FILE

SEGMENT COMPLETION REPORT

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FEDERAL AID IN FISHERIES RESTORACTION ACT

TEXAS

Federal Aid Project No. F-3-R-15

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

Project Leader: Joe E. Toole

JOE E. TOOLE
205 E. MARTINDALE DRIVE
MARSHALL, TEXAS 75670

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

Marion Toole
D-J Coordinator

Eugene A. Walker
Director, Wildlife Services

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ABSTRACT

To determine the effects of paper mill effluent in upper Sam Rayburn Reservoir, varied collections of population data and water quality data have been made.

Eight sampling sites were selected to represent several ecological habitats. From these unit data, comparisons of water quality and fish abundance were made. Polluting effects of paper mill wastes became more detrimental as drought conditions prevailed during the summer and fall months of 1967. Turbidity readings and sedimentation counts can generally be correlated with fish abundance.

Excessive growth of maiden cane (*Panicum hemitomon*) in the Angelina River channel is attributed to high phosphates during minimal flow conditions.

It is recommended that this study be continued to determine more accurately the effects and extent of paper mill effluent dispersion in upper Sam Rayburn Reservoir.

SEGMENT COMPLETION REPORT

State of Texas

Project No. F-3-R-15 Name: Region 3-B Fisheries Studies

Job No. 12 Title: Paper Mill Effluent Study in Sam Rayburn Raservoir

Period Covered: February 1, 1967 - January 31, 1968

PPS 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:

1. Eight permanent sampling stations have been established in Sam Rayburn Reservoir to provide population criteria for aquatic vertebrates and invertebrates in relation to existing environmental conditions.

(a) Experimental gill nets were set at each station at monthly intervals to determine fish population levels and species availability.

(b) Chemical water analyses were conducted in conjunction with netting activities at each station to provide water quality data. These tests included dissolved oxygen, free carbon dioxide, pH, total alkalinity, chlorides, sulfates, ortho-phosphates, turbidity, hydrogen sulfide and temperature.

(c) Volumetric plankton samples were also made at each station. Identification and relative abundance of phytoplankton and zooplankton forms were determined in the laboratory.

(d) Bottom samples were collected from each station and fauna type and abundance were recorded.

(e) Observations were made of aquatic vegetation in collection areas to determine possible effects of paper mill effluent.

2. Comparisons of unit population and water quality data have been made.

DESCRIPTION:

With the impoundment of Sam Rayburn Reservoir, a 114,000 surface acre U.S. Corps of Engineers Project, increased concern over pollution caused by a paper mill effluent in the Angelina River is warranted. Sam Rayburn is the largest impoundment entirely within the State and with its excellent recreational facilities the reservoir is destined to become a sportsman's paradise.

Black water effluent emanating from a paper mill at Herty, Texas, enters the Angelina River through Paper Mill Creek, a tributary of Willis Creek.

At power pool elevation of 164.0 feet above MSL the reservoir will inundate the Angelina River banks to a point near the mouth of Paper Mill Creek. During 1967, pool elevations ranged from approximately 151 to 155. At these elevations the river remains within its banks for a distance of approximately eight miles below the influx of paper mill effluent.

STATION DESCRIPTION:

Eight sampling station sites were selected to provide population and water quality criteria from varied environments. It was originally planned to establish sampling stations at one-half mile intervals, beginning upstream at the influx of pollutant at the mouth of Paper Mill Creek. After a preliminary investigation of the area by boat however, the stations were selected approximate one mile intervals, beginning upstream at Marion Ferry, some seven miles below the influx of effluent in the river. It was felt that this collection area would provide maximum ecological variations for data comparisons.

The following are brief descriptions of physical characteristics at each collection station:

Station 1. Station 1 is located one-half mile upstream from Marion Ferry Park in the Angelina River Channel. The station is in a sharp bend of the river at the upstream margin of a large cleared area of the basin. Channel depth is 18 feet at elevation 152. Bottom soil is primarily clay with marginal sand deposits. A layer of black sediment covers the channel bottom.

Station 2. Station 2, located one-half mile below Marion Ferry, is similar in physical characteristics to Station 1.

Station 3. Station 3 is also similar to stations 1 and 2, located in the river channel one mile upstream from Highway 103 bridge.

Station 4. Station 4 is located immediately upstream from Highway 103 bridge in shallow water adjacent to the river channel. The reservoir bottom is composed of clay loam which is covered with vegetative debris from clearing operations.

Station 5. Station 5 is in the river channel one mile below Highway 103 bridge. Due to excessive felled timber immediately adjacent to the river channel in this area, gill nets were set in a clear area approximately 50 yards from the channel.

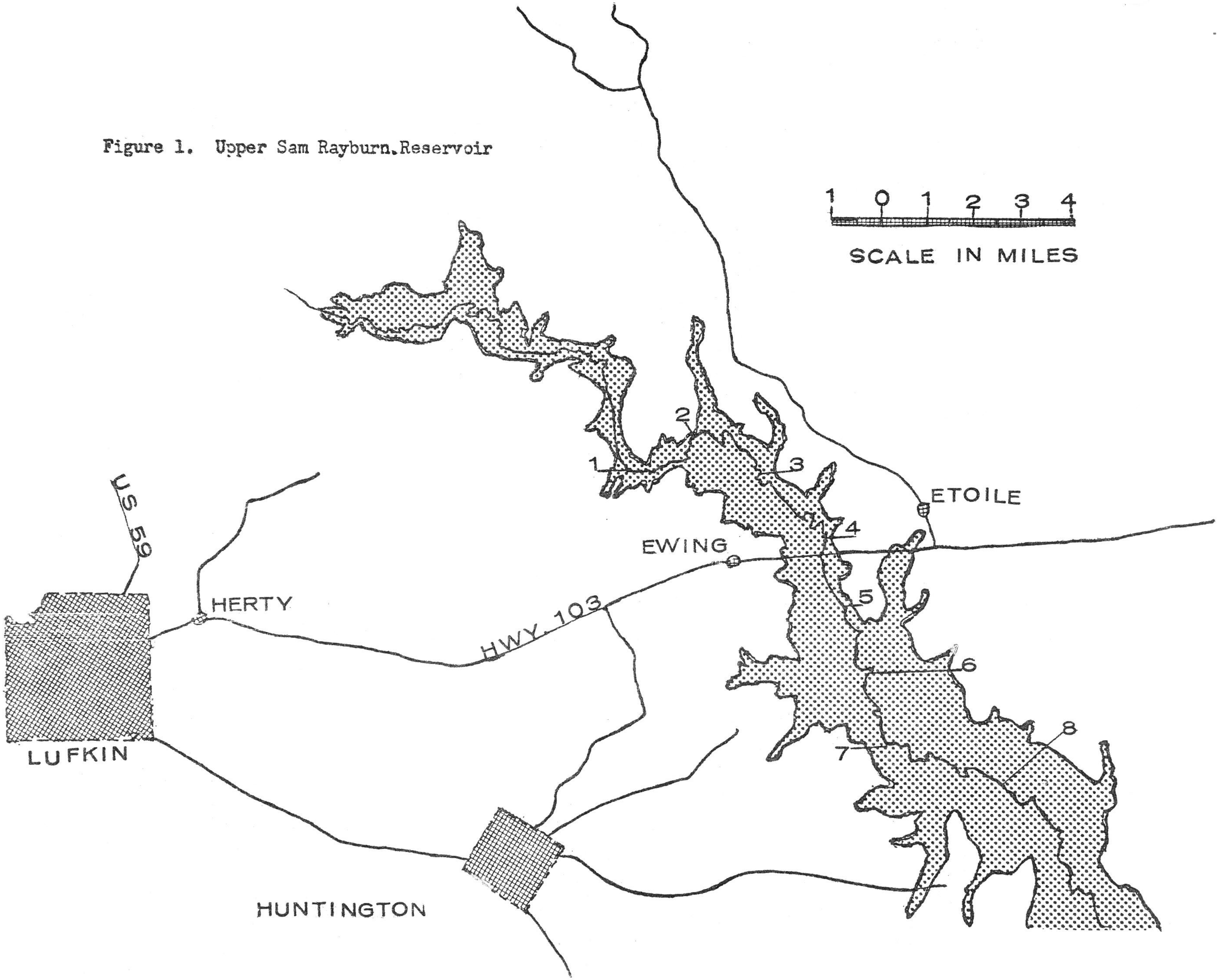
Station 6. Station 6, located in 20 feet of water at elevation 152 is also in an area where timber has been cleared along the river banks. Heavier deposits of black sediment cover the lake bottom in this area.

Station 7. Station 7, is located in the river channel. Heavy timber lines both sides of the channel in this area. Channel depth is 24 feet at elevation 152. Bottom soil is coarse sand overlaid with black sediment.

Station 8. Station 8, is similar to Station 7, located in the river channel and surrounded by dense timber. Depth of the channel is 25 feet and marginal areas 12-15 feet.

Figure 1 is a map of upper Sam Rayburn Reservoir showing station sites.

Figure 1. Upper Sam Rayburn Reservoir



FINDINGS:

As anticipated, the gathering of field data for this study proved to be extensive. Laboratory analyses of bottom, plankton and sedimentation samples required numerous man-days.

These data will be discussed collectively and individually where significant variations in ecological conditions occur.

As previously outlined, vertebrate and invertebrate populations were sampled for comparison to water quality data recorded from their immediate habitat. By these comparisons an evaluation of paper mill effluent effects on fish and other aquatic life in the reservoir can be made.

Considerable research concerning the effects of paper mill wastes on fish and fish eggs has been conducted. Numerous research programs of the Department of Entomology, Fisheries and Wildlife, University of Minnesota, indicate that "while suspended wood pulp and wood fiber mats may not be directly toxic to most adult fish species, they are detrimental to fish eggs and fry. Through oxygen depletion and other chemical reactions, paper fibers and accompanying chemicals can deplete fisheries from large areas of good potential. When eggs, fry or juvenile fish are effected it is reasonable to assume that the harvestable fish crop will be reduced or eliminated" (Smith, 1965).

WATER ANALYSES:

All field analyses were run with a Hach DR EL chemistry kit. This unit utilizes individually sealed reagents for colorimetric tests. Table 1 contains water quality data for each station.

One liter capacity Imhoff sedimentation cones were used to measure suspended solids in milliliters per liter of water at each station. Table 2 contains sedimentation readings for all stations. A correlation exists between sedimentation readings and colorimetric turbidity readings with the exception of a few areas where black dye from sodium lignite in the effluent waters increased turbidity greatly.

Physical effects were more apparent during drought conditions as indicated by water quality data recorded in August, October and November, 1967. Sharp increases in turbidity, chlorides, total alkalinity, sulfates and ortho-phosphates were noted. Black water at the upstream stations in the river channel foamed when agitated.

Increased turbidity during these months made colorimetric methods difficult, particularly sulfate, phosphate and dissolved oxygen tests. All chemical analyses were performed in the field at each station site. During the coming segment highly turbid samples will be tested both in the field and again in the laboratory after being filtered. Comparisons of the filtered sample results will be made to the field tests to determine turbidity influence.

With the exception of a few additional hydrogen sulfide tests, only surface and bottom water samples were analyzed at each station. Additional hydrogen sulfide, dissolved oxygen, carbon dioxide, turbidity and temperature checks will be made at intermediate depths (six foot intervals) at the lower stations during the coming segment. The highest concentrations of hydrogen sulfide gas were found at 12-18 feet at the downstream stations rather than on the bottom in heavy sediment.

Table 1

Water Analyses Data - Sam Rayburn Reservoir

Station #1	April Surface	April Bottom 20 ft.	May Surface	May Bottom 25 ft.	June Surface	June Bottom	July Surface	July Bottom	August Surface	August Bottom	October Surface	October Bottom	November Surface	November Bottom	January Surface	January Bottom
pH	6.7	6.8	6.8	6.7	6.9	6.7	6.8	6.9	7.2	6.9	*	4.8	7.2	6.9	7.0	6.9
Temperature °F.	76		76	71	84	80	80	78	78	77	69	68	59	59	39	40
Turbidity (Jackson Units)	9 in. secchi		125	105	80	110	150	225	250	240	500	300	325	325	45	45
Chlorides (p.p.m.)	85	55	75	80	100	125	100	105	170	165	285	375	225	240	20	20
Ortho-phosphates (p.p.m.)	0.90	0.50	0.2	0.2	0.2	0.25	0.5	0.7	1.2	1.0	2.6	1.6	2.2	1.6	0.2	0.2
Sulfates (p.p.m.)	75	130	55	68	80	72	120	110	350**	350	400**	400	400	400	40	40
Oxygen (p.p.m.)	4.0	4.0	4.0	4.0	6.0	3.0	4.0	2.0	4.0	1.0	2.0	1.0	4.0	0.0	10	10
Total Alkalinity (p.-.m.)	10	50	50	30	50	60	40	50	120	110	140	140	50	50	20	20
Hydrogen sulfide	-	-	0	0.1	0	0	0	0	0	0	-	-	-	-	0	0
Carbon dioxide (p.p.m.)	-	-	-	-	0	6.0	9.0	24.0	4.0	4.0	8.0	60.0	4.0	4.0	4.0	4.0

* Water too turbid to make reading

** High turbidity

Table 1 (Continued)

Station #2	April Surface	April Bottom	May Surface	May Bottom	June Surface	June Bottom	July Surface	July Bottom	August Surface	August Bottom	October Surface	October Bottom	November Surface	November Bottom	January Surface	January Bottom
pH	6.8	6.9	6.8	6.8	8.5	6.6	6.9	6.8	7.0	6.7	*	*	7.2	7.3	7.0	7.1
Temperature °F.	74	-	76	74	88	82	84	79	80	79	*	*	62	59	39	41
Turbidity (Jackson Units)	8 in. secchi		130	130	75	100	110	330	220	280	*	*	300	300	40	40
Chlorides (p.p.m.)	60	65	75	100	110	100	110	55	110	115	*	*	245	240	20	20
Ortho-phosphates (p.p.m.)	0.60	0.60	0.35	0.20	0.20	0	0.40	0.40	0.80	1.10	*	*	2.20	1.70	0.20	0.10
Sulfates (p.p.m.)	70	80	65	65	90	70	90	150	175	250	*	*	400	400	45	50
Oxygen (p.p.m.)	4.0	4.0	4.0	4.0	9.0	2.0	5.0	2.0	4.0	0.0	*	*	3.0	0.0	10	10
Total alkalinity (p.p.m.)	50	50	30	30	45	40	20	30	80	100	*	*	105	120	20	20
Hydrogen sulfide (p.p.m.)	-	-	0	0	0	0	0	0	0	0	*	*	0	0	0	0
Carbon dioxide (p.p.m.)	-	-	-	-	0	8	16	48	3	3	*	*	7	8	4	4

* Sample not taken due to inacessability

Table 1 (Continued)

Station #3	April Surface	April Bottom 12 ft.	May Surface	May Bottom	June Surface	June Bottom 14 ft.	July Surface	July Bottom	August Surface	August Bottom	October Surface	October Bottom	November Surface	November Bottom	January Surface	January Bottom 21 ft.
pH	6.8	7.1	6.7	6.9	6.6	6.5	6.6	6.7	6.9	6.9	*	*	7.4	-	6.8	6.8
Temperature °F.	-	-	75	75	81	80	80	78	78	78	*	*	60	58	40	40
Turbidity (Jackson Units)	7 in. secchi		120	175	50	90	100	110	210	190	*	*	300	300	65	50
Chlorides (p.p.m.)	65	65	75	60	100	85	120	115	115	115	*	*	230	270	15	15
Ortho-phosphates (p.p.m.)	0.5	0.4	0.4	0.5	0.15	0.20	0.3	0.1	1.0	0.8	*	*	2.0	2.0	0.1	0.1
Sulfates (p.p.m.)	60	65	55	60	60	65	100	80	250	250	*	*	400	400	40	50
Oxygen (p.p.m.)	3.5	3.0	3.5	4.0	2.5	0.5	5.0	0	4.0	1.0	*	*	3.0	1.0	10	10
Total alkalinity (p.p.m.)	40	50	30	40	40	40	40	30	80	90	*	*	80	150	20	20
Hydrogen sulfide (p.p.m.)	-	-	0	0	0	0	0	0	0	0	*	*	0	0	0	0
Carbon dioxide (p.p.m.)	-	-	-	-	3	3	36	52	2.0	2.0	*	*	8.0	8.0	4	4

* Sample not taken due to inaccessibility

Table 1 (Continued)

Station #4	April Surface	April Bottom 4 ft.	May Surface	May Bottom 5 ft.	June Surface	June Bottom	July Surface	July Bottom	August Surface	August Bottom	October Surface	October Bottom	November Surface	November Bottom	January Surface	January Bottom 16 ft.
pH	7.0	6.9	6.8	6.6	6.7	6.5	7.0	6.5	7.0	6.9	7.1	7.4	7.2	*	6.8	6.8
Temperature °F.	-	-	74	74	83	81	81	78	78	77	68	67	64	57	40	40
Turbidity (Jackson Units)	8 in. secchi		120	150	40	110	60	100	110	130	200	250	180	500**	70	65
Chlorides (p.p.m.)	65	40	75	60	60	110	75	85	105	110	260	290	220	305	15	15
Ortho-phosphates (p.p.m.)	0.4	0.3	0.29	0.23	0.1	0.25	0.1	0.5	0.4	0.6	0.6	0.8	0.4	3.2	0.1	0.1
Sulfates (p.p.m.)	55	55	55	38	40	40	50	65	85	90	300	-	-	-	40	40
Oxygen (p.p.m.)	5.0	4.0	3.0	3.0	2.0	0	7.0	1.0	5.0	0	5.0	0	5.0	0	10	10
Total alkalinity (p.p.m.)	60	50	30	40	40	40	50	40	70	75	100	-	75	170	20	20
Hydrogen sulfide (p.p.m.)	-	-	0	0	0	0	0	0	0	0	0	0	0	0.3	0	0
Carbon dioxide (p.p.m.)	-	-	-	-	1.0	4.0	40.0	72.0	3.0	4.0	8.0	-	4.0	12.0	4.0	4.0

* Water too turbid to make reading
** High turbidity

Table 1 (Continued)

Station #5	April Surface	April Bottom 23 ft.	May Surface	May Bottom 20 ft.	June Surface	June Bottom	July Surface	July Bottom	August Surface	August Bottom	October Surface	October Bottom	November Surface	November Bottom	January Surface	January Bottom 26 ft.
pH	7.5	6.9	7.1	6.6	6.6	6.7	6.6	5.6	6.8	6.8	7.7	7.7	7.2	-	6.6	7.2
Temperature °F.	-	-	74	73	88	-	82	79	84	76	68	68	63	56	39	42
Turbidity (Jackson Units)	12 in. secchi		75	80	35	140	40	100	50	140	100	110	300	500	130	150
Chlorides (p.p.m.)	60	50	80	75	50	55	50	85	80	100	130	170	107.5	275	15	15
Ortho-phosphates (p.p.m.)	0.4	0.55	0.2	0.35	.05	1.4	0.1	0.4	0.2	0.4	0.6	0.4	0.2	2.0	0.3	0.2
Sulfates (p.p.m.)	60	50	60	39	25	30	40	65	35.0	60.0	100	90	70	400	55	60
Oxygen (p.p.m.)	6.0	0	6.0	1.0	5.0	0	3.0	1.0	5.0	2.0	4.0	0.4	6.0	0	10	10
Total alkalinity (p.p.m.)	40	60	20	40	40	90	40	50	55	60	80	190	60	140	20	20
Hydrogen sulfide (p.p.m.)	0	0	0	0	0	0	0	0	0	0	0	0	0	0.1	0	0
Carbon dioxide (p.p.m.)	-	-	-	-	1.0	36	80	100	4.0	12.0	8.0	4.0	2.0	6.0	4.0	4.0

Table 1 (Continued)

Station #6	April Surface	April Bottom 20 ft.	May Surface	May Bottom	June Surface	June Bottom 20 ft.	July Surface	July Bottom	August Surface	August Bottom	October Surface	October Bottom	November Surface	November Bottom	January Surface	January Bottom 21 ft.
pH	7.1	6.8	6.8	6.9	7.1	6.6	6.7	6.5	6.9	6.9	6.9	7.0	6.9	-	7.0	6.7
Temperature °F.	-	-	75	73	87	80	82	79	83	73	68	68	62	57	39	40
Turbidity (Jackson Units)	10 in. secchi		50	25	-	110	20	85	25	70	60	150	50	500	120	120
Chlorides (p.p.m.)	65	65	80	65	35	130	50	75	65	70	110	180	85	295	15	15
Ortho-phosphates (p.p.m.)	0.20	0.90	0.3	0.8	0.05	1.4	0.1	0.3	trace	0.1	0.2	0.6	0.1	0.6	0.2	0.1
Sulfates (p.p.m.)	60	50	45	50	22	35	25	50	25	50	50	175	40	400	50	50
Oxygen (p.p.m.)	7.0	0	4.0	0	5.0	0	4.0	0	4.0	1.0	4.0	0	4.0	0	10.0	10.0
Total alkalinity (p.p.m.)	40	40	50	60	40	60	30	50	50	50	60	100	60	160	20	20
Hydrogen sulfide (p.p.m.)	-	-	-	0.1	0	* 4.0	0	0.1	0	0	0	0	0	0.4	0	0
Carbon dioxide (p.p.m.)	-	-	-	-	0	40	60	100	3.0	4.0	4.0	8.0	2.0	8.0	4.0	4.0

*H_2S - 12 feet
0.3 p.p.m.

Table 1 (Continued)

Station #7	April Surface	April Bottom 25 ft.	May Surface	May Bottom 22 ft.	June Surface	June Bottom 22 ft.	July Surface	July Bottom	August Surface	August Bottom	October Surface	October Bottom	November Surface	November Bottom	January Surface	January Bottom 26 ft.
pH	7.7	6.6	6.7	6.8	7.7	6.6	6.8	6.5	6.6	6.5	6.8	6.9	7.1	7.2	6.6	6.9
Temperature °F.	-	-	77	73	87	80	81	78	83	73	72	70	64	58	39	40
Turbidity (Jackson Units)	36 in. secchi		35	140	10	110	25	90	20	100	30	80	20	325	130	120
Chlorides (p.p.m.)	70	65	65	70	50	75	30	50	40	100	70	160	80	255	15	20
Ortho-phosphates (p.p.m.)	0.2	1.4	0.1	2.0	0.7	3.8	0.1	0.9	0.1	1.0	0.2	0.4	0.1	1.2	0.3	0.1
Sulfates (p.p.m.)	35	40	35	23	25	21	15	28	20	60	20	75	35	250	60	50
Oxygen (p.p.m.)	7.5	0	4.0	0	5.0	0	9.0	0	3.0	0	4.0	3.0	6.0	2.0	10	10
Total alkalinity (p.p.m.)	60	80	38	90	30	100	40	60	60	90	50	70	55	145	20	20
Hydrogen sulfide (p.p.m.)	-	-	0	* 3.0	0	* 0.3	0	0	0	0	0	0	0	0.3	0	0
Carbon dioxide (p.p.m.)	-	-	-	-	2.0	44.0	40	180	2.0	30	4.0	8.0	2.0	8.0	4.0	4.0

*H_2S - 13 feet 4.0 p.p.m.   *H_2S - 12 feet 4.0 p.p.m.

Table 1 (Continued)

Station #8	April Surface	April Bottom 23 ft.	May Surface	May Bottom 25 ft.	June Surface	June Bottom	July Surface	July Bottom	August Surface	August Bottom	October Surface	October Bottom	November Surface	November Bottom	January Surface	January Bottom
pH	8.0	6.7	6.7	6.5	7.6	6.5	6.7	6.5	6.9	6.5	6.9	7.1	7.0	7.1	7.1	7.0
Temperature °F.	74	-	74	72	88	80	80	77	83	80	74	70	63	58	39	40
Turbidity (Jackson Units)	50 in. secchi		18	50	10	70	15	90	40	100	50	140	15	350	120	130
Chlorides (p.p.m.)	50	65	30	-	30	60	35	75	50	80	65	190	60	230	20	15
Ortho-phosphates (p.p.m.)	0.05	1.0	0.3	1.4	0.05	1.6	0.1	1.2	0	0.9	0.1	0.7	0.1	1.2	0.2	0.1
Sulfates (p.p.m.)	25	60	25	22	20	35	20	55	20	70	20	150	25	250	50	60
Oxygen (p.p.m.)	8.0	0.5	4.0	0	5.0	0	6.0	0	5.0	0	3.0	0	6.0	0	10	10
Total alkalinity (p.p.m.)	40	50	20	60	60	80	50	90	60	90	70	100	70	130	20	20
Hydrogen sulfide (p.p.m.)	0	0	0	* 3.0	0	* 5.0	-	-	0	4.0	-	-	0	0.4	0	0
Carbon dioxide (p.p.m.)	-	-	-	-	0	20.0	32.0	164.0	2.0	24.0	2.0	8.0	2.0	8.0	4.0	4.0

*H_2S - 18 feet 5.0

*H_2S - 12 feet 3.0 p.p.m.

Table 2

Sam Rayburn Reservoir Sedimentation Counts* - 1967

Date	Station 1.	Station 2.	Station 3.	Station 4.	Station 5.	Station 6.	Station 7.	Station 8.
4/6/67	0.5	0.5	0.2	0.4	2.0	0.4	trace	trace
5/16/67	0.4	0.3	0.2	0.2	0.4	trace	trace	trace
6/21/67	0.4	0.4	0.2	0.5	0.1	0.1	trace	trace
7/17/67	0.3	0.3	0.1	0.3	0.1	trace	0.1	-
8/17/67	0.4	0.2	0.2	0.2	0.1	0.1	trace	trace
10/27/67	3.0	-	-	0.1	0.1	trace	trace	trace
11/21/67	5.0	trace	0.1	0.1	trace	0.1	0.1	trace
1/16/68	0.1	0.1	trace	0.1	0.1	0.1	trace	trace

*milliliters per liter (Imhoff Cones)

Water elevation of Sam Rayburn ranged from an approximate high of 155.4 in June, 1967, to a low of 151.5 in November. As previously stated, general water quality declined as the water level dropped during the summer months. Surface turbidity readings dropped at the downstream stations but bottom readings increased to 350 - 500 Jackson Turbidity Units (JTU). A heavy build-up of suspended solids was evident at all stations in November. Water quality was homologous at the upstream stations. At the lower stations variation in surface and bottom samples indicated sediment stratification beginning at 12 feet and extending to the bottom.

Heavy rains in December raised the reservoir elevation to 153. The flushing action of this rise is apparent in the January, 1968, collection data. Dissolved oxygen readings were a uniform 10 p.p.m., sulfate, ortho-phosphates, chlorides and total alkalinity were much lower. Turbidity ranged from 40 JTU at the upstream stations to 130 JTU (surface) at the lower stations. No black water or sediment was observed. Sedimentation samples registered only 0.1 milliliter and much of this material was soil particles.

Apparently, the heavy mass of suspended solids in the river channel was disspersed further into the reservoir. When the reservoir power pool elevation of 164.0 is reached, it is the writer's belief that the flushing action of heavy rains will be minimal in the present collection area. This would provide a continual build-up of suspended pulp and fiber. Tremendous amounts of hydrogen sulfide gas would be formed and could produce large fish kills at lake turnovers. The vast amount of decaying timber and secondary vegetation in this area of the reservoir will no doubt be a detriment in itself.

PLANKTON SAMPLES:

Plankton samples were taken at each station in conjunction with other collection a tivities. A marine type plankton net of No. 12 silk cloth was used, the net being raised vertically rather than towed. Relative abundance of phytoplankton and zooplankton forms were recorded in the laboratory. Zooplankton was more abundant at the downstream stations, particularly copepods, crustaceans and rotifers. More phytoplankton forms were collected in the upstream sites. During the coming segment only volumetric measurements of cubic centimeters plankton per cubic meter of water will be conducted. Existing plankton identification data will be studied further to determine water quality influence on group abundance.

BOTTOM SAMPLES:

Bottom soil samples were obtained with an Ekman 6 X 6 inch dredge. Soil samples were washed and examined for fauna. Due to the difficulty involved in breaking through the layers of vegetative debris and the limited organisms found in these bottom samples, they will be discontinued during the coming segment. Only limited oligochetes, cestodes and phyllopods were recovered.

SEDIMENTATION SAMPLES:

Sedimentation samples were taken at each station and returned to the laboratory. One liter capacity Imhoff cones were used for determining milliliters of sediment per liter of water. Table 2 contains sedimentation data for each station. As expected, the upstream stations nearest the influx of paper mill effluent contained higher concentrations of suspended solids. Only occasionally did suspended solids found at the lower stations exceed upstream readings.

FISH POPULATION DATA:

One hundred and fifty feet of experimental gill net was set overnight at each station. Table 3 contains monthly net collections for each station.

These netting data indicate fewer species and numbers of fish at the upstream stations. Also, fish were not netted consistantly at the upstream stations, indicating that changes in water quality periodically force them to leave these areas. Turbidity apparently has definite influence on fish availability at the upper stations in the river. When surface turbidity readings exceeded 100 JTU at station 1 and 2, fish collections decreased sharply. This is apparent in the June collection for station 3 also. Turbidity readings were 120 JTU on the surface and 125 JTU on the bottom in May, when only 7 fish were netted. The June readings were 50 JTU surface and 90 JTU bottom. Twenty-four fish were netted in June. In July turbidity readings at station 3 had increased to 100 and 110 respectively and again only 7 fish were netted.

In relation to sedimentation counts, 150 JTU represents approximately 0.5 ml. sediment per liter of water.

A total of 816 fish were netted this segment. Of this total 221 or 27.08 per cent were game fish. Sunfish species collected at stations 7 and 8 increased this per cent by number for game fish. Game fish comprised only 8.42 per cent of the total collection by weight.

VEGETATION:

In early June clumps of maiden cane (Panicum hemitomon) were noted in the river channel at the upstream stations. By October, maiden cane had completely blocked sections of the channel making access to station 2 and 3 impossible. Figures 2 and 3 are photographs of the dense maiden cane mats in the river channel. Ortho-phosphates were high during the months of August, September and October, the period of maximum plant growth.

The maiden cane appeared frostbitten when the November collections were made and had receeded to the margins of the channel.

CONCLUSIONS AND RECOMMENDATIONS:

As anticipated during the planning of this study, the multiple collections of field data and ensuing analyses were time consuming. Through this first segment's work, needed modifications and additions have been determined to provide more useful field data.

Additional tests for hydrogen sulfide, carbon dioxide, dissolved oxygen and turbidity at intermediate depths will determine more accurately the extent and locations of suspended solids at the downstream stations. Oxygen demand index (ODI) tests, adaptable to the Hach DR EL field kit will also be utilized to provide data equivalent to the standard BOD test with a minimum of laboratory equipment and time.

Netting collections will be continued and supplemented with seining collections where physical conditions permit to determine if reproduction of game fish species is sufficient.

Table 3

Sam Rayburn Reservoir Netting Data - 1967

Station No. 1.

Species	April No.	April Wt.	May No.	May Wt.	June No.	June Wt.	July No.	July Wt.	August No.	August Wt.	Oct. No.	Oct. Wt.	Nov. No.	Nov. Wt.	Jan. No.	Jan. Wt.
alligator gar			1	8.50												
spotted gar	12	22.87			1	1.50	1	3.00								
longnose gar			1	2.25												
bowfin	1	6.50							1	6.50			2	9.50		
smallmouth buffalo					1	.62										
spotted sucker	1	1.00					1	1.13							1	1.50
carp	3	11.50					2	6.50								
black bullhead	3	2.25											1	0.75		
bluegill sunfish	1	0.75					2	0.50								
Totals	21	44.87	2	10.75	2	2.12	6	11.13	1	6.50	0	0	3	10.25	1	1.50
Total game fish:	No. 3	Wt. 1.25														
Total rough fish:	33	85.87														
Grand Total:	36	87.12														

Table 3 (Continued)

Station No. 2.

Species	April No.	April Wt.	May No.	May Wt.	June No.	June Wt.	July No.	July Wt.	August No.	August Wt.	Oct. No.	Oct. Wt.	Nov. No.	Nov. Wt.	Jan. No.	Jan. Wt.
alligator gar			1	11.00												
spotted gar	5	11.25	6	15.00	2	3.62	2	5.13	1	1.50	No Sample		No Sample		1	2.25
longnose gar			2	3.13												
gizzard shad					4	0.96	2	0.37								
spotted sucker															5	7.50
carp	2	9.00			1	3.75			1	2.50						
black bullhead	1	1.00			2	1.62	2	1.50								
flathead catfish									3	6.25						
largemouth bass							1	0.19								
bluegill sunfish			3	1.00			2	0.25								
redbreast sunfish					1	0.19										
white crappie					1	0.19			1	0.32						
drum	2	2.00	1	1.00					3	5.00						
Totals	10	23.25	13	31.13	11	10.33	9	7.44	9	15.57	0		0		6	9.75

	No.	Wt.
Total game fish:	12	8.39
Total rough fish:	46	89.08
Grand Total:	58	97.47

Table 3 (Continued)

Station No. 3.

Species	April No.	April Wt.	May No.	May Wt.	June No.	June Wt.	July No.	July Wt.	August No.	August Wt.	Oct. No.	Oct. Wt.	Nov. No.	Nov. Wt.	Jan. No.	Jan. Wt.
spotted gar	1	2.25			4	6.25			1	1.37						
longnose gar	1	3.88	6	13.00							No Sample					
bowfin	1	4.00														
gizzard shad					5	0.65										
smallmouth buffalo															1	1.50
spotted sucker															1	1.25
carp	5	16.25														
blackbullhead catfish	1	0.88			2	1.63	2	0.88								
flathead catfish	1	4.00														
largemouth bass	2	1.88													1	0.62
warmouth					2	0.87										
spotted sunfish	2	0.50														
bluegill sunfish	1	0.50			1	0.25										
redbreast sunfish	4	0.62			3	0.38	1	0.13	1	0.19						
white crappie					5	0.76	3	0.56							1	0.19
black crappie					1	0.13									1	0.13
flier	1	0.19														
drum			1	1.13	1	1.25	1	0.75								
Totals	20	34.95	7	14.13	24	12.17	7	2.32	2	1.56	0	0	0	0	5	3.69

	No.	Wt.
Total game fish:	30	11.77
Total rough fish:	35	57.05
Grand Total:	65	68.82

Table 3 (Continued)

Station No. 4.

Species	April No.	April Wt.	May No.	May Wt.	June No.	June Wt.	July No.	July Wt.	August No.	August Wt.	Oct. No.	Oct. Wt.	Nov. No.	Nov. Wt.	Jan. No.	Jan. Wt.
spotted gar	1	2.50	1	1.75	1	2.00	5	7.37	2	5.25						
longnose gar	7	18.50														
bowfin	2	5.13	2	8.00					2	10.25					1	5.75
gizzard shad							5	0.75								
smallmouth buffalo	1	2.00							1	5.00					8	19.00
spotted sucker	1	0.19													6	8.50
carp	10	32.00	3	9.88			1	3.88							2	6.00
channel catfish											1	0.81				
blue catfish	2	0.62														
black bullhead	4	3.75	1	1.06					1	1.19	1	0.50			2	1.50
yellow bullhead									2	2.00					1	0.88
largemouth bass															1	1.75
warmouth							1	0.37								
spotted sunfish																
bluegill sunfish			1	0.37			2	0.25	1	0.25						
redbreast sunfish							1	0.25								
white crappie	4	0.75					6	1.62	1	0.37					3	0.50
black crappie			1	0.37			1	1.00			3	0.37			2	0.37
drum									1	1.37						
Totals	32	65.44	9	21.43	1	2.00	22	15.49	11	25.68	5	1.68	0	0	26	44.25

	No.	Wt.
Total game fish:	31	10.02
Total rough fish:	75	165.95
Grand Total:	106	175.97

Table 3 (Continued)

Station No. 5.

Species	April		May		June		July		August		Oct.		Nov.		Jan.	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
spotted gar	1	6.00	3	4.13					4	10.00						
bowfin	3	9.25			2	7.50			2	5.25						
gizzard shad					3	0.50			5	1.63						
bigmouth buffalo							1	4.88								
smallmouth buffalo			6	7.50			2	4.25	2	3.75	1	2.44			3	8.25
spotted sucker			1	0.75											3	3.50
lake chubsucker															1	0.13
carp	4	12.25	3	7.88	1	3.50										
channel catfish							1	2.25								
black bullhead	1	1.50	4	3.50	2	1.25					2	2.50			1	1.25
yellow bullhead									1	0.75						
flathead catfish											1	5.75				
largemouth bass									1	1.00						
bluegill sunfish			1	0.25											1	0.25
white crappie			1	0.62	1	0.19			5	1.50	1	0.55			2	0.31
black crappie									1	0.19					1	0.13
Totals	9	29.00	19	24.63	9	12.94	4	11.38	21	24.07	5	11.24	0	0	12	13.82

	No.	Wt.
Total game fish:	17	12.99
Total rough fish:	62	114.09
Grand Total:	79	127.08

Table 3 (Continued)

Station No. 6.

Species	April No.	April Wt.	May No.	May Wt.	June No.	June Wt.	July No.	July Wt.	August No.	August Wt.	Oct. No.	Oct. Wt.	Nov. No.	Nov. Wt.	Jan. No.	Jan. Wt.
spotted gar	2	3.50	1	2.00	6	10.25	5	11.25	5	13.00						
longnose gar					1	3.00										
bowfin	4	13.50							1	2.50						
gizzard shad					13	2.44	2	0.31	3	0.75						
bigmouth buffalo					1	4.00	1	2.62			1	6.44				
smallmouth buffalo			4	6.50	6	10.25	3	6.00							4	8.75
river carpsucker															2	3.37
carp	2	7.88							1	2.00						
golden shiner															2	0.37
channel catfish			1	0.75			1	1.25								
blue catfish					1	1.00							1	1.00		
black bullhead	4	4.50			1	0.75									1	0.69
yellow bullhead					2	2.75										
flathead catfish			1	7.37												
warmouth							1	0.13								
bluegill sunfish					2	0.25	2	0.62	2	0.75						
white crappie	1	0.13	1	0.13	3	1.13	1	0.19	1	0.25					1	0.13
black crappie															3	0.69
spotted sucker															3	4.00
Totals	13	29.51	8	16.75	36	35.82	16	22.37	13	19.25	1	6.44	1	1.00	16	18.00

	No.	Wt.
Total game fish:	16	14.02
Total rough fish:	88	134.80
Grand Total:	104	148.82

Table 3 (Continued)

Station No. 7.

Species	April No.	April Wt.	May No.	May Wt.	June No.	June Wt.	July No.	July Wt.	August No.	August Wt.	Oct. No.	Oct. Wt.	Nov. No.	Nov. Wt.	Jan. No.	Jan. Wt.
alligator gar	1	20.00														
spotted gar	4	6.50	2	5.50	5	11.50	2	4.00	3	5.50	2	2.75				
longnose gar	2	6.00					3	12.81								
bowfin			2	7.13			1	4.31	1	3.50						
gizzard shad	3	0.75			2	0.25	12	1.62			1	0.62	16	2.00		
bigmouth buffalo	1	4.50									1	6.44				
smallmouth buffalo	4	7.75	2	3.37	4	7.50	4	8.75	2	4.50	5	14.00	5	12.00	8	21.13
carp	1	3.00														
black bullhead	1	1.00	2	1.25	3	0.88	2	0.62	3	3.13						
yellow bullhead			1	1.00	1	0.75							1	0.75		
warmouth					1	0.25										
bluegill sunfish	2	1.00			2	0.50			5	1.25			2	0.75		
white crappie	1	1.13											3	1.00		
black crappie													3	0.62	1	0.62
flier					1	0.25										
drum									1	1.25						
Totals	20	51.63	9	18.25	19	21.88	24	32.11	15	19.13	9	23.81	30	17.12	9	21.75

	No.	Wt.
Total game fish:	21	7.37
Total rough fish:	114	198.37
Grand Total:	135	205.74

Table 3 (Continued)

Station No. 8.

Species	April No.	April Wt.	May No.	May Wt.	June No.	June Wt.	July No.	July Wt.	August No.	August Wt.	Oct. No.	Oct. Wt.	Nov. No.	Nov. Wt.	Jan. No.	Jan. Wt.
alligator gar							1	3.50	1	5.50						
spotted gar			2	2.25	2	5.00	3	3.75	2	4.00						
longnose gar	1	4.13	1	2.00					1	5.75						
bowfin	2	7.50	2	8.00	1	4.50	1	2.13	1	3.50	1	4.75	2	7.25		
gizzard shad	6	0.88	1	0.13	2	0.32	12	1.50	4	0.25	4	0.75	18	2.25		
grass pickerel													1	0.50		
bigmouth buffalo	1	3.50	1	4.25											1	3.00
smallmouth buffalo	9	16.25	2	4.62	4	6.50	5	9.50	8	17.00	4	10.00	3	7.75	4	8.25
spotted sucker	1	1.00			1	1.25									1	1.62
carp							2	9.69	2	10.50						
golden shiner															1	0.13
black bullhead	1	0.88	1	1.00									11	7.00	2	1.56
yellow bullhead	2	1.00											2	2.25		
largemouth bass	1	1.75														
warmouth					1	0.37										
spotted sunfish			1	0.25												
redear sunfish							1	0.31								
bluegill sunfish	16	5.62	14	5.50	15	4.75	9	2.62	13	3.88	7	2.37	2	0.75	1	0.50
redbreast sunfish	1	0.62														
white crappie							1	0.19			3	0.44				
black crappie	1	0.50	1	0.19	1	0.13			1	0.19					1	0.19
Totals	42	43.63	26	28.19	27	22.82	35	33.19	33	50.57	19	18.31	39	27.75	11	15.25

	No.	Wt.
Total game fish:	91	31.12
Total rough fish:	141	208.59
Grand Total:	232	239.71

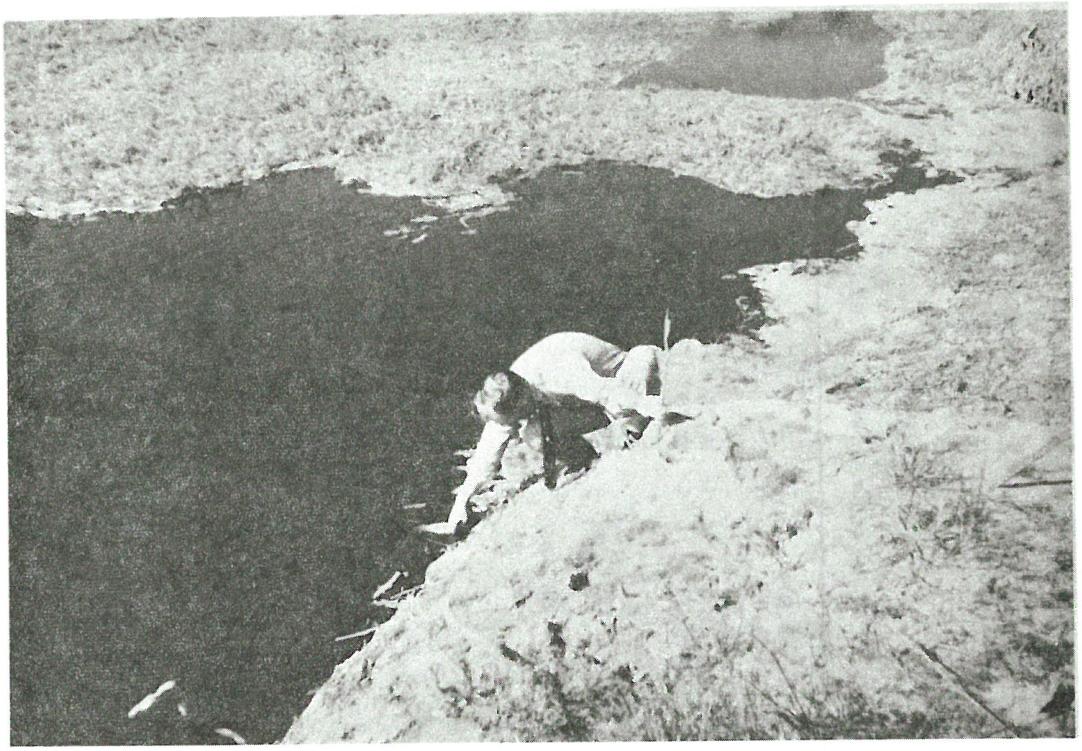


Figure 2. Dark water and dense growth of maiden cane at station 1.

Figure 3. Dense mat of maiden cane blocking Angelina River between stations 3 and 4.

Emphasis will be placed on determining the extent of sediment dispersion from the river channel in downstream areas within the reservoir.

It is recommended that this job be continued to provide additional data to more fully evaluate the effects of paper mill effluent on aquatic life in Sam Rayburn Reservoir.

Prepared by Joe E. Toole
Project Leader

May 14, 1968

Approved Marion Toole
Coordinator

Charles E. Gray
Fisheries Supervisor

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