However, the effectiveness of the trawl as a method of collection is limited by the areas where it can be used. The bottom must be flat, or gently rolling, without channels or abrupt dropoffs. The run tract should be at least one-half mile in length and clear of such obstacles as rocks, stumps, snags and submerged trash. Trotlines and commercial nets should be avoided for obvious reasons. Submerged vegetation, such as pondweeds and mosses, as well as flooded terrestrial weeds, also prevent good catches of fish. Areas which can be selected, cleared and marked before the basin is flooded, make good trawl sites if they can be kept clean and free of trash and trotlines.

Physical conditions of the water also influence trawl catches. In clear water, fish apparently see the trawl coming and attempt to escape it. The best trawl catches have been made in murky or turbid water with Secchi readings of 20 inches or less. As with seining, the best trawl collections in clear shallow waters are made after dark.

Based on the results of this study, it is apparent that trawls do not replace either gill nets or seines, but will serve as a supplement to these two standard methods of collection and it is concluded that trawling in freshwater can provide a useful additional method of sampling for fishery workers.

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FIELD OBSERVATIONS ON THE USE OF SODIUM CYANIDE IN STREAM SURVEYS

By William R. Tatum
Tennessee Game and Fish Commission
Nashville, Tennessee

ABSTRACT

Sodium cyanide has been an effective method for sampling the stream fish populations in Eastern Tennessee. Its portability makes it a practical stream management tool. Cyanide is an excellent cold weather sampling method. Three ounces of cyanide in trout streams and 6 ounces in warmwater streams per cubic foot a second flow will sample 100 yards. In water colder than 55°F mortality of fish is not acute. Rainbow trout and various warmwater fish collected with cyanide and held in aquaria showed no deleterious effects from exposure to the chemical. Reduction in stream invertebrate populations after cyanide application is evident.

INTRODUCTION

Sodium cyanide has been extensively employed as a sampling method for stream fish populations in Eastern Tennessee. It has been effective for collecting study specimens, for determining the presence of reproduction, and for determining the approximate carrying capacity of streams. It has been functional in both warm and coldwater streams.

Liquid cresol and rotenone can be cumbersome when sampling streams in remote areas. Electro-fishing equipment has proved ineffectual in mountain streams because of the low conductivity of the water (Wilkins, 1955). The portability of sodium cyanide makes it an effective tool for use when the above methods are not functional or are impractical.

Cyanide in the form of "Cyanbricks" weighing approximately 1 ounce, is the most practical form for stream use. It has a slow dissolution rate and its uniform size makes weighing unnecessary. Lewis and Tarrant (1960) described the physical properties of sodium cyanide when used in pond culture.

Application of Sodium Cyanide

The most effective method for introducing cyanide into streams is to place the desired number of "Cyanbricks" into a dipnet and swish it back and forth at a narrow turbulant point in the stream. Natural mixing action carries it into solution. Fish usually begin surfacing within 10 to 30 seconds, depending on the water temperature.

The rate and amount of application must be determined by experience. Stream temperature, velocity, volume, and pool size all affect the length of the area sampled. However, the general rule of 3 ounces of cyanide in trout streams and 6 ounces in warmwater streams per cubic foot a second flow for each 100 yards of stream sampled may be used. Additional applications at downstream intervals may be desired to keep the chemical at a uniform strength for sampling longer areas of stream.

Hardness and alkalinity of streams have no apparent effect on the success of cyanide. Toxicity usually persists longer at lower temperatures because of loss of strength through volatizilation at higher temperatures. This and its quick reaction at low temperatures make cyanide an excellent cold weather sampling method.

Upon solution in water, cyanide ions combines with hydrogen ions in the water to form weakly dissociated hydrogen cyanide, thereby tending to raise the pH of the solution (McKee and Wolf, 1963). When cyanide was injected into a stream with a normal pH of 6.5, the pH rapidly increased to 9.7. In another stream with a normal pH of 8.0, the pH was increased to 9.1 after the introduction of cyanide.

Effect on Fish

Mckee and Wolf (1963) indicates that the toxicity of cyanides toward fish is affected by the pH, dissolved oxygen, and concentration of minerals. However, the size and species of the fish, length of exposure, and water temperatures is important. In general, the toxicity is greater at temperatures above 55°F. Young fish are more susceptable than are older fish.

Mortality of fish in water colder than 55°F is usually negligible. Above this temperature, mortality becomes more acute with progressive temperature increases. Most fish, however, can be revived if placed in fresh water immediately.

The highest mortality in trout occurs when cyanide is injected into streams with water temperatures in the 55°F to 70°F range. Within this range, mortality may approach 100 percent unless the fish are immediately placed in fresh water. Mortality in trout species decreases noticably at temperatures lower than 55°F. Brook Trout, *Salvelinus fontinalis*, and Brown Trout, *Salmo trutta*, are more tolerant to cyanide than are Rainbow Trout, *Salmo gairdneri*. Most warmwater species will recover as fresh water replaces the treated water in the sampling area. However, high mortality in Cyprinids, Percinids, and Catostomids has been noted at temperatures above 55°F. Carp, *Cyprinus carpio*, Bullheads, *Ictalurus* sp., and Goldfish, *Carassius auratus*, are extremely resistant to cyanide in flowing water. It is difficult to obtain a representative sample of these species unless they are exposed to cyanide in excess of 15 minutes.

Fish that come into contact with cyanide in streams exhibit a tendancy to move downstream, therefore escaping the full effects of the chemical. A net stretched across the lower end of the sampling area will assist in obtaining a more accurate sample.

Rainbow trout and various warmwater fish collected with sodium cyanide and held in aquaria for one week at local fair exhibits showed no deleterious effects from exposure to the chemical.

Effect on Benthos Organisms

Ten benthos sampling stations were established in a small mountain stream (1.2 miles long) and 20 square foot collections were made with a Surber sampler. Sodium cyanide was then allowed to flow through the entire length of the stream at a normal rate at which time samples of Southern redbelly dace, *Chrosomus erythrogaster*, Tennessee shiner, *Notropis leuciodus*, and brown trout were collected. Five days later another 20 square feet of samples were made. Reductions in the numbers of all groups of organisms collected were evident (Table 1). The total benthos population was reduced by about 77 percent. During the collection of the second series of samples, numerous dead organisms were observed.

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TABLE 1.
The effect of sodium cyanide on the benthos of a small mountain stream.

Order	*No. Before Application*	*Percent of Total*	*No. 5 days after Application*	*Percent of Total*
Insecta				
Ephemeroptera	358	49.4	68	28.7
Plecoptera	83	11.4	69	29.1
Trichoptera	67	9.2	33	13.9
Coleoptera	103	14.2	24	10.1
Diptera	47	6.6	13	5.5
Odonata	25	3.4	19	8.0
Mollusca				
Gastropoda	35	4.8	9	3.9
Annelida				
Oligochaeta	5	0.7	1	0.4
Crustacea				
Decapoda	2	0.3	1	0.4
Totals	725	100.0	237	100.0

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