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# Direct Effects of Wide-Area Malathion Application on Fish

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## ABSTRACT

The primary objective of this investigation was to determine if fish mortality would result directly from a wide-area application of 561 fluid grams, technical grade malathion per hectare. This cooperative study with the Department of Entomology, University of Nebraska, was conducted in Dawson County, near Lexington, Nebraska. Field tests were conducted on two adjoining 9.94-square-kilometer areas. The area receiving spray served as the experimental area; the other area served as a control. Mortality rates were determined both for captive bluegill *(Lepomis macrochirus)* and for fish populations native to Buffalo Creek. Data obtained throughout the course of this study indicated that malathion, when aerially applied at an ultra low volume rate over a wide area, did not result in direct mortality of fishes.

## INTRODUCTION

The objective of this investigation was to determine if fish mortality would result directly from an application of 561 fluid grams, technical grade malathion, per hectare. The area treated measured 9.94 $km^2$.

In recent years a trend has developed towards greater use of non-persistent insecticides with relatively low mammalian toxicity and a narrower spectrum of activity. These chemicals, the primary group of which are the organo-phosphates, have mitigated the problems of persistent pesticide residues being incorporated into food chains. However, the control of injurious insects has become more complex. With individual farmers applying insecticides at different times during the growing season, repeated applications may often be necessary to combat reinvasion by insects from adjacent untreated fields. To eliminate the necessity of repeated applications, research entomologists are studying the feasibility of treating large areas with the relatively nonpersistent organo-phosphates. However, the effect of such a wide-area treatment on the total environment is unknown.

Malathion, *O, O*-dimethyl dithiophosphate of diethyl mercato-succinate, has been one of the most widely used insecticides (6 to 12 million pounds a year) in the United States (Kennedy and Walsh, 1970, p. 3).

While malathion does have a relatively low mammalian toxicity, it is highly toxic to aquatic organisms. Holden (1964, p. 361) reports that it is generally more toxic to fish-food organisms than to fish. Murphy, et al. (1968, p. 24) found that malathion was highly toxic to fish and attributed this sensitivity to the inability of fish to deactivate enzymatically the lethal metabolite malaxon. Eaton (1970, p. 680), exposed bluegill *(Lepomis macrachirus)* to various malathion concentrations in a flowing-water test

system and found that concentrations of 6.6 and 2.8 ppb (parts per billion) were lethal within 16 and 54 days, respectively. He further reported that while no fish were killed in a concentration of 1.0 ppb, 33 percent developed spinal deformities.

During June, 1969, large tracts of balsam-fir forest in Koochiching County, Minnesota, were sprayed with malathion for control of spruce budworm. Ultra low volume spray techniques were used in the aerial application of 13 fluid ounces (368 fluid grams) of malathion per acre. The Technical Services Section of the Minnesota Division of Game and Fish conducted an evaluation of the effects of this application on aquatic life in the Little Fork River. The application apparently caused no harm to the fish population (mostly walleye, northern pike and rock bass) in the river (Bonnema, et al., 1969, p. 4).

In 1968, the Department of Entomology, University of Nebraska, initiated a long-term study in Dawson County, Nebraska, to determine the effects of a "ULV" (Ultra Low Volume) application of malathion on pest species and nontarget components of the environment. A 9.94 $km^2$ study area was selected on the basis of crop and soil homogeneity. A control area of the same size was established contiguous with the experimental area (Figure 1). The Research Division, Nebraska Game and Parks Commission, was

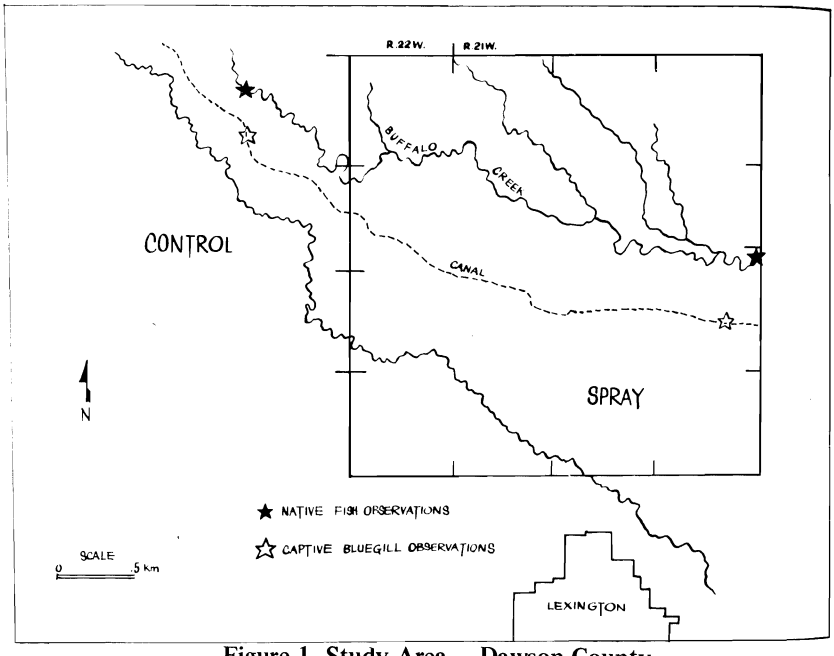


**Figure 1. Study Area – Dawson County**

invited by the University to carry out an investigation in conjunction with the application which would assess direct effects on fishes.

## MATERIALS AND METHODS:

Efforts were made to determine the direct effects of malathion on bluegill held captive in an irrigation canal, and on fishes native to Buffalo Creek which flowed through the study area.

Two stations were established adjacent to the irrigation canal which flowed through the study area. The station within the treated area (SE¼ Sec. 21, T. 10N., R. 22W.) served as the experiment station. The control station (NW¼ Sec. 11, T. 10N., R. 22W) was located 0.621 km upstream from the treated area (Figure 1). Two stock tanks (1.82 m long) were placed at each station so that water from the irrigation canal could be continuously siphoned through them.

In 1969, 45 bluegill were held for observation at each station. These fish had a mean total length and weight of 136 mm, 54 gm, and 138 mm, 61 gm, respectively at the experimental and control stations. In 1970, the mean total length and weight of the 29 bluegill held in the spray area were 133 mm and 51 gm. The 22 bluegill held in the control area in 1970 had a mean total length of 131 mm and a mean weight of 47 gm. Fish were acclimatized in the tanks at each station for a week to 10 days prior to spraying. They were fed twice each day with insects collected from adjacent fields. Feeding was discontinued following the application of malathion due to the scarcity of insects at the experiment station. Mortality was recorded daily at each station commencing three days prior to spraying and continuing five days after the application was completed.

Buffalo Creek, a small tributary of the Platte River, is a turbid, slow moving (velocity less than 15 cm/sec.) stream. A survey of the creek revealed the presence of 15 species of fish.

The mortality of fishes naturally occurring in Buffalo Creek was determined in the following manner. A control station was established 0.621 km upstream from the area to be sprayed and an experiment station was established near the lower boundary of the area to be sprayed (Figure 1). Each station consisted of a stretch of stream approximately 6 m long. All dead or dying fishes were counted during four 15-minute periods (7 AM, 10 AM, 2 PM and 6 PM) each day, beginning three days preceding application and continuing through the fifth day following the completion of spraying.

## RESULTS AND DISCUSSION

In 1969, three captive bluegill died at each station during the 10-day observation period. At the spray station, two fish died on the third day

following the application of malathion and one on the fourth day after spraying. Mortality of the three fish at the control station occurred on the day before, the day of, and the day following the spraying operation.

It is believed that the mortality which occurred at both stations resulted from the severe stress which the fish were subjected to enroute to the study.

In 1970, no mortality occurred at either the spray or control stations where captive bluegill were held for observation.

Three fishes were observed to be dead or dying at the spray station on Buffalo Creek in 1969: one on the day of spraying and one on the two days following the application of malathion. The fishes were identified as a small carp and two *Notropis* sp. No dead or dying fish were seen at the control station during the same observation period.

Data supporting the conclusion that the observed mortality at the Buffalo Creek spray station in 1969 was the result of the malathion were not obtained in 1970, as no dead or dying fish were observed at either the spray or control stations.

## CONCLUSIONS AND RECOMMENDATIONS

Based on the results and observations made throughout the course of this investigation, it was concluded that the aerial spraying of malathion (561 fluid gms/hectare) on the 9.94 $km^2$ study area in Dawson County did not directly result in mortality to fishes. However, drift samples collected from the canal by University of Nebraska personnel indicated that numerous aquatic insects were killed by the malathion (Peterson, 1971, p. 1). The extent of mortality and the recovery period of such fish-food organisms following application of malathion is still a question.

Future investigations should determine whether fishes experience any chronic or long-term effects from ULV applications of malathion.

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