

SEGMENT COMPLETION REPORT

As required by

FEDERAL AID IN FISHERIES RESTORATION ACT

TEXAS

Federal Aid Project No. F-3-16

Region 3-B Fisheries Studies

Job No. 12 Paper Mill Effluent Study in Sam Rayburn Reservoir

Project Leader: Joe E. Toole

J. R. Singleton
Executive Director
Texas Parks and Wildlife Department
Austin, Texas

Marion Toole
D-J Coordinator

Eugene A. Walker
Director, Wildlife Services

March 19, 1969

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ABSTRACT

Seven sampling stations in upper Sam Rayburn Reservoir were utilized this segment to obtain water quality and fish population data during eight field collections.

These data indicated that surface waters at most stations was of sufficient quality to support aquatic life throughout the year. The inundated Angelina River channel serves as a collecting basin for organic deposits and resulting decomposition created water quality toxic to fish life below a depth of 12 feet during the summer months. Lake "turnover" occurred in early October and the mixing action dispersed toxic concentrations of hydrogen sulfide gas and other chemicals.

Some degree of correlation between fish movements and water quality is evident, although a relatively low number of fishes were collected this segment. Significantly better water quality has existed in the reservoir since it filled to power pool elevation in early 1968. This suggests that either less pollutant is entering the Angelina River or increased dispersion exists from the river channel. Analyses will be conducted both in the channel and at a considerable distance from the channel at three stations during the coming segment to better evaluate dispersion range and degree.

J. R. Singleton
Executive Director
Texas Parks and Wildlife Department
Austin, Texas

Eugene A. Walker
Director, Wildlife Services

Patton Toole
D-1 Coordinator

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SEGMENT COMPLETION REPORT

State of Texas

Project No. F-3-16

Name: Region 3-B Fisheries Studies

Job No. 12

Title: Paper Mill Effluent Study in
Sam Rayburn Reservoir

Period Covered: February 1, 1968 - January 31, 1969

PS OBJECTIVE:

To determine the effects of paper mill effluent on vegetation, vertebrates and invertebrates in Sam Rayburn Reservoir.

SEGMENT OBJECTIVE:

To collect data concerning certain aquatic vertebrates, invertebrates and vegetation in those areas of Sam Rayburn Reservoir which may be effected by the effluent discharged by a paper mill.

PROCEDURES:

During the previous segment of this study, eight sampling stations were utilized for field collections in upper Sam Rayburn Reservoir. Water elevations in 1967 ranged from 155.4 to 151.5. In early 1968, the reservoir filled to power pool elevation 164.0. Due to this increase of approximately ten vertical feet in water level, several modifications were made in station locations.

Station 1 was moved upstream, 1,000 yards above the confluence of Paper Mill Creek in the Angelina River. Station sites 1 and 2 of the previous segment were eliminated. The remaining downstream stations remained unchanged. (Figure 1 is a map of Sam Rayburn Reservoir showing relative station locations.)

Experimental gill nets were again set at each station in conjunction with water quality analyses to correlate fish population levels with water quality. These nets consist of six 25-foot sections with square mesh increasing from 1 inch to 3 1/2 inches in 1/2-inch increments.

Chemical water quality analyses were made at each station with a Hach DR EL chemistry field kit. This unit utilizes individually sealed reagents for colorimetric tests. These analyses included dissolved oxygen, free carbon dioxide, pH, total alkalinity, chlorides, sulfates, ortho-phosphates, turbidity, hydrogen sulfide and temperature. Analyses were made at the surface and one foot above the bottom at all stations. Tests were made at 6 foot intervals in the inundated river channel at downstream stations.

One liter capacity Imhoff sedimentation cones were used to measure suspended solids in parts per thousand. These sedimentation samples were taken 1 foot off the bottom at each station.

FINDINGS:

Water quality and net collection data were compared to correlate water quality influence on fish movements. Due to the rather large volume of field data collected, it is presented in graph form with discussions of each collection.

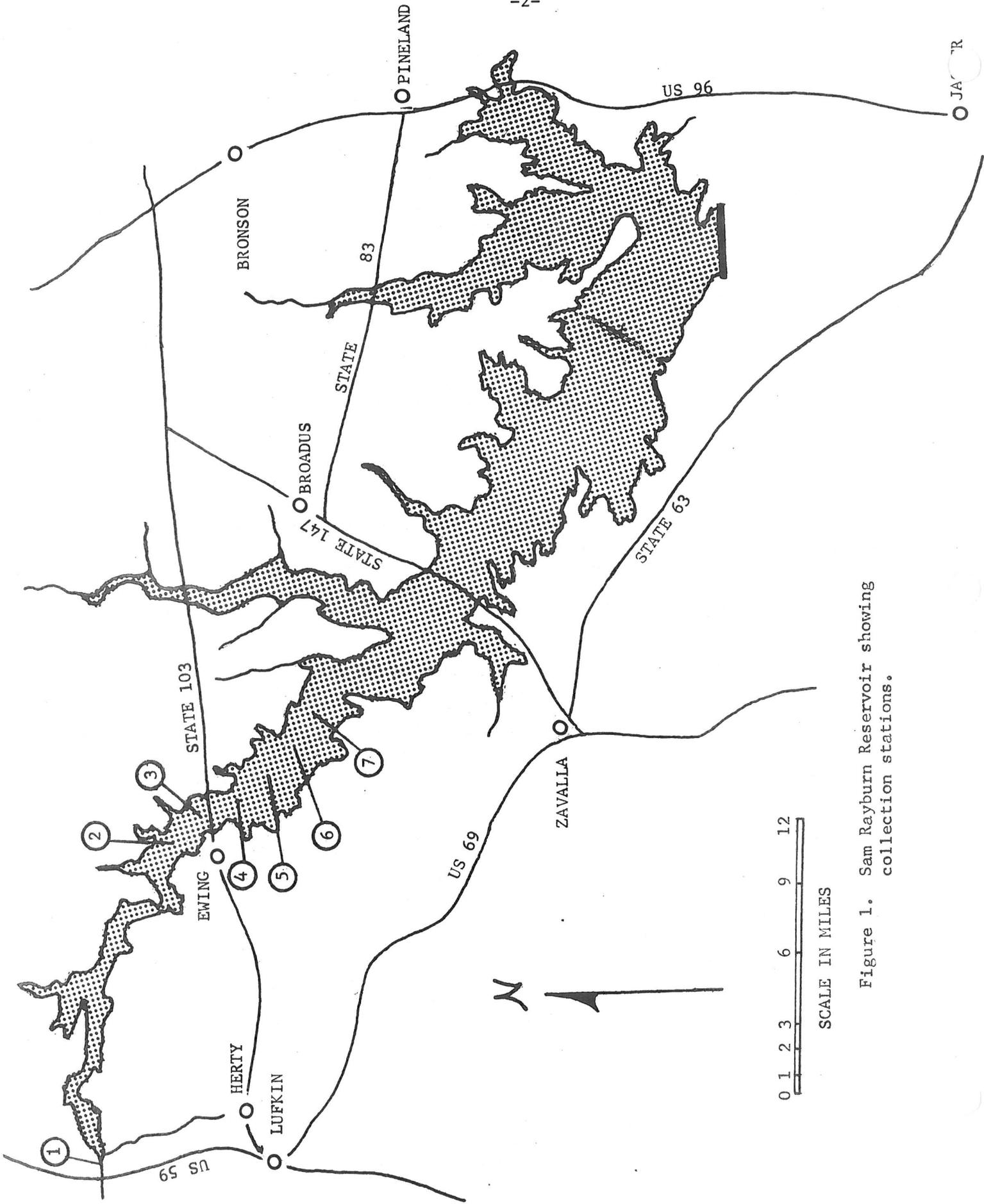


Figure 1. Sam Rayburn Reservoir showing collection stations.

MARCH

Extremely high bottom turbidity of 285 JTU was recorded at station 1 as well as a relatively high sulfate concentration of 100 ppm. Only four rough fish were caught at this station.

Station 2 revealed a decrease in both turbidity and sulfates and a corresponding increase in fish collected. Ten fish were netted, including 1 game fish.

Station 3 data indicated no adverse water quality conditions, and 26 fish were collected.

Station 4 water quality data included a sharp increase in sulfates, from 80 at the previous station to 300 ppm. The fish collection decreased drastically with only 3 rough fish species netted. Turbidity also increased slightly here.

Station 5 water quality was good and 18 fish were netted, including 5 game fish.

Station 6 water quality analyses were made in the river channel and bottom samples indicated increases of sulfates, chlorides, and turbidity. The fish collection here included 36 fishes, three of which were game fish.

The station 6 collection cannot be correlated with the bottom water quality data as the net was set parallel to the river channel in relatively shallow water. Toxic concentrations of sulfates and suspended solids were apparently confined to the river channel. A sedimentation sample taken near the channel bottom contained 40.0 ml/L suspended solids.

Station 7 data showed increases in carbon dioxide, pH and turbidity. Dissolved oxygen concentrations dropped to 6.0 ppm on the surface and to 2.0 ppm on the bottom. Only three fish were netted at this station.

Fluxuations in turbidity, sulfates and suspended solids were responsible for fish movements at all stations in March. Figure 2 contains these water quality variations and the total numbers of fish collected at each station.

APRIL

Stations 1, 2, and 3 exhibited similar water quality during the April collection. No toxic chemical concentrations were recorded. Only 8 fish were collected at station 1, as compared to 61 at station 2, and 34 at station 3.

Station 4 water analyses revealed increases in carbon dioxide and total alkalinity. Dissolved oxygen however, did not decrease. Smallmouth buffalo (Ictiobus bubalus) comprised a high percentage of the fish collection at this station. Sunfish (Lepomis sp.) were the most numerous game fishes collected.

Inverse stratifications of dissolved oxygen and carbon dioxide were recorded at station 5. Five fish were collected here as compared to 52 at the previous station.

Figure 2. Station variations in selected areas of water quality for March 1968, Sam Rayburn Reservoir. Surface water samples are represented by a solid line, bottom water samples by a dashed line.

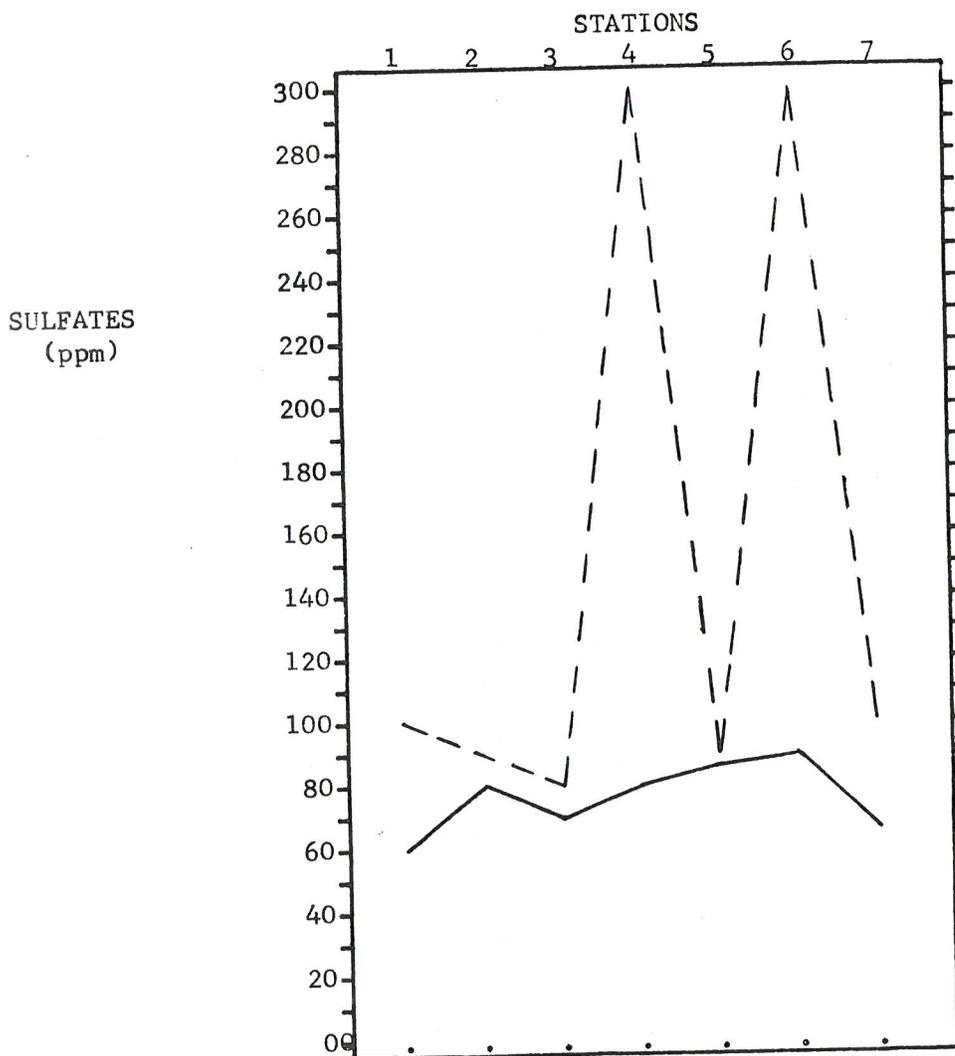
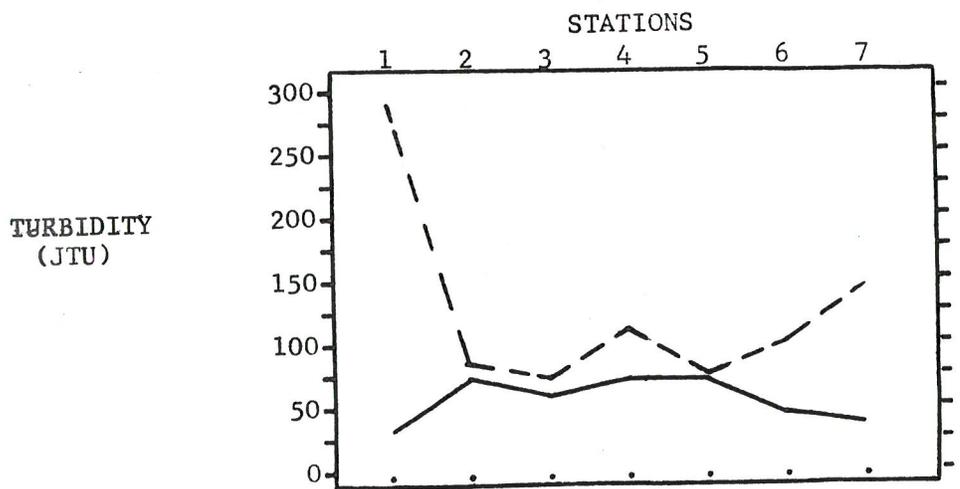
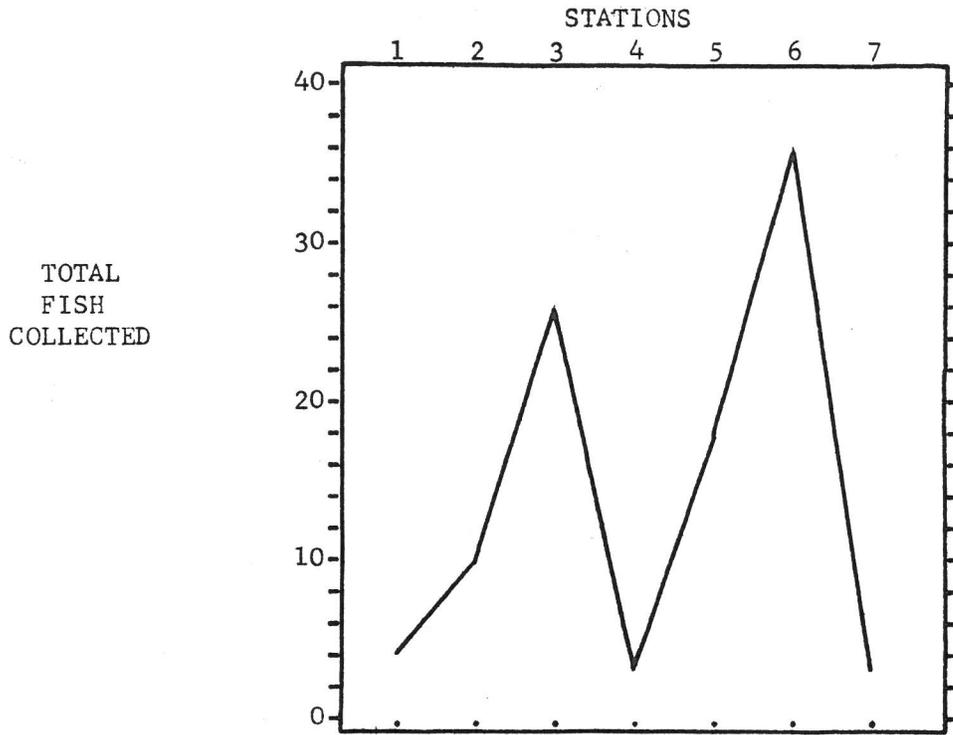


Figure 2. (continued)



	STATIONS						
SEDIMENT SAMPLES (ml/l)	1	2	3	4	5	6	7
	trace	0.1	0.5	10.0	10.0	40.0	trace

Dissolved oxygen continued to decrease at both the surface and bottom at station 6. Bottom phosphates increased sharply, as did the turbidity. Total fish netted was 8, including 1 game fish. Bottom samples were again taken in the river channel here at a depth of 33 feet. High turbidity and phosphate concentrations again appeared to follow the river channel.

Station 7 analyses revealed water quality very similar to station 5. A total of 16 fishes was netted, ten of which were smallmouth buffalo.

Figure 3 contains graphs of dissolved oxygen, carbon dioxide, and total fish data for all stations in April. Concentrations of smallmouth buffalo and longnose gar (Lepisosteus osseus) at the upstream stations were responsible for the wide variations in netting collections. Satisfactory surface water quality existed at all stations. Bottom water quality was poor at stations 5, 6, and 7, with decreases in dissolved oxygen and corresponding increases in free CO₂.

MAY

Water quality was generally good at stations 1, 2, and 3 in May. Only two longnose gar were netted at station 1 and three at station 3. At station 2, a total of 28 fishes was netted, 11 of which were smallmouth buffalo.

Surface and bottom dissolved oxygen began decreasing at station 4, with corresponding increases in carbon dioxide. The fish collection here consisted of two rough fish.

Turbidity increased slightly at station 5 and bottom oxygen decreased to 2.0 p. Surface pH increased from 6.6 at the previous station to 7.0. Total fish collected increased to 8.

Surface dissolved oxygen at station 6 remained the same but dropped to zero ppm on the bottom. Both surface and bottom CO₂ readings increased. Bottom pH increased from 6.6 to 7.5 with a similar high increase in total alkalinity. Phosphate concentrations also reached a toxic level on the bottom with a reading of 2.3 ppm. Only bluegill sunfish were netted near the surface at this station. Tests were made for hydrogen sulfide gas here at six foot intervals. The following concentrations were recorded: surface 0.3 ppm, 12 feet 1.5 ppm, 24 feet 1.0 ppm, and 30 feet 0.3 ppm. Thus, the toxic concentration of hydrogen sulfide was stratified at 12 - 24 feet.

No fish were collected at station 7. Surface and bottom CO₂ readings were relatively high, as was the bottom turbidity. Dissolved oxygen was zero ppm on the bottom but remained at 7.0 on the surface. Hydrogen sulfide gas was found to be concentrated on the bottom here with a reading of 3.0 ppm at a depth of 31 feet. Figure 4 contains water quality and net data for May.

JUNE

Water quality at station 1 was good except for the turbidity and sulfate concentrations. Turbidity readings ranged from 125 JTU on the surface to 150 JTU on the bottom. Surface and bottom sulfate readings were 50 and 60 ppm respectively. The netting results were fairly good here with eight game fish and eight rough fish comprising the catch.

Figure 3. Station variations in selected areas of water quality for April 1968, Sam Rayburn Reservoir. Surface water samples are represented by a solid line, bottom water samples by a dashed line.

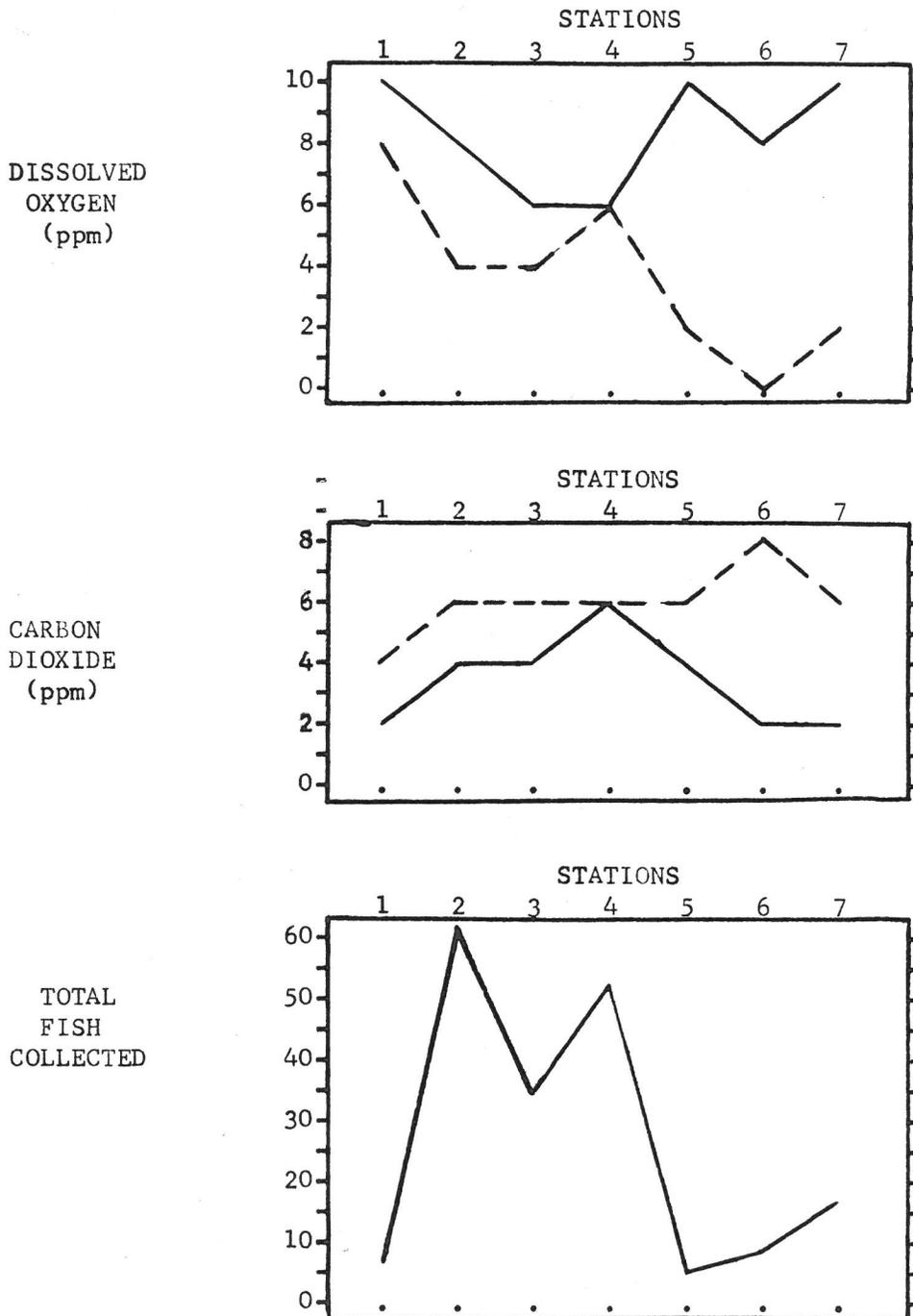


Figure 4. Station variations in selected areas of water quality for May 1968, Sam Rayburn Reservoir. Surface water samples are represented by a solid line, bottom water samples by a dashed line

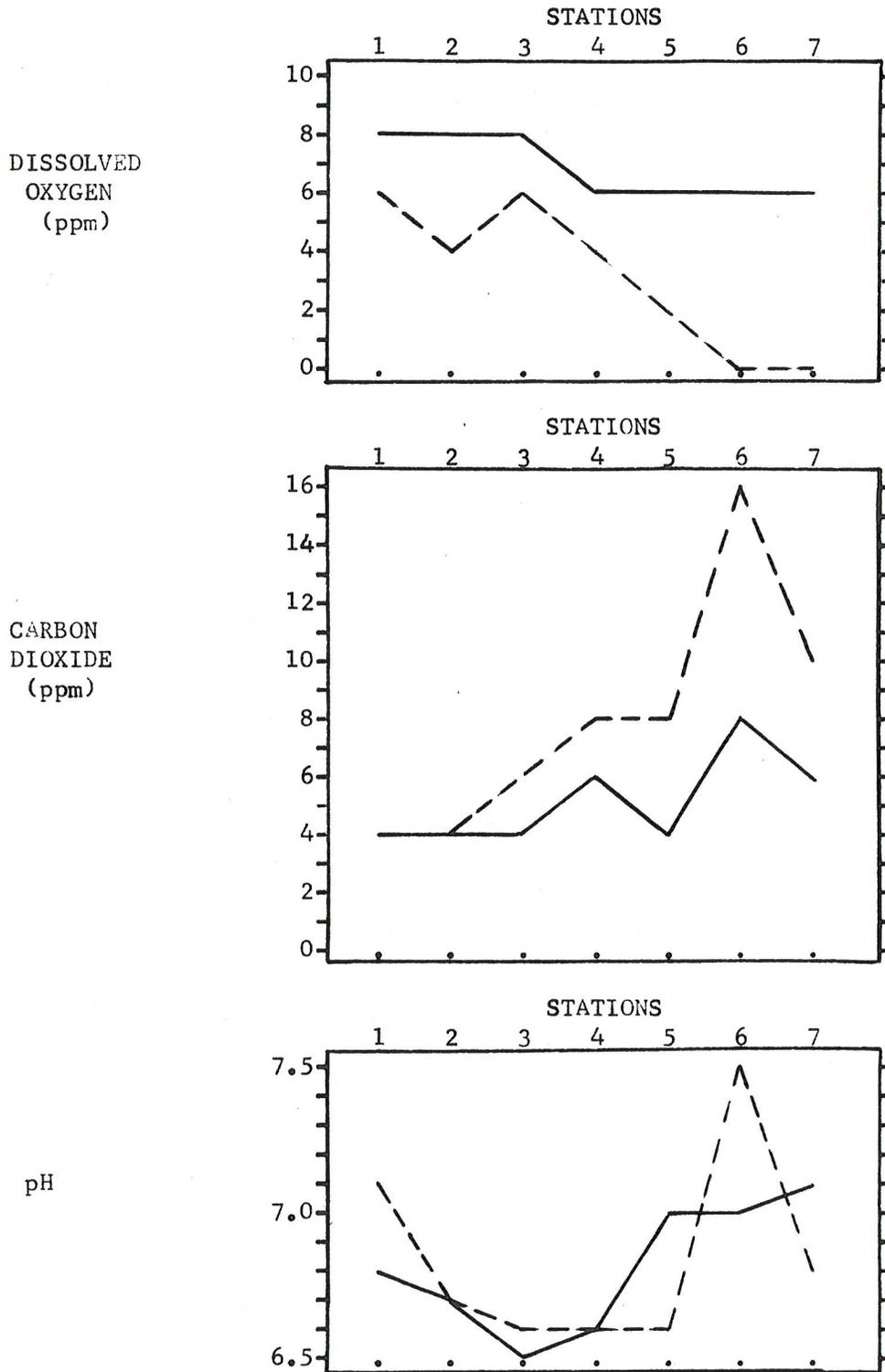
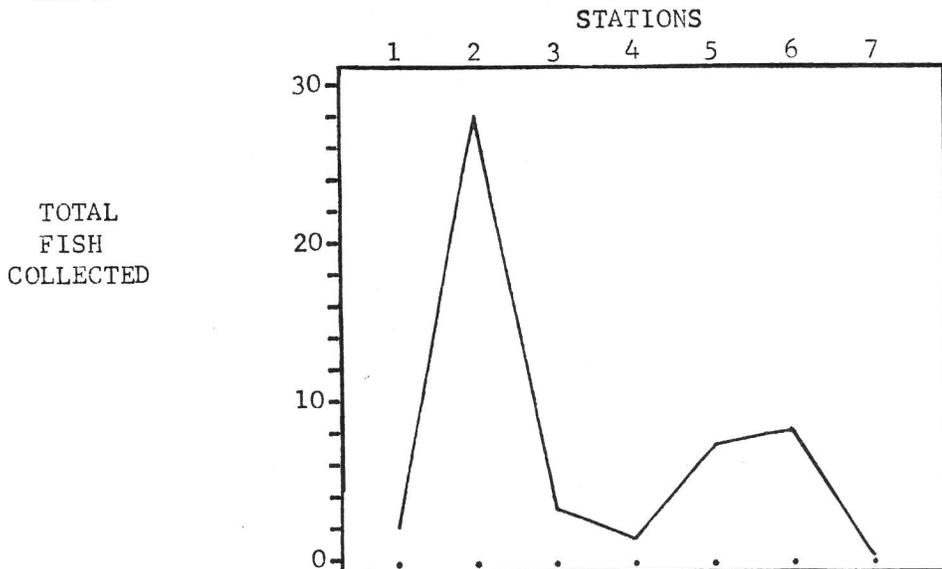
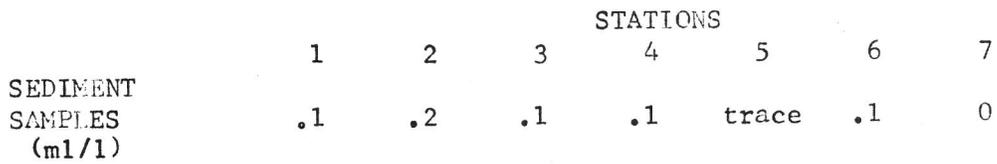
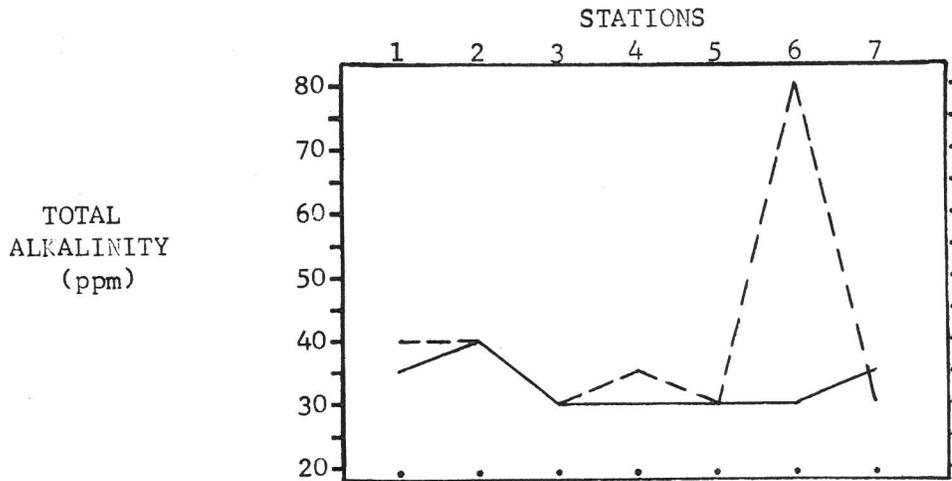
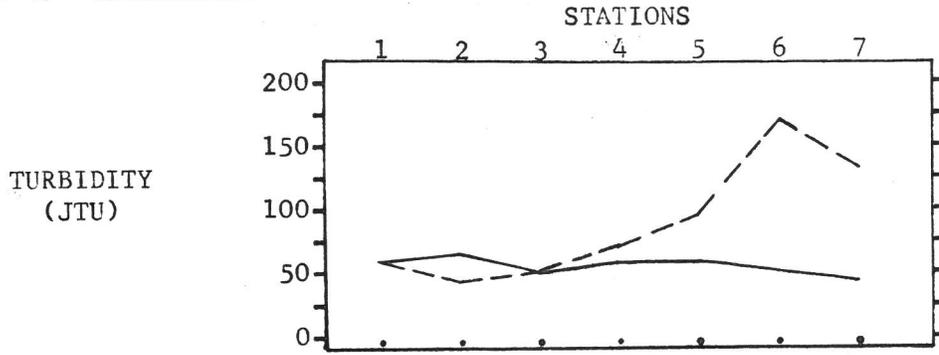


Figure 4. (continued)



There were no game fish netted at station 2. The oxygen had dropped to an undesirable concentration accompanied by a slight increase in the CO₂. The sediment sample was one of the highest recorded in June at 2 ml/L.

Dissolved oxygen increased to an acceptable concentration at station 3. Bottom alkalinity and phosphate concentrations had increased slightly. There was an overall decrease in fish netted.

Tests for phosphates, turbidity and sulfates were not conducted at station 4 because of a malfunction of the colorimeter. Dissolved oxygen decreased to zero at the bottom and remained so through the remaining downstream stations. A concentration of 0.3 ppm hydrogen sulfide was found at 12 feet. Netting results improved here with 8 game fishes collected.

Netting results reached a peak at station 5, with 12 of the 30 fishes collected being game fish species. There were no adverse water conditions at this station other than hydrogen sulfide gas at a concentration of 0.3 ppm at a depth of 12 feet and 1.0 ppm at 19 feet.

Data from station 6 showed a drastic increase in bottom turbidity. Only four fish were netted here. A high concentration of 5.0 ppm hydrogen sulfide was found at 15 feet.

Surface water condition was optimum at station 7 in June. Hydrogen sulfide was stratified in the river channel below 12 feet and reached a maximum concentration of 3.0 ppm at a depth of 31 feet. Figure 5 contains water quality and netting data from the June collection.

AUGUST

The turbidity at station 1 was the highest of the month with a respective surface and bottom reading of 110 and 270 JTU. The pH was higher than normal, but not high enough to cause any adverse effects.

A bottom depletion of dissolved oxygen occurred at station 2 and remained so except for a slight increase to 1.0 ppm at station 5. The carbon dioxide increased considerably on the bottom. This increase was not to a toxic concentration, but could have had some influence on movement of fish. This station was one of two where a low number of fish was netted. The bottom pH exhibited a decrease from 7.9 at station 1 to 6.7. The turbidity decreased to a somewhat normal level at this station and remained fairly constant at the remaining stations with the exception of station 6.

The highest number of fish was netted at station 3 this month. An equal number of game and rough fish were taken. The stratification of oxygen and CO₂ which was evident at station 2 continued at the downstream stations. A decrease in bottom CO₂ at station 3 may have influenced the better netting results at this station.

Station 4 had a depletion of sulfates on the surface. At previous stations sulfates ranged from 10 to 20 ppm. Station 4 data indicated increases in phosphates, CO₂, and hydrogen sulfide on the bottom. Hydrogen sulfide was found to be concentrated at 2.5 ppm in the river channel at 25-31 feet.

A decrease of CO₂ and phosphates on the bottom was observed at station 5. The suspended solids were at the highest concentration for this month.

Figure 5. Station variations in selected areas of water quality for June 1968, Sam Rayburn Reservoir. Surface water samples are represented by a solid line, bottom water samples by a dashed line.

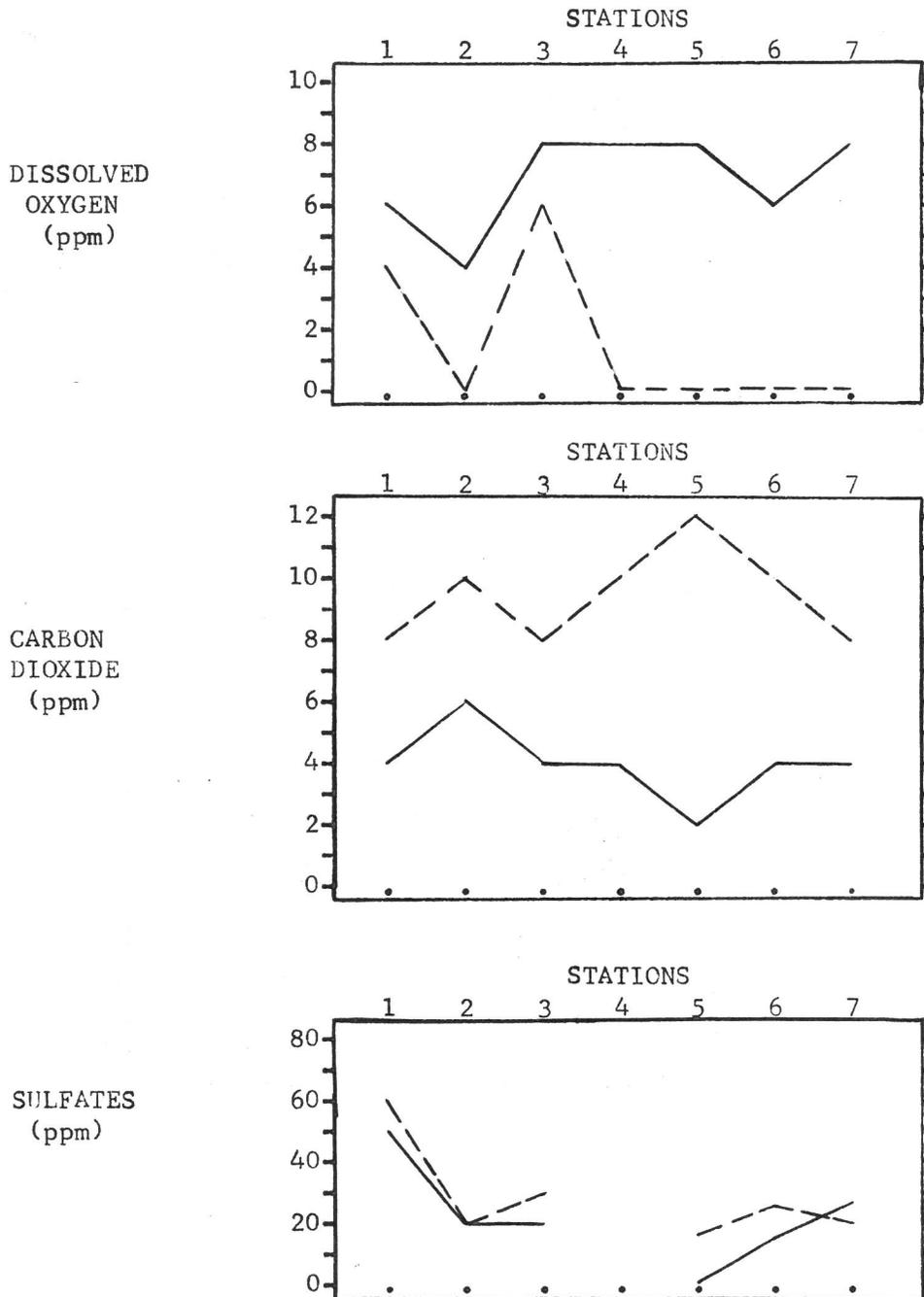
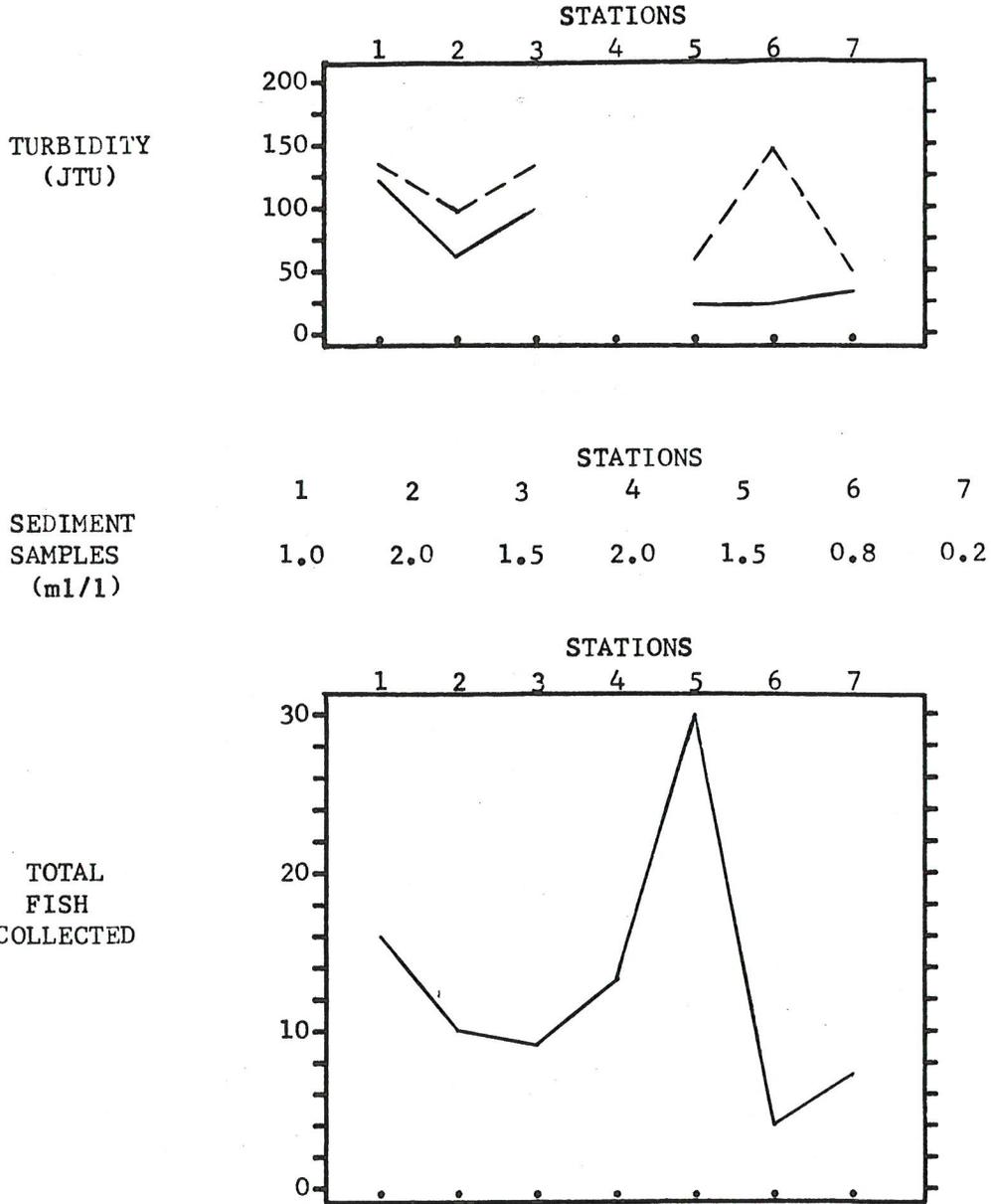


Figure 5. (continued)



At station 6, a decrease in the netting collection was accompanied by a large increase in total alkalinity, phosphates, CO₂, and turbidity on the bottom. Surface concentrations remained constant. Hydrogen sulfide gas was again stratified in the river channel at 2.5 ppm.

There was a further decrease of game fish netted at station 7, but the rough fish increased the total collection. Nearly all of the changes that occurred at station 6 have approached the condition noticed at station 5. The number of fish netted at station 7 also correlate very closely with those at station 5.

Poor quality water was evident for this month, particularly in the river channel. Stations 2-7 appeared to be well stratified in regards to dissolved oxygen and free CO₂. Figure 6 contains pertinent water quality data and total fish collection data for August.

OCTOBER

Water quality at station 1 in October was reasonably good except for turbidity and sulfate concentrations. A bottom sulfate concentration of 90 ppm was recorded and the surface and bottom turbidity readings were 80 JTU and 160 JTU respectively. Total alkalinity was between 20 and 30 ppm and remained constant at all stations. Phosphate, chlorides and sediment concentrations were at optimum levels at all stations.

The data for station 2 included an increase in fish collected with game fish comprising some of the catch. The high turbidity and sulfate readings encountered at station 1 had decreased and remained so at the remaining 5 downstream stations. Dissolved oxygen however decreased to 4.0 ppm on the surface and was depleted on the bottom at station 2.

Low oxygen was also recorded at stations 3 and 4. Carbon dioxide increased to its highest level on the bottom at station 4 with a reading of 12 ppm. The water was on the acid side at the first three stations, neutral at station 4 and alkaline at stations 5, 6 and 7.

Surface oxygen concentrations increased to an acceptable level at stations 5, 6 and 7. Station 5 also had the highest number of fish collected this month with a total of 33. Twenty of these were gizzard shad.

The water quality was fairly homogenous at the individual stations in October. Figure 7 contains October water quality and netting data.

NOVEMBER

Surface and bottom data were homogenous at each station in November. Considerable variations is noted in comparing stations however. Carbon dioxide readings remained low at all stations. The surface pH was slightly acidic at the upstream stations but became neutral at stations 5-7.

Fairly good representations of game fish were collected at stations 3, 4, and 6. The numbers of rough fish netted did not show a significant change from one station to the next. Figure 8 contains water quality and total fish collection data for the November collection.

Figure 6. Station variations in selected areas of water quality for August 1968, Sam Rayburn Reservoir. Surface water samples are represented by a solid line, bottom water samples by a dashed line.

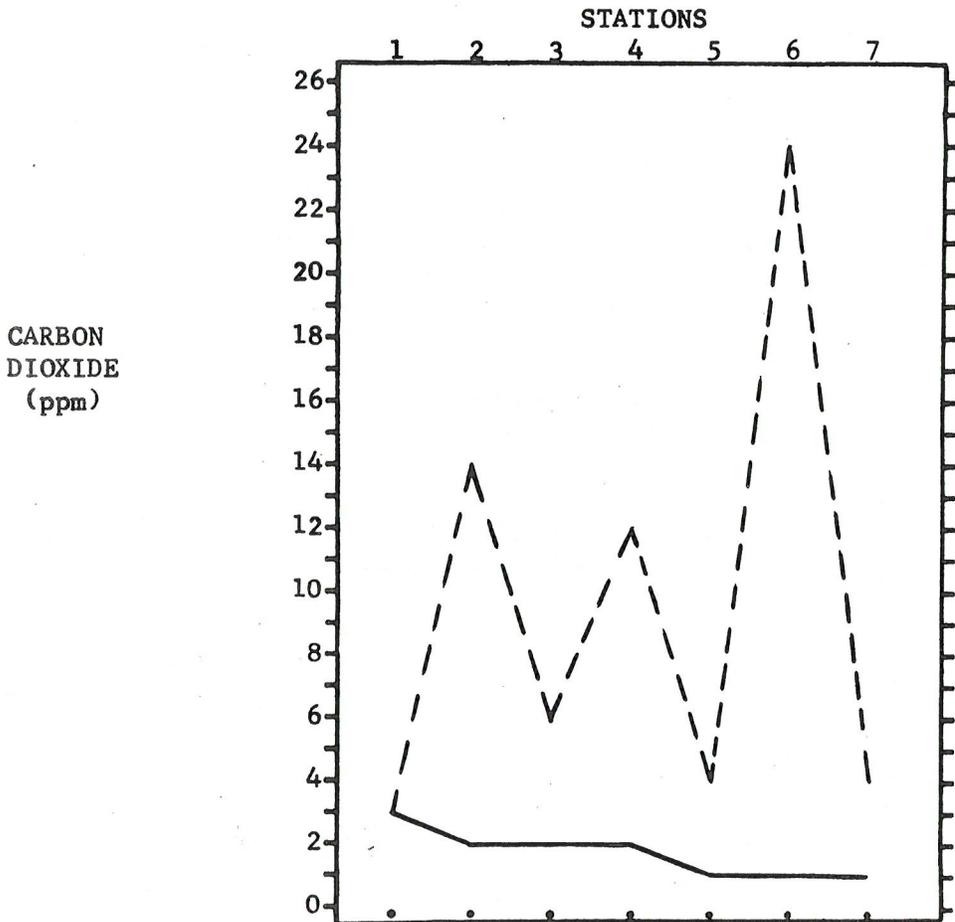
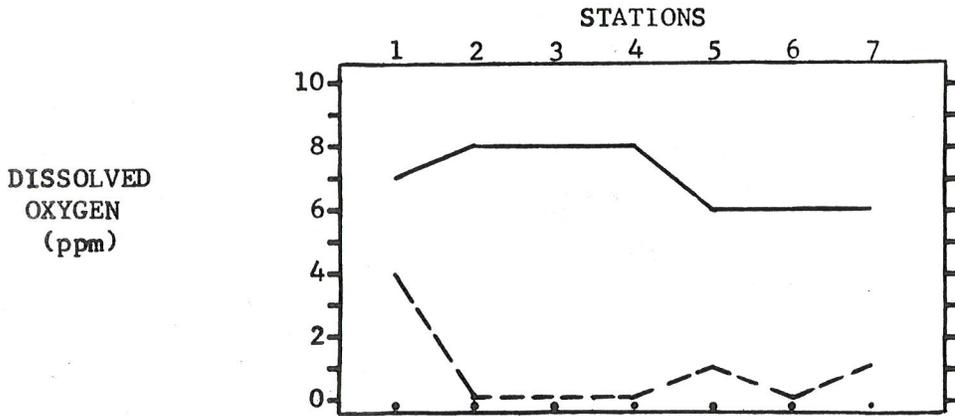
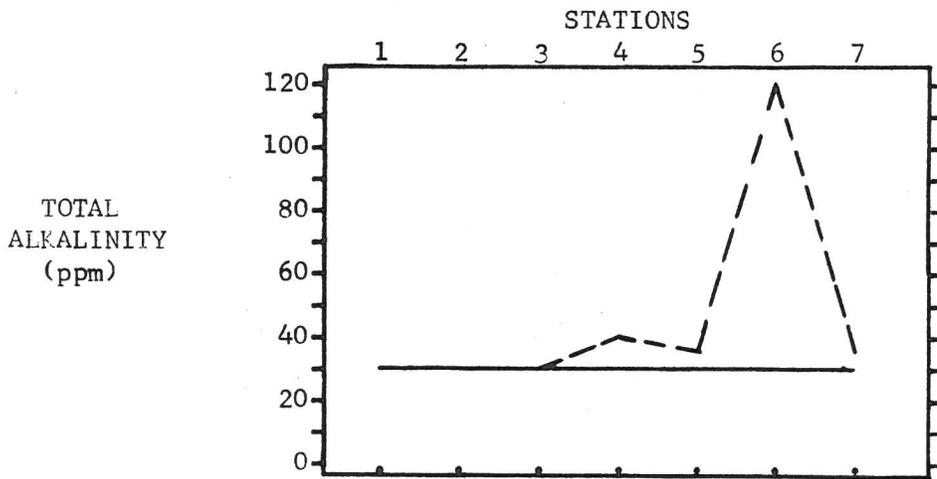
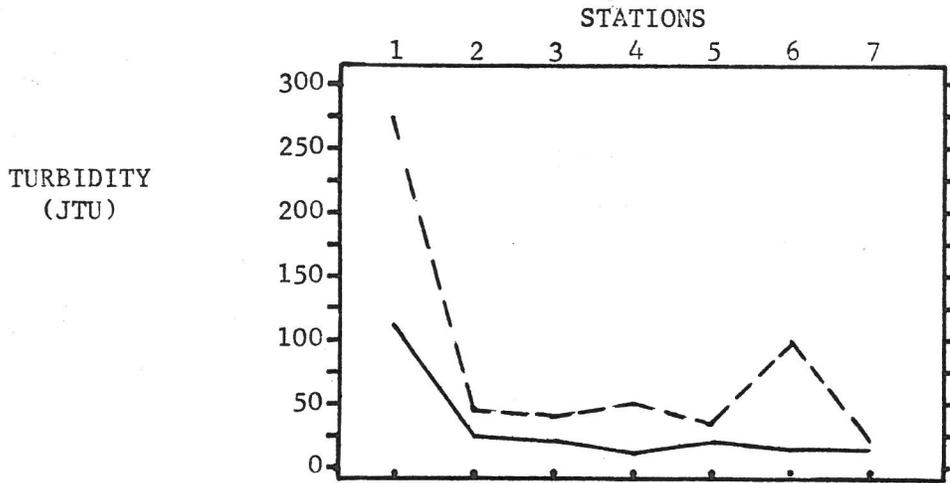


Figure 6. (continued)



SEDIMENT SAMPLES (ml/l)

STATIONS	1	2	3	4	5	6	7
SAMPLES	2	2.15	2.3	4.5	5.0	0.5	2.0

Figure 6. (continued)

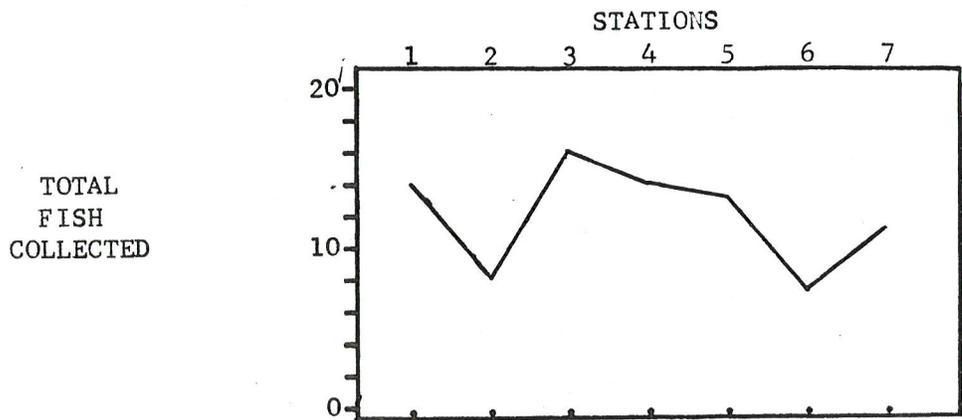
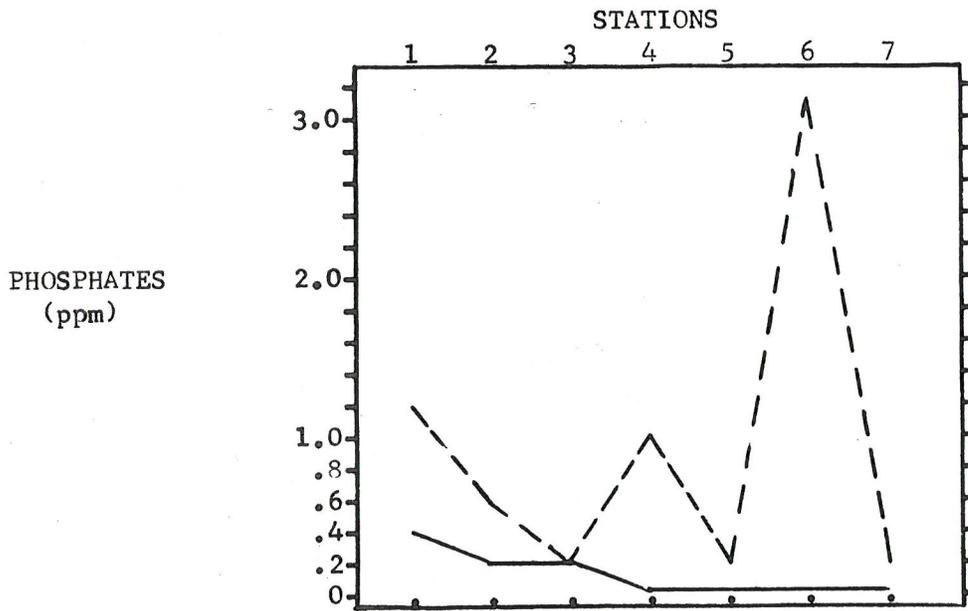


Figure 7. Station variations in selected areas of water quality for October 1968, Sam Rayburn Reservoir. Surface water samples are represented by a solid line, bottom water samples by a dashed line.

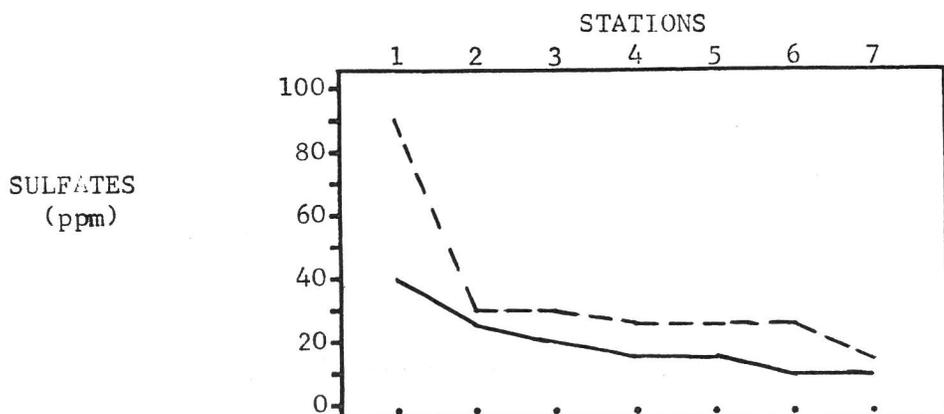
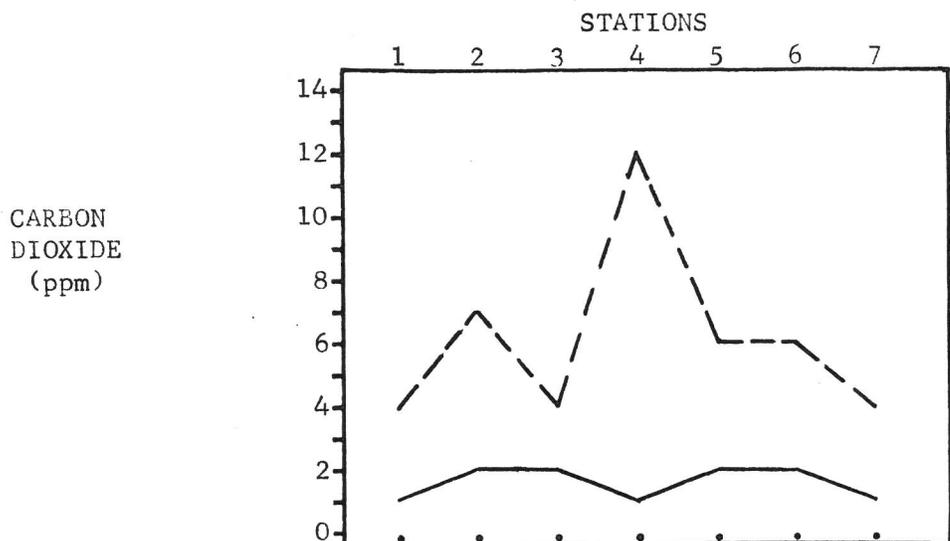
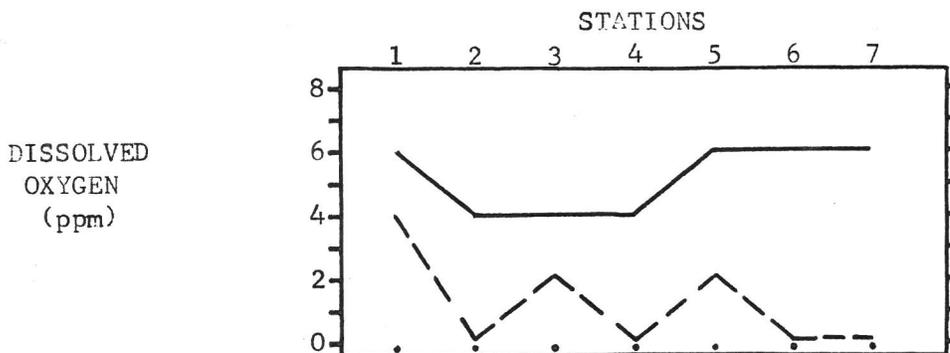


Figure 7. (continued)

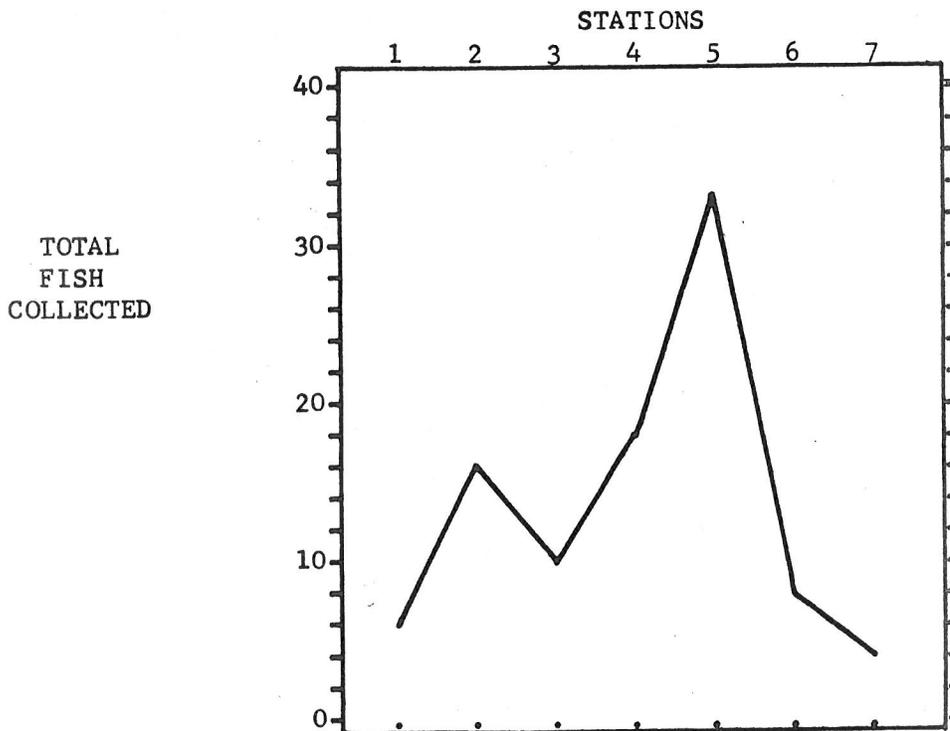
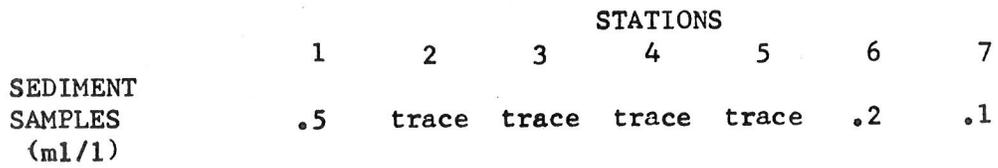
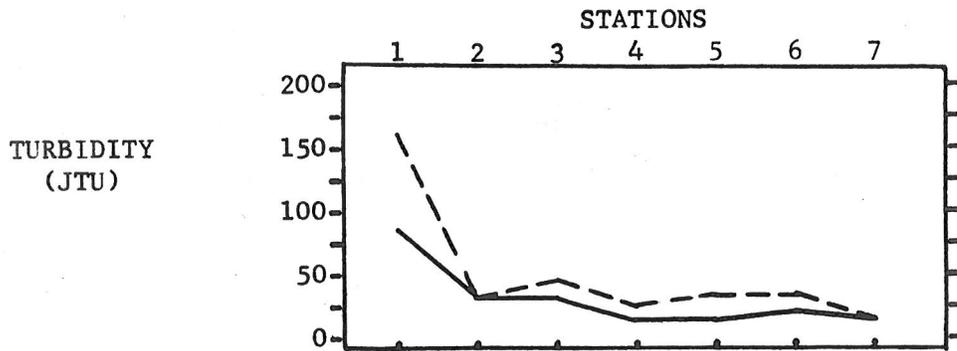


Figure 8. Station variations in selected areas of water quality for November 1968, Sam Rayburn Reservoir. Surface water samples are represented by a solid line, bottom water samples by a dashed line.

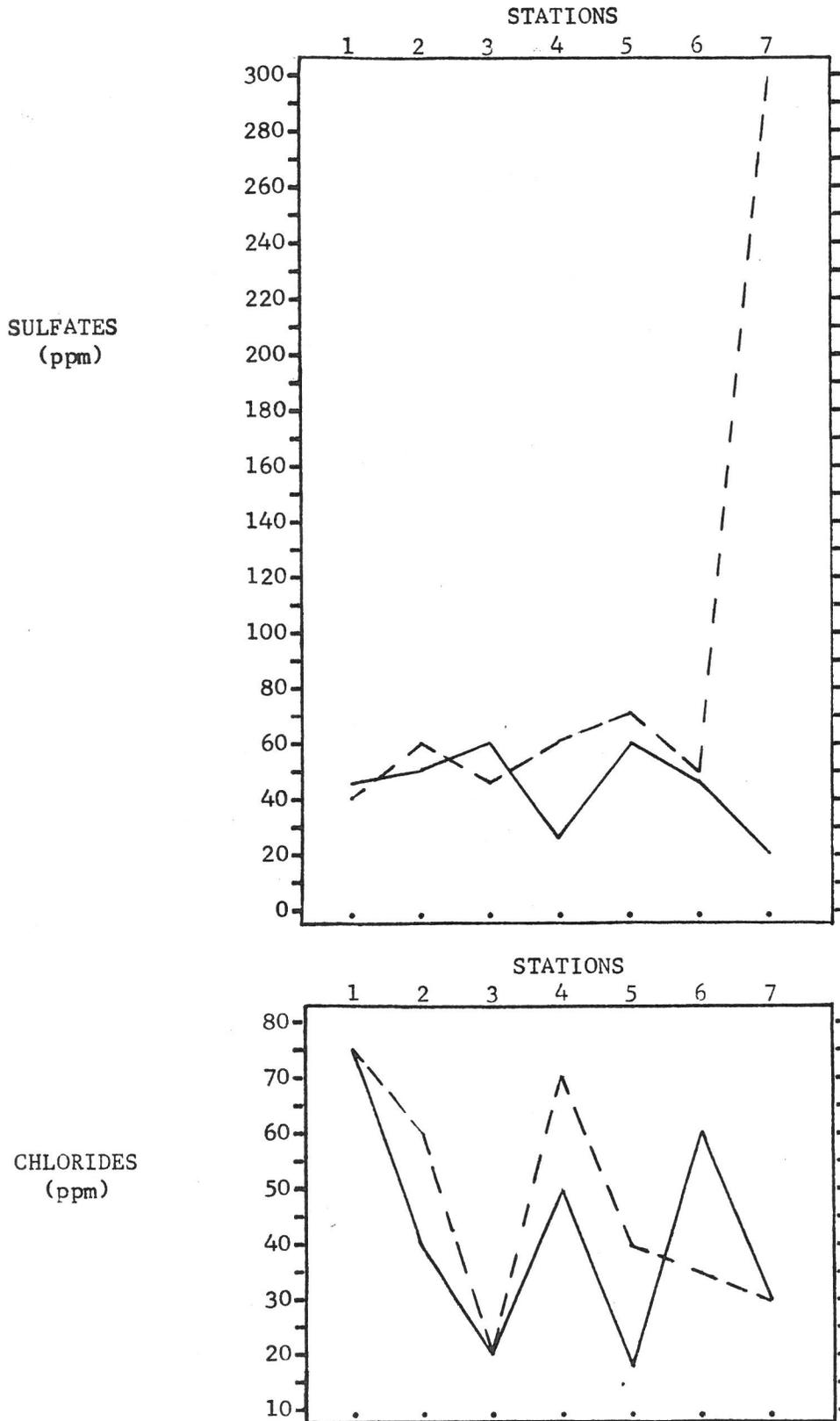
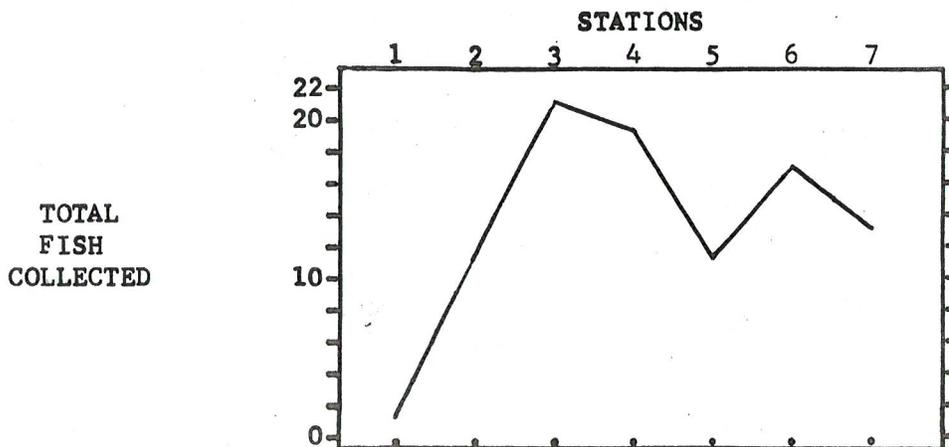
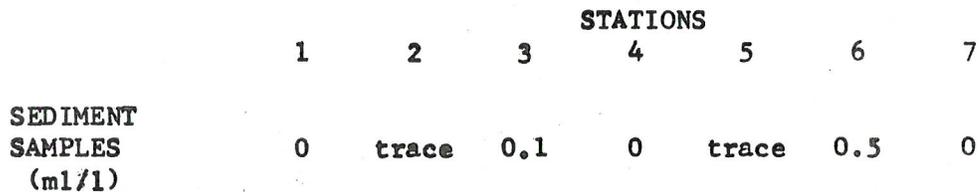
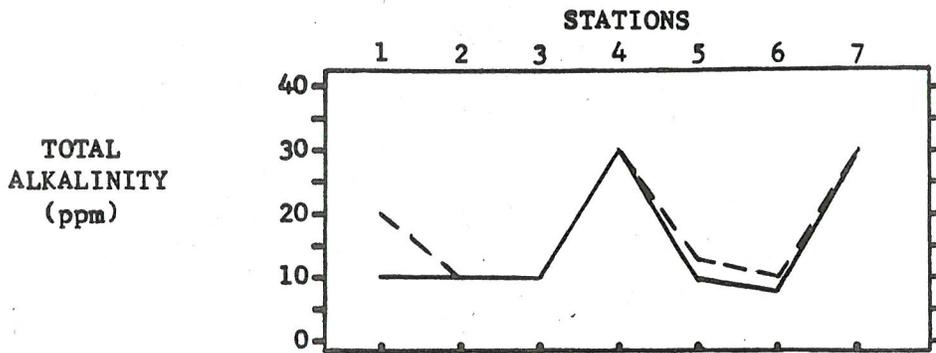
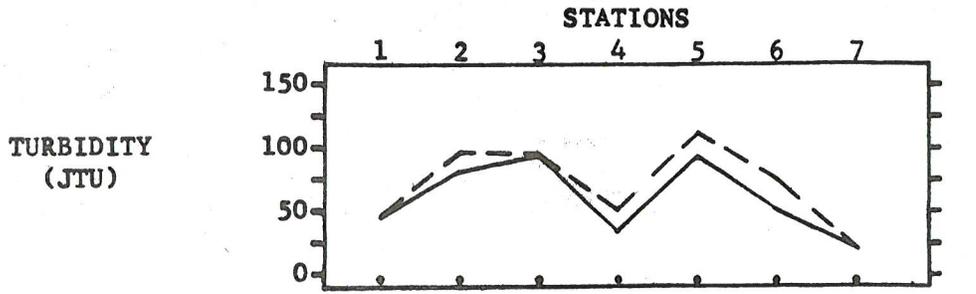


Figure 8. (continued)



JANUARY

Water quality analyses conducted in January revealed optimum conditions at all depths. Dissolved oxygen was adequate at all stations and CO₂ surface and bottom readings were completely homogenous at each station, ranging from 4.0 ppm to 2.0 ppm. Hydrogen sulfide gas was depleted in the river channel. A netting collection was not made in conjunction with these analyses.

CONCLUSIONS AND RECOMMENDATIONS:

Correlations of water quality and netting data indicate various elements of water quality were responsible for fish abundance or population fluxuations at given stations throughout the year.

In March, high turbidity and sulfates at several stations were apparently detrimental to fish movements.

April water quality data revealed satisfactory surface readings, but low dissolved oxygen and increased CO₂ on the bottom at the downstream stations.

Fish collections declined at most stations in May. Bottom water quality was poor at stations 4-7. Hydrogen sulfide gas was beginning to build up in the inundated river channel at stations 6 and 7.

Low dissolved oxygen and high CO₂ readings were again recorded for most stations in June. Surface readings were good, with adequate dissolved oxygen available. Hydrogen sulfide was again found to be stratified below 12 feet in the river channel at downstream stations 4-7.

Poor water quality was found at all stations in August. Stratification of dissolved oxygen and carbon dioxide existed at stations 2-7. Hydrogen sulfide concentrations were stratified in the river channel.

Somewhat homogenous water quality existed at all stations in October with the exceptions of increased pH and a lack of dissolved oxygen below 15 feet at the downstream stations.

November water quality readings were very erratic from one station to the next although homogenous conditions did exist in surface and bottom samples from each station. Game fish were collected at stations 3, 4 and 6 this month. The numbers of rough fish netted did not change significantly from station to station.

It is concluded that surface water from all stations was generally adequate for supporting fish life. Bottom and intermediate analyses revealed toxic concentrations of one or more chemical elements and/or a lack of dissolved oxygen at most stations in May, June, July and August. Decreased oxygen and increases in free carbon dioxide, phosphates and hydrogen sulfide gas were the results of organic decomposition. The inundated river channel serves as a collecting basin for suspended wood fiber and other debris. Resulting water quality in the river channel is toxic to fish below a depth of 12 feet during the summer months.

Lake "turnover" occurred in early October, as reflected by the homogeneity of surface and bottom analyses recorded that month. As expected, January's analyses revealed optimum water quality at all stations as a result of this mixing action.

The excessive growths of maiden cane (Panicum hemitomon) observed at stations 2 and 3 last segment did not occur this year. In 1967, before the river banks were inundated at these stations, phosphates increased sharply during the summer months and influenced rapid growth of maiden cane in the channel. No noxious vegetation was observed this segment.

In comparing these 1968 data with those of the previous segment, significant decreases are noted in turbidity, chlorides, total alkalinity and free carbon dioxide. This suggests that more adequate dispersion of chemicals and suspended solids exists since the reservoir filled to power pool elevation.

Data will continue to be collected at stations 1, 4 and 7 during the third and final segment of this study. Chemical analyses will be conducted in the river channel and at an adjacent area out of the channel at each station. Further study and a comparison of the data from all segments will be included in the final report.

Prepared by Joe E. Toole and Stephen F. Smith
Project Leader Asst. Project Ldr.

Approved by Marion Toole
Coordinator

Date March 19, 1969

Charles E. Gray
Fisheries Supervisor