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TOTAL CHEMICAL RECLAMATION OF BEAR RIVER, CHARLEVOIX AND EMMET COUNTIES

William McClay, Fisheries Habitat Biologist

SUMMARY

The Bear River, from Walloon Lake to McManus Dam and two tributaries were chemically reclaimed with rotenone in August, 1973. Pro-noxfish was applied from constant flow drip stations and a helicopter to achieve a total kill. The total treatment time was reduced to 9 1/2 hours by starting each station in sequence in a manner that would allow a 1/2 to 1 hour overlap in toxicant from station to station. The helicopter was used to treat nearly 50 dead water areas and about 2.8 miles of stream, utilizing only two men.

Observations indicated the treatment resulted in a near to total kill of all species.

ACKNOWLEDGEMENTS

I would like to thank Dale Pettingale of the U.S. Geological Service, Grayling, for the use of the Gurley current meter and staff gages, without which this project could not have been begun. Special thanks go to Fred Vansimaeys, Regional Pilot, for his interest in the project which stimulated design and construction of an aerial spraying system. Without his special skills as a pilot in dropping the toxicant where needed and in relaying his observations, this treatment could not have been a success. Thanks also to Warren Yoder, Hatchery Biological Service Center, who spent many hours in the lab building and testing the rotenone kit, then putting it to use in the field to aid our detoxification efforts. Our appreciation is also expressed to Oden Hatchery for the use of their planting units for detoxification and to Fire Division for the use of three men. The bulk of the preliminary surveys, actual treatment, and final clean-up were carried out by the District 5 Fisheries crew consisting of Steve Swan, Mason Shouder, William (Bill) Horsell, Harold (Blackie) Brado, George (Archie) Reeves, and myself.

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INTRODUCTION

Bear River originates from Walloon Lake and flows about 12 miles in a northerly direction to its confluence with Little Traverse Bay (Lake Michigan) at Petoskey (Figure 1). Although only three and one-half miles of the river flows through State land, it is almost totally undeveloped until it reaches the Petoskey City limits. The river flows mostly through lowland hardwoods which flood frequently. It is classed as second quality trout water, primarily because of a lack of natural reproduction.

Haymarsh Creek is one of two major tributaries which enter the Bear River. It is a second quality trout stream, about five miles long, which joins the Bear about one mile below Walloon Lake. It also flows through lowland hardwoods, but unlike the Bear, it has a low gradient and a bottom composed mostly of muck over sand. Numerous beaver dams create floodings along the lower half of the creek.

Springbrook Creek, the other major tributary, enters the Bear River about one mile below Haymarsh Creek. Because it is a top quality trout stream it was not a part of this project and hence will not be considered in this report.

Numerous biological and physical surveys have been conducted on the Bear River in recent years. This data has been summarized on fisheries management cards and by McClay (1973). The data indicated the Bear River was capable of producing a good quality trout fishery, however competing species (mostly suckers, rockbass and northern pike) should be removed. In addition to competition, the main limiting factor for sustaining trout populations in the Bear is natural reproduction, hence an active stocking program following treatment was planned.

METHODS AND MATERIALS

The stream treatment was designed to result in a total kill of all fish species from Walloon Lake to McManus Dam (now removed). Rotenone (pro-noxfish) was selected as the toxicant, chiefly because of our familiarity with its performance. A detoxification station was set up at McManus Dam. The chemical reclamation was carried out on August 15, 1973.

Stream Flows and Dye Times

Prior to treatment, extensive field surveys were conducted to determine flow rates and dye times so that drip stations could be established. Numerous aerial surveys were also made to locate bayous and oxbows which

would have to be treated by helicopter. Staff gage stations were established at six locations along the river and were correlated with actual flow measurements made with a Gurley current meter (Figures 2-7). Flows varied from 24 to 26 c.f.s. at the upper station (Bear River Road) and from 58 to 81 c.f.s. at the lower end (Howard Road). Springbrook Creek flows varied 24 to 46 c.f.s, while Haymarsh contributed an average of about 4 c.f.s.

Green fluorescein dye was applied at four locations at a rate of one pound per 10 c.f.s to determine flow times between access points (Table 1). The total flow time from Walloon Lake to McManus Dam was estimated at about 28 hours.

Drip Stations

Four drip stations were established on the mainstream and one each on Haymarsh and Springbrook Creeks (Figure 1). The Haymarsh station was located at Bowman Road and was timed so that rotenone would enter the Bear River for at least one hour after the first slug from the mainstream arrived at the confluence. This overlap prevented fish from using Haymarsh as a refuge. The drip station at Springbrook was established upstream from its mouth for the same reason. The maximum and minimum distance between stations was 3.1 and 1.6 miles respectively. The maximum and minimum flow times were 7 hours-10 minutes and 3 hours-25 minutes, respectively.

Fifty-five gallon barrels equipped with constant flow siphons (Price & Haus, 1963) were installed at each drip station. The amount of rotenone to be applied at any station (Table 1) was calculated from the flow at the next station downstream, based on a six hour contact time. This was done to maintain a minimum concentration of 5 ppm, assuming no degradation of the toxicant. Some authors (Fernholz and Slifer, 1967) estimate dillution and dissipation will approximate 50 percent per mile. Even so, our minimum concentrations at any point would have amounted to 2.5 ppm, which was adequate to assure a complete kill. All barrels were filled with rotenone and "topped off" with water the day before the treatment. Under the constant flow siphon system and with all barrels at the same level, each drip can could be adjusted to flow at the same rate (19 oz/min.) and would thus empty in about six hours. This arrangement allowed for easier calibration at each station.

Because of the extreme length of the total flow time (28 hours), it was decided to arrange the sequence of starting the six drip stations so that any barrel would empty one hour AFTER rotenone first arrived from the next station upstream. This reduced the elapsed treatment time to just over nine hours, yet still insured an overlap of toxicant slugs so there would be no areas of escape. Starting times and sequence are shown in Table 1. The Haymarsh Creek station was begun the previous evening to insure arrival of toxicant at the confluence during the Bear River treatment.

Each drip station was equipped with an extra gallon of rotenone and a supply of fluorescein dye. Immediately after starting the drip station, the gallon of toxicant was distributed laterally across the stream to

BEAR RIVER

FIG 1

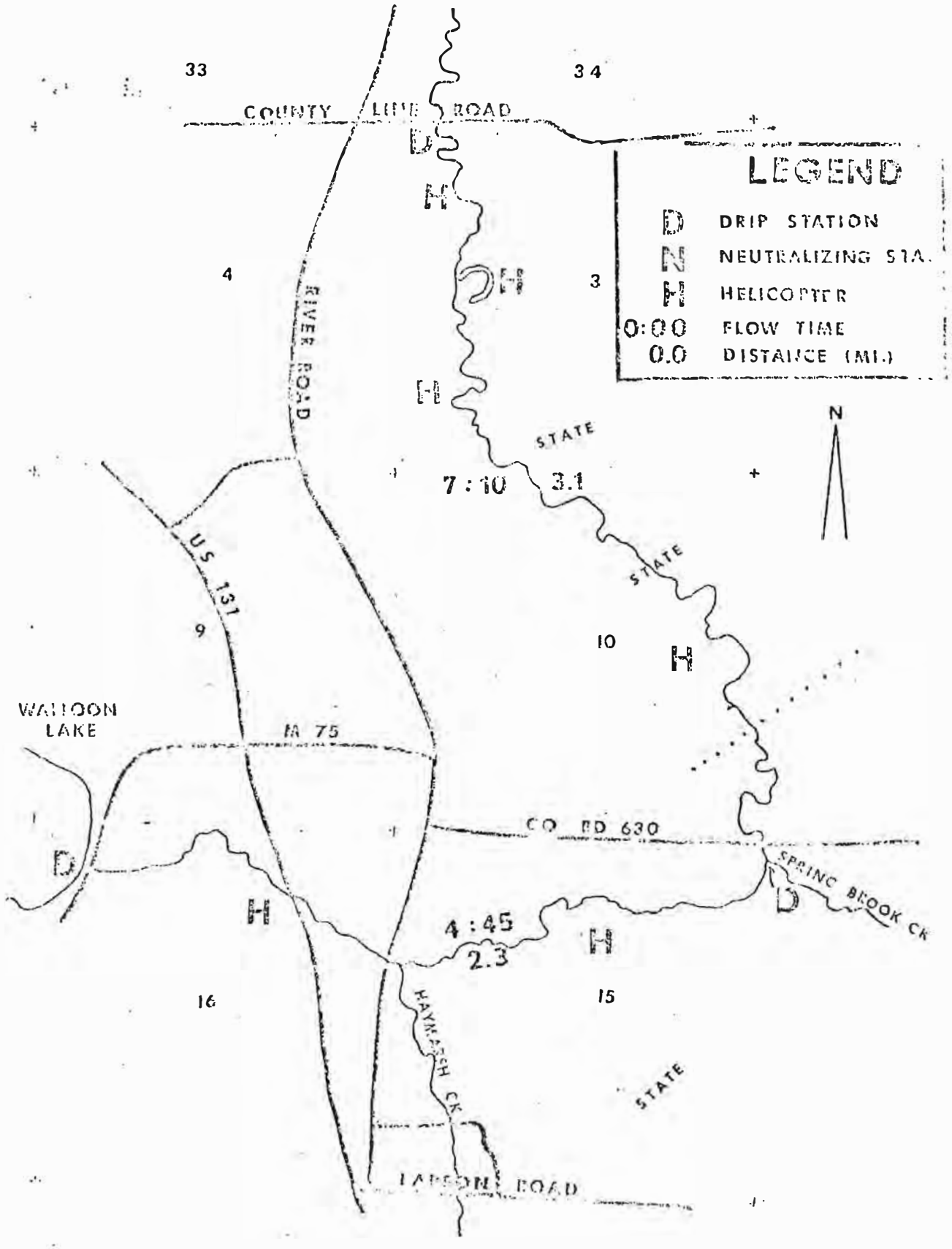


FIG 1

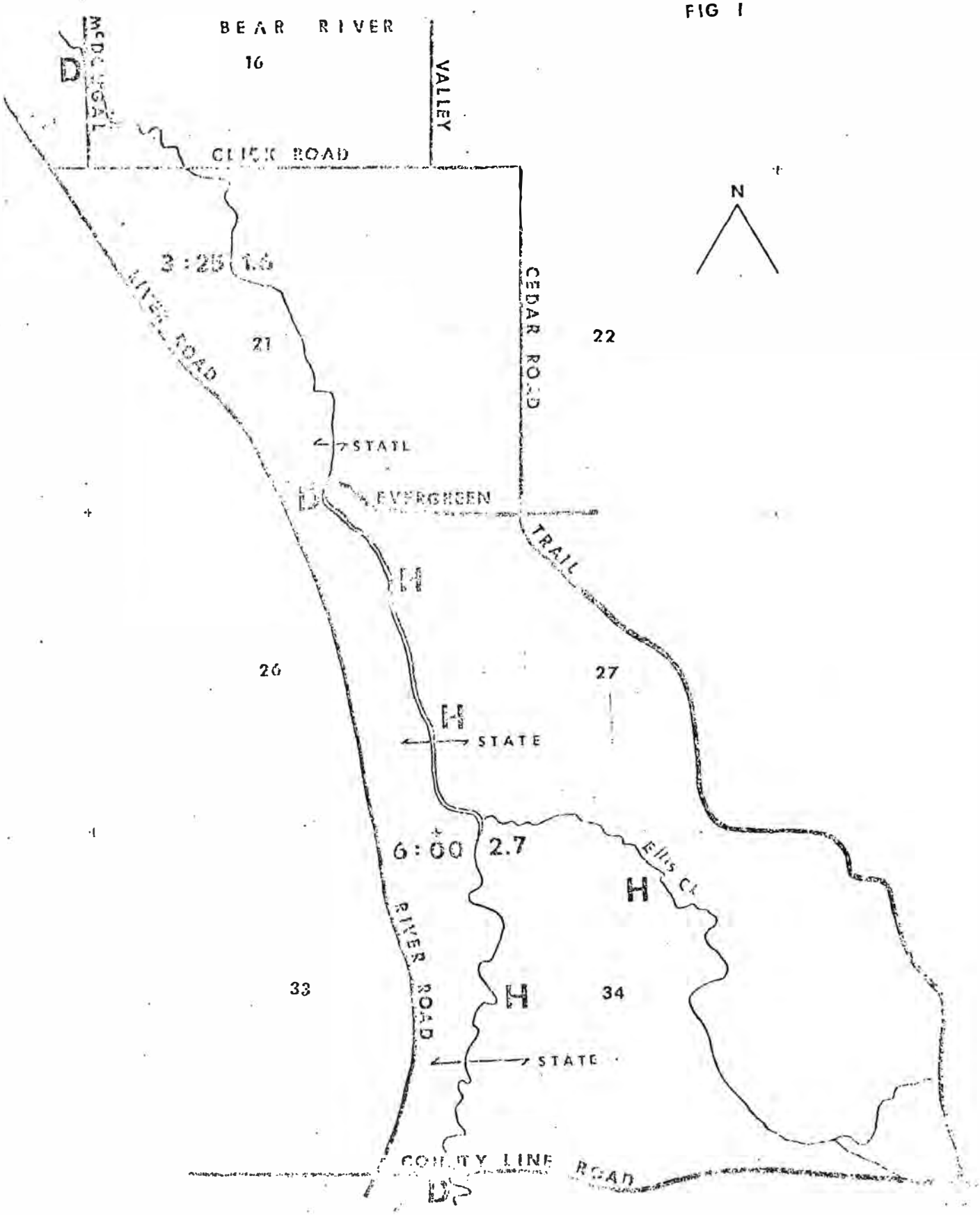
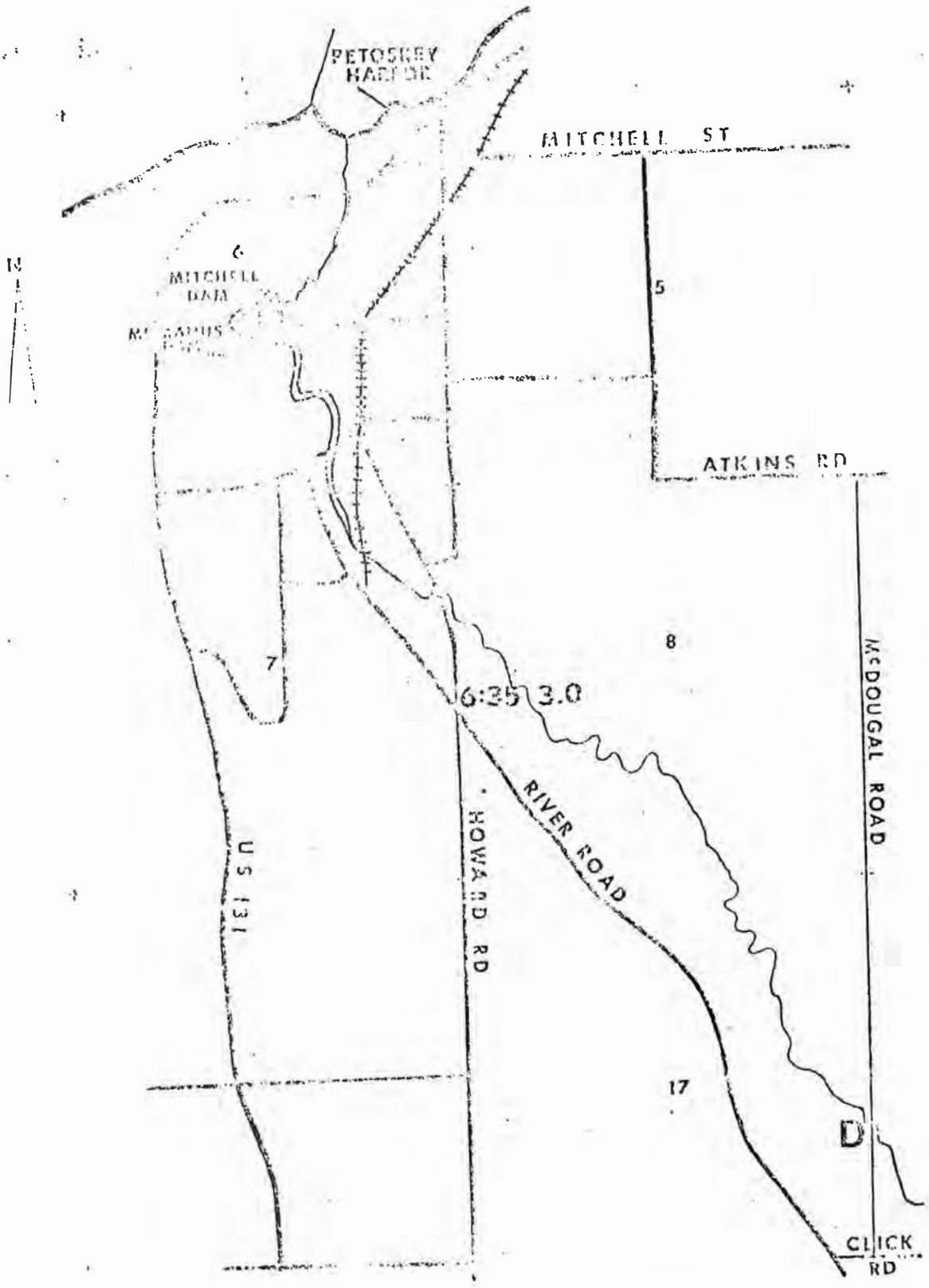

BEAR RIVER
16
VALLEY
CLICK ROAD
N
3 : 25
1.6
RIVER ROAD
21
22
CEDAR ROAD
STATE
EVERGREEN
TRAIL
26
27
STATE
6 : 00
2.7
Ellis Ck
RIVER ROAD
33
34
STATE
COUNTY LINE ROAD

FIG 1


PETOSKEY HARBOR
MITCHELL ST
MITCHELL DAM
6
5
ATKINS RD
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McDOUGAL ROAD
RIVER ROAD
HOWARD RD
US 131
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D
CLICK RD

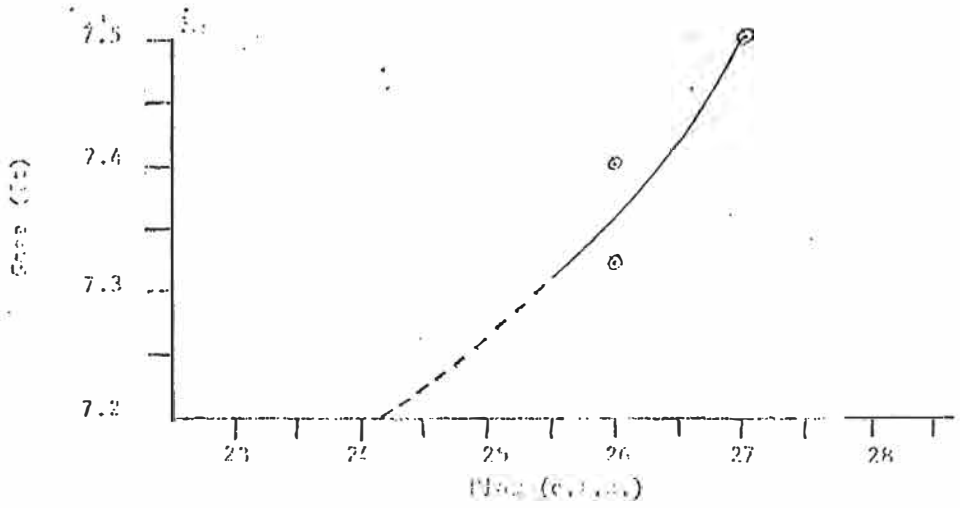

Fig. 2 Relationship between stream flow and staff gage readings at Bear River Road.

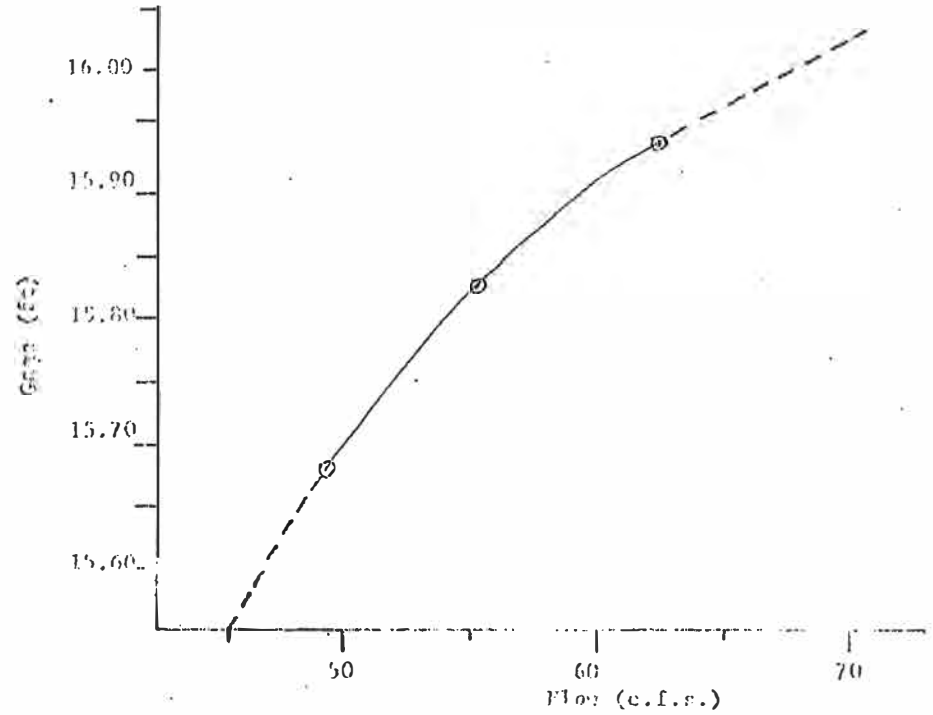

Fig. 3 Relationship between stream flows and staff gage readings at Co. Road 630.

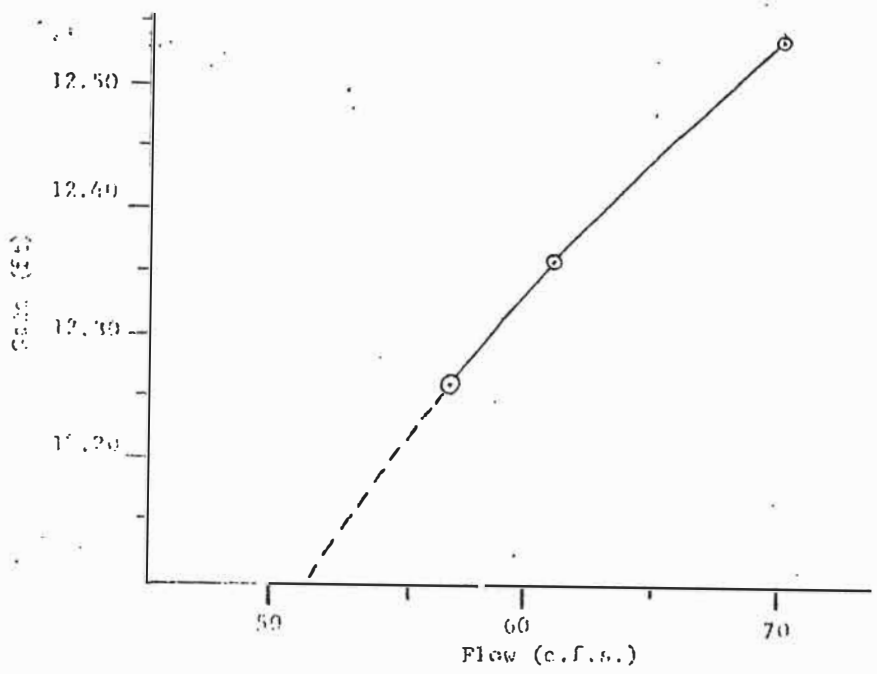

Fig. 4 Relationship between stream flows and staff gage readings at County Line Road.

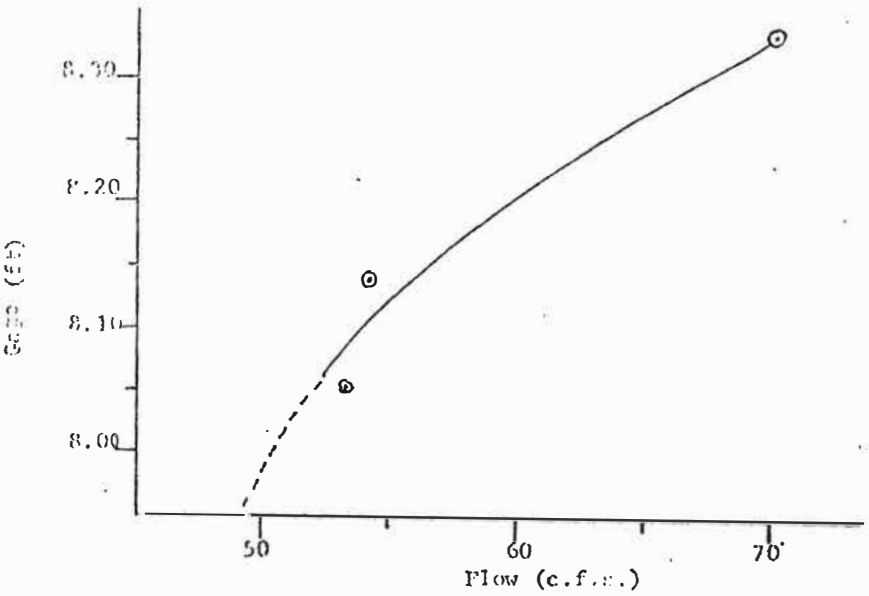

Fig. 5 Relationship between stream flows and staff gage readings at Evergreen Road.

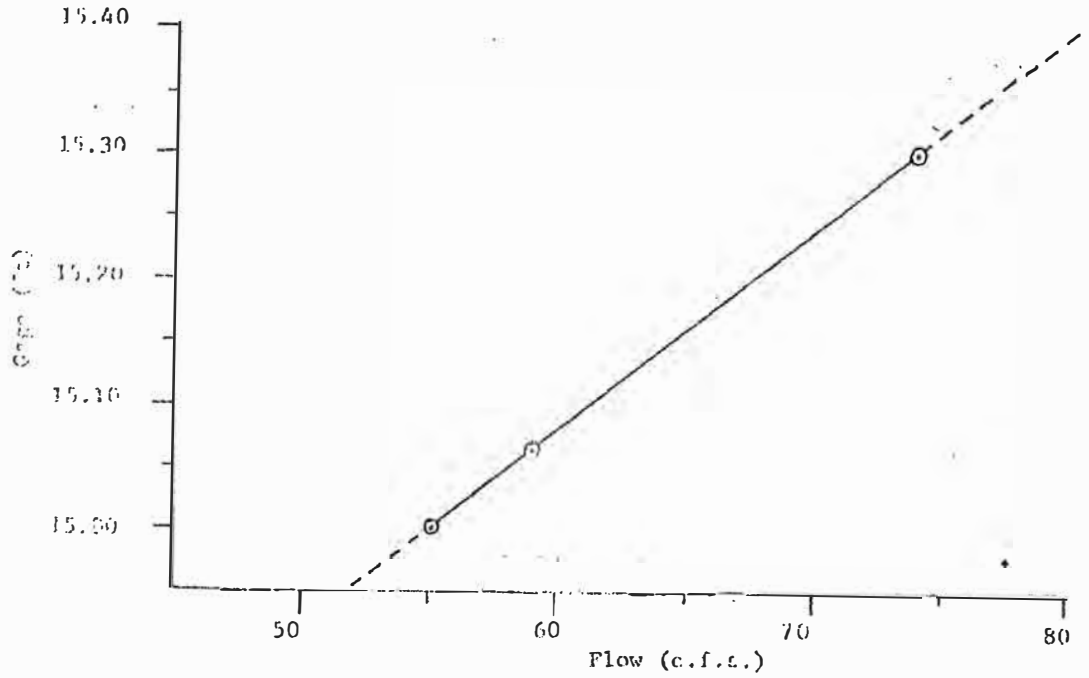

Fig. 6 Relationship between stream flows and staff gage readings at Click Road.

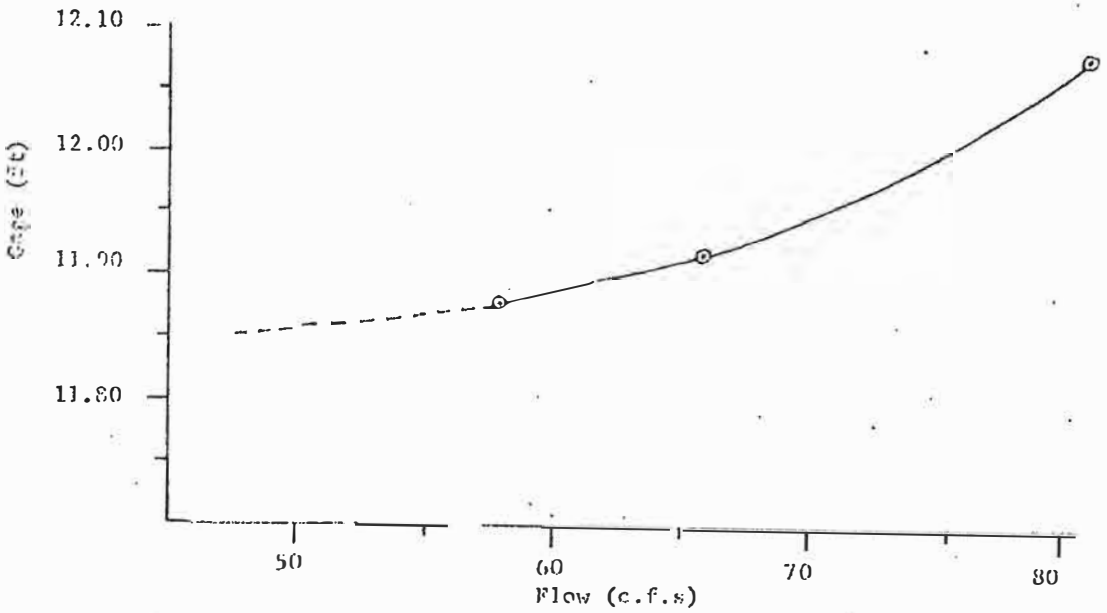

Fig. 7 Relationship between stream flows and staff gage readings at Howard Road.

TABLE 1. Bear River flows and flow times, distances to next drip station, amount of dye and rotenone used and starting times and order of treatment. (*) Indicates station was located on Haymarsh Creek. (**) Indicates treatment was begun the previous evening.

Station	Flow (c.f.s.)	Flow time to next station (hrs.-mins.)	Distance to next station (mile)	Dye Used (lbs.)	Rotenone Used (gal.)	Starting Order	Starting Time
Bowman Rd.*	4	7-0 est.			13	1	10:00PM**
Walloon Lake	23	4-45	2.3	2.5	36	5	8:15AM
Springbrook Creek	55	7-10	3.1	5.5	50	2	6:00AM
Co.Line Rd.	65	6-00	2.7	6.5	60	4	8:10AM
Evergreen Road	62	3-25	1.6	6.5	38	6	9:10AM
Click Rd.	67	↓	↓				
McDougal Rd.		6-25	3.0		56	3	7:35AM
Howard Rd.	72	↓	↓				
McManus Dam				NEUTRALIZATION		7	1:10PM
Total		27-50	12.7	21.0	240		

insure treatment of the edges until complete dispersion of the toxicant from the drip can would occur. Subsequently the dye (which had been premixed) was also poured in. It was assumed that the dye slug would travel at the same rate as the toxicant, thus allowing observation of the progress of the treatment. This technique worked well and insured overlapping of toxicant at each station - that is the head of an upstream slug would reach the next station downstream before that station ran out. A total of 240 gallons of toxicant were applied from drip cans and six gallons were used for slugging at each station.

Spray Treatment

In addition to the six drip stations, a heliport was established at the Evergreen Road site to provide facilities for an aerial spraying program. Numerous bayous, oxbows, and other dead water areas are located along the entire length of the Bear. In addition, one unnamed tributary, to which there is no access by road, enters the Bear above Evergreen Road (Figure 1). These areas were selected for spraying by helicopter because previous dye tests indicated there would be little or no diffusion of toxicant into these areas.

The chopper was equipped with a 30 gallon aluminum tank and shut off lever which was set in the passenger seat of a two-place helicopter. Flexible hose was used as a connector to an eight foot by two inch aluminum pipe which was attached crossways to the skids. The pipe was perforated with eighteen 5/32 inch holes which would allow the tank to be emptied by gravity flow in a minimum of twelve minutes. A service truck with extra fuel was also on hand.

Twenty-five gallons of rotenone were allocated for aerial spraying. This was split equally between five 55 gallon barrels which were then filled with water. The resultant mixture (totalling 275 gallons) was transferred with a jet pump into the chopper and was distributed along 10 predetermined sections (Figure 1). Fluorescein dye was not used in this mixture because at this concentration, the rotenone was easily visible when sprayed on the water.

Detoxification

The Bear River empties into the boat harbor at Petoskey which is a part of Little Traverse Bay. Large stockings of lake trout, brown trout, and chinook salmon have been made in this area in recent years and individuals of at least some of these species were expected within the harbor during the treatment. For this reason, a detoxification station was set up a McManus Dam (Figure 1) for neutralizing with potassium permanganate ($KMnO_4$). Two hatchery trucks, each with a 950 gallon capacity, were used as mixing and dispensing units. A total of 770 lbs. of $KMnO_4$ were mixed with water in the trucks, at a rate of about 3 lbs. per gallon. The circulating pumps were activated to aid in mixing. It was calculated that this mixture would permit detoxification at a rate of 5 ppm for 8 hours. The anticipated need was for 2.5 ppm for six hours.

RESULTS AND DISCUSSION

The chemical reclamation of the Bear River was carried out on August 15, 1973 and almost all objectives were met. Problems did arise with detoxification and as a result, complete neutralization was not achieved. Stream flows were comparable to those when the dye tests were conducted, so no adjustments were made for flows or flow times (Table 1).

All drip stations were started on schedule and ended well within acceptable limits. The desired overlapping did occur and varied from a minimum of 30 minutes to a maximum of 75 minutes, well within the desired range (Table 2). A minimum contact time of six hours was attained at all points. The constant flow siphons worked to perfection and needed no adjustments after initial rates were established. The barrels could have been left unattended, providing vandalism was not a consideration.

One of the most impressive aspects of the project was the usefulness and versatility of the helicopter. In addition to treating areas which could not be reached by man, the chopper permitted instant knowledge of the progress of the dye slugs and status of the treatment. Because of the nature of the stream, lateral dispersion of the toxicant from drip stations was not good in many areas. About 50 bayous (each one acre or less), one oxbow (about two acres), and 2.8 miles of stream were treated with the chopper, using only one man other than the pilot. Without the chopper, I do not believe the project could have been successful since these stream sections could not have been effectively reclaimed using conventional methods.

Detoxification proved to be more of a problem than anticipated - but, only because the potassium permanganate did not completely dissolve. A hint of this condition did not come until the first truck was completely empty and a slight residue was observed on the bottom. It could not be confirmed until the next day when the trucks were cleaned - and the false bottoms were removed. It is estimated that as much as one-fifth of the $KMnO_4$ did not enter solution. The use of the recirculating pumps may have prevented even more from settling out. It was obvious that three gallons of water per pound of $KMnO_4$ was not enough to provide total suspension. It is possible that the utilization of cold (48^{o}) hatchery water (from Oden) plus the fact that the mixture sat overnight without circulation may have contributed to the settling.

However, in spite of the above problems, it was apparent that detoxification was effective up until the time neutralization was halted (Table 2). A rotenone detection kit (Post, 1955) was utilized to determine the presence or absence of toxicant at various times and locations. Based on dye tests toxic water was predicted to leave the McManus Dam impoundment at 1:10 PM. The detection kit indicated toxic water was entering at noon, so detoxification was begun at 1:00 PM at an initial rate of 4 ppm. The detection kit indicated only 0.5 ppm rotenone in the impoundment so the rate was cut to 2 ppm at 2:30 PM. One-half part per million rotenone was detected one-half mile downstream at 2:30 PM and one chinook was observed in a distressed condition. At 2:45 PM, the first dye slug passed through the impoundment and at 3:00 PM the neutralization rate was increased to 4 ppm. Rotenone concentrations one-half

TABLE 2. Observations Made During Treatment of Bear River

Station	Time	Elapsed Time (Hours-Minutes)	Observations
Walloon Lake	8:15 AM		Began treatment
	2:15 PM	6 hours	Ended treatment
131 Bridge	10:15 AM	2 hours	Walloon Lake dye slug present
Bear River Rd.	10:30 AM	2-45	Walloon Lake dye slug present
Springbrook Ck.	6:00 AM		Began treatment. Flow 55 c.f.s. Water Temp. 57°. Air Temp. 55°
	1:45 PM	5-15	Estimated arrival of Walloon Lake dye slug. Est. overlap:30 min.
	2:10 PM		Dead fish collection
	2:15 PM	14 hours	Haymarsh Ck. dye slug 1/2 mile above Springbrook
	2:45 PM	8-45	End treatment
County Line Rd.	8:10 AM		Began treatment. Flow 68 c.f.s.
	11:00 AM	3-10	Rotenone test kit indicated toxicant level in river was 5 ppm.
	1:30 PM	7-30	Springbrook dye slug present. Overlap estimated at 40 min.
	1:45 PM		First dead fish observed.
	2:00 PM	8-00	Springbrook dye slug present 1/2 mile below here.
	2:10 PM		Estimated time of end of treatment
Evergreen Rd.	9:10 AM		Began treatment
	1:45 PM		First dead fish observed
	2:00 PM	4-50	Co. Line dye slug 100 yds. above rd.
	2:15 PM	5-05	Estimated time of arrival of dye slug Overlap estimated at 55 min.
	3:00 PM		Dead fish collection
	3:10 PM		Estimated time of end of treatment
McDougal Rd.	7:35 AM		Began treatment
	1:45 PM		First dead fish seen
	2:15 PM	5-00	Estimated time of arrival of Evergreen Rd. dye. Overlap est. at 1-15
	3:35 PM		Estimated time of end of treatment
Howard Rd.	11:35 PM	4-0	McDougal Rd. dye slug present. Rotenone concentration est. at 0.5 ppm or less.
McManus Dam	12:50 PM	5-20	Rotenone concentration est at 0.5 ppm
	1:00 PM		Began detoxification at 4 ppm
	1:05 PM		Rotenone concentration 0.5 ppm
	1:20 PM		Rotenone concentration 0.5 ppm
	1:40 PM		Rotenone concentration 0.5 ppm
	2:00 PM		Rotenone concentration 0.5 ppm
	2:30 PM		Detoxification rate cut to 2 ppm
	2:45 PM	7-10	McDougal Rd. dye slug arrived
	3:00 PM		Detoxification rate increased to 4 ppm
	4:00 PM		First 950 gal. of neutralizer dispensed
	8:00 PM	7-00	Detoxification ended

TABLE 2. Observations Made During Treatment of Bear River (Continued)

Station	Time	Elapsed Time	Observations
City Park	2:30 PM	6-55	McDougal Rd. dye present. Rotenone concentration 0.5 ppm. Fish in distress.
	2:45 PM		Rotenone concentration 0.5 ppm
	3:30 PM		Rotenone concentration 0.1 ppm
	3:55 PM		Rotenone concentration negative
	4:20 PM		Rotenone concentration negative
	4:40 PM		Rotenone concentration 0.1 ppm
	5:00 - 8:00 PM		Rotenone concentration negative (8 readings)

mile downstream were reduced to 0.1 ppm by 3:30 PM and to nearly 0.0 ppm by 3:55 PM. Essentially negative readings were received until 8:00 PM when both monitoring and detoxification was curtailed. Both tank trucks were emptied in the seven-hour neutralization operation.

A total of three hundred chinook salmon averaging about 20 pounds were killed as a result of the treatment. Most fish turned up in Petoskey Harbor on the first and fourth day post-treatment. No other species were killed, however, a few suckers, northern pike, and thousands of minnows drifted down to the harbor from upstream areas. It is believed that other species of fish were present in the harbor, but that the chinook were especially vulnerable due to stress factors related to spawning activity. It is doubtful that toxic levels were greater than 0.5 ppm in either the lower river or the harbor.

EVALUATION OF TREATMENT

On August 20, 1973, 5 days post-treatment, a series of live cages containing brown trout were set at various locations as far down as County Line Road to determine the extent of detoxification. All fish survived a minimum of 16 hours exposure in both Bear River and Haymarsh Creek. Within the next three days, 10,500 FF (fall fingerling) brown and 6,500 FF brook trout were planted in the Bear River and 1,000 FF brook trout in Haymarsh Creek. The Bear River brook trout plants were made at County Road 630 and at the County Line Road. The brown trout were distributed from each access point from Walloon Lake downstream to McManus Dam.

An electrofishing survey was conducted at four locations (131 bridge, County Road 630, County Line Road, and Click Road) on August 27, 1973. Five mud-minnows were captured at the first location; planted trout at the second and third; and no fish at the fourth in two hours of electrofishing. Four overnight experimental gill net sets were made in the impoundments behind both McManus and Mitchell Dams. The only fish captured was one brook trout in the lower impoundment. Based on these surveys, it appears as if a near total kill was achieved throughout the Bear River system.

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