

WATER QUALITY CONDITIONS  
AT THE

JORDAN RIVER  
NATIONAL FISH HATCHERY

ELMIRA, MICHIGAN

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION

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JORDAN RIVER NATIONAL FISH HATCHERY  
Elmira, Michigan

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Great Lakes Region  
Federal Water Pollution Control Administration  
Department of the Interior

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TABLE OF CONTENTS

	<u>Page</u>
INTRODUCTION . . . . .	1
DESCRIPTION OF SITE . . . . .	2
ANALYTICAL METHODS . . . . .	2
CRITERIA . . . . .	2
FIELD OBSERVATIONS . . . . .	4
CHEMICAL RESULTS . . . . .	4
BIOLOGICAL RESULTS . . . . .	5
SUMMARY . . . . .	7
CONCLUSIONS . . . . .	7
RECOMMENDATIONS . . . . .	7

## INTRODUCTION

The Bureau of Sport Fisheries and Wildlife's (BSF&W) Jordan River National Fish Hatchery began operation in 1964. The annual lake trout production of 135,000 pounds is utilized in the Great Lakes Fisheries Commission's restoration program.

The question of possible hatchery effluent pollution of the Jordan River first arose in 1965. Since that time, there have been numerous articles in local newspapers protesting the alleged pollution. During the spring of 1966 the BSF&W conducted a study to determine the effects of the hatchery on the chemical quality of the river. This study, while showing high levels of nutrients in the river, indicated that the hatchery's contribution to the total load was very small.

A draft of a report prepared by Mr. W. Steucke, Fish Hatchery Biologist, BSF&W, indicated that organic material was being deposited at the confluence of the hatchery effluent and the Jordan River, and that a treatment lagoon to remedy this problem had been proposed.

In a memorandum dated September 4, 1968, the Acting Regional Director of the BSF&W, Minneapolis, Minnesota requested that the Federal Water Pollution Control Administration (FWPCA) conduct an evaluation of possible pollution of the Jordan River by the hatchery. As a result of this request, two field investigations of the area were conducted in the fall of 1968. This report presents the findings of these investigations.

Federal agencies are required by Executive Order 11258 to provide leadership in the effort to improve water quality and to prevent water pollution from Federal Government activities. While this order specifically exempts fish hatchery effluents from the generally applicable requirement of secondary treatment; it does not relieve hatcheries of the responsibility of providing a lesser degree of treatment if it is shown to be necessary. As mentioned earlier, the BSF&W recognizes this responsibility and has proposed a treatment lagoon for the hatchery.

## DESCRIPTION OF SITE

The Jordan River National Fish Hatchery (for lake trout propagation) is located six miles southwest of Elmira, Antrim County, Michigan. The hatchery property is adjacent to the Jordan River. (See Figure 1)

The terrain in the vicinity of the hatchery is level to a gentle roll. The Jordan River, however, has a stabilized regime in a deep valley. The valley depth near the hatchery is approximately 400 feet.

Water is supplied to the hatchery by two springs. Both springs flow continuously throughout the year. The Five-Tile Spring has an average annual flow of 2300 gallons per minute. The Six-Tile Spring has an average annual flow of 3900 gallons per minute.

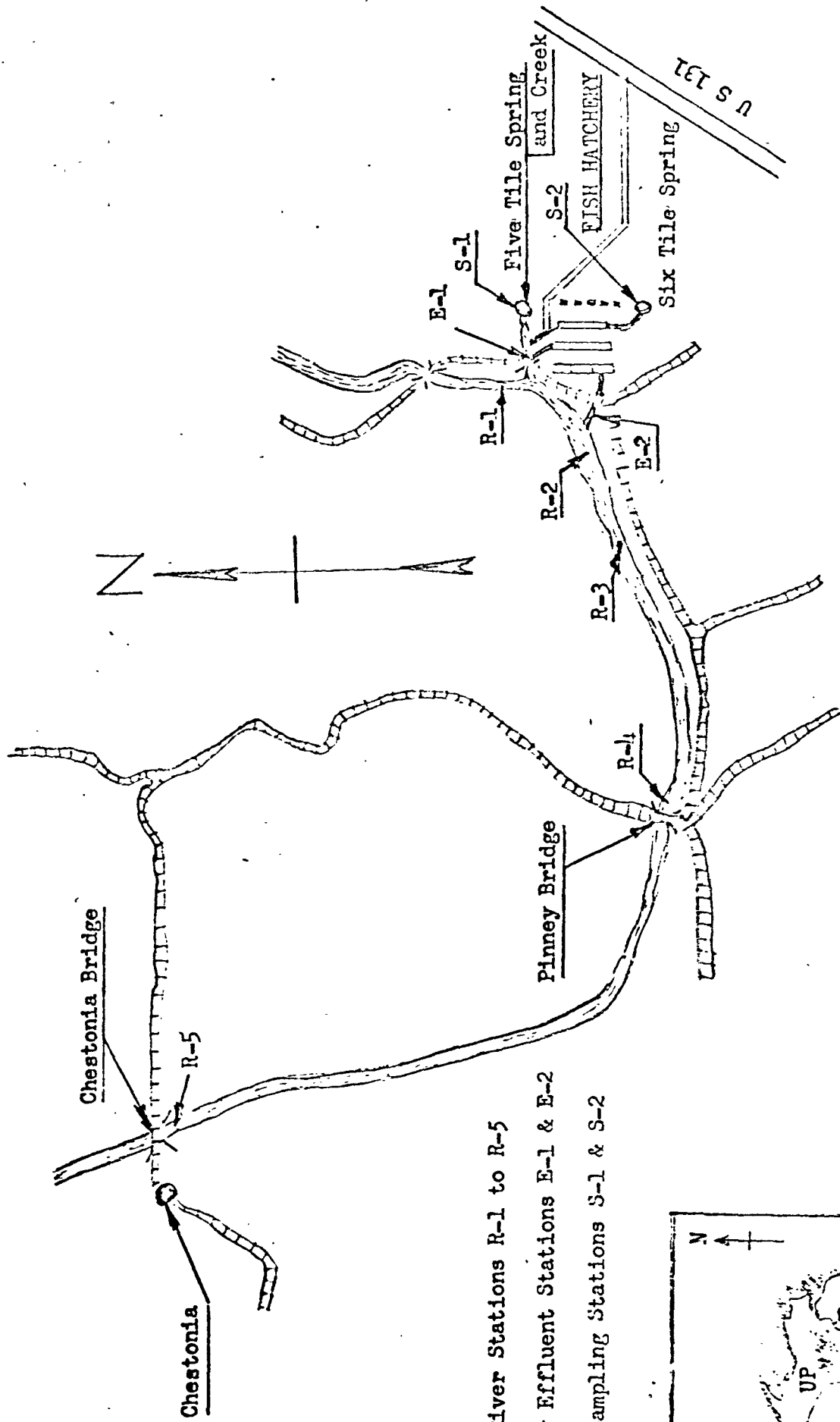
The outfalls flowing into Five-Tile Creek carry the waste water from the propagation tanks and from the feeding and habitation tanks. A portion of the Six-Tile Spring flow is used in the mature fish feeding and habitation tank and is discharged directly to the Jordan River through a 24 inch culvert.

## ANALYTICAL METHODS

Field and laboratory chemical analyses were performed using the FWPCA Official Interim Methods for chemical analysis of surface waters as selected by the Committee on Methods Validation and Analytical Quality Control. Biological sampling and classification methods are described in Water Pollution Biology, Field and Laboratory Manual, Lake Michigan Basin Office, FWPCA.

## CRITERIA

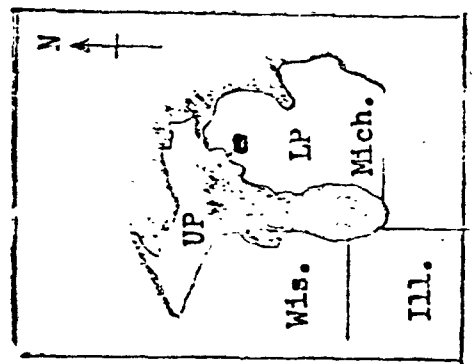
The applicable Michigan State Standards for nutrients and residues established for the protection of fish, wildlife, and other aquatic life are as follows:



Jordan River Stations R-1 to R-5  
 Hatchery Effluent Stations E-1 & E-2  
 Spring Sampling Stations S-1 & S-2

Jordan River National Fish Hatchery Location:  
 W $\frac{1}{2}$ , Sec. 6, T 30 N, R 5 W, Star Township  
 Antrim County, State of Michigan

Note: No scale



Location Map

"Nutrients originating from industrial, municipal, domestic animal sources shall be limited to the extent necessary to prevent the stimulation of growths of algae, weeds and slimes which are or may become injurious to the designated use;"

and

"Floating solids: None of unnatural origin.  
Residues: No evidence of such material except of natural origin."

The report of the National Technical Advisory Committee to the Secretary of the Interior, entitled Water Quality Criteria, and dated April 1, 1968, elaborates on the subject of nutrients and nuisance plant conditions. Abundance of nitrogen and phosphorus

"promotes vegetative production if other conditions for growth are favorable... Limited laboratory studies made to date indicate that different species of algae have somewhat different phosphorus requirements with the range of available phosphorus usually falling between 0.01 and 0.05 mg/l as phosphorus. At these levels, when other conditions are favorable, blooms may be expected... The total phosphorus is governing as it is the reservoir that supplies the available phosphorus. It is believed that allowable total phosphorus depends upon a variety of factors; e.g., type of water, character of bottom soil, turbidity, temperature, and especially desired water use. Allowable amounts of total phosphorus will vary, but in general, it is believed that a desirable guideline is 100 ug/l for rivers and 50 ug/l where streams enter lakes or reservoirs."

"The nitrogen-phosphorus ratio is also of importance. The ratio varies with the water, season, temperature, and geological formation, and may range from 1 or 2:1 to 100:1. In natural waters, the ratio is often very near 10:1, and this appears to be a good guideline for indicating normal conditions."

The N:P ratio is about 3:1 in living systems. When the ratio falls below 3:1 it indicates that the nitrogen is in short supply and is the limiting element. When the converse occurs the phosphorus is in short supply and more nitrogen is present than can be utilized.



## FIELD OBSERVATIONS

October 12, 1968

The initial FWPCA investigation of the effects of the hatchery effluent on the Jordan River included visual observations and water and biological sampling of stations above, at, and below the hatchery outfalls.

Visual observations of pollution indicators included considerable attached algae in Five-Tile Creek and extensive deposition of fecal and other material in the river below the Six-Tile (south) outfall. Some attached algae was noted in the river below the hatchery but not in excessive quantities. With the above exceptions the river appeared to be a clear, esthetically pleasing stream.

November 13, 1968

A significant observation of the second trip was the black scum which was scrubbed out of the feeding and habitation tank and discharged to Five-Tile Creek. This may have been a result of the build-up of fecal material. Fish are fed according to size and total weight. However, not all of the pelletized food is eaten, and some of it may settle to the bottom or may dissolve and disperse. The fecal material and the unconsumed food both contribute to the nutrient levels of the effluent.

The Six-Tile outfall carried a small amount of sediment to the Jordan River. Five-Tile Creek which carries the effluent from the two northern outfalls was clear at the point of confluence with the river. A small patch of algae was seen attached to felled logs in the river. Watercress was growing in widely separated reaches of the Jordan River.

## CHEMICAL RESULTS

Results of chemical analyses for the October survey are shown in Table 1 and for the November survey in Table 2.

Since the N:P ratio for all samples was greater than 3:1, the phosphorus concentrations are the limiting nutrient factors.

TABLE 1

Chemical Determinations  
 Sampling Date: 10/12/68  
 Analysis Dates: 11/6-8/68

<u>CPO#</u>	<u>Sta.#</u>	<u>Description</u>	<u>Total P</u> <u>mg/l</u>	<u>Nitrogen mg/l</u>		<u>N:P</u> <u>Ratio</u>
				<u>NH<sub>3</sub></u>	<u>NO<sub>3</sub>+NO<sub>2</sub></u>	
3288	R-1	Jordan R. 200 yds. upstream from Five-Tile Creek	0.019	0.03	0.50	28:1
3289	E-1	Five-Tile Creek just below north outfall	0.034	0.11	1.6	50:1
3290	R-2	Jordan R. just below Six-Tile outfall	0.026	0.17	1.8	76:1
3291	R-3	Jordan R. 200 yds be- low hatchery site	0.019	0.08	1.4	78:1
3292	R-5	Jordan R. at Chestonia Road Bridge	0.008	0.02	0.67	86:1
3295	S-1	Five-Tile spring	0.004	-	-	-
3294	S-2	Six-Tile spring	0.003	-	-	-

## Limits of sensitivity

P = 0.003 mg/l

N = 0.01 mg/l (all forms)

TABLE 2

Chemical Determinations  
 Sampling Date: 11/13/68  
 Analysis Dates: 11/21-27/68

<u>CFO#</u>	<u>Sta.#</u>	<u>Description</u>	<u>Total P</u> <u>mg/l</u>	<u>Nitrogen mg/l</u>		<u>N:P</u> <u>Ratio</u>
				<u>NH<sub>3</sub></u>	<u>NO<sub>3</sub>+NO<sub>2</sub></u>	
3486	R-1	Jordan R. 200 yds. upstream from Five-Tile Creek	0.007	0.01	1.1	158:1
3487	E-1	Five-Tile Creek just below north outfall	0.086	0.04	2.4	28:1
3489	R-3	Jordan R. 200 yds. below hatchery site	0.069	0.04	1.9	28:1
3483	S-1	Five-Tile spring	0.004	0.01	2.7	680:1
3484	S-2	Six-Tile spring	0.004	0.01	2.5	630:1
3488	E-2	South hatchery effluent at station R-2	0.106	0.20	2.5	25:1
3490	R-4	Jordan R. at Pinney Bridge	0.015	0.01	1.2	80:1

## Limits of sensitivity

P = 0.003 mg/l

N = 0.01 mg/l (all forms)

As would be expected, the samples of spring water had the lowest concentrations of phosphorus of any sample tested, these values being at or near the sensitivity of the test. The Jordan River upstream from the hatchery had low phosphorus content. Two hundred yards below the final hatchery effluent the concentration increased to about 0.03 mg/l in October and about 0.07 mg/l in November. The river recovered to about 0.01 mg/l at about 4 miles downstream from the hatchery.

The ammonia concentration was highest in the south hatchery effluent and in the river below where the south hatchery effluent enters the river. The ammonia, which is indicative of fresh fecal material, was rapidly converted to other forms of nitrogen within a short time after entering the river.

It is interesting to note that the nitrate-nitrite nitrogen was at its maximum concentration in the springs and, therefore, masked any contribution from the hatchery itself. Nevertheless, the nitrate-nitrite concentration recovered to its upstream value by the time the water reached the Pinney Bridge station.

## BIOLOGICAL RESULTS

### Benthos

Benthos samples were collected in the Jordan River and in Five-Tile Creek at various sites above and below the entry of effluents of the hatchery. Results of the analysis of benthos samples are found in Table 3.

Reference to Table 3 indicates that above the hatchery at station R-1 the river possessed a good aquatic habitat. Considerable numbers of pollution sensitive organisms, such as, mayfly larvae, caddisfly larvae, and stonefly larvae were found at this station.

Hatchery effluent station E-1 and river station R-2 were both biologically degraded. Thousands of pollution-tolerant sludgeworms were recorded. No pollution-sensitive benthic organism was collected at either of these stations.

Similar degraded biological conditions were noted in station E-2.

TABLE 3  
BENTHIC FAUNA  
Results Expressed in Numbers of Organisms  
per square meter

CPO#	3296	3297	3298	3299	3495	3300
Station#	R-1	E-1	R-2	R-3	R-4	R-5
Collection Date	10/12/68	10/12/68	10/12/68	10/12/68	11/13/68	10/12/68
Analysis Date	11/5	11/12	11/27	11/8	1/7/69	11/6
Oligochaeta (sludgeworms)	40	49,000	18,000		560	10,000
Tendipedidae (bloodworms)	600	1,400	260	40	770	300
Other Diptera		90			40	
Nematoda (roundworms)				90		40
Amphipoda (scuds)					130	
Turbellaria (flatworms)	40					
Coleoptera (aquatic beetles)	40					
Ephemeroptera (mayfly larvae)	950					
Trichoptera (caddisfly larvae)	260					
Plecoptera (stonefly larvae)	90					
Totals	2,020	50,490	18,260	130	1,500	10,340

Preservative: 10% Formalin

Biological conditions improved somewhat at station R-3 in the river below the hatchery. Bloodworms and roundworms (Nematodes) were recorded here. Sludgeworms were not found in this sample.

Further improvement was noted in the Jordan River at Pirney Bridge, station R-4, approximately four miles below the entrance of the hatchery effluent. Some pollution-sensitive scuds were recorded at this site.

At Chestonia Bridge about 8 miles downstream from the hatchery, station R-5, the Jordan was biologically degraded again. Large numbers of sludgeworms were recorded at this site. The reason for the condition at this site was not determined at the time of the study.

#### Phytoplankton

Phytoplankton recorded in the samples collected in the study are found in Table 4. Pennate diatoms predominated in all the samples collected.

Reference to Table 4 shows that phytoplankton were absent in the samples collected from the two sources of water for the hatchery, namely, Five-Tile spring, station S-1, and Six-Tile spring, station S-2. However, the hatchery effluent at station E-1 in Five-Tile Creek contained 430 phytoplankton/ml and the hatchery effluent at station E-2 contained 270/ml.

Downstream samples contained rather low numbers of phytoplankton - not much greater than the number recorded at station R-1 above the hatchery.

Briefly, phytoplankton populations recorded in this study were quite low. None exceeded 500 organisms/ml, the lowest number generally considered excessive.

Rather low water temperatures occurring during the study may have inhibited the growth of phytoplankton. Findings of a study conducted during the warmer time of the year probably would produce better information on the effects (if any) of the hatchery effluent on the growth of phytoplankton in the Jordan River.

TABLE 4  
PHYTOPLANKTON  
Results Expressed in Number of Organisms per Milliliter

CPO#	Sta. #	Collection Date	Centric Diatoms	Pennate Diatoms	Green Coccoids	Blue-Green Filamentous	Green Flagellates	Totals	Predominant Genera, (%)
3483	S-1	11/13/68						0	
3484	S-2	11/13/68						0	
3288	R-1	10/12/68	20	40	70			130	Navicula, 33; Unident. Green Coccoid 33
3486	R-1	11/13/68		20				20	Frustulia, 100
3289	E-1	10/12/68		40				40	Navicula 50; Cymbella 50
3487	E-1	11/13/68		460		20		480	Cymbella, 72
3290	R-2	10/12/68	20	180	70			270	Navicula, 33
3488	E-2	11/13/68		240				240	Cymbella, 54
3291	R-3	10/12/68	20	110				130	Fragilaria, 53
3489	R-3	11/13/68	20	110				130	Navicula, 53
3490	R-4	11/13/68		60	90		40	190	Scenedesmus, 47
3292	R-5	10/12/68		20				20	Amphora, 100

Samples collected on 10/12/68 were analyzed on 1/10/69.  
Samples collected on 11/13/68 were analyzed on 1/13/69.

Direct, colony-clump count using Sedgwick-Rafter cell.  
Microscope magnification = 200X.

Preservative: Merthiolate.

## SUMMARY

The Jordan River National Fish Hatchery contributes significant amounts of fish-fecal material and unconsumed fish-food to the Jordan River. This material deposits on the bottom and along the banks of the river and supports pollution-tolerant benthic organisms. These deposits are in violation of the intrastate water quality standards of the State of Michigan.

The river above the hatchery and the stretch from several hundred yards below the hatchery to the Pinney Bridge is clear and unpolluted.

The highest phosphorus concentration encountered occurred in one of the hatchery effluents. This value was 0.106 mg/l which is quite close to the FWPCA National Technical Advisory Committee recommended limit of 0.1 mg/l. When this effluent mixes with the Jordan River water, however, the concentration immediately drops to less than 0.1 mg/l. From the standpoint of nutrient enrichment, it appears state standards are not violated by the hatchery.

## CONCLUSIONS

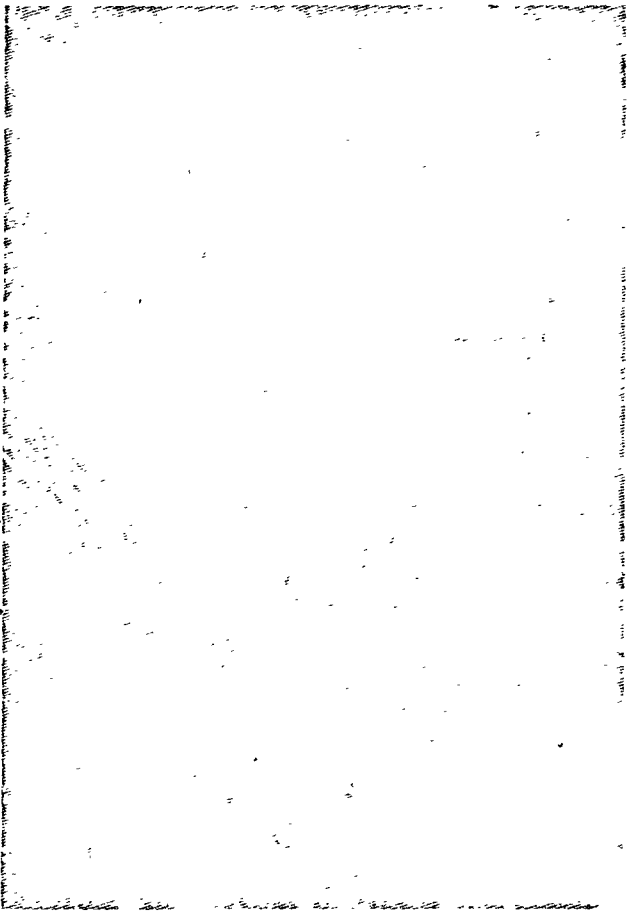
The Jordan River National Fish Hatchery is in violation of Michigan intrastate standards, and its discharge practices are counter to the intent of Executive Order 11283.

## RECOMMENDATIONS

The Bureau of Sport Fisheries and Wildlife should provide the Jordan River National Fish Hatchery with a settling pond or lagoon designed to remove solids from the hatchery effluents.

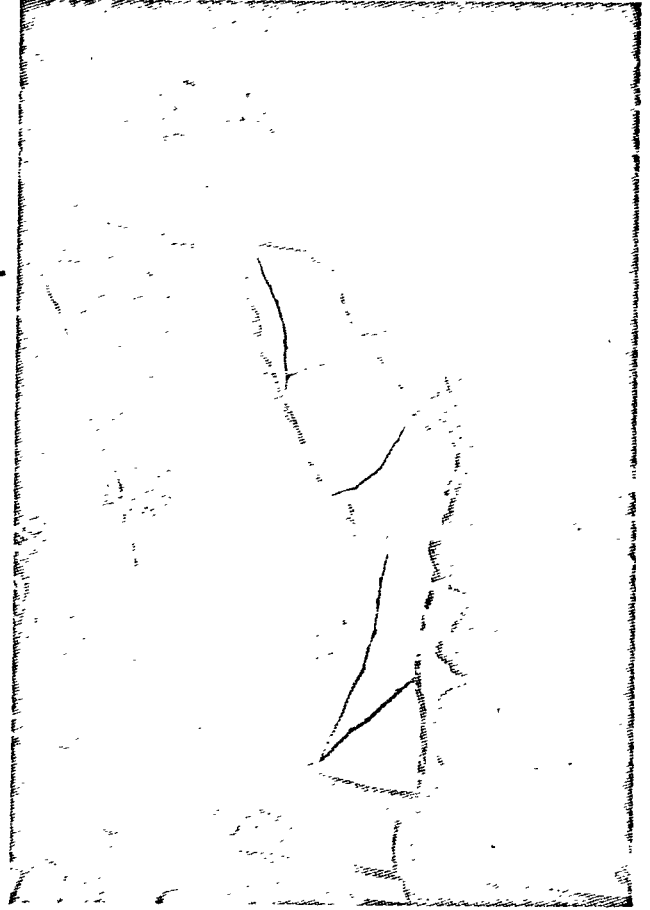
The Federal Water Pollution Control Administration should conduct another water quality survey at the hatchery site during the period of heaviest loading and make further recommendations, if necessary, to alleviate pollution conditions.





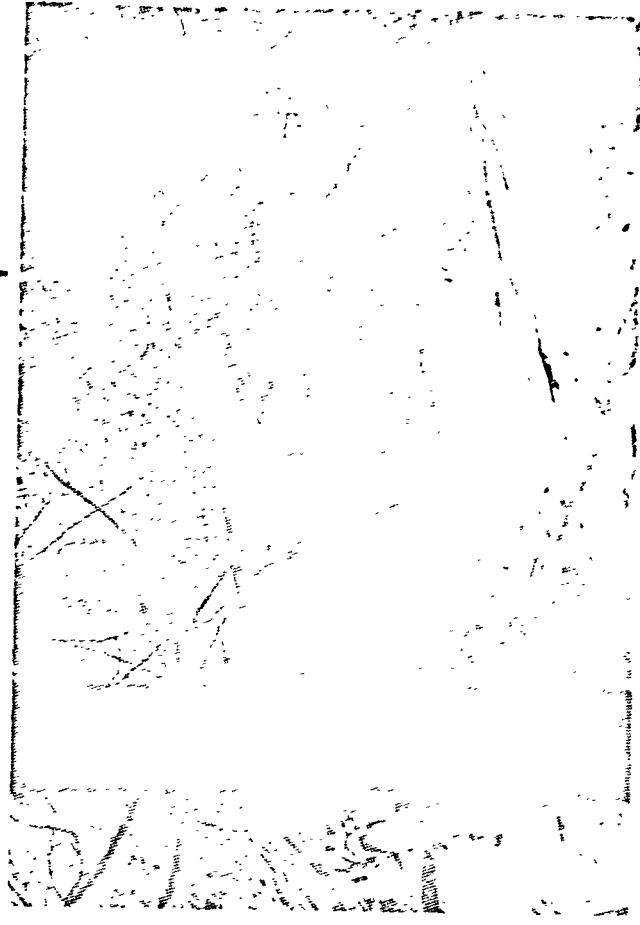
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Station E-1, Five Tile Creek - Note Algae

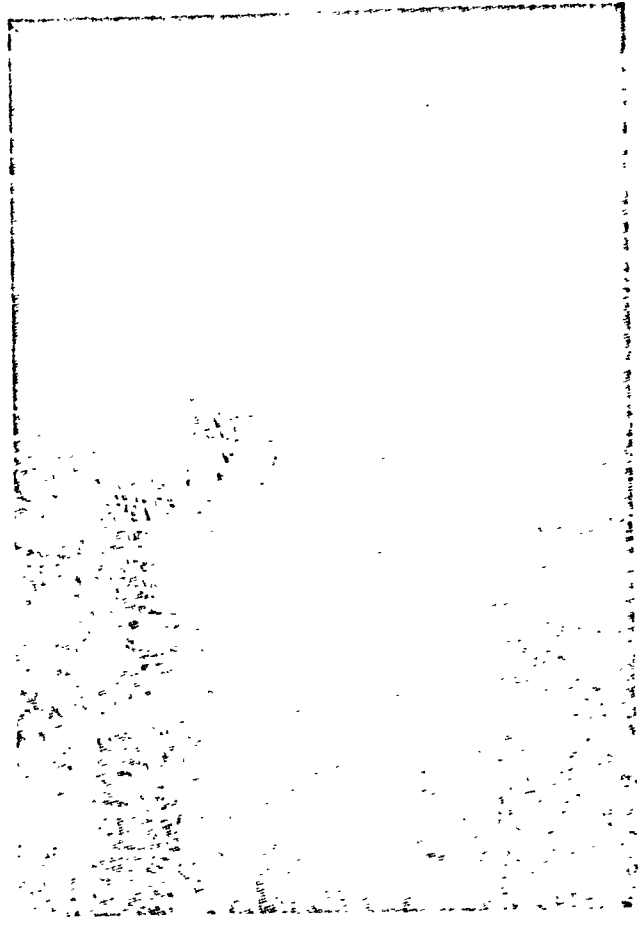


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Outfall E-2, just above Station R-2

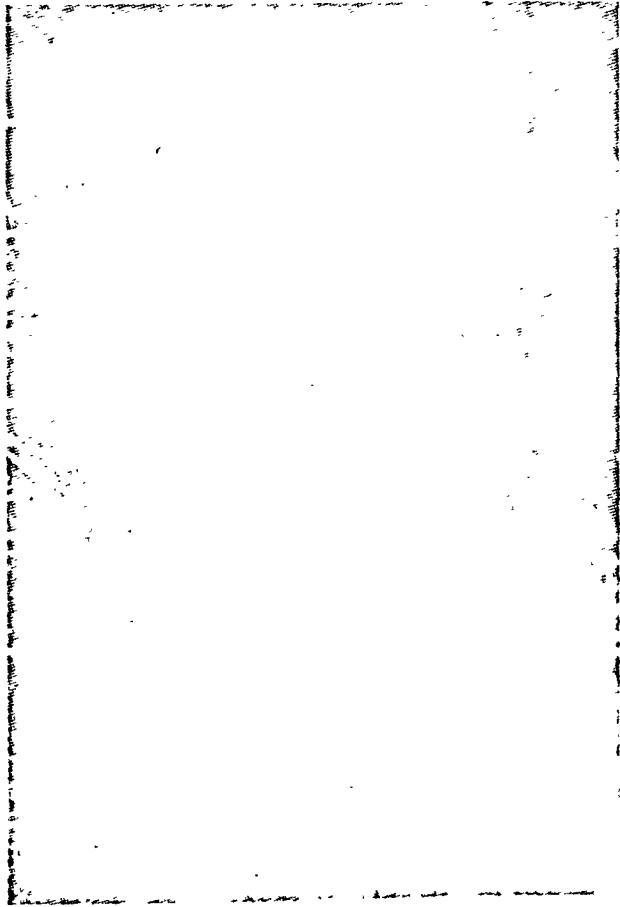


Station R-2, Note discoloration of sand by fecal material

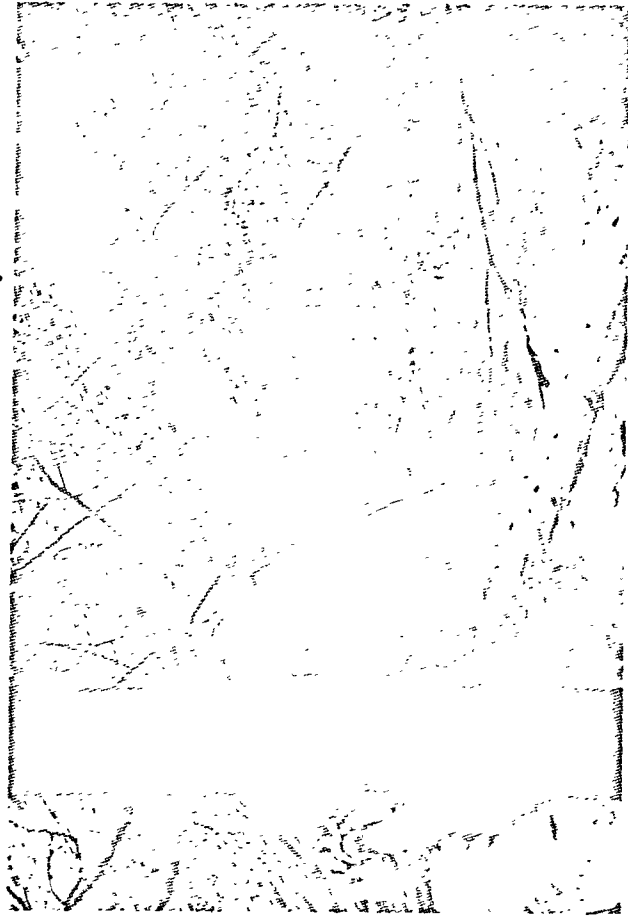


Station K-3, 200 yards downstream from outfall E-2

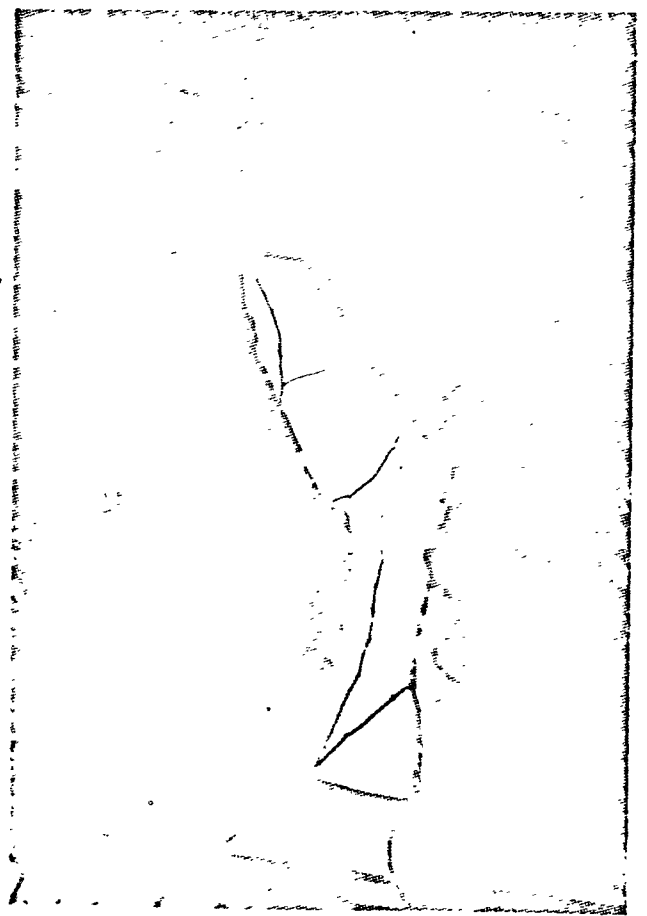
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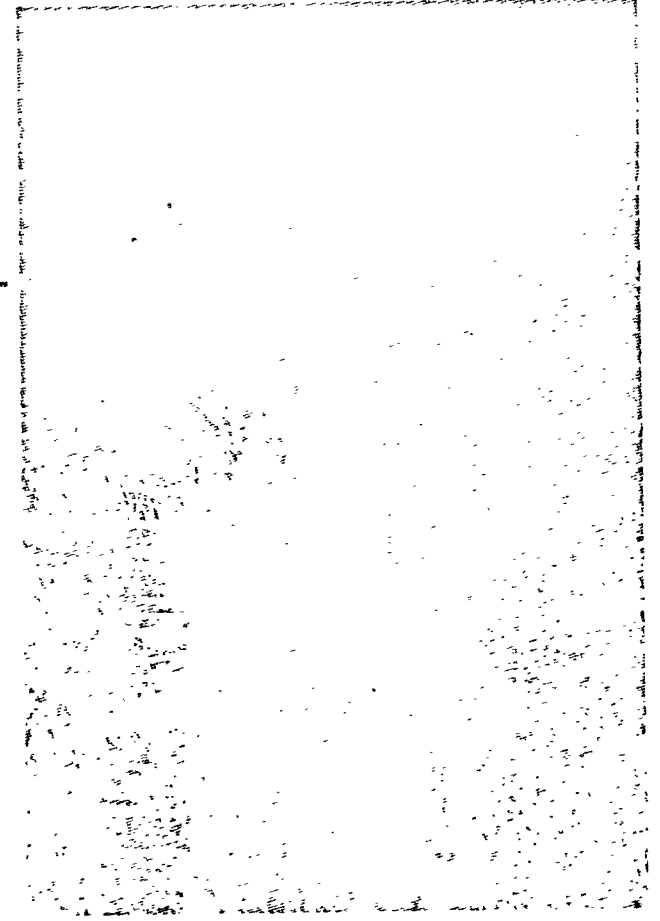
Station E-1, Five Tile Creek - Note Algae



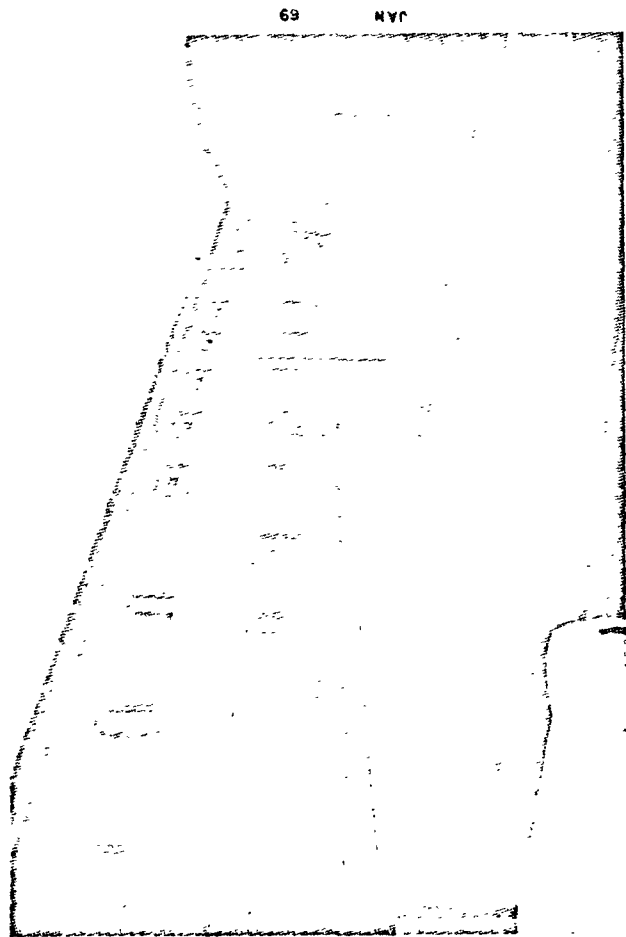
Station R-2, Note discoloration of sand by fecal material



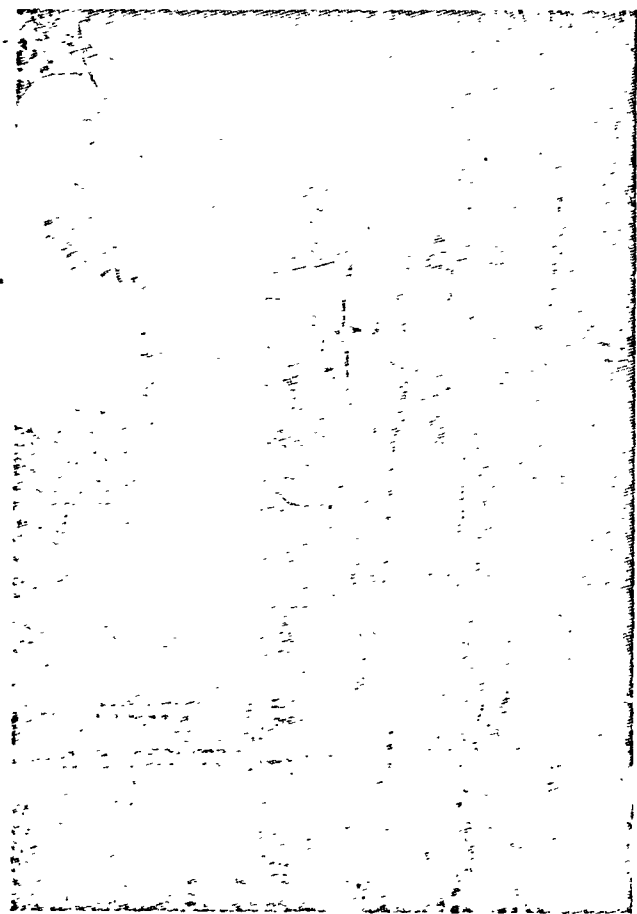
Outfall E-2, just above Station R-2



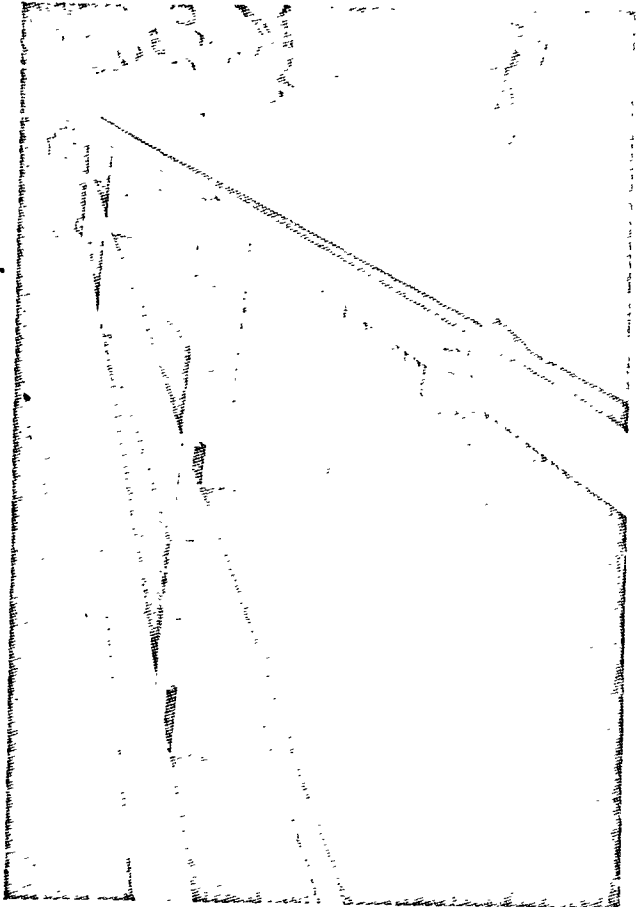
Station R-2, 200 yards downstream from outfall E-2



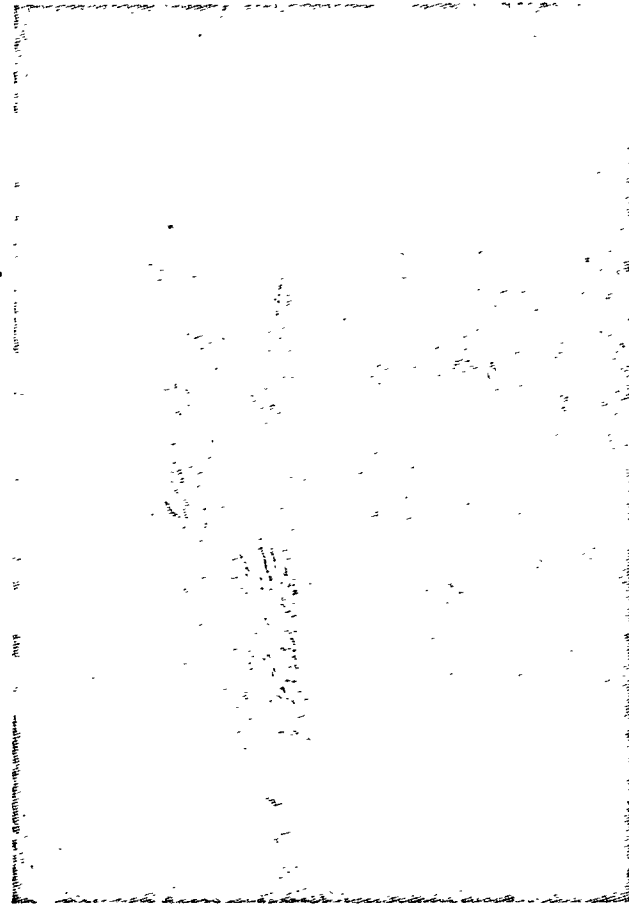
Main hatchery building and office



Jordan River above hatchery at Station R-1



Raceways at feeding time



Clear water at Station R-1