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EFFECTS OF DIELDRIN AND CHLORDANE ON FISH IN TWO SMALL STREAMS IN BERRIEN COUNTY [1]

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The insecticides, dieldrin and chlordane, were applied to 4,800 acres of Chikaming Township, Berrien County, Michigan, during the period of October 19-23, 1968, to control an infestation of the Japanese beetle. Aerial application of granular material consisted of 2 pounds of technical dieldrin per acre on 3,707 acres, and 10 pounds of technical chlordane per acre on 1,152 acres (Fig. 1). An additional area of 441 acres was treated with chlordane by ground application. A monitoring program was designed to measure the impact of this pesticide application on both terrestrial and aquatic environments.

This report deals with monitoring the aquatic environment. Our primary concern at the start was to collect fish for pesticide analysis of tissue samples. Our second goal was to observe any fish mortality and population reduction, but collected fish were subsequently lost due to failure of a deep-freeze unit, so that this report is now concerned just with direct observations on populations and mortality.

The treated area and adjacent areas contain four very small streams, each emptying separately into Lake Michigan. A back-pack

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1 Supported by Dingell-Johnson Project F-28-R, Michigan.

shocker was used to collect fish at two stations on these streams within the treated area and two control stations outside of the area (Fig. 1). One of these streams contained no fish (stations 4 and 5); it was used for other phases of the monitoring program. At each stream site, fish collecting was done in about 200 yards of stream. Following are the station locations, and descriptions of the streams where fish samples were collected.

Control Station No. 1: T. 6 S., R. 20 W., Sec. 18.

The collecting station is located on the northern edge of the village of Bridgman. The stream is slow and sluggish with a soft silt bottom. It drains a watershed of 0.2 square mile; on October 22, 1969, had a flow of 0.28 cfs.

Control Station No. 2: T. 6 S., R. 20 W., Sec. 25.

The station is located within the campground that serves as an overflow camp for Warren Dunes State Park. This stream is of low gradient, with a soft silt bottom. The mean flow during the period of October 1968 to July 1969 was 1.7 cfs, and the extremes were 0.1 and 41.1 cfs. The watershed is 1.2 square miles.

Station No. 3: T. 6 S., R. 20 W., Sec. 35.

This stream is called Painterville Drain. It passes along the southern boundary of Warren Dunes State Park. It has a moderate current and a firm sand bottom. Its character is more riffle-pool than the two control streams. The mean flow during the monitoring period was 9.3 cfs. The extremes were 0.5 and 52.0 cfs. The watershed is 5.0 square miles.

Station No. 6: T. 7 S., R. 20 W., Sec. 9.

This stream is located south of Prairie Road on a private drive west of Camp Hazelhurst. The station extended from 100 yards below the private drive to 100 yards above it. The stream is faster than the control streams, and has a firm sand bottom. There are deeper pools and more fish cover than in the other streams. A stream flow of 0.99 cfs, on October 22, 1969, was the only measurement made on this stream. The stream drains 0.8 square mile.

The first fish collections at these stations were made on October 17, 1968. The original plan was to select one species of fish that was present in all streams, and to collect 20 individuals of that species from each stream for analysis of pesticide residue in the tissues. Similar samples were to be taken periodically for up to 2 years after the insecticide application. This plan proved to be impossible because the streams were variable as fish habitats and no one species of fish was present at all stream stations.

Unfortunately, all fish samples collected for tissue analysis were subsequently lost due to a freezer failure.

A summary of the species of fish collected, and the relative abundance of each, are presented in Table 1.

Prior to insecticide application, the control stream at Station No. 1 contained only mudminnows (Umbra limi), and even this species was quite scarce. Considerable effort was required to collect 20 of them. The stream is so small and sluggish that it probably is not a suitable habitat for other species.

At control stream Station No. 2 we found only green sunfish (Lepomis cyanellus) and mudminnows. The mudminnows were quite abundant and many individuals were exceptionally large. Green sunfish were not abundant; a sample of 20 was collected in approximately 200 yards of stream.

Painterville Drain (Station No. 3) contained populations of the creek chub (Semotilus atromaculatus), blacknose dace (Rhinichthys atratulus), white sucker (Catostomus commersoni), carp (Cyprinus carpio), and burbot (Lota lota), in addition to the green sunfish and mudminnow. Creek chubs and small suckers were numerous; within 200 yards of stream we stunned several hundred fish of these two species. Small schools of creek chubs could be seen moving ahead of the shocker. Probably not more than 50 fish of any other species were seen.

Station No. 6 contained numerous dace, creek chubs and green sunfish; white suckers and mudminnows were sparse. Small schools of creek chubs and dace could be found under any of the abundant natural cover.

The second series of fish collections were made at the several stations on November 7, 1968, approximately 2 weeks after the application of dieldrin and chlordane. Since stream Station No. 1 originally contained such a sparse fish population, this station was omitted in the November 7 sampling. At control Station No. 2 we collected green sunfish and mudminnows; their abundance was similar to that during the previous collection.

Some fish mortality had been reported in Painterville Drain (Station No. 3) between the insecticide application and November 7. We observed several badly decomposed fish in the stream. Probably many dead fish had completely disappeared. The mortality must have been extensive, for we were able to collect less than 10 fish. This was in striking contrast to the abundant populations of creek chubs and suckers prior to treatment. We found no green sunfish. The few fish collected were mostly dace. Our shocker was in good working condition and is highly efficient in small clear streams such as Painterville Drain; thus the apparent scarcity of fish was real.

On November 7, we found several dead fish at Station No. 6; it was obvious that the population had been reduced here also. The decrease in numbers was mostly of dace and creek chubs, which were very abundant in the previous collection.

On November 7, we also visited a farm pond within the dieldrin-treatment area. A fish kill had been reported by the owner, and it was obvious that the mortality was extensive. The dead fish were all bluegills and most appeared to be young-of-the-year. This was a new pond that probably contained only this one year class of fish. The banks of this pond are quite high and probably prevent any drainage into the pond. Springs must be the only source of water. It thus seemed that enough dieldrin must have fallen directly onto the surface of the pond to cause the fish mortality. An application of 2 pounds per acre of dieldrin could result in a concentration of

approximately 0.25 ppm in a pond having an average depth of 3 feet. This is almost ten times greater than concentrations reported to be lethal to bluegills.

Fish collections were made at several stations also on October 2, 1969. The fish population in Painterville Drain (Station No. 3) was still sparse. In about 200 yards of stream we collected 22 mudminnows and 1 green sunfish, and saw only a few other fish. It was obvious that this fish population had made very little recovery almost a year after the insecticide application.

In October of 1969 at Camp Hazelhurst (Station No. 6), the total fish collection was less than 25 individuals. This indicated a drastic reduction in the population since October of 1968, especially of dace and creek chubs which had been very abundant. However, the fish mortality at Station 6 was more gradual than at Station 3, judging from the presence of a fair number of fish in November of 1968, a month after treatment.

The immediate and almost complete fish kill in Painterville Drain, in contrast with the more gradual population reduction at Station No. 6, was probably due to the dissimilar characteristics of chlordane and dieldrin. The movement of chlordane from treated land to stream apparently is much more rapid than with dieldrin. The first heavy rain following treatment resulted in concentrations of 2.40 μg/l of chlordane in

Painterville Drain, but only 0.65 μg/l of dieldrin.[2] Dieldrin runoff was at lower levels but of a more continuing nature. The concentration of dieldrin in April 1969 at Station No. 6, approximately 6 months after application, was 0.33 μg/l.

It has been estimated that of the 6,145 pounds of dieldrin applied in this control program, 7.57 pounds reached Lake Michigan via the study streams in the first 9 months.[2] This may seem to be an insignificant amount and thus one might jump to the conclusion that the control program was safe to the aquatic environment. However, the decimation of the fish populations in the two streams is stark evidence that this rate of application exceeds tolerable levels for fish in inland streams and lakes within the treated area itself.

INSTITUTE FOR FISHERIES RESEARCH

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[2] Willson, Ronald B., Carlos M. Fetterolf, Jr., John L. Hesse, and James W. Bedford. 1971. Stream insecticide monitoring studies, Berrien County, Michigan, October 1968-July 1970. Bur. Water Mgmt., Mich. Dept. Nat. Res., Feb. 1971, 36 p. (mimeo. report)

Table 1.--Fish species present and relative abundance* in three streams before (17 October 1968) and after (7 November 1968 and 1 August 1969) insecticide application

Species	Control Station No. 2			Station No. 3			Station No. 6		
	17 Oct 1968	7 Nov 1968	1 Aug 1969	17 Oct 1968	7 Nov 1968	1 Aug 1969	17 Oct 1968	7 Nov 1968	1 Aug 1969
Mudminnow	+++	+++	++	+	-	+	++	+	+
Green sunfish	++	++	+	+	-	+	++	+	+
Creek chub	-	-	-	+++	-	-	+++	++	+
Blacknose dace	-	-	-	++	+	+	+++	++	+
White sucker	-	-	-	+++	+	+	+	+	-
Carp	-	-	-	+	-	-	-	-	-
Burbot	-	-	-	+	-	-	-	-	-

* Relative abundance:

+++ abundant
++ common
+ sparse
- absent

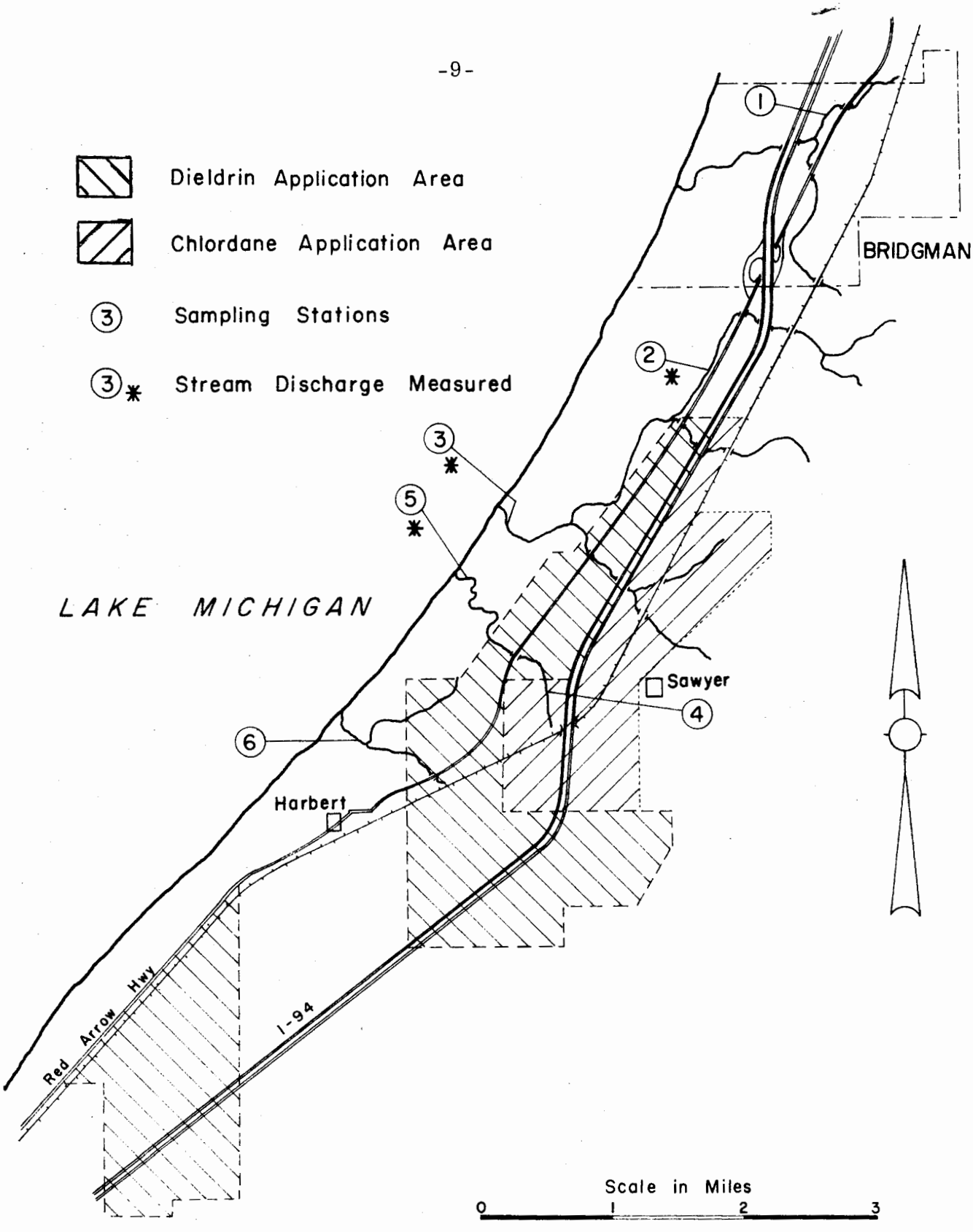

Figure 1.--Insecticide monitoring stations, Berrien County, Michigan, in T. 6 and 7 S., R. 20 W., October 1968 to July 1969.