
TN	25	1.416	0.411	0.790	2.510
NO3	25	0.043	0.079	0.004	0.382
NO2	28	0.008	0.007	0.004	0.037
NH4	28	0.081	0.083	0.010	0.300
TKN	27	1.354	0.421	0.790	2.510
CL	28	15.032	3.473	8.200	24.500
NA	21	9.367	2.204	4.230	14.000
K	21	1.083	0.508	0.120	2.250
CA	20	9.882	3.065	4.600	15.010
MG	20	2.736	0.906	1.000	4.400
SIO2	24	2.958	1.217	0.800	4.900
SO4	23	11.374	4.408	3.000	20.100
ALK	25	0.433	0.158	0.100	0.720
TDORGC	3	13.367	9.122	6.900	23.800
TOTORGC	6	15.617	4.609	10.000	21.100
DO	81	4.723	2.083	1.300	11.400
PH	78	6.393	0.698	4.700	8.200
COND	76	135.553	28.460	80.000	200.000
TURB	14	2.629	1.552	0.900	5.400
COLOR	8	111.625	58.656	55.000	198.000

MID-POOL D

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	31	0.058	0.033	0.021	0.177
OPO4	32	0.022	0.027	0.001	0.124
TN	31	1.289	0.314	0.810	2.200
NO3	30	0.031	0.041	0.004	0.161
NO2	32	0.007	0.004	0.004	0.021
NH4	32	0.082	0.064	0.010	0.240
TKN	32	1.252	0.316	0.670	2.190
CL	31	16.577	4.180	8.100	27.500
NA	24	9.872	2.122	5.550	13.700
K	23	1.223	0.459	0.150	2.100
CA	21	10.254	3.191	4.960	16.850
MG	21	2.841	0.752	1.470	4.460
SIO2	29	3.207	1.290	0.700	5.500
SO4	24	9.796	3.228	3.000	13.700
ALK	28	0.461	0.173	0.100	0.750
TDORGC	3	27.500	15.956	11.800	43.700
TOTORGC	6	15.383	3.416	9.700	19.200
DO	94	4.705	1.733	0.600	9.000
PH	88	6.220	0.839	1.800	7.600
COND	94	137.660	34.122	84.000	220.000
TURB	15	3.247	2.158	0.800	8.000
COLOR	8	111.500	39.163	68.000	180.000

WET SEASON DATA FOR C-38 AND TRIBUTARIES
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MID-POOL E

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	28	0.093	0.065	0.025	0.259
OPO4	28	0.052	0.054	0.002	0.194
TN	28	1.325	0.355	0.760	2.190
NO3	27	0.041	0.064	0.004	0.272
NO2	28	0.008	0.006	0.004	0.028
NH4	28	0.092	0.077	0.010	0.290
TKN	28	1.283	0.364	0.760	2.190
CL	28	19.204	7.754	10.600	49.300
NA	20	10.648	3.051	4.730	17.670
K	19	1.384	0.576	0.130	2.510
CA	19	11.204	3.398	6.800	18.860
MG	19	3.041	0.902	1.830	4.600
SIO2	25	3.164	1.437	0.900	5.700
SO4	22	9.891	3.391	3.000	15.000
ALK	26	0.477	0.196	0.100	0.860
TDORGC	3	17.333	7.407	11.300	25.600
TOTORGC	6	13.667	2.122	11.100	16.200
DO	85	5.033	1.980	2.000	10.000
PH	82	6.454	0.615	5.400	8.300
COND	85	154.976	118.615	65.000	1162.000
TURB	13	3.315	2.401	1.100	8.500
COLOR	8	106.250	45.644	52.000	199.000

	Variable	N	Mean	Standard Deviation	Minimum Value	Maximum Value
ARMSTRONG SLOUGH	TPO4	7	0.128	0.140	0.028	0.437
	OPO4	6	0.079	0.102	0.002	0.276
	TN	6	1.653	0.855	0.610	2.760
	NO3	6	0.008	0.008	0.004	0.024
	NO2	6	0.006	0.002	0.004	0.010
	NH4	6	0.053	0.048	0.010	0.110
	TKN	7	1.547	0.815	0.610	2.750
	CL	6	20.200	5.370	16.100	30.500
	NA	6	11.133	4.043	7.900	18.000
	K	5	2.150	0.876	1.500	3.600
	CA	6	8.383	3.919	4.600	14.400
	MG	6	3.333	0.993	2.000	5.000
	SIO2	6	4.850	2.158	1.500	6.800
	SO4	5	7.980	3.969	3.000	13.600
	ALK	5	0.446	0.347	0.100	0.890
	TDORGC	0	.	.	.	.
	TOTORGC	0	.	.	.	.
	DO	8	4.550	1.876	0.900	6.700
	PH	8	6.294	0.516	5.600	6.900
	COND	8	15.125	46.277	36.000	200.000
	TURB	1	4.500	.	4.500	4.500
	COLOR	0	.	.	.	.

WET SEASON DATA FOR C-38 AND TRIBUTARIES
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	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
SKEETER SLOUGH	TPO4	29	0.073	0.059	0.024	0.331
	OPO4	28	0.031	0.049	0.002	0.256
	TN	27	1.334	0.499	0.680	3.050
	NO3	26	0.008	0.010	0.004	0.047
	NO2	27	0.005	0.003	0.004	0.019
	NH4	28	0.035	0.062	0.010	0.340
	TKN	28	1.311	0.493	0.680	3.020
	CL	27	29.633	21.284	9.100	112.500
	NA	19	13.018	6.101	3.050	26.830
	K	18	1.291	0.724	0.150	3.300
	CA	19	12.655	5.057	5.120	20.890
	MG	19	4.232	1.943	1.390	9.170
	SIO2	24	4.958	2.361	1.200	9.900
	SO4	22	11.095	4.503	3.000	22.500
	ALK	26	0.651	0.353	0.180	1.560
	TDORGC	3	26.833	20.843	9.600	50.000
	TOTORGC	6	15.233	2.099	13.600	18.900
	DO	29	3.024	1.813	0.200	6.700
	PH	27	6.243	0.558	5.500	7.900
	COND	30	190.100	106.377	100.000	650.000
	TURB	14	2.693	1.585	0.600	6.200
	COLOR	8	114.125	47.233	50.000	192.000
BAY HAMMOCK	TPO4	27	0.043	0.021	0.020	0.094
	OPO4	27	0.007	0.010	0.002	0.039
	TN	26	1.391	0.429	0.630	2.350
	NO3	26	0.023	0.036	0.004	0.144
	NO2	26	0.006	0.002	0.004	0.012
	NH4	27	0.049	0.050	0.010	0.200
	TKN	26	1.367	0.421	0.630	2.310
	CL	25	16.204	4.994	6.600	27.300
	NA	18	8.807	3.422	2.960	14.030
	K	17	1.200	0.650	0.180	2.520
	CA	18	9.012	4.864	2.910	20.010
	MG	18	2.527	1.126	0.770	4.640
	SIO2	23	3.826	1.779	1.100	8.200
	SO4	22	10.700	6.614	3.000	35.200
	ALK	26	0.395	0.209	0.100	0.840
	TDORGC	2	18.400	10.889	10.700	26.100
	TOTORGC	6	15.900	3.201	12.500	19.800
	DO	26	5.196	1.927	2.300	9.300
	PH	24	6.154	0.796	4.950	7.800
	COND	27	105.333	48.071	42.000	240.000
	TURB	14	3.871	3.575	1.000	15.000
	COLOR	8	128.875	59.077	57.000	212.000

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	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
ICE CREAM SLOUGH	TPO4	28	0.026	0.011	0.007	0.054
	OPO4	28	0.003	0.003	0.002	0.013
	TN	26	1.196	0.397	0.730	2.710
	NO3	24	0.017	0.037	0.004	0.181
	NO2	27	0.006	0.002	0.004	0.010
	NH4	28	0.036	0.036	0.010	0.170
	TKN	27	1.171	0.394	0.730	2.710
	CL	27	13.544	8.774	4.600	46.700
	NA	19	6.513	3.523	2.700	14.000
	K	17	0.465	0.419	0.040	1.600
	CA	18	5.864	5.735	0.800	22.610
	MG	19	1.460	1.019	0.700	3.850
	SIO2	24	3.012	1.416	1.100	6.800
	SO4	22	8.832	4.631	3.000	21.300
	ALK	26	0.254	0.272	0.070	1.220
	TDORGC	3	32.900	12.834	23.400	47.500
	TOTORGC	6	15.317	3.008	10.900	19.800
	DO	29	5.310	1.548	2.200	8.500
	PH	28	5.655	0.919	4.500	7.800
	COND	30	77.033	52.159	19.000	230.000
	TURB	13	3.792	2.216	1.600	9.900
	COLOR	8	161.750	65.945	56.000	255.000
RIVER RANCH SOUTH	TPO4	26	0.051	0.024	0.022	0.097
	OPO4	26	0.013	0.015	0.002	0.046
	TN	26	1.306	0.354	0.770	2.120
	NO3	24	0.031	0.039	0.004	0.146
	NO2	25	0.005	0.002	0.004	0.010
	NH4	26	0.037	0.031	0.010	0.140
	TKN	26	1.278	0.357	0.750	2.120
	CL	25	16.960	6.758	6.700	40.400
	NA	18	9.442	2.972	3.240	14.100
	K	18	1.058	0.444	0.150	1.770
	CA	18	12.194	5.526	4.630	26.530
	MG	18	2.858	0.917	0.780	4.550
	SIO2	22	4.400	2.328	1.000	9.400
	SO4	21	11.510	4.774	3.000	19.000
	ALK	25	0.515	0.274	0.100	1.370
	TDORGC	3	28.067	22.379	3.600	47.500
	TOTORGC	6	14.700	1.789	12.600	16.700
	DO	26	3.992	2.225	0.500	8.500
	PH	25	6.166	0.720	4.300	7.600
	COND	26	144.385	38.625	50.000	220.000
	TURB	14	3.693	2.545	0.700	8.800
	COLOR	8	111.750	52.987	49.000	218.000

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BLANKET BAY SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	28	0.120	0.107	0.027	0.486
OPO4	28	0.071	0.082	0.002	0.339
TN	27	1.847	1.479	0.910	8.970
NO3	25	0.022	0.042	0.004	0.179
NO2	26	0.006	0.003	0.004	0.013
NH4	28	0.042	0.047	0.010	0.260
TKN	27	1.826	1.483	0.910	8.970
CL	27	17.033	8.905	7.900	51.100
NA	19	8.042	3.741	3.050	15.000
K	18	1.468	0.826	0.050	2.950
CA	19	8.886	4.624	4.800	20.010
MG	19	2.245	1.269	0.940	4.640
SIO2	24	4.529	2.146	0.700	8.600
SO4	22	10.618	7.828	3.000	39.000
ALK	26	0.383	0.239	0.100	1.190
TDORGC	2	22.850	17.748	10.300	35.400
TOTORGC	6	19.083	4.359	13.200	25.500
DO	27	4.237	1.615	1.400	8.500
PH	26	6.124	0.542	5.400	7.600
COND	28	109.500	50.299	36.000	240.000
TURB	14	2.679	2.049	0.600	9.300
COLOR	8	162.875	86.004	60.000	292.000

BUTTERMILK SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	29	0.064	0.033	0.019	0.138
OPO4	29	0.015	0.015	0.002	0.049
TN	28	1.826	0.648	1.090	4.540
NO3	26	0.057	0.121	0.004	0.498
NO2	28	0.008	0.006	0.004	0.031
NH4	29	0.058	0.049	0.010	0.180
TKN	28	1.787	0.647	1.080	4.540
CL	28	17.939	7.898	7.500	43.000
NA	20	9.465	3.646	4.000	18.730
K	19	1.017	0.568	0.080	2.310
CA	20	14.076	10.135	2.800	52.940
MG	20	3.053	1.601	0.870	8.420
SIO2	25	5.124	2.768	1.000	10.900
SO4	23	12.552	4.721	3.000	20.400
ALK	27	0.506	0.513	0.100	2.690
TDORGC	3	32.700	23.407	12.000	58.100
TOTORGC	6	17.733	6.140	10.800	28.400
DO	28	3.493	2.682	0.100	9.000
PH	27	6.206	0.720	5.300	8.000
COND	29	138.655	46.923	58.000	270.000
TURB	14	3.014	1.789	0.900	6.600
COLOR	8	153.125	125.356	51.000	413.000

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PINE ISLAND SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	43	0.030	0.017	0.011	0.112
OPO4	45	0.004	0.005	0.002	0.028
TN	27	1.303	0.417	0.840	2.640
NO3	42	0.030	0.042	0.004	0.206
NO2	44	0.006	0.004	0.004	0.023
NH4	45	0.032	0.033	0.010	0.170
TKN	28	1.319	0.452	0.810	2.600
CL	45	19.264	13.951	7.600	96.500
NA	25	7.223	3.519	3.240	17.810
K	24	0.480	0.534	0.040	2.500
CA	24	6.243	3.843	2.800	15.800
MG	24	1.789	0.917	0.770	4.200
SIO2	39	4.267	1.221	0.800	7.900
SO4	27	8.037	3.834	3.000	15.200
ALK	32	0.239	0.200	0.080	0.860
TDORGC	3	31.067	19.676	15.900	53.300
TOTORGC	6	16.133	4.790	10.000	23.800
DO	29	5.083	1.745	1.200	8.800
PH	27	5.960	0.635	5.100	7.700
COND	30	109.900	51.915	25.000	210.000
TURB	19	3.900	4.999	0.700	22.000
COLOR	8	166.750	76.322	99.000	325.000

TICK ISLAND SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	29	0.028	0.013	0.009	0.066
OPO4	29	0.003	0.002	0.002	0.011
TN	27	1.267	0.285	0.660	1.850
NO3	27	0.027	0.046	0.004	0.191
NO2	28	0.006	0.003	0.004	0.014
NH4	29	0.046	0.040	0.010	0.160
TKN	28	1.225	0.305	0.470	1.840
CL	28	14.396	7.656	6.600	34.800
NA	19	8.757	4.391	3.050	17.880
K	18	0.680	0.526	0.040	1.700
CA	20	10.162	6.783	1.600	25.890
MG	20	2.111	1.276	0.750	4.560
SIO2	25	3.492	1.263	0.900	5.500
SO4	23	11.100	4.418	3.000	19.100
ALK	27	0.376	0.264	0.100	0.930
TDORGC	3	28.867	17.935	9.100	44.100
TOTORGC	6	17.033	3.704	12.100	21.100
DO	28	5.800	1.494	3.600	9.800
PH	26	6.125	0.995	3.600	7.900
COND	28	111.643	60.128	43.000	295.000
TURB	14	3.064	2.197	0.500	8.100
COLOR	8	166.750	51.174	95.000	255.000

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DUCK SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	7	0.197	0.448	0.008	1.212
OPO4	6	0.093	0.220	0.002	0.542
TN	5	1.618	0.481	1.030	2.310
NO3	6	0.008	0.005	0.004	0.016
NO2	7	0.006	0.002	0.004	0.008
NH4	7	0.050	0.068	0.010	0.200
TKN	6	1.482	0.524	0.860	2.300
CL	6	12.933	12.624	5.900	38.600
NA	6	8.083	7.382	4.000	23.000
K	5	0.704	0.684	0.170	1.800
CA	6	7.200	5.232	4.000	17.600
MG	6	2.083	1.458	1.200	5.000
SIO2	5	3.280	1.178	1.500	4.400
SO4	5	8.500	5.272	3.000	15.200
ALK	5	0.280	0.316	0.100	0.830
TDORGC	0	.	.	.	.
TOTORGC	0	.	.	.	.
DO	6	3.667	2.454	1.200	7.700
PH	6	6.033	1.019	5.500	8.100
COND	7	90.571	46.776	48.000	170.000
TURB	1	1.800	.	1.800	1.800
COLOR	0	.	.	.	.

OAK CREEK

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	26	0.073	0.053	0.019	0.247
OPO4	26	0.034	0.044	0.002	0.188
TN	26	1.585	0.440	1.000	3.150
NO3	25	0.032	0.076	0.004	0.306
NO2	26	0.008	0.008	0.004	0.047
NH4	26	0.037	0.040	0.010	0.180
TKN	26	1.552	0.445	1.000	3.140
CL	26	18.577	9.513	8.600	38.700
NA	19	10.162	5.087	4.140	20.320
K	18	0.979	0.474	0.120	2.000
CA	19	9.896	4.089	3.200	14.780
MG	19	2.758	1.708	1.010	5.820
SIO2	23	3.304	1.532	0.500	6.100
SO4	24	11.304	5.057	3.000	19.800
ALK	26	0.335	0.189	0.100	0.730
TDORGC	4	30.100	12.512	11.400	37.800
TOTORGC	6	16.633	4.698	10.500	22.500
DO	26	4.665	2.172	2.000	9.700
PH	25	6.188	0.474	5.600	7.350
COND	25	127.880	53.339	45.000	220.000
TURB	14	1.871	1.018	0.900	4.000
COLOR	10	150.500	72.298	52.000	238.000

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STARVATION SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	19	0.033	0.012	0.004	0.057
OPO4	19	0.007	0.006	0.002	0.017
TN	17	1.572	0.411	1.000	2.510
NO3	17	0.020	0.031	0.004	0.104
NO2	19	0.008	0.007	0.004	0.031
NH4	19	0.087	0.100	0.010	0.340
TKN	18	1.526	0.420	0.980	2.500
CL	19	14.047	3.950	7.500	20.700
NA	18	8.319	2.243	5.000	11.890
K	18	0.783	0.584	0.130	2.220
CA	18	13.263	3.254	7.980	20.750
MG	18	2.324	0.864	1.360	4.010
SIO2	15	3.673	1.761	0.800	7.000
SO4	15	12.387	4.273	3.000	18.600
ALK	17	0.428	0.162	0.170	0.720
TDORGC	3	30.767	19.928	9.200	48.500
TOTORGC	6	18.133	4.674	9.500	21.600
DO	18	3.789	2.991	0.700	10.400
PH	17	6.209	0.712	5.100	8.100
COND	18	148.833	52.691	76.000	300.000
TURB	13	2.938	1.732	0.800	6.400
COLOR	8	126.875	62.263	55.000	208.000

CHANDLER SLOUGH AT C-38

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	104	0.253	0.231	0.034	1.440
OPO4	104	0.187	0.173	0.002	0.699
TN	74	1.689	1.494	0.110	11.490
NO3	86	0.058	0.243	0.004	1.846
NO2	104	0.006	0.002	0.004	0.011
NH4	103	0.034	0.038	0.010	0.230
TKN	85	1.619	1.396	0.110	11.480
CL	102	23.033	7.097	10.000	49.700
NA	45	12.138	2.626	7.500	21.230
K	44	2.142	1.051	0.070	5.100
CA	45	12.479	2.859	7.720	18.000
MG	45	3.056	0.624	1.900	4.240
SIO2	90	4.720	1.351	0.900	10.500
SO4	61	7.436	2.703	3.000	18.200
ALK	78	0.498	0.119	0.120	0.780
TDORGC	3	34.633	21.366	19.100	59.000
TOTORGC	6	17.750	7.027	10.300	30.900
DO	29	4.093	1.911	0.600	7.400
PH	28	6.264	0.326	5.600	6.950
COND	30	165.000	41.567	83.000	240.000
TURB	14	2.979	2.006	0.600	6.200
COLOR	8	183.125	54.875	108.000	275.000

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MAPLE RIVER

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	24	0.212	0.270	0.037	0.992
OPO4	24	0.129	0.228	0.002	0.804
TN	24	1.450	0.453	0.880	2.610
NO3	24	0.028	0.042	0.004	0.136
NO2	24	0.006	0.003	0.004	0.015
NH4	24	0.045	0.055	0.010	0.200
TKN	24	1.423	0.461	0.800	2.610
CL	24	32.275	17.274	15.000	80.600
NA	21	17.251	11.533	7.600	51.080
K	21	1.899	1.073	0.090	5.550
CA	21	15.519	6.129	8.700	31.640
MG	21	4.500	2.304	2.290	11.160
SIO2	21	3.833	2.152	0.800	7.900
SO4	18	12.806	5.567	3.000	23.300
ALK	21	0.589	0.333	0.100	1.510
TDORGC	3	25.033	13.027	14.500	39.600
TOTORGC	6	13.633	2.229	11.100	17.400
DO	27	5.719	2.005	0.700	8.800
PH	25	6.286	0.370	5.400	7.300
COND	27	196.852	79.071	80.000	440.000
TURB	14	2.557	1.167	0.700	4.700
COLOR	8	98.250	48.163	48.000	200.000

YATES MARSH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	8	0.215	0.165	0.028	0.508
OPO4	8	0.154	0.150	0.002	0.444
TN	8	1.546	0.764	0.920	3.290
NO3	8	0.034	0.048	0.004	0.144
NO2	8	0.008	0.007	0.004	0.024
NH4	8	0.099	0.117	0.020	0.350
TKN	8	1.510	0.748	0.920	3.250
CL	8	27.112	9.496	19.700	47.900
NA	8	12.137	2.259	9.000	15.700
K	7	2.114	0.919	1.300	3.900
CA	8	12.050	3.778	7.300	20.200
MG	8	3.237	0.746	2.400	4.500
SIO2	7	5.900	3.306	2.000	10.800
SO4	6	9.767	4.704	3.000	16.400
ALK	6	0.603	0.338	0.100	1.060
TDORGC	0	.	.	.	.
TOTORGC	0	.	.	.	.
DO	6	4.567	2.994	1.500	9.700
PH	6	6.475	0.352	6.100	7.100
COND	6	161.667	63.692	60.000	260.000
TURB	1	5.200	.	5.200	5.200
COLOR	0	.	.	.	.

APPENDIX B

MEAN DRY SEASON CONCENTRATIONS FOR
C-38 TRIBUTARIES

All units in mg/L except:

alkalinity	-	meq/L
pH	-	standard units
conductivity	-	µmhos/cm
turbidity	-	NTU
color	-	Pt units

Phosphorus is as P
Nitrogen is as N

DRY SEASON DATA FOR C-38 AND TRIBUTARIES
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S-65 UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.033	0.019	0.013	0.082
OPO4	22	0.007	0.010	0.002	0.046
TN	22	1.208	0.431	0.100	1.900
NO3	22	0.017	0.022	0.004	0.085
NO2	22	0.005	0.001	0.004	0.009
NH4	22	0.028	0.021	0.010	0.090
TKN	22	1.191	0.441	0.060	1.900
CL	22	21.818	14.261	13.400	67.000
NA	13	12.813	3.195	7.400	20.000
K	13	1.827	0.647	1.180	3.620
CA	13	7.791	1.793	5.710	12.100
MG	13	3.365	0.579	2.410	4.790
SIO2	20	1.950	1.136	0.400	3.900
SO4	17	12.159	7.723	5.000	37.300
ALK	21	0.572	1.001	0.100	4.900
TDORGC	2	18.650	2.333	17.000	20.300
TOTORGC	4	12.550	3.062	8.500	15.800
DO	59	7.754	1.575	3.400	10.500
PH	59	6.703	0.437	5.600	7.450
COND	59	117.983	27.897	37.000	184.000
TURB	8	2.912	1.449	0.400	4.400
COLOR	7	74.857	18.041	60.000	105.000

S-65 DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	20	0.038	0.029	0.016	0.122
OPO4	20	0.005	0.003	0.002	0.011
TN	20	1.278	0.538	0.100	2.650
NO3	20	0.065	0.085	0.004	0.310
NO2	20	0.009	0.014	0.004	0.049
NH4	20	0.066	0.064	0.010	0.280
TKN	20	1.208	0.512	0.060	2.300
CL	20	18.830	6.166	11.300	32.400
NA	11	11.311	2.092	7.550	14.000
K	10	1.683	0.405	1.230	2.570
CA	11	9.475	3.586	5.400	18.470
MG	11	3.261	0.457	2.500	4.170
SIO2	18	2.072	1.261	0.400	4.500
SO4	16	10.087	3.772	5.000	18.600
ALK	19	0.623	1.052	0.100	4.900
TDORGC	2	16.200	3.818	13.500	18.900
TOTORGC	4	11.675	3.774	8.000	15.500
DO	55	7.747	1.701	0.600	10.600
PH	58	6.724	0.369	5.850	7.550
COND	58	116.724	27.082	48.000	198.000
TURB	7	3.229	2.918	0.500	8.700
COLOR	5	73.300	11.189	62.000	92.000

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S-65A UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	18	0.033	0.012	0.015	0.064
OPO4	20	0.013	0.023	0.002	0.109
TN	20	1.270	0.431	0.120	2.130
NO3	20	0.096	0.110	0.004	0.358
NO2	20	0.015	0.026	0.004	0.101
NH4	20	0.062	0.050	0.010	0.230
TKN	20	1.165	0.410	0.060	1.880
CL	20	17.555	5.090	10.400	29.700
NA	11	11.155	2.230	7.110	14.000
K	11	1.556	0.394	0.780	2.130
CA	11	10.216	3.331	6.010	16.800
MG	11	3.076	0.245	2.680	3.460
SIO2	18	2.406	1.467	0.400	4.800
SO4	15	10.393	4.311	5.000	20.400
ALK	19	0.461	0.194	0.130	0.840
TDORGC	3	19.733	4.013	15.100	22.100
TOTORGC	4	10.750	5.409	4.900	15.400
DO	59	7.149	1.841	4.000	11.000
PH	62	6.679	0.296	6.100	7.300
COND	62	132.742	25.062	56.000	182.000
TURB	8	2.900	2.131	0.400	6.000
COLOR	6	99.167	23.447	72.000	138.000

S-65A DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.036	0.014	0.014	0.072
OPO4	20	0.008	0.007	0.002	0.022
TN	21	1.237	0.356	0.140	1.810
NO3	21	0.113	0.130	0.004	0.448
NO2	21	0.011	0.012	0.004	0.050
NH4	20	0.048	0.042	0.010	0.190
TKN	21	1.119	0.357	0.060	1.810
CL	20	17.510	5.440	8.000	36.300
NA	12	11.508	2.728	8.150	18.000
K	12	1.453	0.388	0.700	2.130
CA	12	10.217	3.984	5.400	19.000
MG	12	2.951	0.339	2.540	3.470
SIO2	19	2.447	1.377	0.400	4.600
SO4	16	10.256	4.386	5.000	21.200
ALK	20	0.449	0.218	0.100	0.860
TDORGC	3	15.867	3.707	11.700	18.800
TOTORGC	4	13.450	2.381	11.100	15.600
DO	58	7.195	1.752	4.100	10.800
PH	61	6.714	0.369	6.030	8.300
COND	61	136.066	20.864	86.000	180.000
TURB	8	2.837	2.421	0.100	6.500
COLOR	6	102.667	25.367	75.000	137.000

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S-65B UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	20	0.033	0.014	0.015	0.081
OPO4	20	0.009	0.008	0.002	0.026
TN	21	1.263	0.476	0.160	2.550
NO3	21	0.159	0.210	0.004	0.976
NO2	21	0.008	0.006	0.004	0.027
NH4	21	0.050	0.042	0.010	0.150
TKN	21	1.101	0.383	0.060	1.740
CL	21	18.038	5.142	12.400	36.000
NA	12	11.305	2.619	7.980	18.000
K	12	1.360	0.409	0.750	2.070
CA	12	11.414	4.005	5.860	19.600
MG	12	3.092	0.475	2.270	4.000
SIO2	19	2.574	1.427	0.400	4.500
SO4	15	10.233	4.959	5.000	22.600
ALK	20	0.588	0.173	0.310	0.890
TDORGC	3	18.500	3.996	14.900	22.800
TOTORGC	4	11.100	5.398	4.900	17.500
DO	56	6.484	1.816	1.800	9.800
PH	59	6.610	0.319	5.800	7.200
COND	59	139.831	26.379	73.000	185.000
TURB	8	2.150	1.495	0.300	4.100
COLOR	6	109.333	29.132	80.000	165.000

S-65B DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.038	0.013	0.016	0.075
OPO4	21	0.015	0.014	0.002	0.055
TN	21	1.314	0.603	0.210	3.120
NO3	21	0.244	0.501	0.004	2.299
NO2	21	0.011	0.012	0.004	0.051
NH4	21	0.042	0.030	0.010	0.100
TKN	21	1.064	0.446	0.060	1.840
CL	21	19.057	7.390	12.400	48.600
NA	12	10.886	1.529	8.140	13.000
K	12	1.425	0.419	0.950	2.080
CA	12	12.507	3.348	8.200	19.000
MG	12	3.133	0.384	2.320	3.800
SIO2	19	2.863	1.477	0.400	4.800
SO4	15	10.820	6.083	5.000	27.700
ALK	20	0.615	0.192	0.300	0.930
TDORGC	3	24.833	6.277	19.200	31.600
TOTORGC	4	13.275	1.603	11.400	15.300
DO	57	6.918	1.252	3.900	9.600
PH	60	6.613	0.455	5.200	7.350
COND	60	143.167	28.700	65.000	190.000
TURB	8	2.162	1.657	0.200	4.600
COLOR	6	113.333	29.770	85.000	170.000

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S-65C UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	22	0.042	0.018	0.016	0.082
OPO4	21	0.016	0.014	0.002	0.050
TN	22	1.243	0.410	0.210	2.070
NO3	22	0.174	0.152	0.004	0.518
NO2	22	0.006	0.004	0.004	0.020
NH4	21	0.059	0.040	0.010	0.160
TKN	22	1.068	0.399	0.060	1.800
CL	21	18.624	5.953	11.400	38.500
NA	13	10.694	1.995	7.250	14.000
K	13	1.441	0.427	0.690	2.140
CA	13	13.196	4.868	5.350	22.800
MG	13	5.369	7.709	2.700	31.000
SIO2	19	3.068	1.645	0.400	5.100
SO4	16	12.037	4.242	6.000	23.200
ALK	20	0.600	0.235	0.080	1.010
TDORGC	3	13.833	5.781	7.200	17.800
TOTORGC	5	11.640	5.122	6.100	17.900
DO	63	6.492	1.560	3.400	10.100
PH	66	6.677	0.382	5.900	7.400
COND	66	159.061	29.678	99.000	225.000
TURB	9	1.689	1.067	0.600	3.200
COLOR	6	117.833	30.169	85.000	160.000

S-65C DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	22	0.050	0.025	0.017	0.133
OPO4	22	0.023	0.017	0.002	0.053
TN	22	1.407	0.510	0.280	2.500
NO3	22	0.189	0.131	0.004	0.397
NO2	22	0.007	0.004	0.004	0.020
NH4	22	0.088	0.056	0.010	0.250
TKN	22	1.216	0.535	0.060	2.480
CL	22	20.582	11.534	10.400	66.300
NA	12	10.857	2.122	7.550	14.000
K	12	1.498	0.410	0.850	2.120
CA	11	12.240	2.988	8.200	17.820
MG	11	3.052	0.303	2.290	3.400
SIO2	20	3.230	1.713	0.400	5.400
SO4	17	11.912	3.679	5.300	17.200
ALK	21	0.549	0.244	0.100	0.990
TDORGC	3	24.667	7.616	18.900	33.300
TOTORGC	5	12.820	3.304	7.900	15.700
DO	62	6.673	1.211	4.300	10.000
PH	65	6.848	0.411	6.220	8.000
COND	65	159.708	29.555	100.000	210.000
TURB	9	1.911	1.170	0.700	4.000
COLOR	6	115.333	33.267	80.000	162.000

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S-65D UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.060	0.036	0.021	0.187
OPO4	20	0.029	0.023	0.002	0.078
TN	21	1.290	0.463	0.320	2.590
NO3	21	0.196	0.150	0.004	0.492
NO2	21	0.008	0.007	0.004	0.032
NH4	21	0.059	0.038	0.010	0.170
TKN	21	1.092	0.440	0.060	2.240
CL	21	21.390	11.369	11.300	65.100
NA	11	11.475	2.417	7.010	15.000
K	11	1.677	0.533	0.790	2.340
CA	11	13.986	4.304	9.540	23.400
MG	10	3.262	0.327	2.930	4.000
SIO2	19	3.442	1.809	0.400	6.100
SO4	17	11.153	4.448	4.000	19.000
ALK	20	0.763	1.010	0.100	4.900
TDORGC	3	19.933	1.762	18.300	21.800
TOTORGC	3	14.867	2.417	12.300	17.100
DO	57	7.012	1.591	2.900	9.900
PH	60	6.952	0.390	6.380	7.700
COND	57	162.333	34.263	100.000	235.000
TURB	7	1.757	0.914	0.700	3.000
COLOR	4	105.250	12.527	91.000	120.000

S-65D DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.057	0.026	0.021	0.131
OPO4	21	0.032	0.024	0.002	0.082
TN	21	1.304	0.363	0.360	2.190
NO3	21	0.184	0.140	0.004	0.452
NO2	21	0.008	0.006	0.004	0.029
NH4	21	0.052	0.038	0.010	0.110
TKN	21	1.118	0.351	0.060	1.830
CL	21	21.214	9.738	13.400	59.300
NA	11	11.966	2.263	8.450	14.500
K	11	1.739	0.489	0.940	2.500
CA	10	14.783	5.832	7.080	23.560
MG	10	3.339	0.382	2.640	4.000
SIO2	19	3.432	1.851	0.400	6.200
SO4	17	11.565	4.015	5.500	19.900
ALK	20	0.802	0.997	0.100	4.900
TDORGC	3	19.967	1.986	17.700	21.400
TOTORGC	3	13.833	5.046	8.100	17.600
DO	59	7.375	1.448	5.400	11.300
PH	62	6.950	0.430	6.320	7.650
COND	62	169.677	34.404	102.000	230.000
TURB	7	1.943	0.911	0.500	3.100
COLOR	4	104.750	13.301	89.000	120.000

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S-65E DOWNSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	22	0.069	0.034	0.033	0.160
OPO4	22	0.040	0.028	0.006	0.136
TN	22	1.306	0.437	0.380	2.220
NO3	22	0.229	0.151	0.004	0.470
NO2	22	0.009	0.006	0.004	0.022
NH4	22	0.056	0.028	0.010	0.110
TKN	22	1.073	0.458	0.060	1.920
CL	22	30.568	15.729	13.200	69.300
NA	12	14.754	4.646	8.620	26.000
K	12	1.855	0.542	0.790	2.770
CA	11	15.532	4.800	8.190	24.800
MG	11	3.808	0.689	2.930	4.800
SIO2	20	3.760	1.804	0.400	6.200
SO4	18	18.583	11.117	6.800	43.400
ALK	21	0.694	0.312	0.100	1.360
TDORGC	3	20.100	3.051	16.600	22.200
TOTORGC	4	16.750	7.846	6.600	25.700
DO	61	6.951	1.468	3.400	9.900
PH	64	6.930	0.383	6.400	7.700
COND	64	222.109	79.324	102.000	400.000
TURB	8	1.625	0.873	0.500	3.000
COLOR	6	113.500	22.412	72.000	135.000

S-65E UPSTREAM

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.067	0.037	0.025	0.170
OPO4	21	0.040	0.031	0.003	0.141
TN	22	1.286	0.475	0.340	2.590
NO3	22	0.205	0.132	0.004	0.432
NO2	22	0.007	0.005	0.004	0.021
NH4	22	0.048	0.027	0.010	0.090
TKN	22	1.079	0.496	0.060	2.590
CL	21	24.695	8.063	16.000	41.300
NA	12	12.666	2.662	8.090	16.000
K	12	1.923	0.552	0.850	3.100
CA	11	15.115	5.077	6.920	24.800
MG	11	3.624	0.874	2.680	5.740
SIO2	20	3.695	1.598	0.800	5.900
SO4	18	16.100	7.059	7.900	34.600
ALK	21	0.623	0.254	0.100	1.140
TDORGC	3	18.300	2.805	15.600	21.200
TOTORGC	4	13.425	4.901	7.600	18.400
DO	62	7.158	1.660	3.600	10.800
PH	65	6.952	0.398	6.380	7.700
COND	65	195.800	48.031	102.000	300.000
TURB	8	1.450	0.711	0.600	2.700
COLOR	5	112.800	27.004	69.000	135.000

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MID-POOL A

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.032	0.011	0.016	0.058
OPO4	21	0.007	0.007	0.002	0.025
TN	21	1.244	0.355	0.120	1.740
NO3	21	0.084	0.110	0.004	0.364
NO2	21	0.011	0.019	0.004	0.075
NH4	21	0.050	0.035	0.010	0.120
TKN	20	1.149	0.365	0.060	1.720
CL	21	17.029	4.360	9.400	29.200
NA	12	11.392	2.169	7.110	14.000
K	12	1.461	0.363	0.840	2.040
CA	12	9.892	3.965	5.930	18.640
MG	12	3.073	0.371	2.410	3.700
SIO2	19	2.058	1.268	0.400	4.300
SO4	17	10.018	3.874	5.000	15.900
ALK	20	0.423	0.178	0.140	0.870
TDORGC	3	14.800	9.338	8.300	25.500
TOTORGC	4	12.600	2.837	9.000	15.600
DO	60	7.677	1.560	5.000	11.400
PH	63	6.712	0.265	6.120	7.150
COND	63	129.651	25.273	79.000	190.000
TURB	8	2.387	1.665	0.500	5.500
COLOR	6	93.667	22.015	67.000	130.000

MID-POOL B

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	22	0.034	0.012	0.015	0.065
OPO4	22	0.009	0.006	0.002	0.023
TN	22	1.288	0.443	0.240	2.250
NO3	22	0.113	0.096	0.004	0.273
NO2	22	0.010	0.016	0.004	0.081
NH4	22	0.040	0.027	0.010	0.130
TKN	22	1.169	0.453	0.060	1.980
CL	22	17.255	3.785	4.000	25.200
NA	12	11.487	3.059	8.620	20.000
K	12	1.385	0.448	0.780	2.260
CA	12	11.711	3.846	5.860	19.600
MG	12	3.055	0.401	2.220	3.700
SIO2	19	2.426	1.314	0.400	4.600
SO4	16	9.394	3.403	5.000	15.300
ALK	21	0.587	0.166	0.280	0.880
TDORGC	3	18.300	0.436	18.000	18.800
TOTORGC	5	13.540	3.399	7.500	15.400
DO	60	6.975	1.826	2.000	10.600
PH	63	6.666	0.289	6.100	7.200
COND	63	139.984	23.594	68.000	170.000
TURB	8	1.975	1.696	0.100	5.100
COLOR	7	107.571	28.029	80.000	167.000

DRY SEASON DATA FOR C-38 AND TRIBUTARIES
NOVEMBER 1 ST THROUGH APRIL 30 TH : 1973 - 1978

	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
MID-POOL C	TPO4	21	0.038	0.011	0.016	0.064
	OPO4	20	0.014	0.012	0.002	0.044
	TN	21	1.219	0.373	0.210	1.790
	NO3	21	0.155	0.168	0.004	0.608
	NO2	21	0.006	0.003	0.004	0.012
	NH4	21	0.048	0.034	0.010	0.130
	TKN	21	1.063	0.394	0.060	1.790
	CL	21	16.786	2.434	11.400	20.700
	NA	12	10.722	1.692	8.300	13.000
	K	12	1.412	0.413	0.700	2.060
	CA	12	12.921	4.042	7.870	20.200
	MG	12	3.177	0.462	2.330	3.800
	SIO2	19	2.916	1.592	0.400	4.900
	SO4	16	11.944	4.214	6.800	21.300
	ALK	20	0.623	0.181	0.350	0.990
	TDORGC	3	18.967	10.629	11.300	31.100
	TOTORGC	4	12.550	2.516	10.400	15.200
	DO	60	7.243	1.407	4.400	10.100
	PH	63	6.689	0.532	5.300	7.650
	COND	63	145.206	27.451	76.000	195.000
	TURB	8	1.975	1.656	0.500	5.100
	COLOR	6	109.667	25.469	90.000	160.000
MID-POOL D	TPO4	23	0.053	0.026	0.017	0.139
	OPO4	23	0.024	0.022	0.002	0.085
	TN	23	1.321	0.450	0.340	2.770
	NO3	23	0.175	0.131	0.004	0.426
	NO2	23	0.007	0.003	0.004	0.015
	NH4	23	0.056	0.033	0.020	0.160
	TKN	23	1.143	0.443	0.060	2.510
	CL	23	19.600	7.875	11.300	43.200
	NA	13	11.257	2.162	6.680	13.500
	K	13	1.558	0.473	0.790	2.330
	CA	12	12.398	5.038	5.500	22.800
	MG	12	3.098	0.352	2.500	3.600
	SIO2	21	3.176	1.771	0.400	5.500
	SO4	18	16.383	20.671	5.000	98.000
	ALK	22	0.500	0.251	0.070	1.050
	TDORGC	3	21.000	9.207	15.000	31.600
	TOTORGC	5	13.260	3.973	8.700	17.100
	DO	61	7.425	1.161	5.200	10.200
	PH	64	6.942	0.374	6.300	7.850
	COND	61	158.885	29.226	101.000	215.000
	TURB	9	1.789	1.219	0.700	4.200
	COLOR	6	111.167	22.275	85.000	152.000

MID POOL E

DRY SEASON DATA FOR C-38 AND TRIBUTARIES
NOVEMBER 1 ST THROUGH APRIL 30 TH : 1973 - 1978

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.070	0.044	0.024	0.205
OPO4	21	0.037	0.029	0.004	0.128
TN	20	1.302	0.378	0.360	2.070
NO3	21	0.213	0.169	0.004	0.630
NO2	21	0.007	0.003	0.004	0.015
NH4	21	0.049	0.038	0.010	0.160
TKN	20	1.082	0.356	0.060	1.780
CL	21	20.367	8.901	13.200	56.000
NA	11	11.661	2.499	7.650	16.000
K	11	1.774	0.512	0.760	2.500
CA	10	14.182	4.877	8.190	24.200
MG	10	3.434	0.324	3.020	4.200
SIO2	19	3.658	1.834	0.400	6.000
SO4	17	13.694	7.282	5.800	30.600
ALK	20	0.831	0.993	0.200	4.900
TDORGC	3	38.833	31.979	16.100	75.400
TOTORGC	3	13.333	5.072	7.500	16.700
DO	57	7.374	1.137	5.400	9.800
PH	60	6.984	0.370	6.400	7.600
COND	60	174.900	38.670	102.000	260.000
TURB	7	1.457	0.757	0.400	2.600
COLOR	4	119.250	24.541	92.000	150.000

DRY SEASON DATA FOR C-38 AND TRIBUTARIES
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	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
ARMSTRONG SLOUGH	TPO4	7	0.048	0.017	0.022	0.079
	OPO4	7	0.021	0.020	0.003	0.053
	TN	7	1.026	0.531	0.100	1.750
	NO3	7	0.006	0.003	0.004	0.012
	NO2	7	0.005	0.002	0.004	0.008
	NH4	7	0.031	0.019	0.010	0.050
	TKN	7	1.019	0.544	0.060	1.750
	CL	7	22.243	7.555	9.000	31.300
	NA	6	14.000	1.897	12.000	16.000
	K	6	1.765	0.432	1.200	2.500
	CA	6	10.227	6.342	1.100	20.200
	MG	6	3.550	1.183	2.200	5.200
	SIO2	7	2.014	0.807	1.000	3.200
	SO4	5	10.020	4.974	5.000	16.100
	ALK	6	0.493	0.216	0.100	0.700
	TDORGC	0	.	.	.	.
	TOTORGC	0	.	.	.	.
	DO	8	7.637	1.297	5.300	9.400
	PH	8	6.581	0.450	5.900	7.100
	COND	8	144.375	45.311	80.000	210.000
	TURB	0	.	.	.	.
	COLOR	0	.	.	.	.

DRY SEASON DATA FOR C-38 AND TRIBUTARIES
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SKEETER SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	20	0.037	0.020	0.016	0.107
OPO4	20	0.010	0.007	0.002	0.025
TN	20	1.172	0.445	0.100	1.820
NO3	20	0.053	0.089	0.004	0.314
NO2	20	0.006	0.006	0.004	0.030
NH4	20	0.033	0.026	0.010	0.100
TKN	20	1.116	0.424	0.060	1.650
CL	20	31.655	22.860	10.400	81.700
NA	11	28.501	39.317	11.000	146.050
K	11	3.384	2.572	1.290	10.110
CA	11	13.503	4.114	8.000	22.810
MG	11	4.490	1.771	2.800	8.320
SIO2	18	2.933	1.618	0.400	6.500
SO4	15	15.627	11.837	5.000	50.700
ALK	19	0.535	0.314	0.100	1.270
TDORGC	2	26.300	13.859	16.500	36.100
TOTORGC	4	15.050	0.785	14.000	15.900
DO	23	6.709	1.765	3.200	9.800
PH	23	6.564	0.406	5.800	7.250
COND	23	169.304	54.803	110.000	330.000
TURB	7	1.143	0.472	0.500	1.900
COLOR	6	120.333	38.764	62.000	180.000

BAY HAMMOCK

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	19	0.034	0.013	0.015	0.065
OPO4	20	0.010	0.013	0.002	0.059
TN	20	1.207	0.370	0.170	1.930
NO3	20	0.071	0.100	0.004	0.351
NO2	20	0.006	0.004	0.004	0.022
NH4	20	0.046	0.034	0.010	0.150
TKN	20	1.135	0.377	0.060	1.930
CL	20	18.165	4.456	11.400	28.300
NA	11	11.612	1.368	10.000	14.000
K	11	1.452	0.388	0.990	2.440
CA	11	8.968	2.574	5.860	13.660
MG	11	2.550	0.632	1.510	3.400
SIO2	18	2.767	1.597	0.400	6.300
SO4	15	9.600	4.156	5.000	17.200
ALK	19	0.414	0.178	0.100	0.700
TDORGC	2	12.650	2.475	10.900	14.400
TOTORGC	4	13.200	2.681	9.300	15.300
DO	19	7.268	1.768	4.500	11.600
PH	20	6.594	0.529	5.400	7.300
COND	20	124.150	22.525	72.000	170.000
TURB	7	1.986	1.311	0.400	4.600
COLOR	6	120.167	38.654	65.000	180.000

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ICE CREAM SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	21	0.029	0.015	0.010	0.070
OPO4	21	0.007	0.007	0.002	0.026
TN	21	1.019	0.349	0.100	1.700
NO3	20	0.021	0.028	0.004	0.093
NO2	21	0.005	0.002	0.004	0.009
NH4	21	0.050	0.081	0.010	0.380
TKN	21	0.998	0.351	0.060	1.690
CL	21	20.029	16.831	9.600	90.300
NA	12	10.477	3.826	3.020	18.000
K	12	0.658	0.491	0.190	1.500
CA	12	9.412	4.937	3.270	17.200
MG	12	1.870	1.073	0.820	3.800
SIO2	19	2.847	2.964	1.000	14.500
SO4	17	8.665	3.166	5.000	13.200
ALK	20	0.616	0.609	0.100	2.890
TDORGC	3	17.233	2.417	15.000	19.800
TOTORGC	4	11.150	4.836	5.400	15.900
DO	22	7.468	1.283	5.700	10.800
PH	23	6.532	0.693	5.400	7.500
COND	23	121.000	43.314	60.000	210.000
TURB	7	2.729	1.075	1.300	4.700
COLOR	5	121.000	35.951	80.000	165.000

RIVER RANCH SOUTH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	15	0.038	0.022	0.017	0.097
OPO4	15	0.008	0.009	0.002	0.030
TN	15	1.136	0.424	0.100	1.820
NO3	15	0.078	0.119	0.004	0.384
NO2	15	0.006	0.004	0.004	0.017
NH4	15	0.021	0.009	0.010	0.040
TKN	15	1.057	0.411	0.060	1.650
CL	15	18.253	4.193	10.400	27.500
NA	11	12.729	1.508	10.820	16.000
K	11	1.831	0.756	0.910	3.780
CA	11	14.574	6.658	7.200	31.270
MG	11	3.446	0.307	3.000	3.990
SIO2	13	3.538	2.731	0.600	10.700
SO4	11	12.973	8.142	5.000	35.700
ALK	14	0.581	0.318	0.270	1.540
TDORGC	2	15.850	3.889	13.100	18.600
TOTORGC	4	12.250	4.285	6.900	16.800
DO	17	5.724	2.709	1.400	10.800
PH	17	6.400	0.364	5.800	7.050
COND	17	161.588	32.863	92.000	215.000
TURB	7	1.414	0.821	0.200	2.800
COLOR	6	81.667	17.874	52.000	101.000

DRY SEASON DATA FOR C-38 AND TRIBUTARIES
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	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
BLANKET BAY SLOUGH	TPO4	20	0.115	0.209	0.016	0.727
	OPO4	20	0.075	0.186	0.002	0.639
	TN	20	1.251	0.516	0.100	2.630
	NO3	20	0.039	0.043	0.004	0.141
	NO2	20	0.009	0.013	0.004	0.060
	NH4	20	0.034	0.022	0.010	0.080
	TKN	20	1.206	0.519	0.060	2.590
	CL	20	22.945	5.485	14.400	31.700
	NA	11	12.411	2.162	9.000	16.000
	K	10	3.379	2.395	0.280	6.890
	CA	11	11.063	3.127	5.800	15.790
	MG	11	2.654	0.857	1.300	3.840
	SIO2	17	1.771	1.004	0.500	3.400
	SO4	16	10.737	3.104	5.000	14.800
	ALK	19	0.476	0.247	0.100	0.860
	TDORGC	1	19.400	.	19.400	19.400
	TOTORGC	4	15.650	2.873	11.900	18.000
	DO	21	6.914	1.751	3.400	11.000
	PH	21	6.620	0.530	5.800	7.550
	COND	21	144.095	38.612	58.000	215.000
	TURB	7	1.771	0.663	0.700	2.500
	COLOR	6	179.667	141.930	52.000	370.000

	VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
BUTTERMILK SLOUGH	TPO4	21	0.044	0.022	0.016	0.094
	OPO4	21	0.013	0.013	0.002	0.045
	TN	21	1.476	0.689	0.100	3.700
	NO3	21	0.181	0.402	0.004	1.728
	NO2	21	0.010	0.012	0.004	0.049
	NH4	21	0.079	0.105	0.010	0.520
	TKN	21	1.288	0.490	0.060	2.300
	CL	21	21.010	7.547	11.300	41.000
	NA	12	13.906	3.019	10.700	22.350
	K	12	1.977	1.659	0.630	7.000
	CA	12	21.235	20.061	6.400	81.240
	MG	12	4.221	2.017	2.800	10.230
	SIO2	19	4.447	4.695	0.700	22.300
	SO4	17	17.424	11.918	5.000	43.700
	ALK	20	0.664	0.726	0.220	3.540
	TDORGC	2	33.200	10.748	25.600	40.800
	TOTORGC	4	13.600	2.927	9.300	15.500
	DO	21	6.590	2.324	2.500	9.700
	PH	22	6.481	0.512	5.500	7.400
	COND	22	172.909	95.291	95.000	560.000
	TURB	8	2.600	2.582	0.400	8.600
	COLOR	6	147.333	82.817	75.000	260.000

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PINE ISLAND SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	14	0.027	0.018	0.003	0.070
OPO4	14	0.010	0.011	0.002	0.043
TN	13	1.243	0.273	0.970	1.840
NO3	14	0.263	0.925	0.004	3.470
NO2	14	0.005	0.001	0.004	0.008
NH4	14	0.034	0.023	0.010	0.090
TKN	14	1.199	0.279	0.830	1.830
CL	14	29.493	10.425	17.800	49.200
NA	6	14.842	6.251	9.530	23.290
K	6	2.337	2.000	0.320	4.980
CA	6	8.790	2.978	6.150	13.790
MG	6	2.302	0.800	1.410	3.540
SIO2	13	3.092	2.115	0.500	7.900
SO4	12	8.808	3.031	5.000	12.700
ALK	14	0.489	0.241	0.100	0.910
TDORGC	3	24.600	7.712	19.900	33.500
TOTORGC	3	12.567	1.387	11.400	14.100
DO	13	6.792	1.653	3.400	9.200
PH	14	6.371	0.604	5.600	7.450
COND	14	155.214	46.407	96.000	240.000
TURB	7	1.086	0.501	0.600	2.000
COLOR	5	143.800	32.553	109.000	185.000

TICK ISLAND SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	2	0.017	0.008	0.012	0.023
OPO4	2	0.004	0.003	0.002	0.006
TN	2	0.660	0.778	0.110	1.210
NO3	2	0.095	0.060	0.053	0.138
NO2	2	0.004	0.000	0.004	0.004
NH4	2	0.050	0.000	0.050	0.050
TKN	2	0.565	0.714	0.060	1.070
CL	2	25.700	2.546	23.900	27.500
NA	2	14.000	1.414	13.000	15.000
K	2	0.370	0.240	0.200	0.540
CA	2	9.560	4.327	6.500	12.620
MG	2	2.000	0.283	1.800	2.200
SIO2	2	4.600	1.414	3.600	5.600
SO4	0	.	.	.	.
ALK	2	9.390	12.318	0.680	18.100
TDORGC	0	.	.	.	.
TOTORGC	0	.	.	.	.
DO	4	6.050	0.370	5.500	6.300
PH	4	6.025	0.330	5.700	6.400
COND	4	140.000	23.094	120.000	160.000
TURB	0	.	.	.	.
COLOR	0	.	.	.	.

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DUCK SLOUGH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	4	0.024	0.010	0.014	0.038
OPO4	4	0.007	0.005	0.002	0.014
TN	4	1.307	0.161	1.160	1.500
NO3	4	0.026	0.028	0.004	0.061
NO2	4	0.005	0.002	0.004	0.008
NH4	4	0.022	0.015	0.010	0.040
TKN	4	1.282	0.189	1.100	1.500
CL	4	21.025	4.104	17.400	26.100
NA	3	12.333	0.577	12.000	13.000
K	3	1.233	0.153	1.100	1.400
CA	3	15.133	5.327	9.000	18.600
MG	3	3.400	0.200	3.200	3.600
SIO2	4	2.375	1.109	1.100	3.400
SO4	4	10.150	4.431	5.000	15.800
ALK	4	0.632	0.192	0.420	0.810
TDORGC	0	.	.	.	.
TOTORGC	0	.	.	.	.
DO	4	6.700	1.864	4.100	8.100
PH	4	6.982	0.247	6.700	7.200
COND	4	161.250	30.380	125.000	195.000
TURB	0	.	.	.	.
COLOR	0	.	.	.	.

OAK CREEK

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	19	0.051	0.034	0.019	0.168
OPO4	19	0.022	0.017	0.002	0.060
TN	19	1.239	0.308	0.630	1.710
NO3	19	0.063	0.099	0.004	0.384
NO2	19	0.006	0.002	0.004	0.010
NH4	19	0.037	0.038	0.010	0.160
TKN	19	1.178	0.302	0.490	1.710
CL	19	22.163	6.611	15.100	40.000
NA	11	14.760	4.136	10.670	24.000
K	11	1.649	0.647	0.570	2.720
CA	11	16.649	6.928	8.100	27.360
MG	11	3.323	0.942	2.000	5.490
SIO2	18	2.556	1.541	0.500	7.200
SO4	15	14.187	8.217	5.000	37.400
ALK	19	0.875	1.010	0.230	4.900
TDORGC	2	16.850	0.354	16.600	17.100
TOTORGC	3	16.100	2.081	14.800	18.500
DO	21	6.648	2.024	2.600	10.800
PH	21	6.755	0.701	5.300	7.800
COND	21	145.238	40.659	50.000	200.000
TURB	6	1.250	0.677	0.700	2.500
COLOR	5	133.600	42.835	78.000	180.000

CHANDLER SLOUGH AT C-38

Variable	N	Mean	Standard Deviation	Minimum Value	Maximum Value
TPO4	49	0.117	0.047	0.039	0.296
OPO4	52	0.085	0.057	0.002	0.391
TN	54	1.339	0.286	0.100	2.200
NO3	54	0.013	0.018	0.004	0.085
NO2	54	0.004	0.001	0.004	0.008
NH4	54	0.037	0.026	0.010	0.110
TKN	54	1.328	0.287	0.060	2.200
CL	54	37.859	16.759	18.600	86.300
NA	31	18.490	6.708	13.200	34.950
K	31	3.887	3.326	1.600	11.810
CA	29	9.540	7.010	1.200	22.800
MG	30	3.143	1.471	1.300	5.980
SIO2	52	4.715	2.171	1.100	8.400
SO4	50	7.008	3.461	4.300	18.000
ALK	53	0.470	0.217	0.100	0.980
TDORGC	5	12.400	7.721	6.700	25.700
TOTORGC	4	13.775	6.297	7.100	19.200
DO	25	6.924	1.151	4.100	9.300
PH	26	6.681	0.430	6.050	7.700
COND	26	233.308	59.232	90.000	340.000
TURB	10	1.390	0.698	0.700	2.600
COLOR	5	141.600	44.725	98.000	195.000

DRY SEASON DATA FOR C-38 AND TRIBUTARIES
NOVEMBER 1 ST THROUGH APRIL 30 TH : 1973 - 1978

MAPLE RIVER

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	14	0.107	0.103	0.033	0.430
OPO4	14	0.059	0.114	0.002	0.449
TN	14	1.212	0.363	0.110	1.650
NO3	14	0.116	0.147	0.004	0.516
NO2	14	0.007	0.008	0.004	0.034
NH4	14	0.035	0.022	0.010	0.070
TKN	14	1.094	0.360	0.060	1.500
CL	14	32.779	11.985	16.700	60.000
NA	11	20.215	6.024	10.520	28.000
K	11	2.465	1.716	0.920	7.410
CA	10	18.984	5.508	8.500	28.200
MG	10	4.931	1.168	2.970	6.550
SIO2	12	2.992	1.953	0.500	5.800
SO4	10	15.550	7.153	5.000	30.400
ALK	13	0.895	0.543	0.390	2.350
TDORGC	3	19.000	4.293	15.100	23.600
TOTORGC	3	12.200	6.669	4.500	16.100
DO	18	6.983	2.425	3.600	11.400
PH	19	6.768	0.386	6.100	7.550
COND	19	251.000	59.396	114.000	350.000
TURB	7	1.443	0.665	0.300	2.400
COLOR	4	90.000	25.166	55.000	115.000

YATES MARSH

VARIABLE	N	MEAN	STANDARD DEVIATION	MINIMUM VALUE	MAXIMUM VALUE
TPO4	6	0.086	0.034	0.045	0.140
OPO4	7	0.051	0.034	0.013	0.106
TN	6	1.122	0.527	0.100	1.560
NO3	7	0.069	0.077	0.004	0.210
NO2	7	0.005	0.002	0.004	0.008
NH4	7	0.049	0.021	0.030	0.090
TKN	6	1.042	0.515	0.060	1.460
CL	7	25.329	6.637	17.000	35.400
NA	6	16.833	3.710	14.000	22.000
K	6	1.707	0.600	1.080	2.800
CA	5	14.992	5.628	7.900	23.400
MG	5	3.560	0.456	3.000	4.000
SIO2	7	3.214	1.944	0.400	5.500
SO4	5	11.020	4.438	6.300	18.100
ALK	6	0.797	0.154	0.580	1.030
TDORGC	0	.	.	.	.
TOTORGC	0	.	.	.	.
DO	7	7.529	1.293	5.700	9.700
PH	7	6.800	0.597	5.900	7.550
COND	7	195.714	43.916	125.000	265.000
TURB	0	.	.	.	.
COLOR	0	.	.	.	.

APPENDIX C

TOTAL PHOSPHORUS, DISSOLVED OXYGEN, CHLORIDE, PH, TOTAL NITROGEN, AND INORGANIC NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES

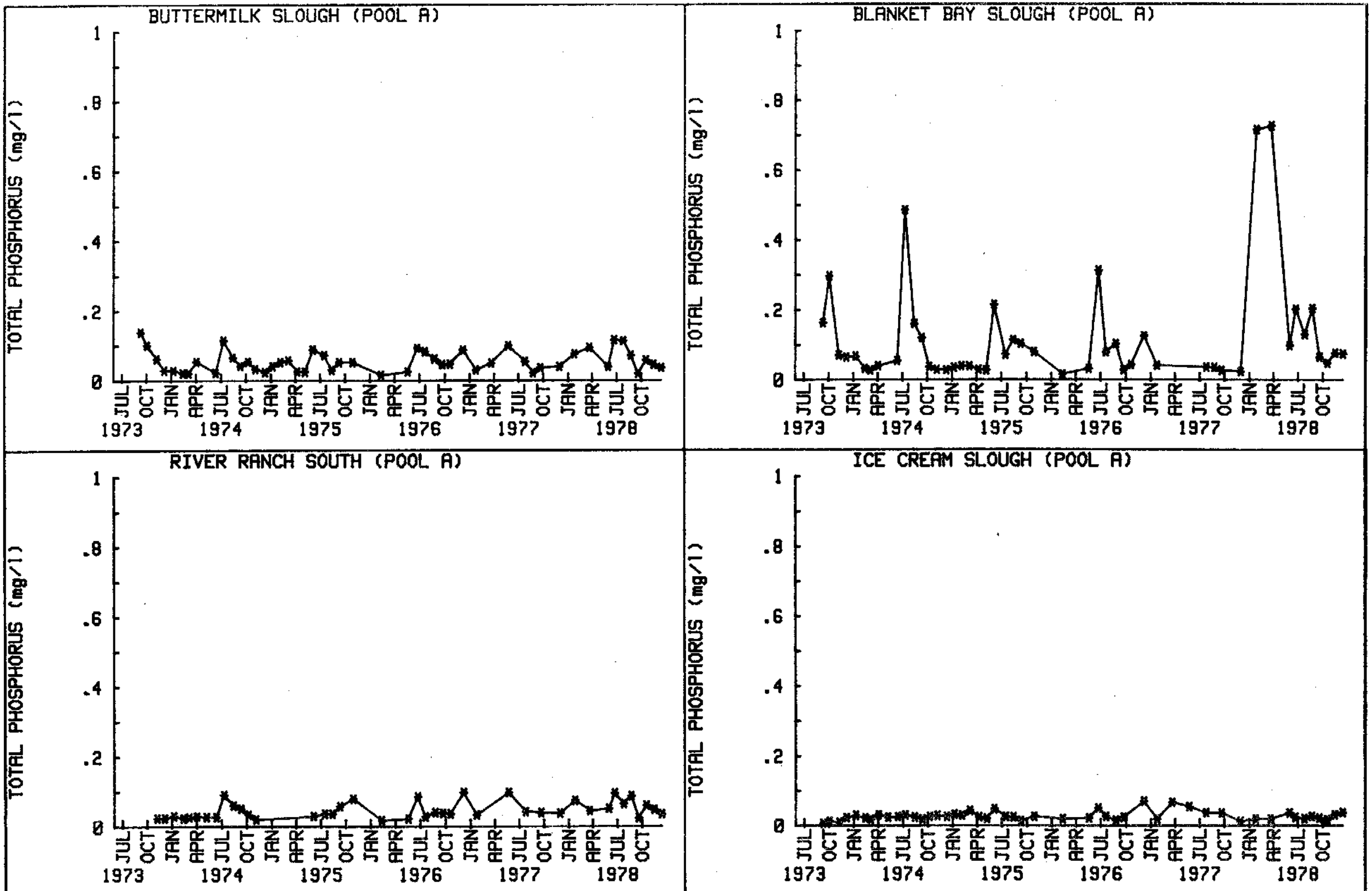

FIGURE C-1. TOTAL PHOSPHORUS VERSUS TIME FOR C-38 TRIBUTARIES

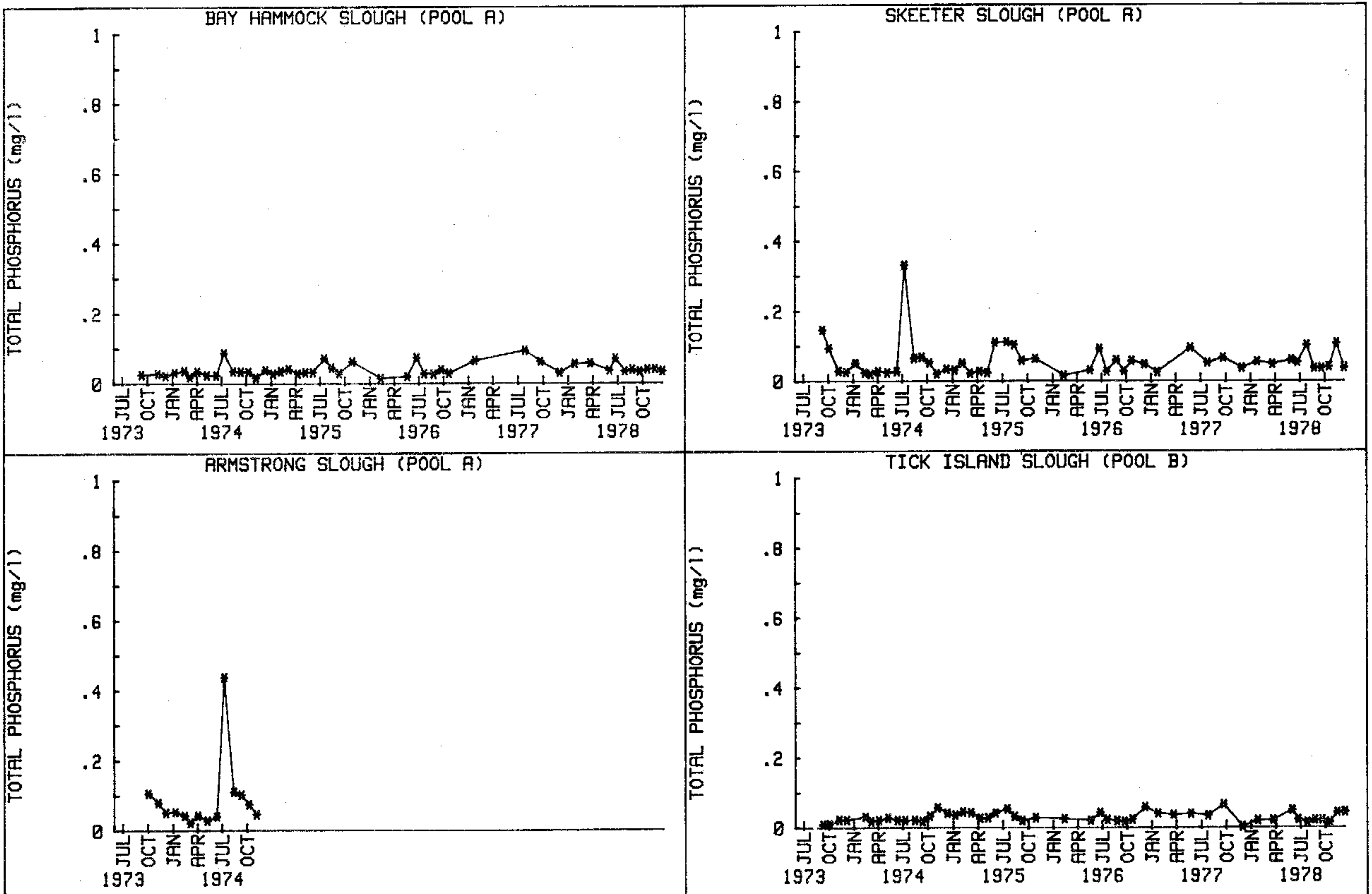

FIGURE C-1(continued). TOTAL PHOSPHORUS VERSUS TIME FOR C-38 TRIBUTARIES

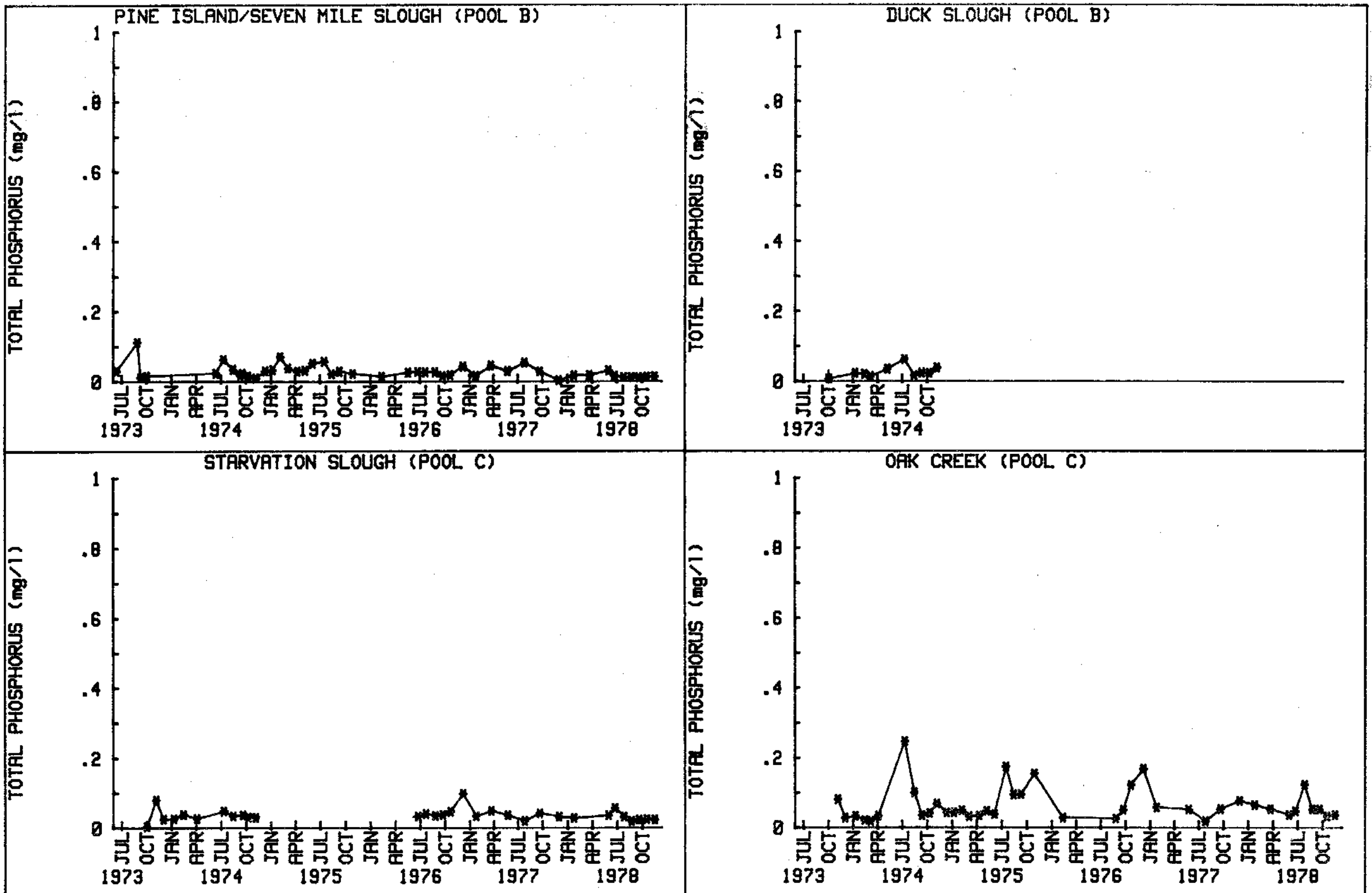

FIGURE C-1 (continued). TOTAL PHOSPHORUS VERSUS TIME FOR C-38 TRIBUTARIES

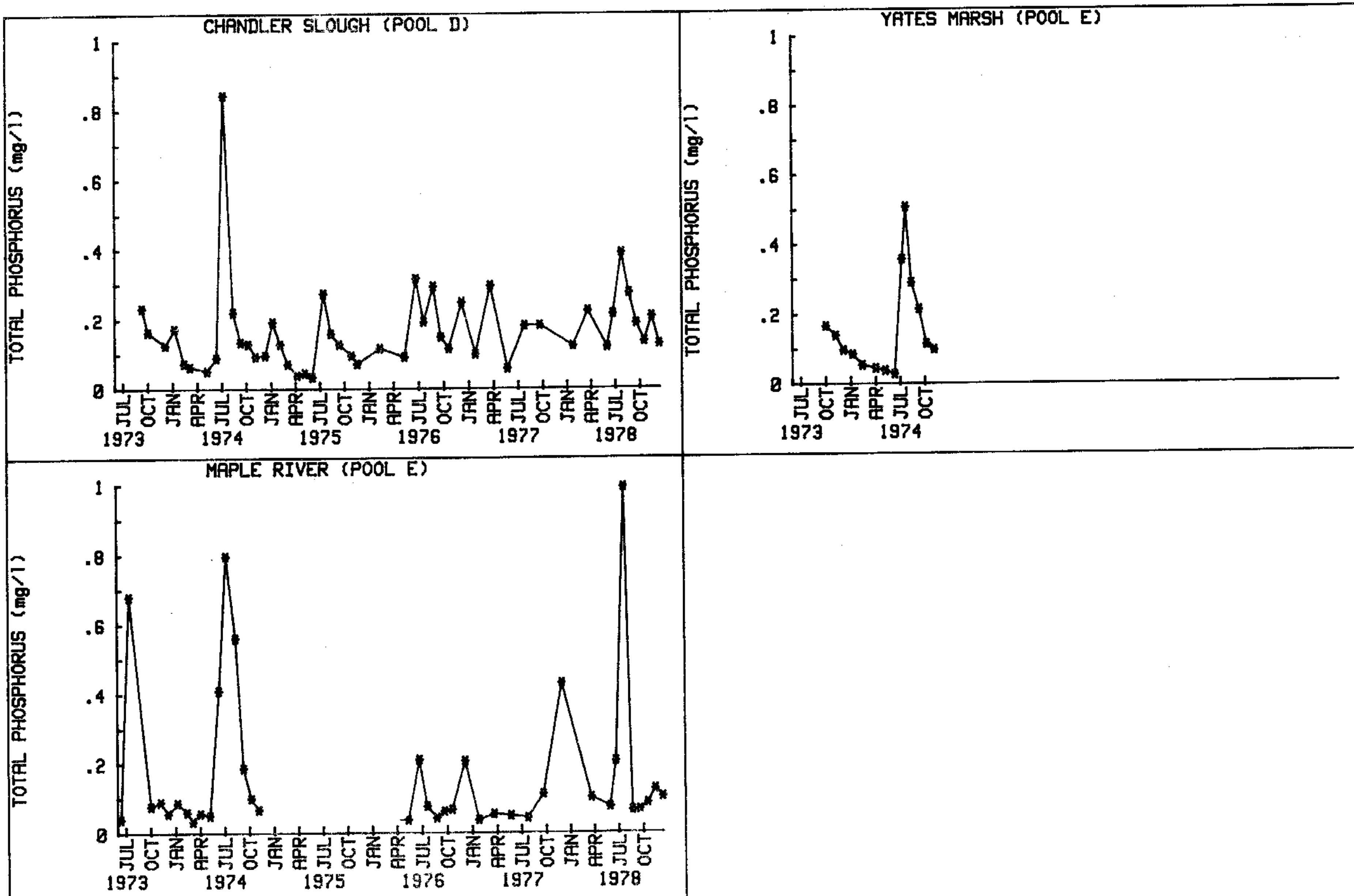

FIGURE C-1 (continued). TOTAL PHOSPHORUS VERSUS TIME FOR C-38 TRIBUTARIES

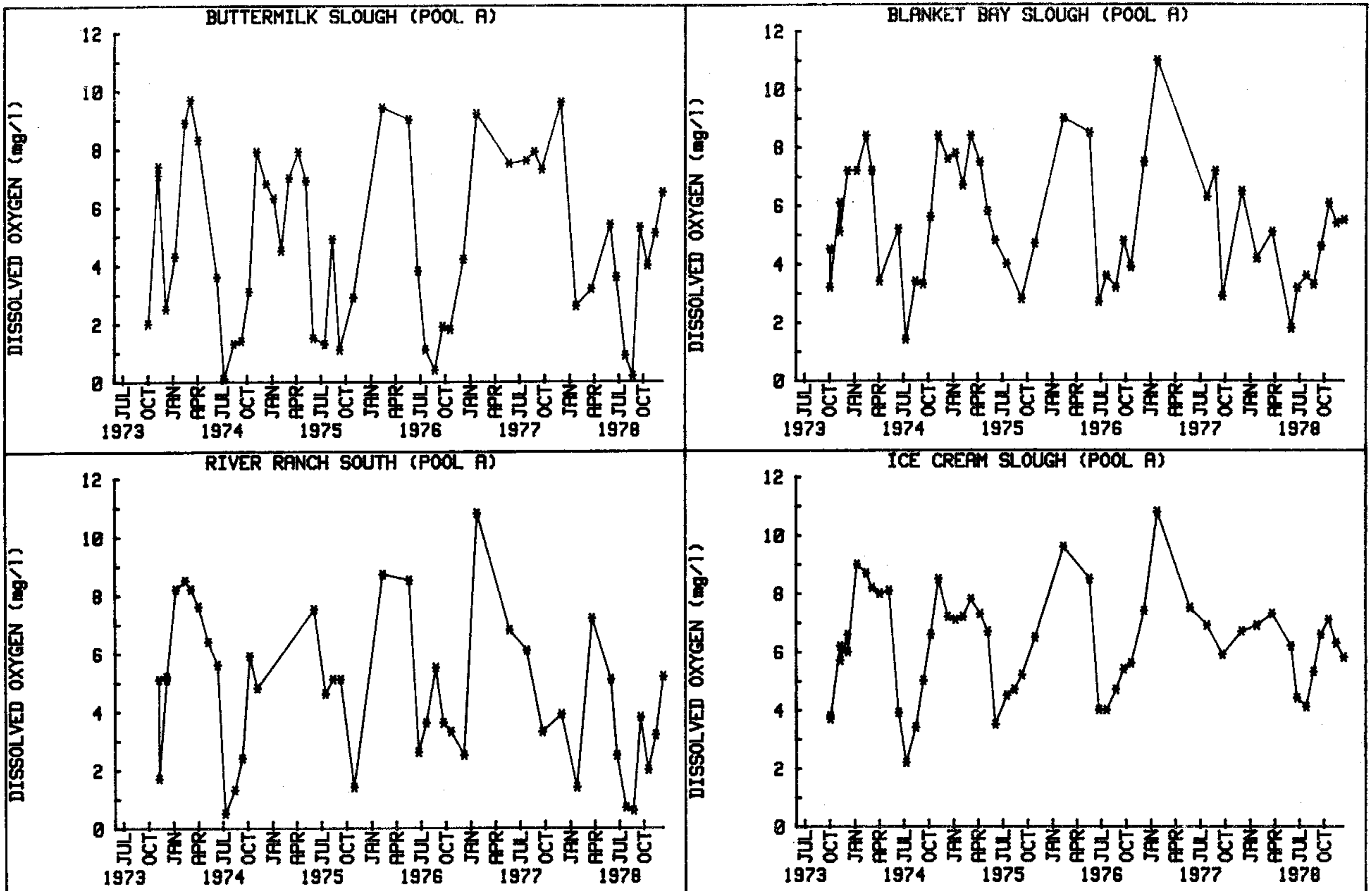

FIGURE C-2. DISSOLVED OXYGEN VERSUS TIME FOR C-38 TRIBUTARIES

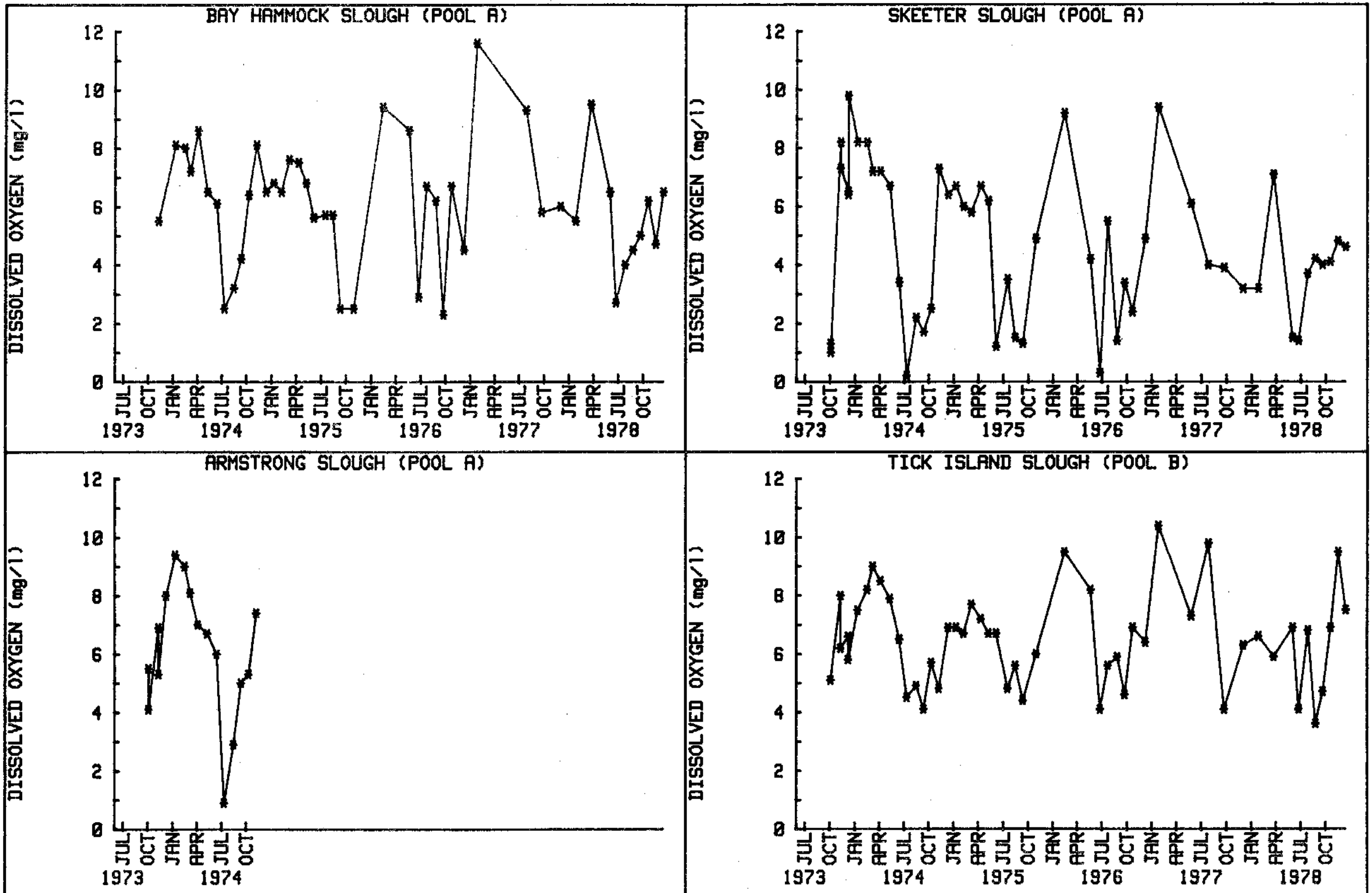

FIGURE C-2 (continued). DISSOLVED OXYGEN VERSUS TIME FOR C-38 TRIBUTARIES

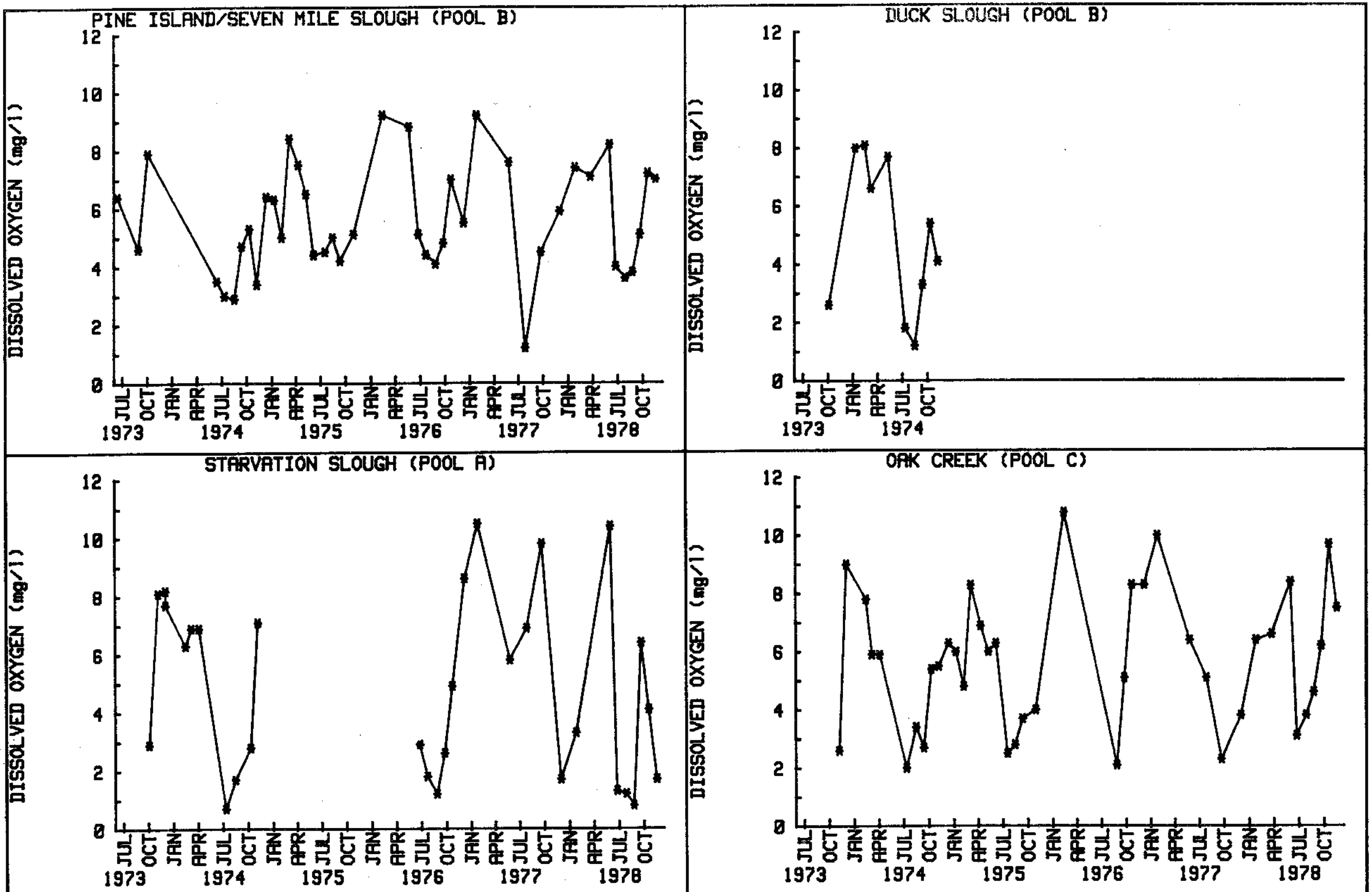

FIGURE C-2(continued). DISSOLVED OXYGEN VERSUS TIME FOR C-38 TRIBUTARIES

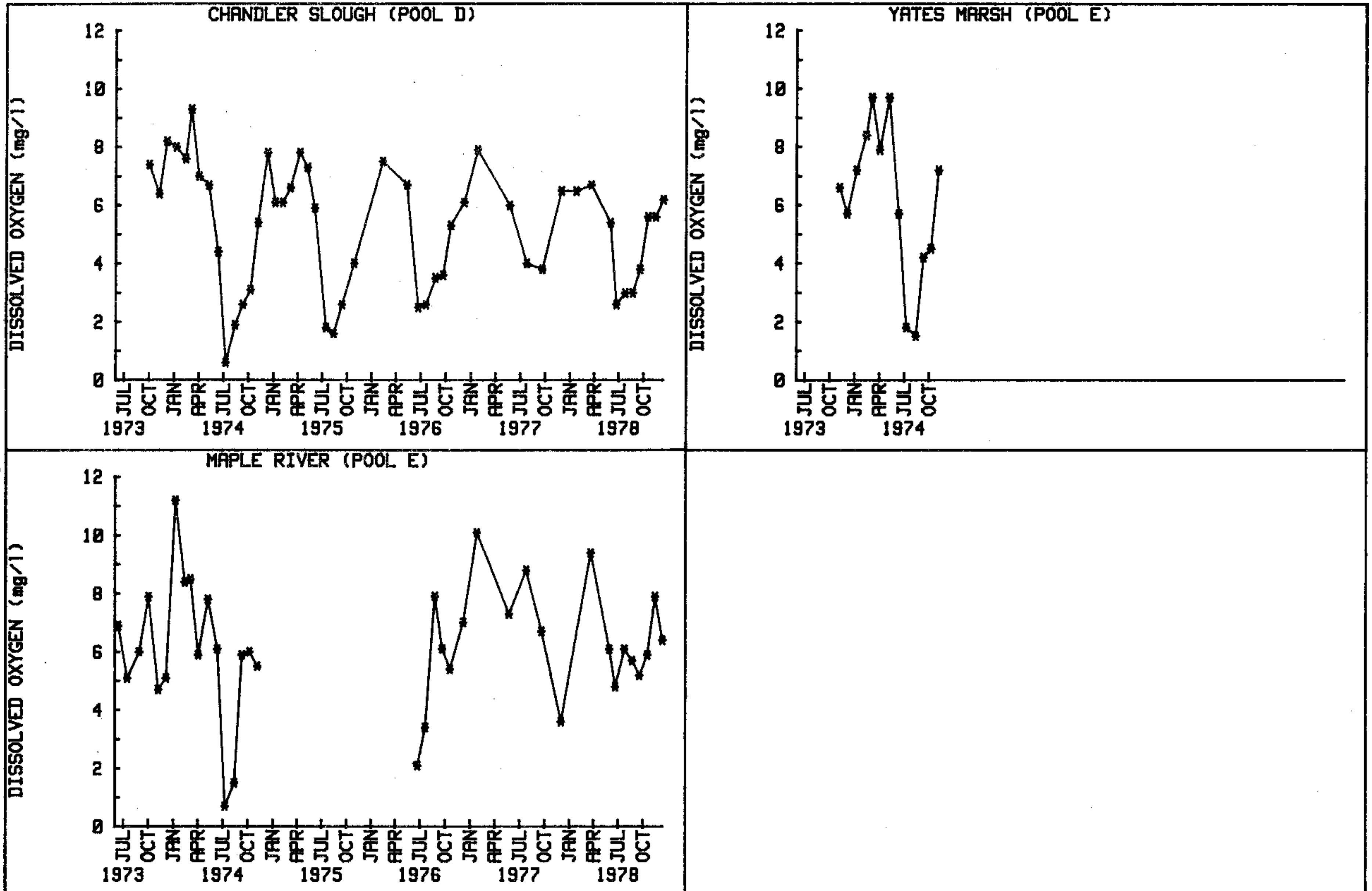

FIGURE C-2(continued). DISSOLVED OXYGEN VERSUS TIME FOR C-38 TRIBUTARIES

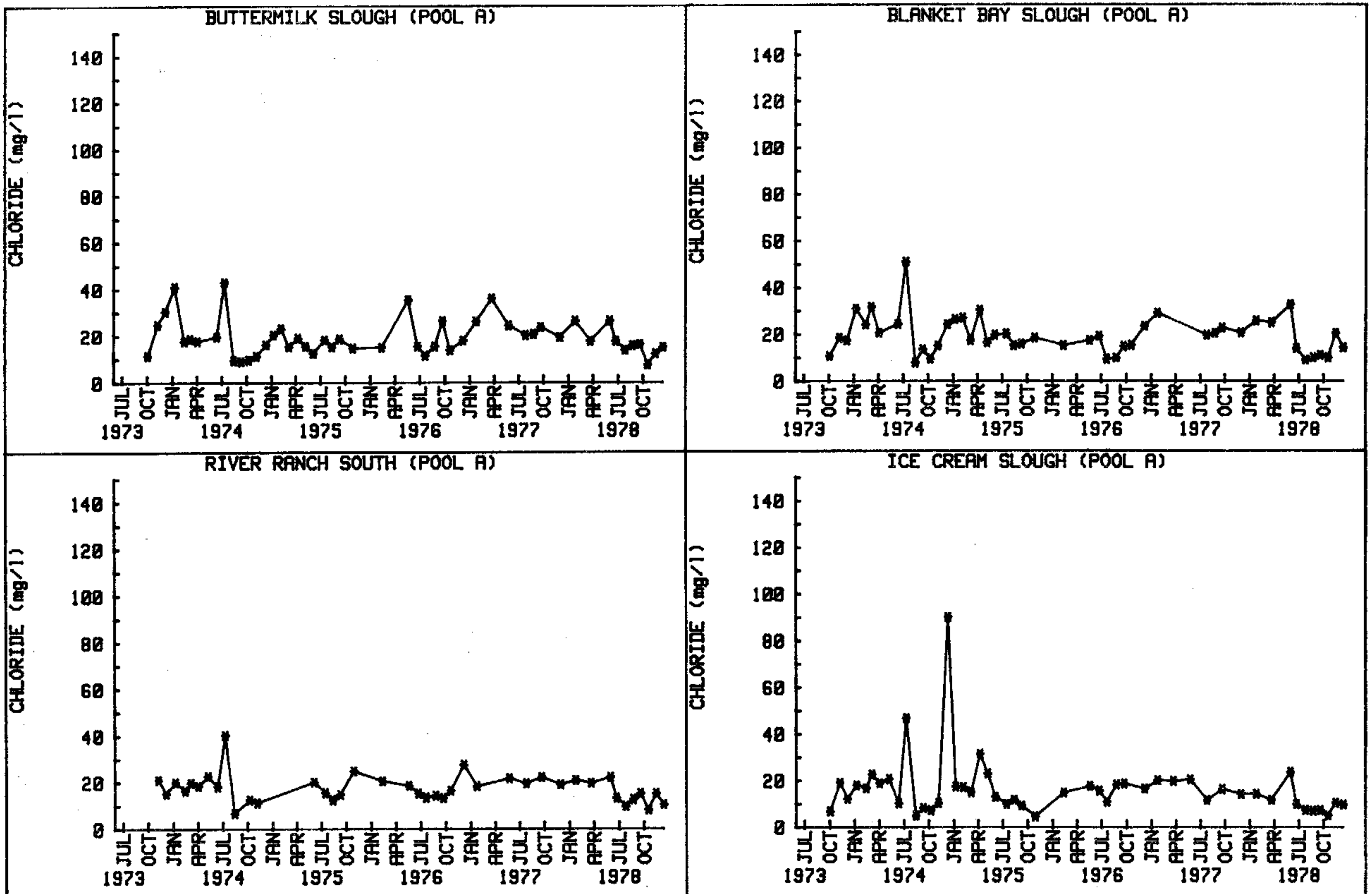

FIGURE C-3. CHLORIDE VERSUS TIME FOR C-38 TRIBUTARIES

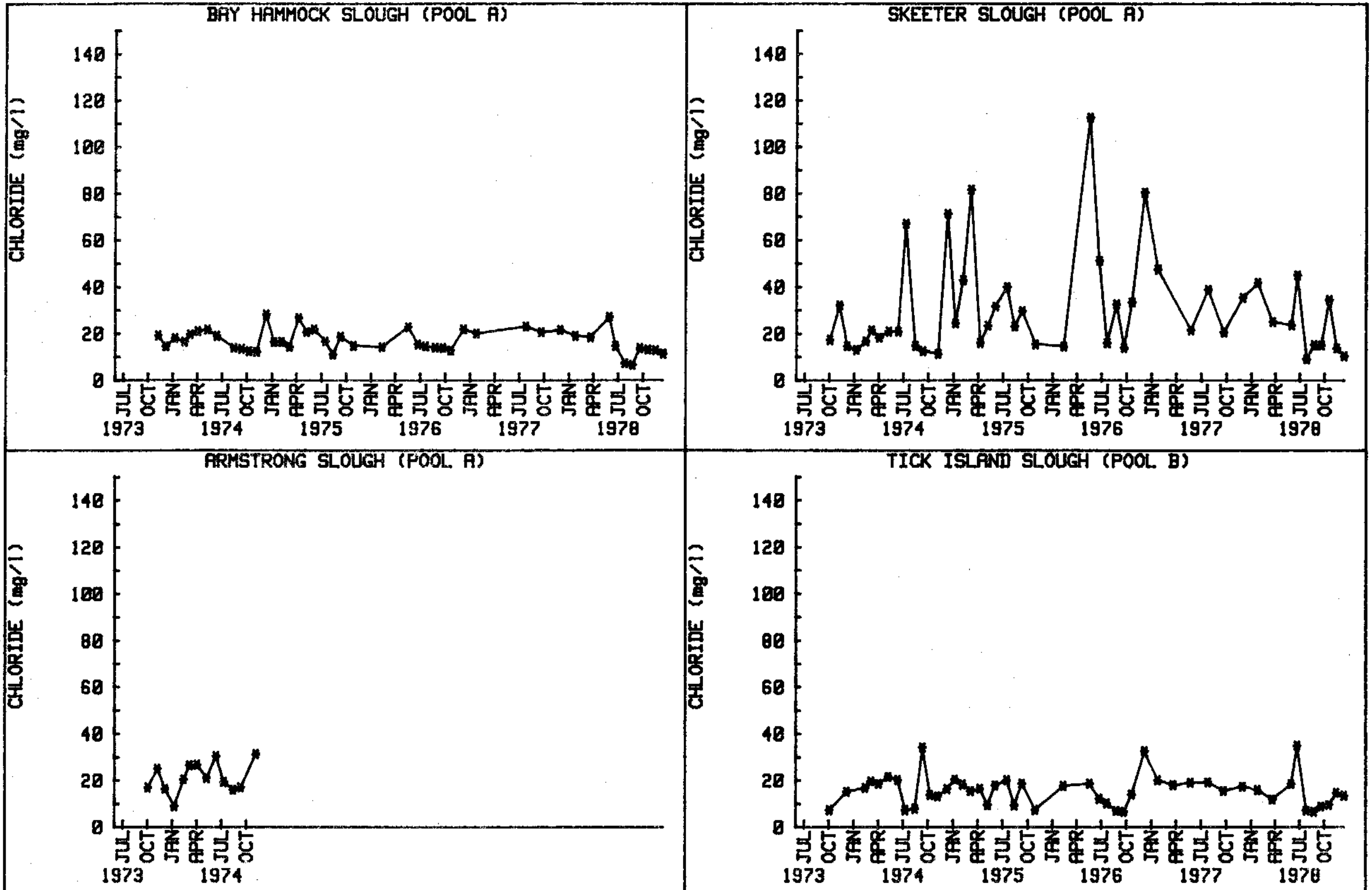

FIGURE C-3 (continued). CHLORIDE VERSUS TIME FOR C-38 TRIBUTARIES

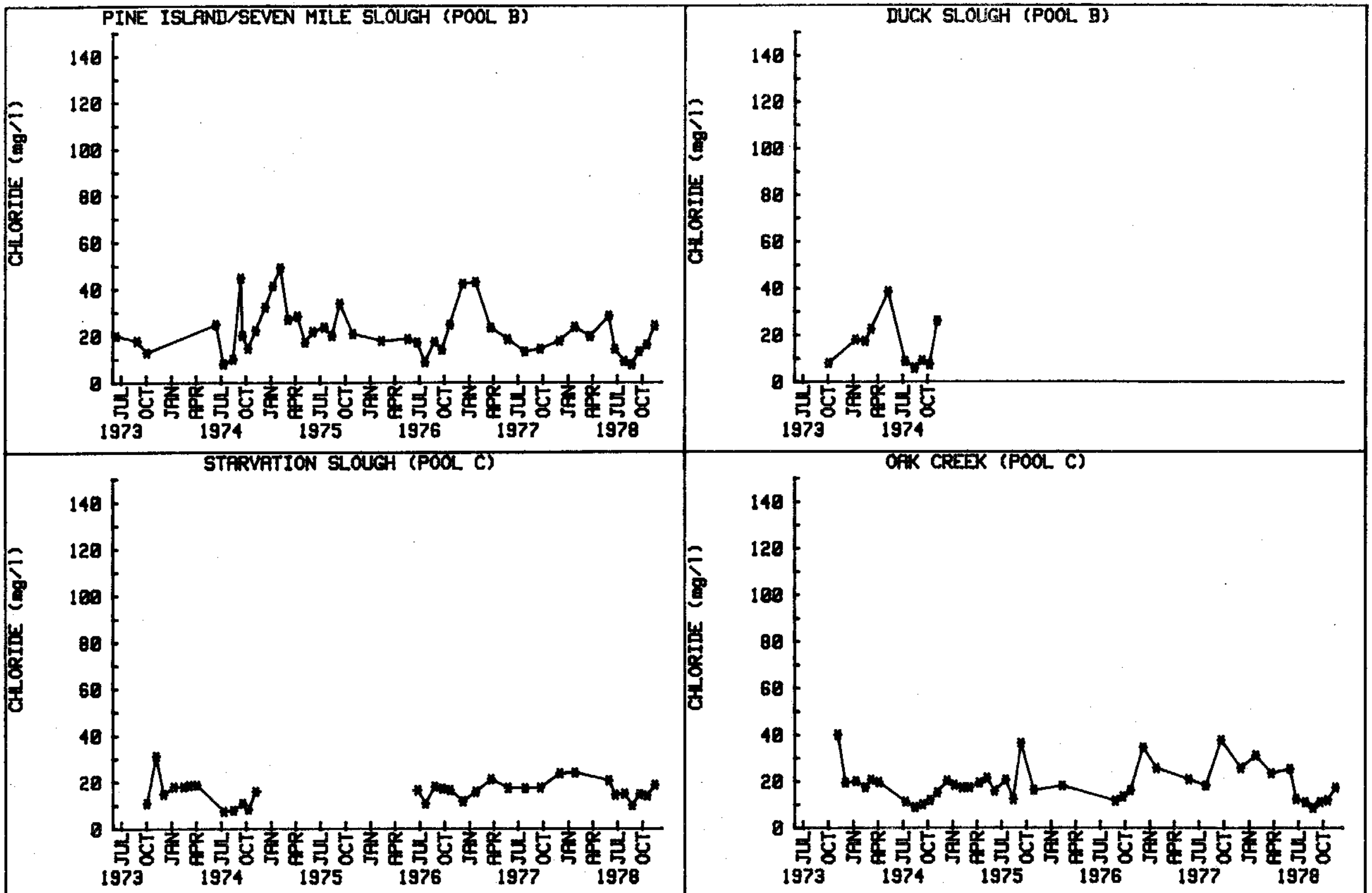

FIGURE C-3(continued). CHLORIDE VERSUS TIME FOR C-38 TRIBUTARIES

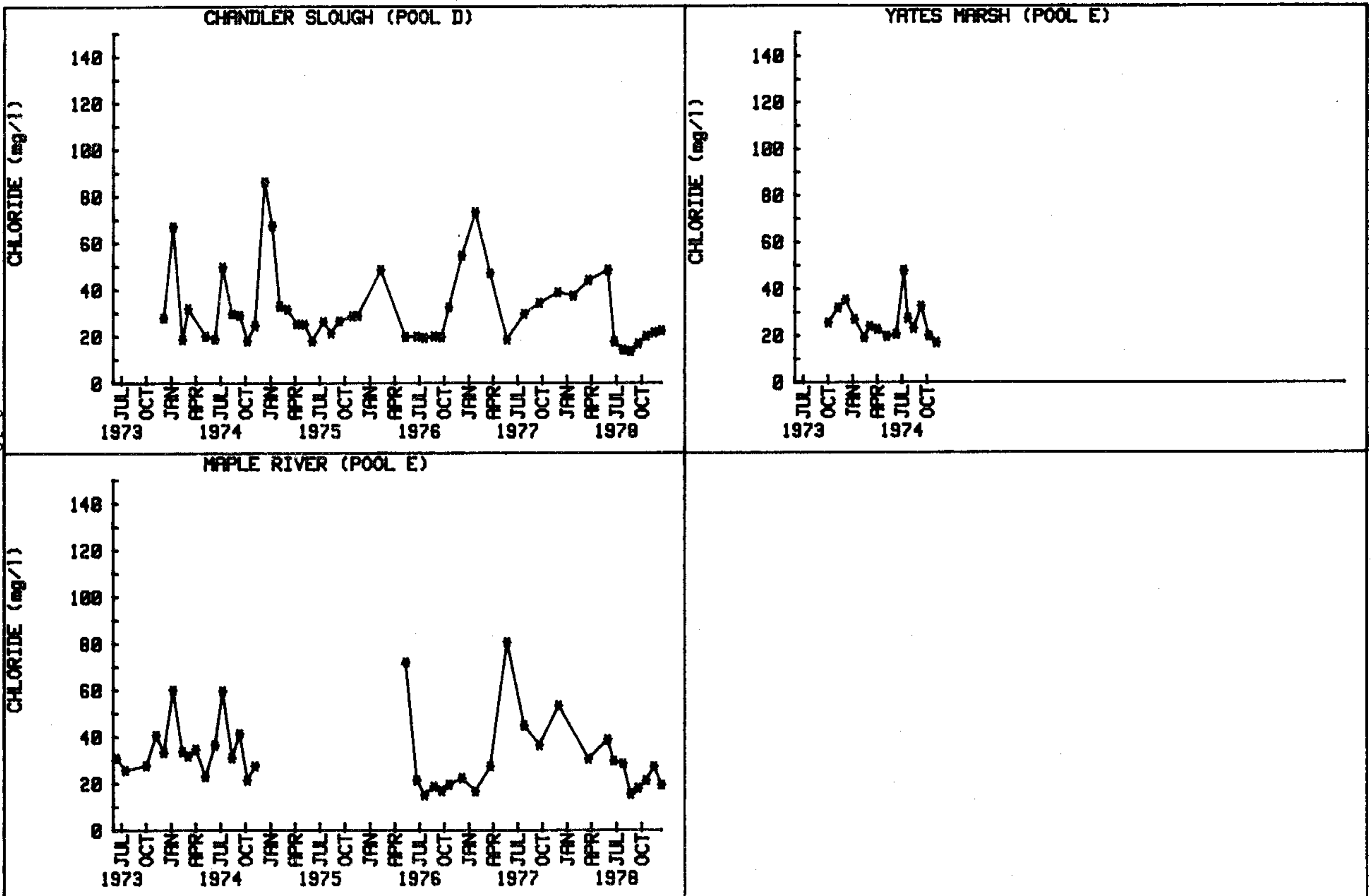

FIGURE C-3(continued). CHLORIDE VERSUS TIME FOR C-38 TRIBUTARIES

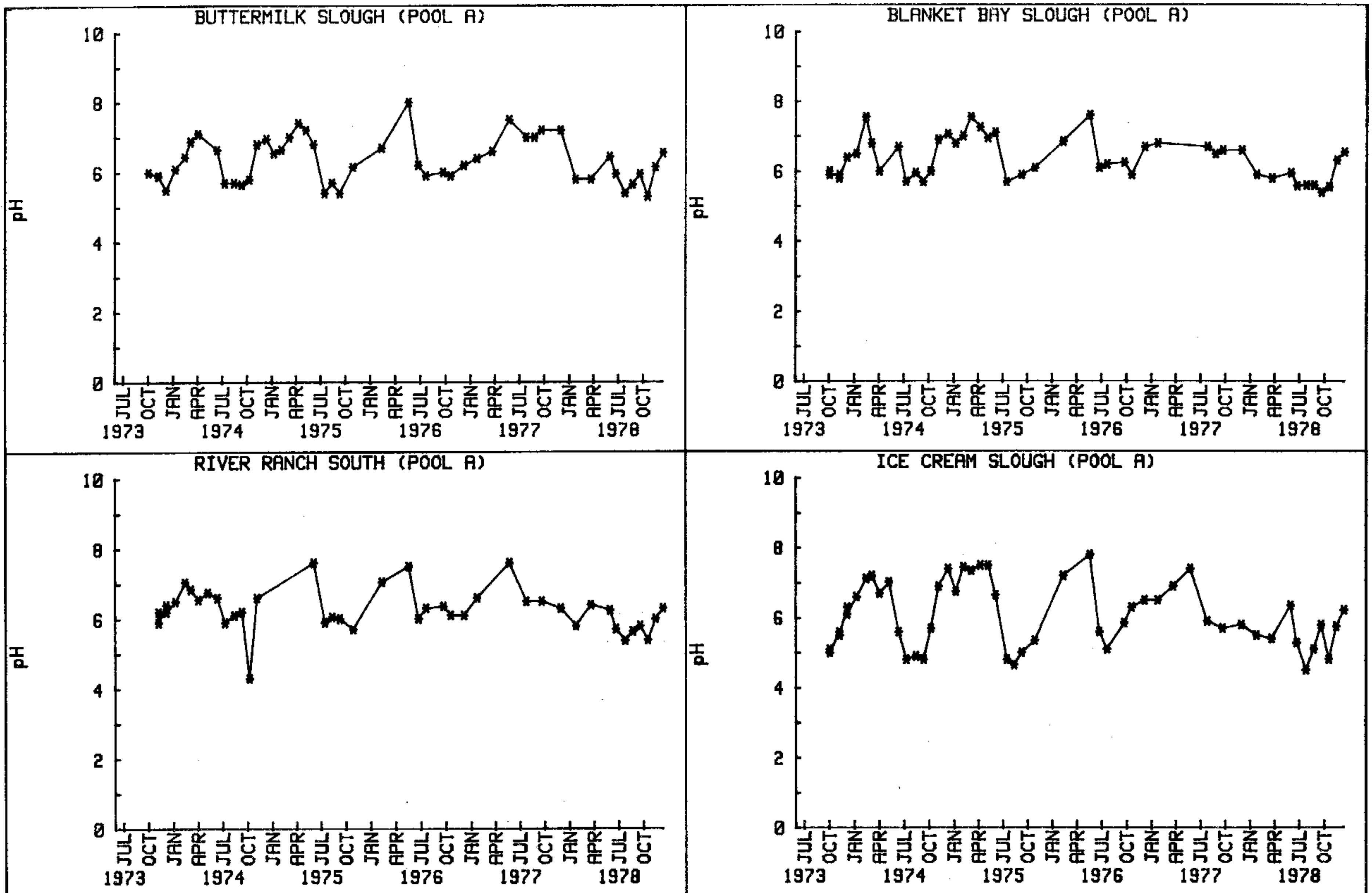

FIGURE C-4. pH VERSUS TIME FOR C-38 TRIBUTARIES

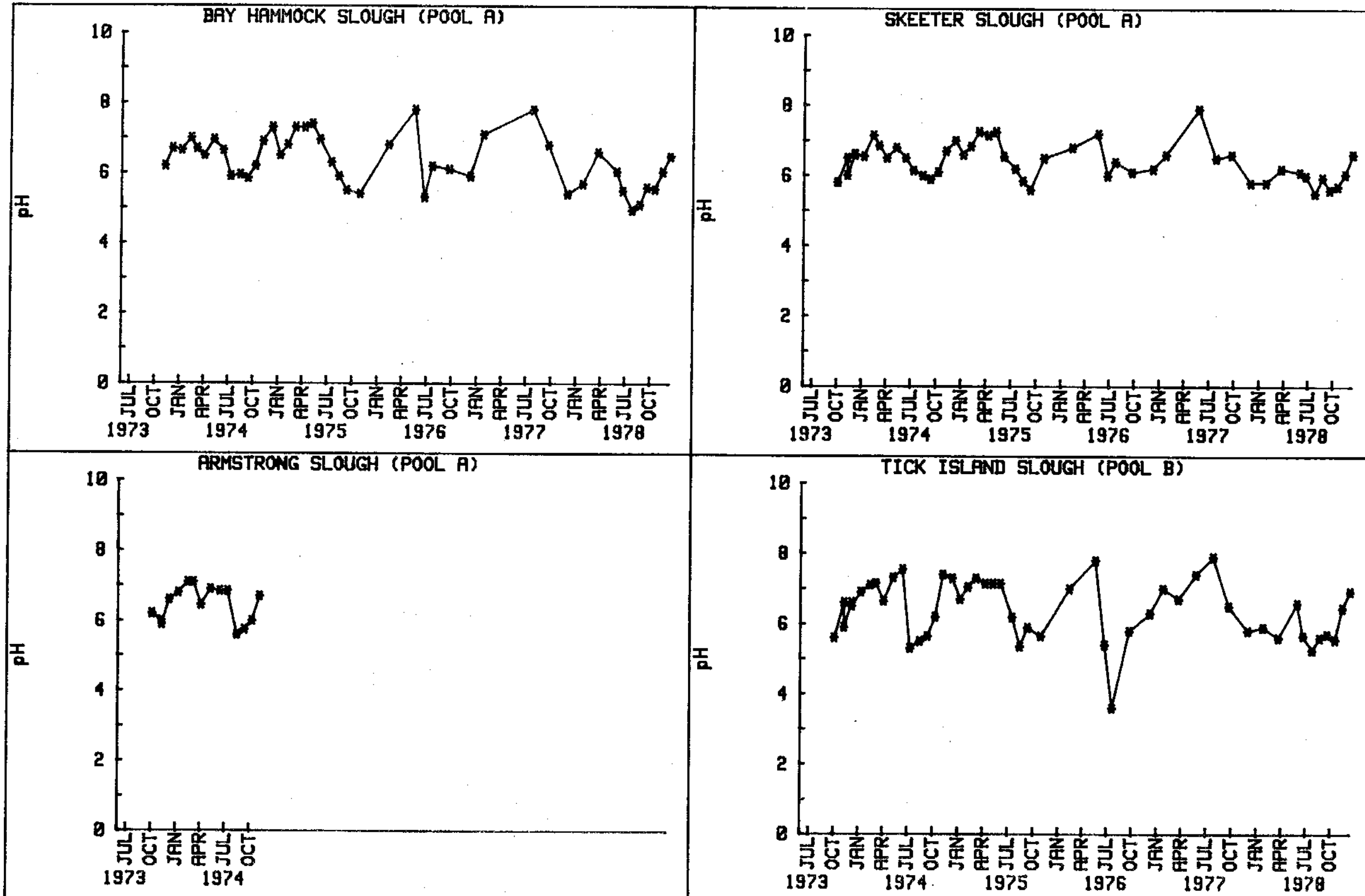

FIGURE C-4 (continued). pH VERSUS TIME FOR C-38 TRIBUTARIES

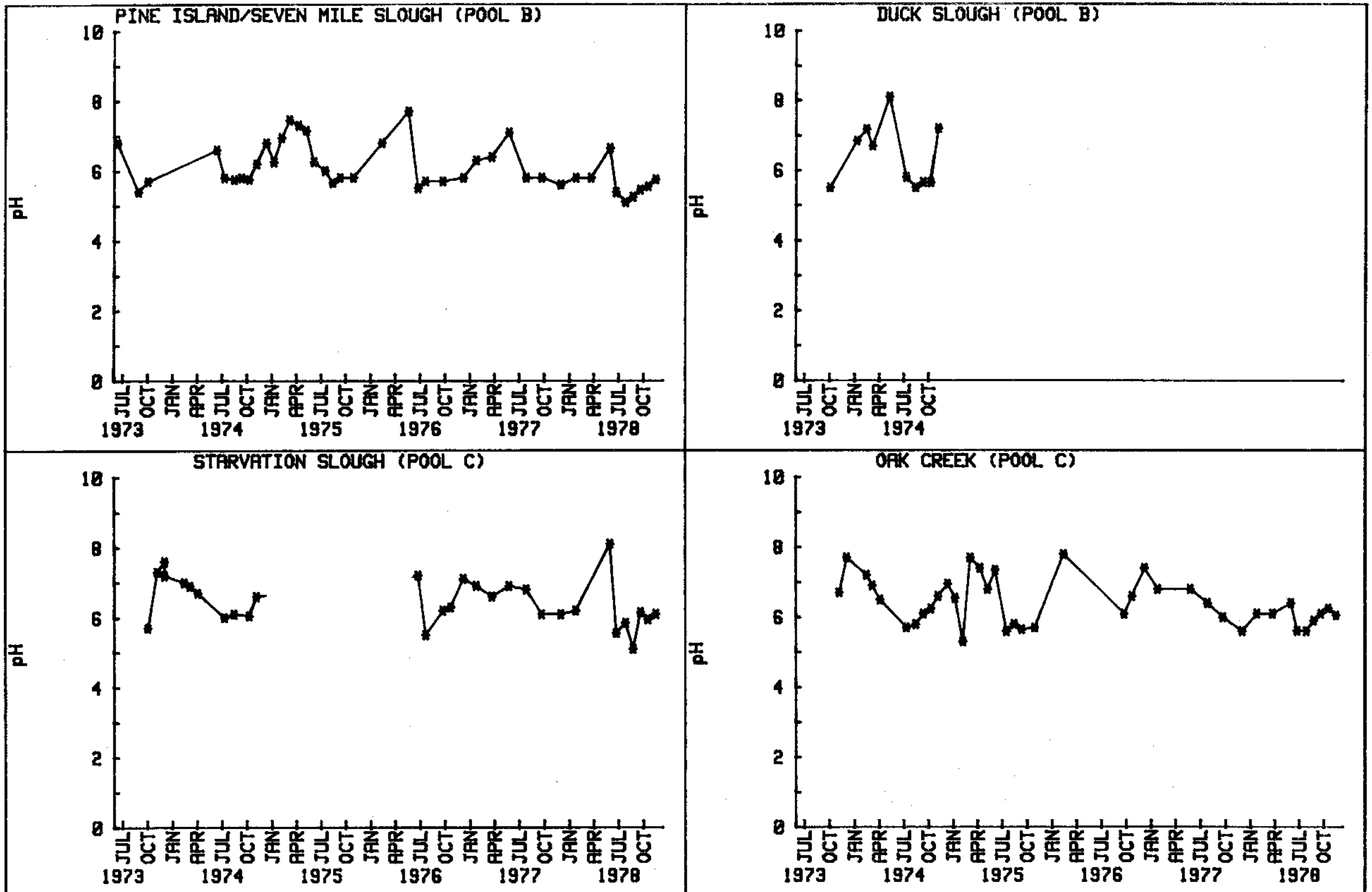

FIGURE C-4(continued). pH VERSUS TIME FOR C-38 TRIBUTARIES

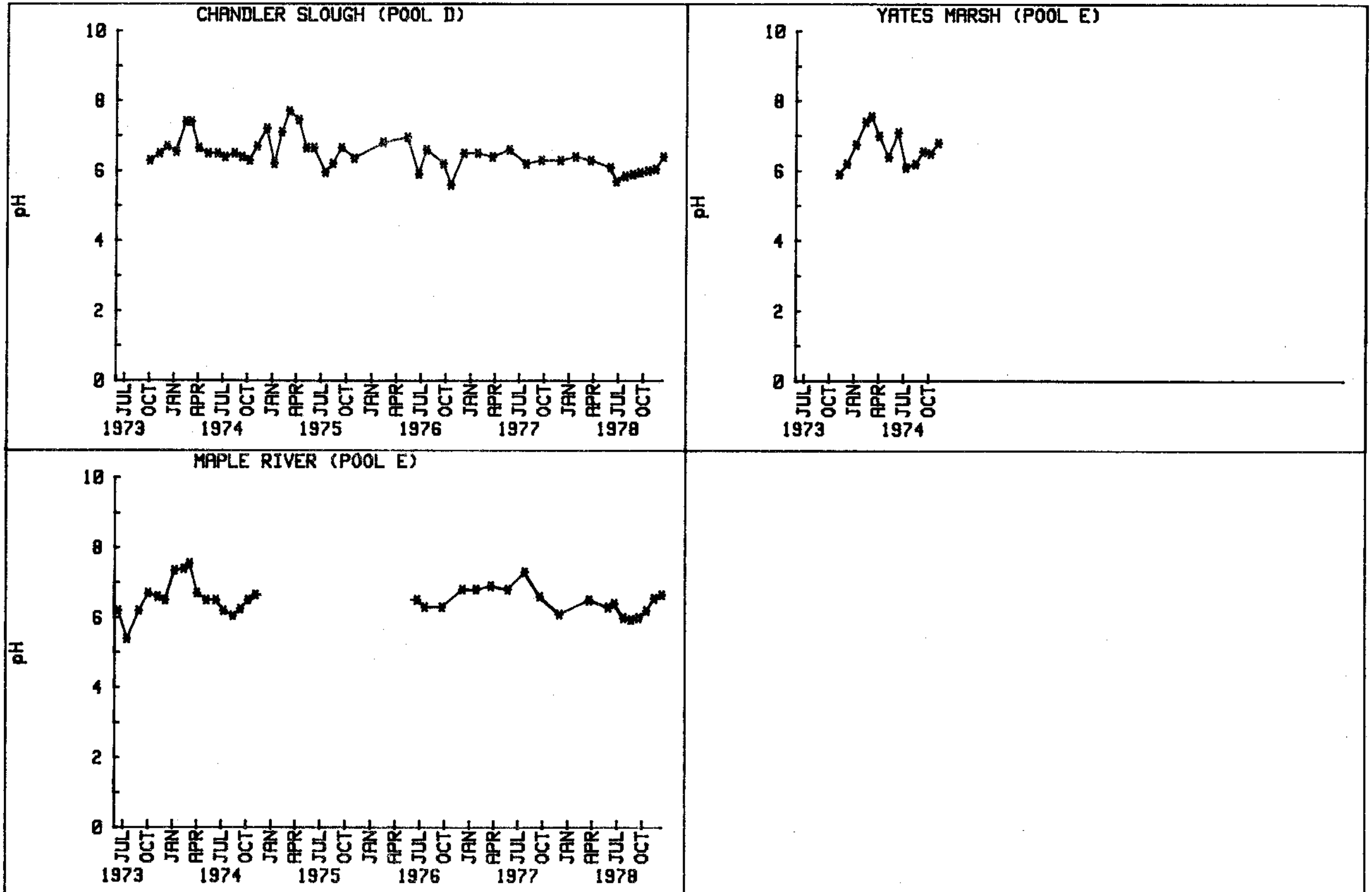

FIGURE C-4(continued). pH VERSUS TIME FOR C-38 TRIBUTARIES

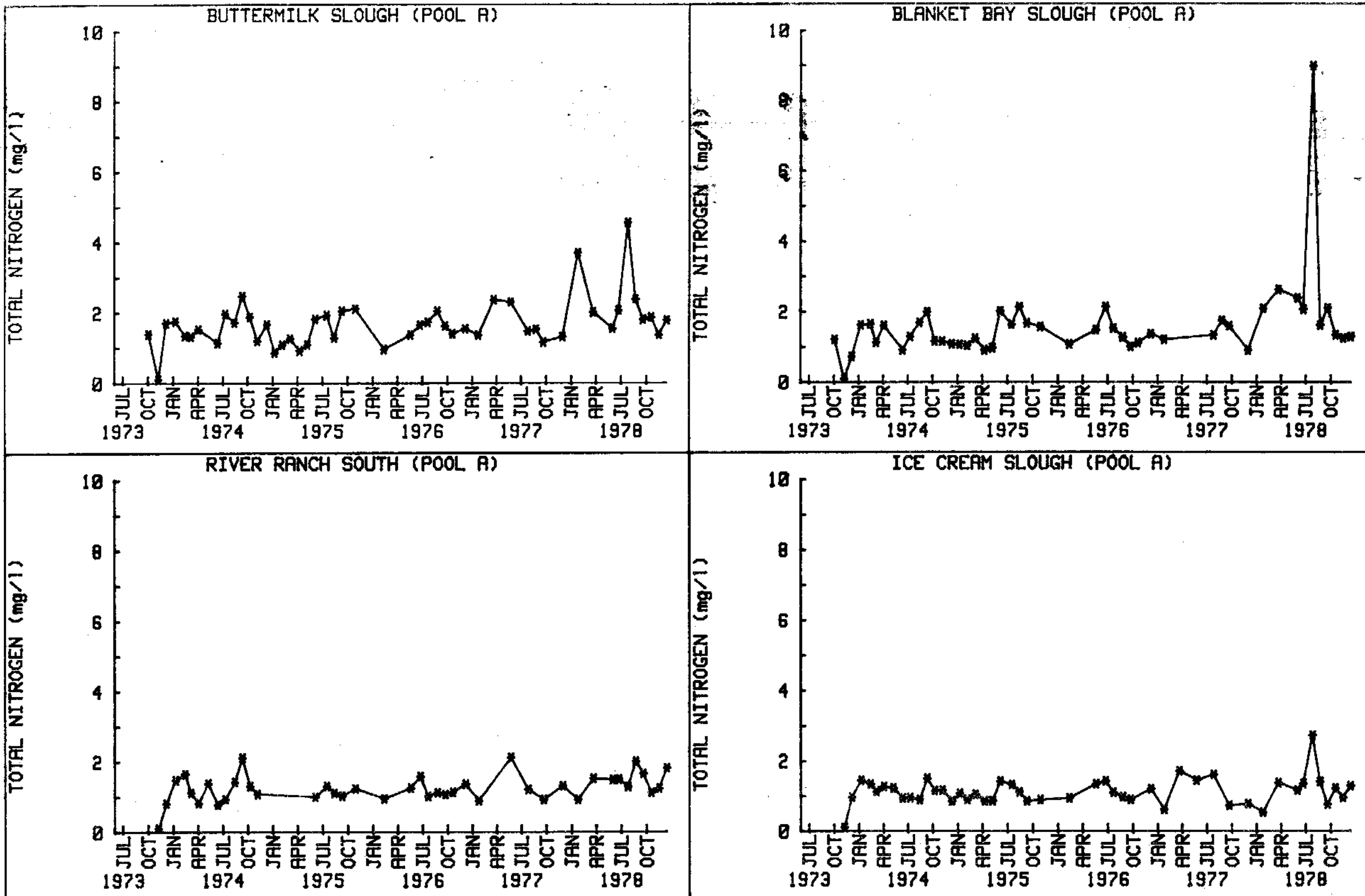

FIGURE C-5. TOTAL NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES

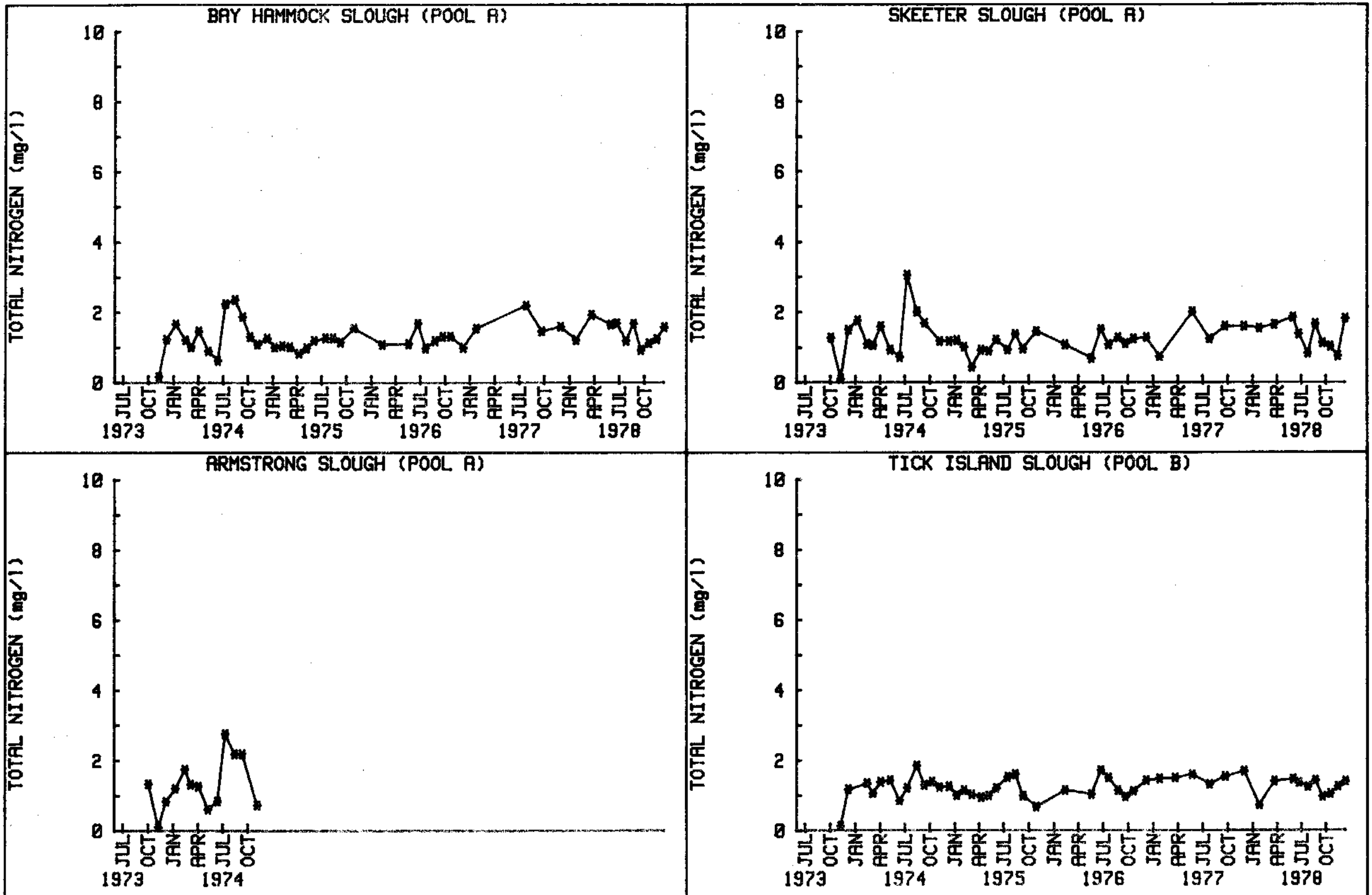

FIGURE C-5(continued). TOTAL NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES

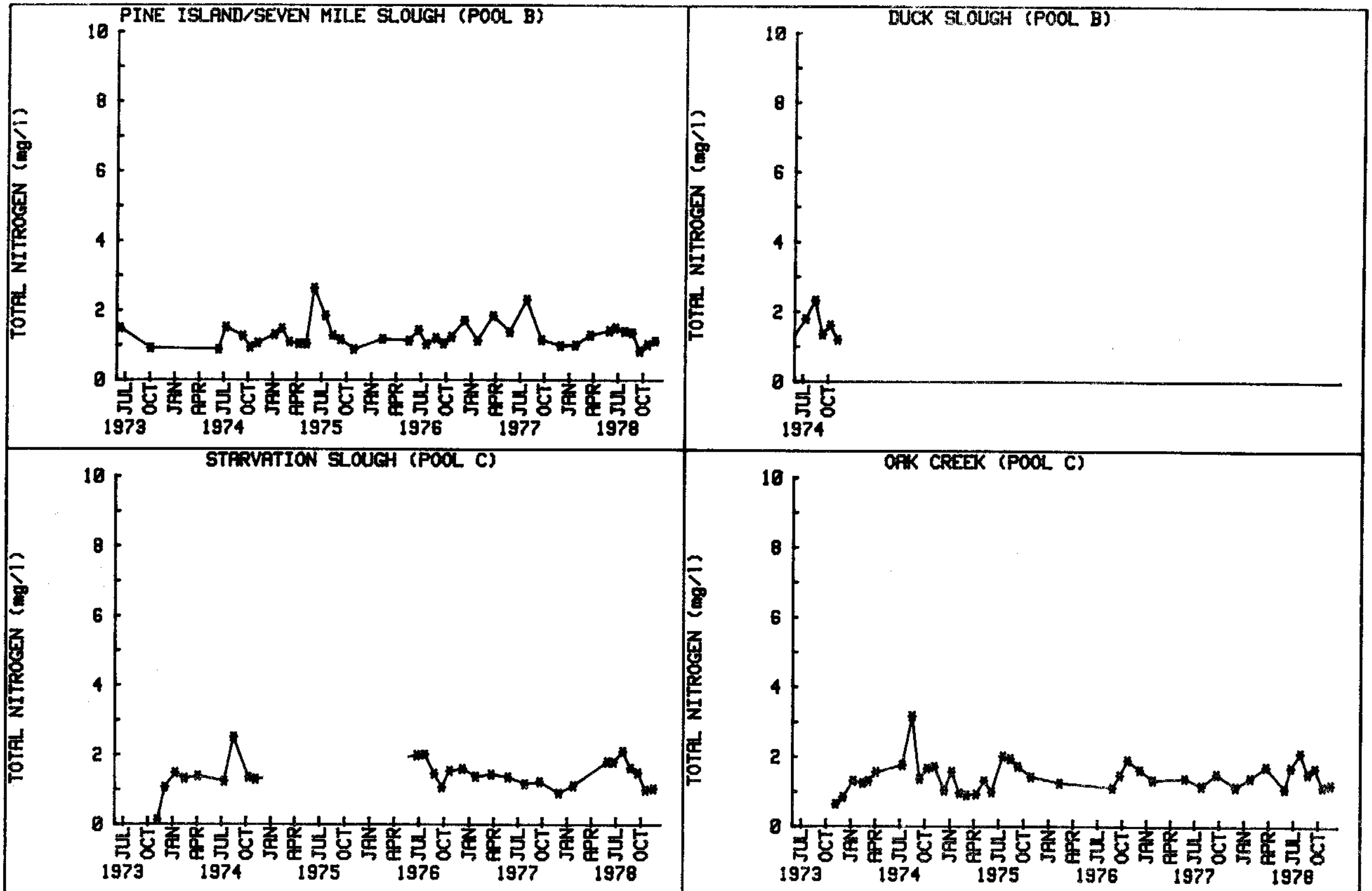

FIGURE C-5(continued). TOTAL NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES

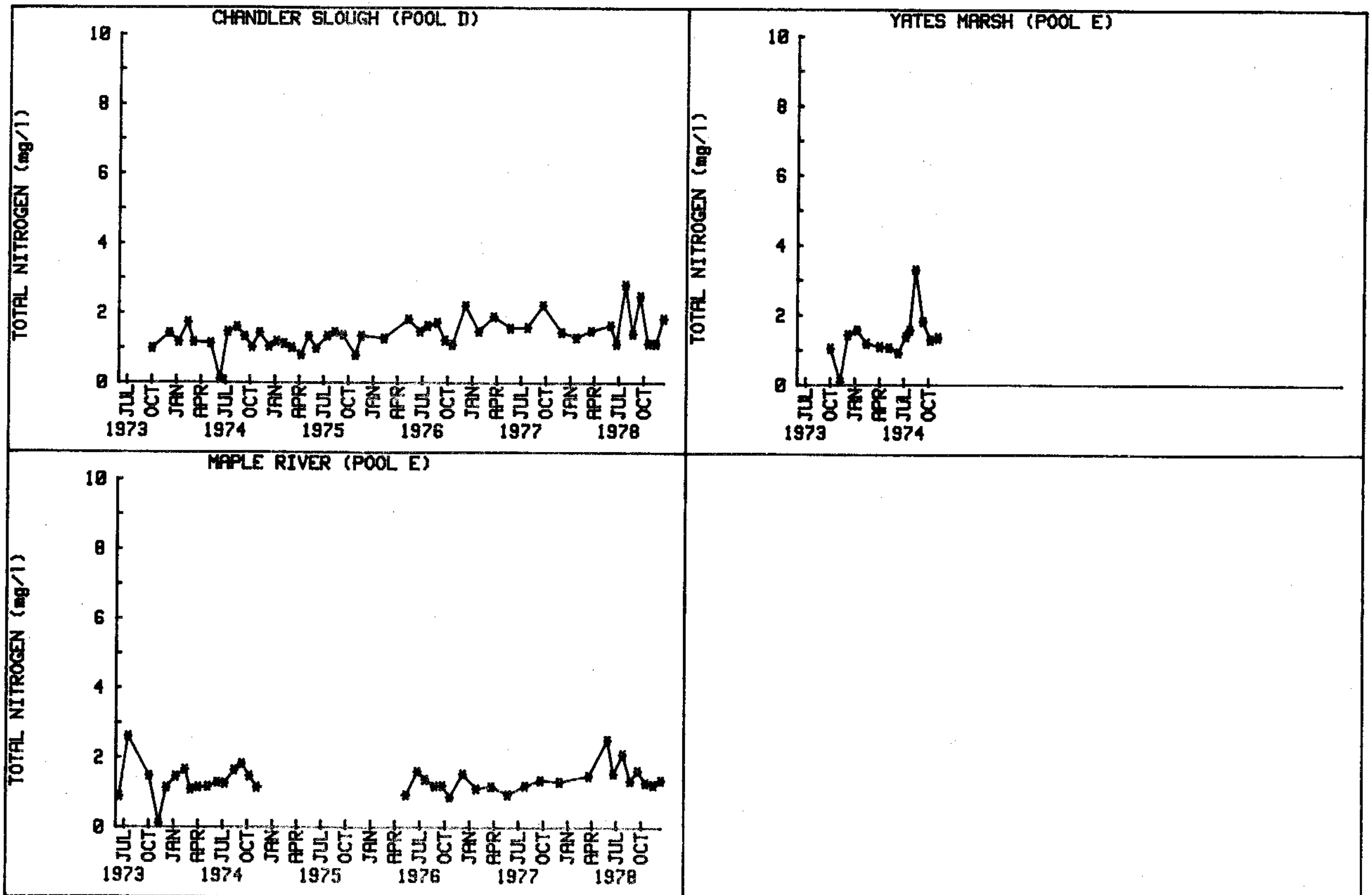

FIGURE C-5(continued). TOTAL NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES

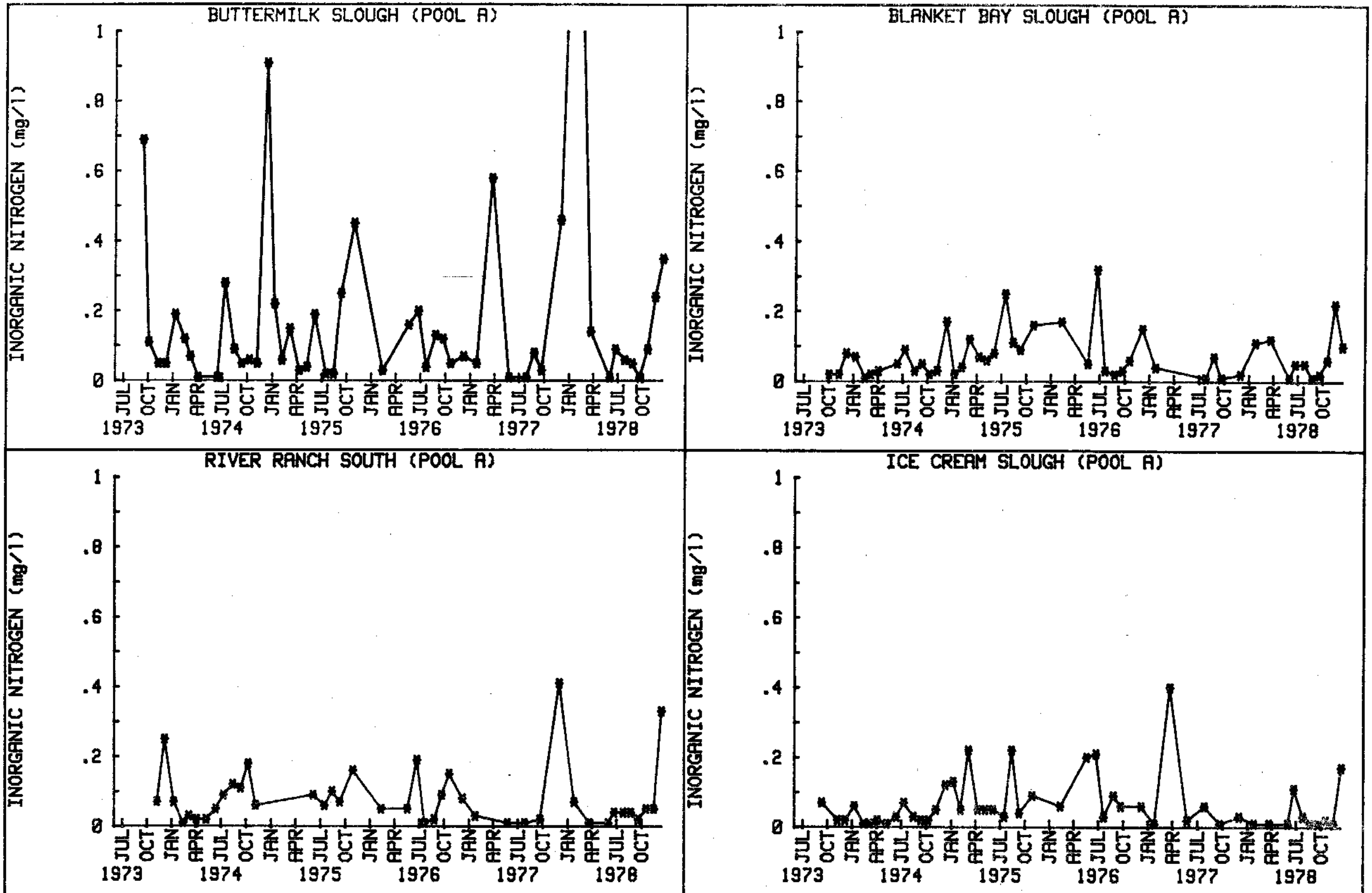

FIGURE C-6. INORGANIC NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES

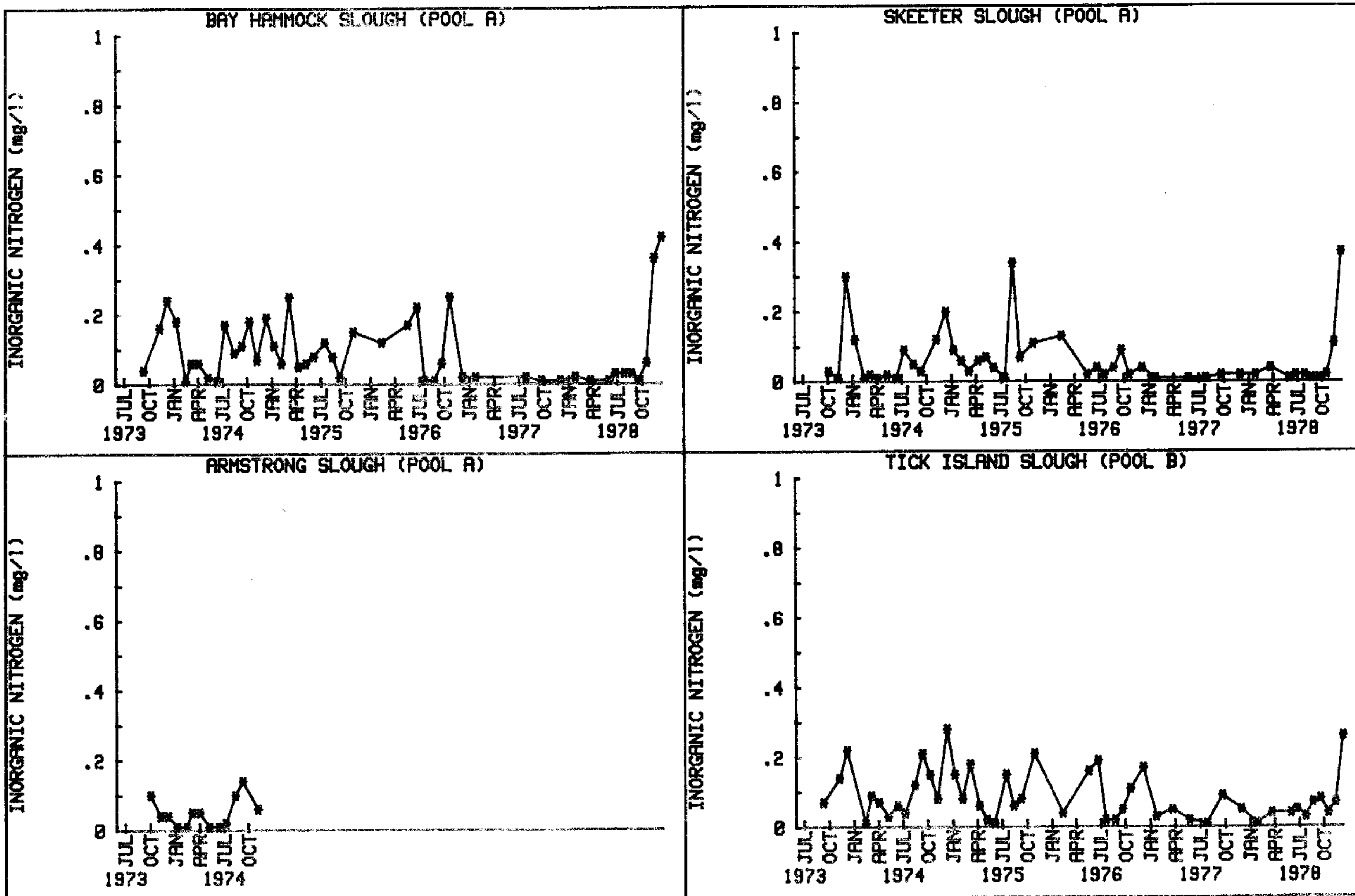

FIGURE C-6(continued). INORGANIC NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES

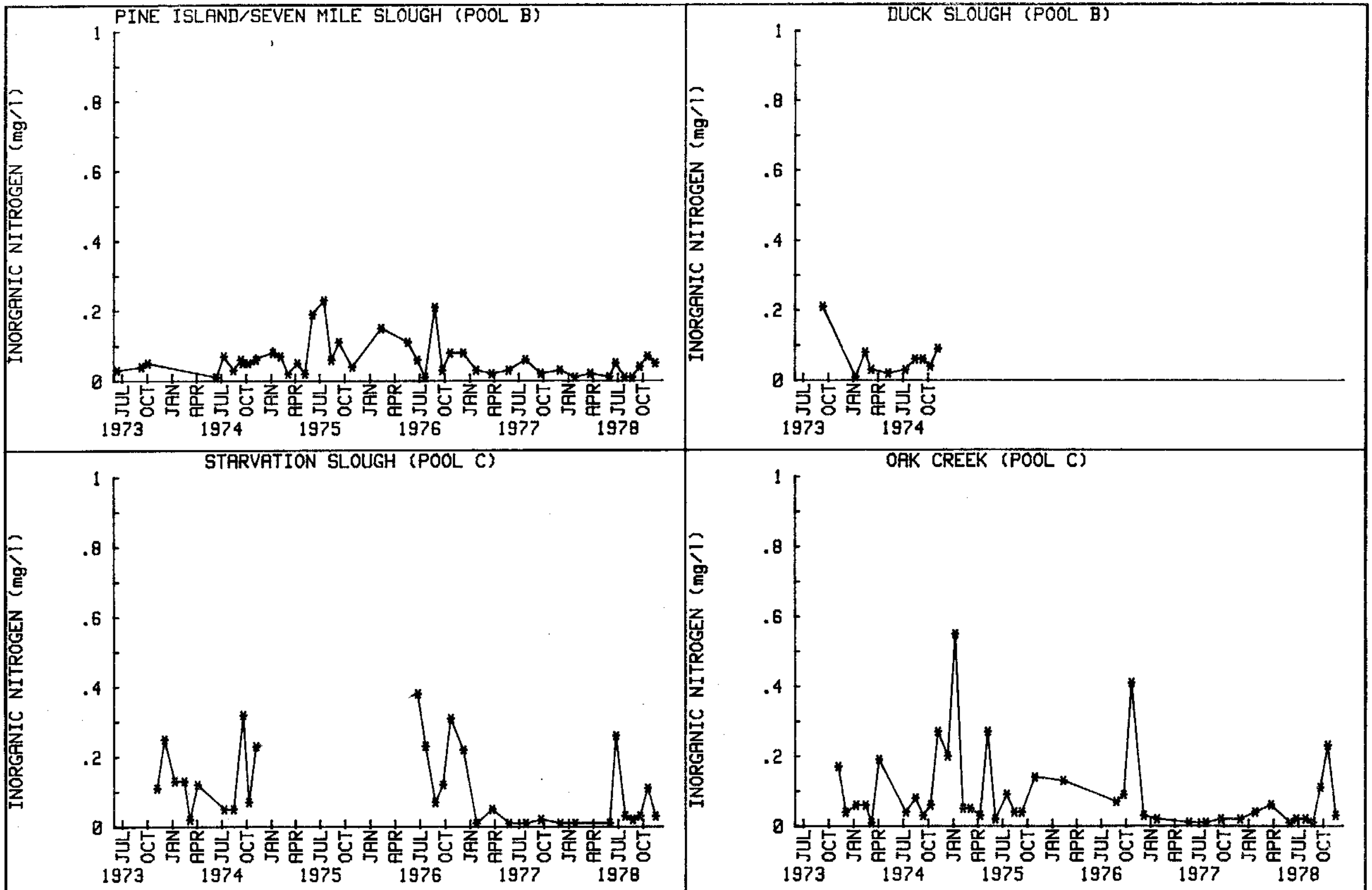

FIGURE C-6(continued). INORGANIC NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES

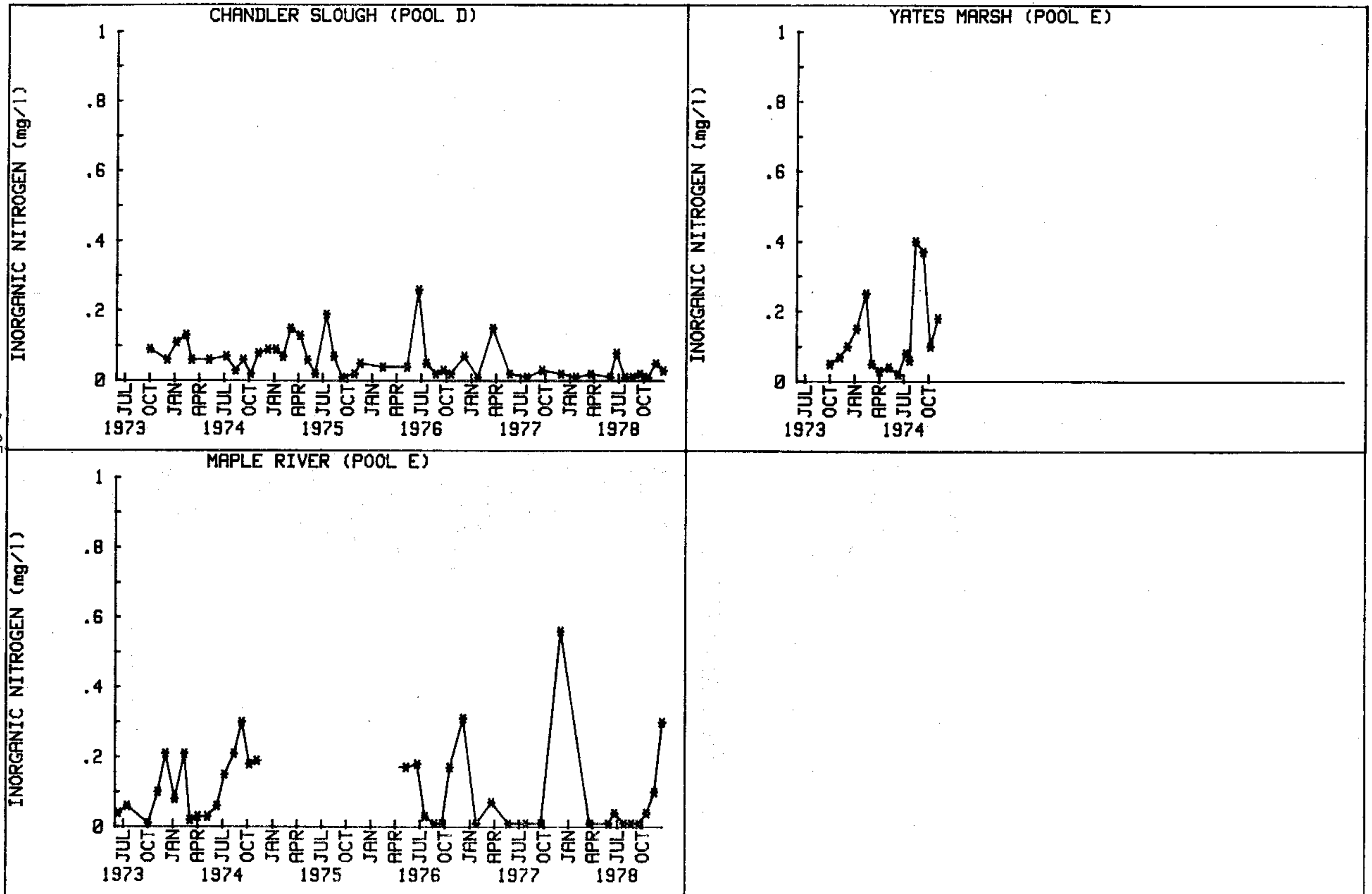

FIGURE C-6(continued). INORGANIC NITROGEN VERSUS TIME FOR C-38 TRIBUTARIES