THE EFFECTS OF AERIAL SPRAYING ON FISH AND WILDLIFE

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Since World War II there has been a tremendous increase in the use of chemical pesticides throughout the country. In 1956, it was estimated that over 500 million dollars worth of pesticides were produced, seven times the volume of 1940. By 1975 production is expected to exceed 2 billion dollars' worth annually.

Much of this growth resulted from the development of chemicals not on the market before the war. DDT was one of the first and was soon followed by other chlorinated hydrocarbons such as toxaphene, aldrin, and dieldrin. A second group, the organic phosphates, was also developed. The popularity of this latter group has increased recently as many insects have become resistant to DDT and related compounds. In all, more than 60 new insecticides have been developed.

Better methods of application have also encouraged the use of pesticides. Of principle importance in this respect is the use of the airplane. Some 6,000 aircraft, flying over one-half million hours, are used in dispensing the various formulations. A major portion of these are insecticides.

Another reason for the increased production of pesticides is that government agencies have entered the pest control picture on a broad scale. Examples of these control programs include grasshopper, gypsy moth, tussock moth, spruce budworm and most recently, the fire ant.

The annual spraying or dusting of millions of acres of the nation's crop, forest, range, and marshlands has caused considerable concern among wildlife biologists, public health departments, and the general public. This concern has been heightened by the increasing number of control programs and the use of more potent chemicals.

The economic importance of the various pests is considerable. It is estimated that losses to insects, plant diseases and weeds cost our country about 11 billion dollars annually. The U. S. Forest Service estimates that insects alone do considerably more damage to our forests than fire. Impressive as these figures are, the importance of our fish and wildlife resources should not be overlooked. Twenty-five million people (1 of every 5 aged 12 or over) fished or hunted in 1955. In doing so they spent approximately 3 billion dollars. In Montana the recreational and tourist industry is considered our third most important. Fisherman expenditure studies conducted on the Madison River and Gallatin River from 1949 through 1952 showed the fishery value of these streams approached $15,000 per mile annually. It is impossible, however, to express the intangible values in dollars. The general public considers the recreational and esthetic values much more important than economic values.

Except for limited observation with respect to grasshopper control, the Montana Fish and Game Department did not become directly concerned with aerial spraying of insecticides until adverse effects to fish were associated with the spruce budworm control program. Spruce budworm epidemics in Montana were reported as early as 1923, but most of these outbreaks were of short duration and subsided from natural causes. The current infestation, first reported in Montana in 1948, continued to spread so that by 1951, the U. S. Forest Service decided to attempt chemical control. During 1952 and 1953, "hot spot" spray programs were conducted on several forests in Montana and in Yellowstone National Park. These were followed by more extensive programs amounting to approximately 300,000 acres in 1955, 900,000 acres in 1956 and 800,000 in 1957.

During October 1955, 4 months following spraying in the area, the Fish and Game Department received reports of fish dying in the Yellowstone River. Mortalities were observed along about 90 miles of the river within and below the spray area. Dead fish were primarily whitefish, brown trout and suckers, and densities of about 600 fish in less than 300 yards were noted. Bottom organisms were sampled in sprayed and unsprayed areas and comparison showed a noticeable absence of aquatic insects in sprayed areas. Chemical analysis was made on sick fish and DDT was found in brain, liver and kidney tissues.

In attempting to explain this unusual mortality, fishery biologists looked to the spruce budworm control program carried out in July as it was the only apparent activity in the area that was different from other years. Considerable controversy ensued, particularly because of the time lapse between spraying and fish mortality. Also, the Forest Service had made inquiries into possible danger to fish and wildlife from DDT and had been informed that when used at less than 2 pounds per acre, there would be little or no adverse effects.

A review of the literature, however, revealed many conflicting observations. Fish mortalities attributed to DDT were reported in at least 10 states, Alaska and Canada. Most important of these were in Oregon where heavy losses were reported on sea-run steelhead fingerlings and on the Miramichi River in New Brunswick where severe losses of young salmon occurred. Although DDT had been studied more than any other insecticide, much of the information available was fragmentary and not applicable to the situation in Montana. Because of this, a cooperative study was initiated in 1956 to determine the effects of future spray operations on fish and wildlife. The immediate objective was to determine the effect of the aerial application of one pound of DDT per acre on the fish resources and ways of minimizing any possible detrimental effect.

During the summer and fall of 1956, studies in relation to the spray program were made on small mammals and native grouse. These limited observations did not indicate any adverse effects due to DDT.

Studies with respect to fish were more extensive and cooperating agencies included the U. S. Forest Service, U. S. Fish and Wildlife Service, Montana State College and the Montana Fish and Game Department. The general design of these studies was to sample stream bottom organisms and fish populations prior to and following spraying. Oil-sensitive cards were placed

along banks to indicate the amount of spray reaching the stream. Thirteen trout streams were selected for study during 1956. Six of these streams were later dropped because the expected amount of spray did not reach the stream or the data collected were insufficient for significant results.

The studies on these streams showed that aquatic bottom organisms were materially reduced by DDT spray. Reductions of over 90 per cent of the volume were common. Sampling on two streams continued throughout the summer and fall. By October, insect recovery on these streams represented only a small fraction of normal volumes. Downstream effects on these streams varied but in general decreased within a few miles below the spray boundary.

A total of 158 trout were held in live cages in two streams during spraying. None of these died on spray day or during the three days following. Comparison of fish populations before and after spraying was made difficult as high water prevented efficient prespray sampling. The census did not reveal any fish losses within a month after spraying.

The seven streams were studied again during 1957 to observe any delayed effects on fish and the recovery rate of bottom organisms.

The sampling indicated that by the end of the second summer the volume of bottom organisms on one of the streams exceeded the prespray volume. On five streams, quantitative recovery had progressed considerably but did not equal prespray volumes. On the seventh stream (one of the richest in bottom fauna) only a trace of aquatic organisms in sprayed sections was found in the second summer.

Fish populations in the second summer on five of the streams approximated those of the previous year. Some slight declines in numbers were noted but these could have been the result of normal population fluctuations.

On the sixth stream (Musselshell River) the number of brook trout in the two study sections in July 1956 was 253. In August 1957, only 75 were recovered. This decline (about 70 percent) is more than would be expected in normal population fluctuations. Although the number of trout 3 inches and larger decreased, numerous live 1- and 2-inch fish were observed.

Five study sections had been established on the seventh stream (Sheep Creek). The upper three sections were in the spray area and the lower two were several miles below. The number of game fish sampled in the lower two sections remained about the same between 1956 and 1957 while numbers in the sprayed sections decreased from 180 to 29 or about 84 percent. Many sculpins were observed in these sections in 1956 but none were seen in 1957. This is also the stream where aquatic insect recovery was practically absent. These two streams were sampled again in 1958. The numbers of fish in the affected sections had increased to approximately those of 1956, however, these were predominately young fish. Again, no sculpins were found in the sprayed sections of Sheep Creek. Analysis of bottom samples is not complete but insect recovery appears to have progressed considerably.

In 1957 it was decided to intensify investigations on a single stream. Principle effort in this study was directed towards the chemical analysis of water, vegetation, sediment, and fish tissues to determine the presence of DDT and patrolling the stream to observe fish mortality.

Approximately three miles of the Ruby River were sprayed at the rate of one pound of DDT per acre. Immediately after spraying the surface water contained 1.35 ppm DDT while sub-surface water contained less than 0.1 ppm. The quantities detected decreased rapidly and within 32 hours, only a trace could be found.

The effect of this spray on bottom organisms was similar to that observed in previous studies.

High water again prevented efficient sampling of the fish population but it was determined that suckers were by far the most abundant fish. Dead suckers began to appear within a few days after spraying. In a regularly patrolled section (about 2 miles long) the number found per day increased to 80 about 10 days following spraying. Dead suckers were found throughout the summer and fall but in smaller numbers. The mortality extended downstream for about 8 miles below the spray area.

Although no dead trout were found in this area during the summer, they were observed in November and December. The extent of this die-off could not be determined but the mortality was greater than usual, even during the spawning season.

Fish tissues were chemically analyzed for DDT and it was found in all fish (dead or alive) collected following spraying. The amounts contained varied from less than one ppm to about six ppm, but in some cases, more DDT was found in live fish than in dead fish. The inconsistency of the results invalidate these figures as criteria for determining the amount of DDT in tissues necessary to kill fish. The results did show a slight trend towards greater amounts of DDT accumulating in tissues as the season progressed.

No DDT was found in bottom sediments collected before or after spraying. DDT was found in aquatic vegetation samples collected as late as September and for at least 10 miles below the spray area.

Mortalities following spraying were observed on two other areas during 1957. About 50 dead trout were found along the shoreline of a small mountain lake a few days after spraying. An oil film on the water surface was reported on spray day and DDT was found in the dead fish.

On the other area, the Big Hole River, suckers began to die a few days following spraying. The die-off lasted about three weeks and extended for at least five miles below the spray boundary. During that winter, a whitefish die-off occurred in the same area but only a few dead trout were observed.

Other interesting observations were made during the course of the study. Limited data collected on young fish in streams did not show that they were more susceptable to DDT than older fish. However, during 1957

the Montana Fish and Game Department undertook laboratory analysis, under controlled conditions, on the effects of DDT on trout and whitefish. These bio-assays showed that high mortalities occurred with trout less than 1.5 inches long at concentrations as low as 0.02 ppm.

The effect of various physical, chemical and biological factors on mortalities in streams could not be determined since the concentration of DDT in the water and length of exposure were not accurately determined. Bio-assays showed that slight environmental changes, such as a three degree increase in water temperature, resulted in an immediate increase in mortality rates.

Observations also showed that delayed mortalities occur and these are generally more serious than those occurring immediately following spraying. Game fish comprising the bulk of observed mortalities were brown trout, brook trout and whitefish. All of these are fall spawners.

On the two rivers where heavy sucker mortalities were observed in 1957, indications were that the suckers were in the process of or had completed spawning just prior to spraying. It is possible that poorer condition and physiological stress due to spawning may result in stored DDT becoming lethal. Bio-assays conducted during 1957, substantiate this view.

For these reasons the Montana Fish and Game Department is opposed to spraying where valuable fish resources are endangered. The department is particularly opposed to repeated spraying as affected areas will not have a chance to recover adequately.

Approximately 700,000 acres are scheduled for spraying in Montana during 1959. The program will be reviewed by department personnel and potential danger areas will be designated. By exercising extreme caution in spraying near streams and lakes the hazard to fish will be reduced. The department will continue to cooperate with the Forest Service in determining ways to minimize adverse effects.

Although DDT has been studied more than any other insecticide, many questions still remain unanswered. Investigations on side effects have lagged far behind the research on chemical control of pests. Congress has recently authorized the Department of the Interior to continue studies on the effects of pesticides on fish and wildlife. The U. S. Fish and Wildlife Service will begin operations along these lines during the coming year. This aspect needs as much attention as the finding of chemicals to control pests.