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# ROTENONE STREAM FISH SAMPLING IN MICHIGAN

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## SUMMARY

Rotenone sampling has proven to be an excellent method for large stream fish sampling in Michigan. Other methods such as electrofishing and netting have been largely ineffective in obtaining complete fish samples in moderate to large rivers.

In 1978, the Grand River in Michigan was surveyed by means of rotenone sampling. Twenty-three stations were sampled from the headwaters downstream to its confluence with Lake Michigan. Stream discharge rates as high as 1700 CFS and stream widths up to 600 feet were encountered.

Fish were collected in a blocking net at the downstream end of each station. Potassium permanganate was used below the blocking net to detoxify the rotenone.

All fish were measured, weighed, and scale sampled for complete analysis. Total poundage was calculated and estimates of pounds per acre standing crop were made at each station.

Survey results are being utilized to assist the Department of Natural Resources, Fisheries Division, in anadromous and warmwater fisheries management in the Grand River.

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## INTRODUCTION

It is difficult to obtain fish population assessments from moderate to large rivers. Netting and electroshocking have definite shortcomings. Netting is not feasible where currents are moderate to swift. Electrofishing is limited to shallow, clear water. Neither method yields representative samples.

Rotenone sampling has long been an accepted and valuable technique for lake surveys but problems with fish recovery and downstream fish kills have been major obstacles for its widespread use in lotic situations.

Experience gained by Johnson and Pasch in Georgia in 1973 and 1974 proved that rotenone sampling could be accomplished without the above problems by the use of a downstream blocking net and by detoxification of the rotenone by the use of potassium permanganate. Their project was largely experimental and was very costly.

The purpose of our project was to determine if this method could be used effectively and in an economically feasible manner.

The Grand River, located in Michigan's southern Lower Peninsula, was our choice for this project. Its drainage basin comprises an area of 5,572 square miles and it is the largest watershed in Michigan. The total main channel length is in excess of 300 miles. Flow discharges as high as 1700 CFS and stream widths as wide as 600 feet were encountered. Its velocity is slow to moderate with habitat varying from deep holes to shallow, rocky riffles.

The Grand River is basically a warmwater stream containing gamefish such as walleyes, smallmouth bass, largemouth bass, northern pike, various panfish, channel and flathead catfish. It receives anadromous runs of steelhead, coho, and chinook salmon from Lake Michigan seasonally.

It was previously surveyed in 1970 by means of electrofishing and trap nets. This gave us the opportunity to compare survey methods and evaluate changes in the fishery in 1978.

During July and August of 1978, the river was divided into 23 representatives or "natural" segments. Stations were selected within each segment that best represented its habitat conditions while offering reasonable equipment access. The 1970 survey stations were duplicated when feasible.

## METHODS

At each selected site, measurements were taken to describe the morphology of the station and to allow calculation of chemical requirements. Station length was generally 183 meters (600 feet), although longer and shorter lengths were sometimes used to accommodate unusual channel structure or habitat. Generally, seven transects were made to calculate the average cross-sectional profile area. Average velocity through the station was measured with fluorescein dye. Instantaneous velocities, to calculate station discharge values, were based on the Embody float technique. Chemical requirements were based on these station discharge values. In addition, water temperatures and qualitative observations of benthic organisms, bottom types, and aquatic macrophytes were taken at each station.

Rotenone (Pro-Nox-Fish) was applied at a concentration of three parts per million. The method used to apply the toxicant was based upon water depth at the upstream limit of the station. When the river was shallow, easily wadable, and non-boatable, rotenone was applied by spraying with one or more gasoline-driven pumps. If water depths were sufficient to allow the use of a boat with an outboard motor, the rotenone was gravity fed into the outboard back-wash while the boat made consecutive transects across the river. Exposure time was maintained for 45 minutes.

At the downstream end of the station, a barrier net was placed across the river. Nets of several lengths and depths were used to accommodate the various station morphologies encountered. The bar mesh size of these nets ranged from 22-25 mm (7/8 - 1 inch). The float line of this barrier net was attached to a head rope which had previously been set across the river and pulled taut. Braided dacron line was used for this head rope at most stations; however, steel aircraft cable was substituted at the two largest stations because of river width and velocity. The lead line of the net was held in place with 40 pound trap net anchors. In high velocity situations, it was necessary to attach additional lines to the head rope. These lines were directed upstream and helped to prevent downstream sag of the net. In practice, the lead line was not anchored until treatment was ready to begin. This prevented the build-up of debris in the net which tended to pull the float line under the water's surface. No upstream blocking net was believed necessary. Experience has shown that fish rapidly flee downstream to avoid contact with rotenone when possible.

Immediately downstream from the barrier net, the toxicant was neutralized by adding potassium permanganate to the river at a rate of four parts per million. Three parts per million was necessary to detoxify the rotenone, while an additional part per million was necessary to counter the potassium permanganate demand of the river. The oxygen demand of the river for potassium permanganate was determined at one station by laboratory analysis. This factor was used at all stations without consequence, though it probably fluctuated. The chemical was sprayed into the river with gasoline-driven pumps after having first been dissolved in river water placed in spray barrels. Because of the relative insolubility of potassium permanganate, it was necessary to add additional pumping units as the river became larger.

Also, in some cases, it was necessary to pump a slurry of the mixture, rather than a totally dissolved compound. At the largest station, four boat mounted pump and barrel units were used. Two workers per unit were involved in this procedure. Detoxification was maintained for 55 minutes.

Attempts were made to collect all fish from the study area. Dead and distressed fish were immediately collected with hand nets. Dead fish that accumulated on the barrier net were allowed to remain. Several sweeps of the entire study area were made by boat and wading to remove fish that had been washed ashore or had become lodged in obstructions. When it was determined that no additional dead fish were accumulating on the barrier net, the net was lifted and the fish were removed. To account for the small fish that passed through the station without being collected, two to three sub-samplers were placed just downstream from the barrier net. These sub-samplers were constructed of knotless nylon with a maximum diagonal opening of 4.8 mm (3/16 inch).

Fish were identified as to species, measured, and weighed to the nearest 1/10 of a pound in aggregate by species. Very large species collections were sub-sampled for length-frequency by measuring the first 100 fish. Scales and pectoral spines were taken from selected species for age and growth analysis. To save time and storage space, large fish were processed at the sample site. Smaller fish or those species difficult to identify were often frozen for later laboratory processing. Size range by species was determined and the total sample at each station was weighed.

## RESULTS AND DISCUSSION

Rotenone sampling, with detoxification, proved to be an excellent method for sampling fish. This was particularly true when river discharge values were in the range of 100-1000 CFS. Sample numbers in the small upper river stations were probably not improved. These stations were easily wadable allowing conventional electrofishing techniques to be effective. The two most downstream stations presented problems for this sampling method. At each, because of the large river widths, only half of the station width was sampled at island locations. At the very last station, the depth was so great the chemical did not penetrate to the bottom depths. Trap netting at this station seven days following the survey produced a larger collection of fish.

Rotenone sampling yielded large representative fish samples. Large fish as well as small forage species were easily captured.

When the riverbed configuration was relatively simple with no large pools and eddies and where stream velocities ranged from 2.5 to 4.5 feet per second, we believe efficiency approached 100 percent. Large pools and eddies within a station tended to make the uniform application of rotenone more difficult and slowed the movement of fish downstream to the blocking net. Where these pools were associated with deep, slow water, it is likely that not all fish were recovered from the station.

When water velocities were very high (greater than six feet per second) at the blocking net, debris tended to accumulate on the net causing a hydraulic head which forced the float line under the water's surface. This occurred at two stations and caused a minor escapement of dead fish.

Detoxification of the rotenone with potassium permanganate proved adequate. Significant downstream fish mortalities were limited to those instances where mechanical failure of the permanganate pumping units occurred. Since more pumping units were required in the lower river, the probability of malfunction was greater and it was here that several minor fish kills occurred. Also, the rate of application of potassium permanganate was based on the assumption that the rotenone concentration was uniform across the river. Irregular river flows likely invalidated this assumption. This resulted in insufficient quantitites of permanganate being added to certain cross-sectional areas of the detoxification station, leading to minor fish mortalities. In addition, each station required a mixing zone before complete detoxification occurred, and minor mortalities were observed in this zone. These problems were mitigated by excellent TV and newspaper coverage of the riverside communities.

Attempts to compare results from the 1978 rotenone survey to a 1970 electrofishing survey are difficult.

Some parameters of comparison taken from the 23 similar station areas are total numbers of fish and total numbers of species captured. In 1970, 3,158 fish and 17 different species were taken by means of electrofishing. In 1978, using rotenone methods, 24,356 fish and 70 different species were captured.

The percentage of gamefish captured in 1978 was smaller than 1970. The more complete sample taken with rotenone included larger fish such as carp and redhorse suckers. Also, small minnow species were readily taken by the rotenone method using the small mesh sub-sample equipment. Species numbers were greater because of this added efficiency.

In very small river sections, we were able to sample two stations in a 10 hour day. With larger stream flows with widths less than 200 feet, we could sample one station per 10 hour day. Larger stations required two days each. One day was required to place the net and set up equipment and another day for sampling and equipment removal. The larger stations required as many as 15 people to accomplish the task. Smaller stations could be done with as few as 6-7 persons.

Where truly representative sampling of moderate to large streams is necessary or where standing crop estimates are needed, rotenone sampling works where other methods fail.

## LITERATURE CITED

Johnson, Thomas L. and Pasch, Ronald W. Improved Rotenone Sampling Equipment for Streams. Fisheries Management, Department of Natural Resources, Game and Fish Division, Albany Georgia. 19 pp.