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MONTANA DEPARTMENT OF FISH AND GAME
FEDERAL AID IN FISH RESTORATION SECTION
Helena, Montana

JOB COMPLETION REPORT
INVESTIGATIONS PROJECT

State of Montana

Name Western Montana Fishery Study

Project No. F-12-R-6

Title Inventory of Waters of the Project Area

Job No. I (Supplemental Report)

Effects of Forest Spraying with DDT on Aquatic Life

Period Covered May 1, 1959 - April 30, 1960

ABSTRACT:

In the early summer of 1959, the U. S. Forest Service conducted an aerial DDT spray program for the control of the spruce budworm in certain areas of the East and West Forks of the Bitterroot River drainage. In order to determine the effects of the spraying upon the aquatic habitat of the area, a fishery study was conducted coincident with the spraying. Insect life in the streams within the spray areas was sampled before, during, and after the spraying. The spraying was observed by department personnel, both from the ground and from the air.

Several severe insect kills were correlated with various phases of the spray application and one minor fish kill occurred coincident with the spray operation, but no major fish kills are known to have occurred that could be attributed solely to the DDT spray.

OBJECTIVES:

To determine the effects of aerial application of DDT for spruce budworm control upon the aquatic environment. To predict, if possible, future effects on the fishery in order to determine the necessity of instigating special management measures on waters of the spray area. To observe as much of the spray application job as possible. To compare determined effects on habitat with observed methods of application, in order to make any feasible recommendations possible for the reduction of damage from future spray jobs.

TECHNIQUES USED:

The spray was applied from airplanes at the rate of one pound of DDT emulsified in one gallon of oil per acre of forest. The spraying was accomplished in the early morning hours of from dawn to about 10:00 a.m. The pilots were instructed to turn off the spray when crossing non-forested land and to stay at least one-quarter mile away from the streams of importance in the spray area.

Prior to the application of the DDT spray, sample sites were picked on all streams within the spray boundaries. In addition, some sample sites were chosen outside of the spray area for control.

Before and after the application of the spray one, four-square-foot, bottom sample was taken at most of the stations on each collecting date. The bottom sampler consisted of a four-square-foot metal frame to outline the sample area and a collecting net made of common window screen fastened to wooden poles. The bottom within the metal frame was agitated until all, or nearly all, insects were dislodged and washed into the wire screen. The insects were then picked from the screen and preserved for later identification. All of the bottom samples were taken from riffle areas and care was taken to avoid sampling the same four-square-foot area more than once.

Drift samples were taken from some of the bottom sampling sites during and following the spraying. These drift samples were collected by holding a screen similar to that used for the bottom samples in the stream for a period of time ranging from 30 seconds to five minutes. The time that the screen was held in the stream was dictated by the amount of insects floating downstream. The screen was then picked of insects and these insects preserved for later identification and measuring.

The bottom and drift samples were sent to the department fishery laboratory to be measured and identified. Data recorded for each sample included the identification of the insects to the following groups: Ephemeroptera (mayflies), Diptera (trueflies), Plecoptera (stoneflies), and miscellaneous. The miscellaneous catagory included the Coleoptera, Odonata, Hemiptera, Trichoptera, Annelida, and Nematoda. Each of the groups were measured volumetrically to the nearest one-tenth cubic centimeter. Volumes less than one-tenth cubic centimeter are expressed as a trace (T).

Observations of the spraying operation were made by personnel stationed on the ground and from personnel in a department airplane. Notes were kept on the effectiveness of the spray pilots on keeping the DDT out of the streams.

Fish kills reported to have occurred within or in the vicinity of the spray area were investigated and the cause of death determined as accurately as possible.

FINDINGS:

Although some stations were sampled on the East and West Forks and all of their tributaries within the spray areas, detailed discussion in this report will be limited to only the principle streams, on which the major portion of our survey effort was spent. These are: The East Fork of the Bitterroot River and two tributaries, Camp Creek and Warm Springs Creek, and the West Fork of the Bitterroot River and three tributaries, Slate Creek, Overwhich Creek and Hughes Creek. These were considered important fishing streams by the Forest Service and the Fish and Game Department, and spraying was not to be done closer than one-quarter mile from their edges. Spray patterns were not broken for the other, smaller streams in the area, and investigation on them consisted principally of drift sampling and/or direct observation following spraying. Dead insects were noted in all of such streams checked.

EAST FORK UNIT

Timbered areas along the East Fork of the Bitterroot and its tributary streams were sprayed commencing June 30 and ending July 8, 1959. Five stations were sampled in the East Fork; four of these stations were within the spray area and one station was one mile above the spray boundary. Figure 1 shows the locations of these sampling stations.

Figure 1. East Fork Unit.

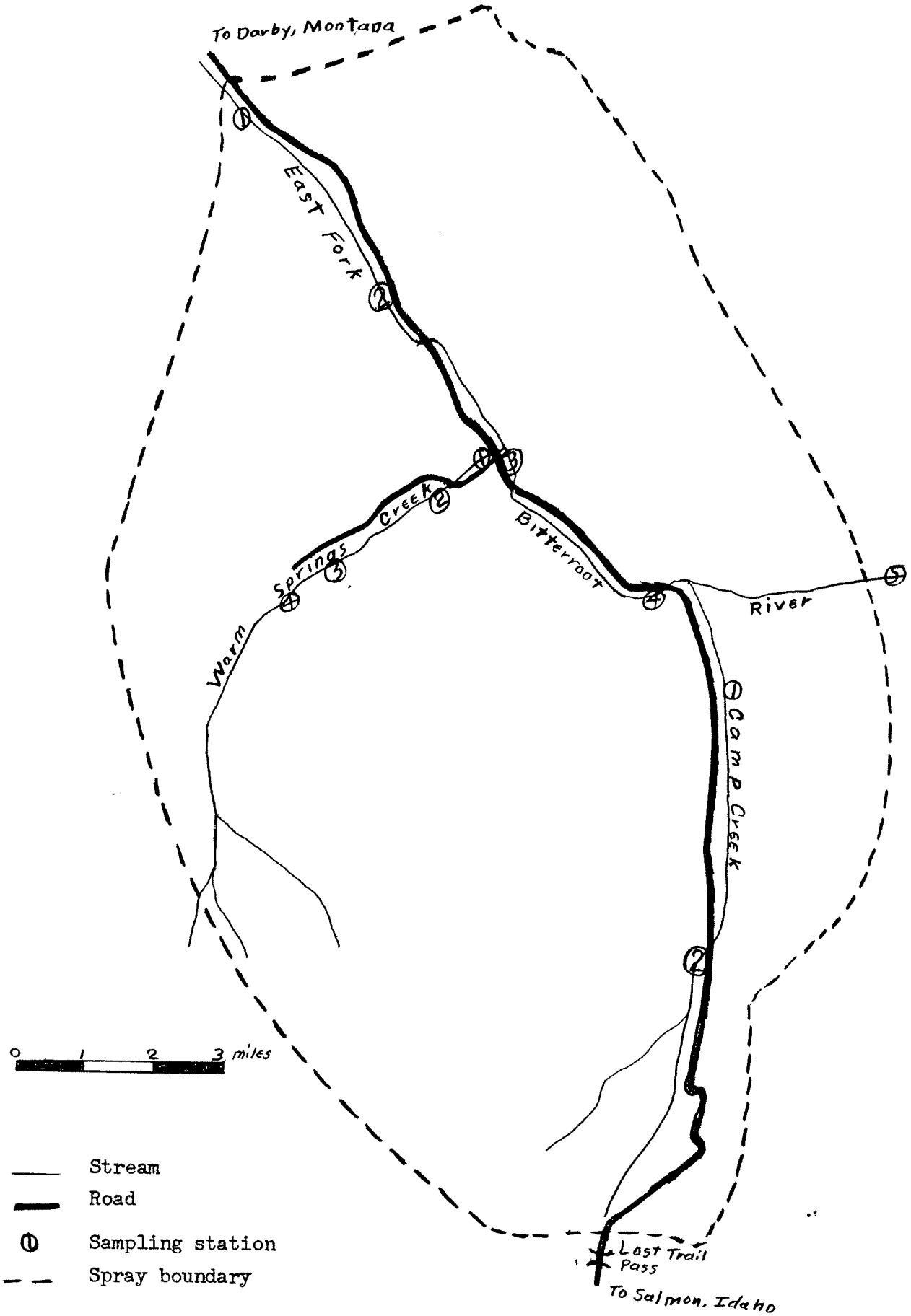


Table 1. Four-square-foot pre-spray and post-spray bottom samples collected from the East Fork of the Bitterroot River, during 1959.

Station	Date	Sample	Insects	No.	Volume
3	June 29	Pre-spray	Mayflies	103	1.2
			Trueflies	5	.1
			Stoneflies	9	1.0
			Others	9	.1
3	July 21	Post-spray	Mayflies	2	T
			Trueflies	8	.5
			Stoneflies	184	29.2
3	Sept. 17	Post-spray	Mayflies	33	.2
			Stoneflies	8	1.1
			Others	9	.3
4	June 30	Pre-spray	Mayflies	50	.1
			Trueflies	9	.2
			Stoneflies	11	2.2
			Others	1	T
4	July 21	Post-spray	Mayflies	39	.4
			Trueflies	33	1.0
			Stoneflies	8	2.0
			Others	5	.1
4	Sept. 17	Post-spray	Mayflies	66	.6
			Trueflies	51	.8
			Stoneflies	29	2.1
5	June 29	Control	Mayflies	21	.8
			Trueflies	3	T
			Stoneflies	1	T
5	July 21	Control	Mayflies	2	.1
			Trueflies	1	T
			Stoneflies	5	.3
5	Sept. 17	Control	Mayflies	89	.8
			Trueflies	19	.4
			Stoneflies	16	.3
			Others	2	T
1	July 21	Post-spray	Trueflies	1	T
			Stoneflies	132	20.3
1	Sept. 17	Post-spray	Mayflies	13	.2
			Trueflies	24	.2
			Stoneflies	106	15.3
			Others	6	.1
2	July 21	Post-spray	Mayflies	6	.2
			Trueflies	5	.2
			Stoneflies	158	18.6
2	Sept. 17	Post-spray	Mayflies	15	.1
			Trueflies	47	1.2
			Stoneflies	81	6.3
			Others	15	.3

Pre-spray bottom samples were taken at stations 3, 4, and 5. Post-spray bottom samples were taken at all stations. The results of these samples are given in Table 1. A comparison of these data indicate that little damage was done to the bottom fauna of the East Fork of the Bitterroot River. It may be noted from Table 1 that the numbers of mayflies decreased from the pre-spray to the post-spray samples at all stations where pre- and post-spray samples were taken. At those stations where no pre-spray bottom samples were taken, the mayflies were either absent or present in low numbers in the post-spray bottom samples.

Drift sample data collected from the East Fork at stations 1-4 show that the mayflies were the most numerous drifting insect present at the time of sampling. Station 5 was outside of the spray area and only one individual insect was taken in one drift sample. It is realized that many of the insects drifting in the East Fork may have originated from the tributary streams and not from the East Fork itself. The drift sample data for the East Fork stations are presented in Table 2.

Table 2. One minute pre-spray and during-spraying drift samples from stations 1-5, East Fork of the Bitterroot River.

Station	Date	Time	Insects	No.	Volume
1	June 25	Pre-spray	None	--	--
1	June 30	1030	Mayflies	1000's	--
			Trueflies	1000's	--
			Stoneflies	1000's	--
			Others	100's	--
2	July 3	0930	Mayflies	2	T
			Stoneflies	2	.5
			Others	1	T
3	June 29	Pre-spray	Mayflies	1	T
			Trueflies	2	T
3	July 2	1145	Mayflies	16	.1
			Stoneflies	4	.5
			Others	5	.1
3	July 3	0920	Mayflies	1	T
			Stoneflies	4	.1
4	June 30	Pre-spray	Mayflies	1	T
4	July 1	0915	Mayflies	86	.1
			Trueflies	6	T
			Stoneflies	1	T
			Other	2	T
4	July 1	1030	Mayflies	12	T
			Trueflies	1	T
4	July 2	0830	Mayflies	2	T
			Stoneflies	1	T
			Others	2	T
4	July 5	0950	Mayflies	1	T
4	July 7	1215	Mayflies	1	T
5	July 2	Control	Others	1	T

None of the DDT spray was observed to have drifted into the East Fork. The timber bordered the stream at only one place, a short distance upstream from station 3. The remainder of the stream shoreline was open and free of timber.

No fish kills were observed or reported in the area of the East Fork that was sprayed.

Camp Creek: Two sample stations were set up on Camp Creek, a small tributary of the East Fork. Figure 1 shows the sampling sites. Pre-spray drift and bottom samples were taken from station 1. Only post-spray bottom samples were taken from station 2. The summary of the pre- and post- bottom samples is given in Table 3.

Table 3. Four-square-foot pre-spray and post-spray bottom samples for stations 1 and 2, Camp Creek.

Station	Date	Sample	Insects	No.	Volume
1	June 30	Pre-spray	Mayflies	91	2.0
			Trueflies	1	.1
			Stoneflies	1	.1
			Other	4	.4
1	July 21	Post-spray	Mayflies	1	.1
			Stoneflies	2	.2
			Other	1	.1
1	Sept. 17	Post-spray	Mayflies	10	.1
			Trueflies	105	5.5
			Stoneflies	2	.3
2	July 21	Post-spray	Mayflies	62	5.0
			Stoneflies	1	.1
			Others	3	.3
2	Sept. 17	Post-spray	Mayflies	1	.1
			Trueflies	7	.1
			Stoneflies	4	.1
			Others	3	.4

Drift samples were taken at both stations when areas immediate to or above the station were sprayed. A summary of the pre-spray drift samples and during-spraying drift samples is given in Table 4.

From these data it is apparent that Camp Creek suffered a heavy insect kill. The spraying in the vicinity of Camp Creek station 1 took place July 1st and 2nd. The data for July 1st, in Table 4 show that the full impact of the DDT upon the insect life occurred some two hours after application, with a steady decrease thereafter.

The spraying of the headwaters of Camp Creek occurred July 7th. The drift samples from 0745 to 1045 hours indicate that very little DDT entered the stream. At approximately 1100 hours, a heavy rainstorm occurred. Drift samples taken after this rainstorm show a large increase in the number of insects collected. Apparently, the rain run-off may have washed additional DDT into the stream.

A large percentage of the insects killed were mayflies. A comparison of the bottom samples from station 1 indicate a decrease in the number of mayflies from the pre-spray sample to the post-spray sample.

No fish kills were reported or observed in Camp Creek.

The spray pilots were able to keep the DDT spray out of Camp Creek, above station 2, and if clear weather had followed the spray job, this portion of the stream may have suffered only very light damage.

Table 4. One minute pre-spray and during-spraying drift samples from station 1 and 2, Camp Creek.

Station	Date	Time	Insects	No.	Volume
1	June 30	Pre-spray	Mayflies	1	T
			Others	1	T
1	July 1	0645	Mayflies	12	.1
			Trueflies	1	T
			Stoneflies	2	.1
			Others	3	.2
1	July 1	0745	Mayflies	1000's	
			Trueflies	100's	
			Stoneflies	100's	
			Others	100's	
1	July 1	0930	Mayflies	99	.2
			Trueflies	10	T
			Stoneflies	2	T
			Others	2	T
1	July 2	1120	Mayflies	116	.2
			Others	3	.2
2	July 7	0745	Mayflies	22	.3
			Others	3	.2
2	July 7	0845	Mayflies	36	.4
			Stoneflies	11	.1
			Others	6	.2
2	July 7	1045	Mayflies	76	.7
			Stoneflies	3	.2
			Others	30	.8
2	July 7	1245	Mayflies	168	1.5
			Stoneflies	3	.2
			Others	27	.6
2	July 7	1415	Mayflies	149	2.3
			Stoneflies	5	.1
			Others	32	1.3

Warm Springs Creek: Three sampling sites were selected for Warm Springs Creek. A single drift sample and a post-spray bottom sample were taken at a fourth station and are given in Table 9.

Unlike the rest of the streams in the East Fork Unit, Warm Springs Creek, except for the lower one-half mile, was timbered down to the stream's edge. On one occasion a spray pilot forgot to shut off the spray when passing over the stream. On several other occasions, the spray would be shut off, but faulty shut-off valves would allow additional DDT to leak out while the plane was over the stream. Immediately following the spraying of June 30th an oil slick, indicating DDT spray, was observed in the stream, on automobiles parked by the stream, and in pans used to sort the drift samples.

Table 5 gives the data from the pre- and post-spray bottom samples. These data do not indicate any serious damage to the bottom fauna. It should be noted that the pre-spray bottom samples for stations 1 and 2 are poor and may not be indicative of the fauna present at that time.

Table 5. Four-square-foot pre-spray and post-spray bottom samples, stations 1, 2 and 3, Warm Springs Creek.

Station	Date	Sample	Insects	No.	Volume
1	June 25	Pre-spray	Mayflies	2	T
			Trueflies	1	T
1	July 21	Post-spray	Mayflies	2	.2
			Trueflies	2	.1
			Stoneflies	22	4.5
1	Sept. 17	Post-spray	Mayflies	7	T
			Trueflies	15	.2
			Stoneflies	29	.8
			Others	1	T
2	June 25	Pre-spray	Mayflies	1	T
2	July 21	Post-spray	Mayflies	25	1.3
			Stoneflies	2	.2
			Others	3	.1
2	Sept. 17	Post-spray	Stoneflies	26	.6
3	June 25	Pre-spray	Mayflies	15	.4
			Trueflies	1	T
			Stoneflies	1	T
			Others	1	T
3	July 3	Pre-spray	Mayflies	41	1.8
			Others	6	1.1
3	July 21	Post-spray	Mayflies	37	.4
			Stoneflies	2	.2
3	Sept. 17	Post-spray	Mayflies	2	T
			Trueflies	5	T
			Stoneflies	17	T

Table 6 gives the results of the drift samples taken during and following spraying of the forest area above station 1. Station 2 was also in the area sprayed and, therefore, was not sampled at this time. This area was sprayed the morning of June 20. The samples taken indicate a large kill occurred immediately following spraying, followed by a decrease within one-half hour. The sudden increase and decrease may have been the result of one spray plane making a pass over the creek a few hundred yards above the sampling site without turning the spray off.

Table 6. One minute drift samples collected from Station 1, Warm Springs Creek.

Date	Time	Insects	Number	Volume
June 30	0630	Mayflies	5	T
		Trueflies	1	T
		Stoneflies	2	T
June 30	0700	Mayflies	113	.8
		Trueflies	31	.3
		Stoneflies	232	5.2
		Others	187	3.6
June 30	0730	Mayflies	10	T
		Trueflies	33	.1
		Stoneflies	33	T
		Others	4	T
June 30	1245	Mayflies	27	.4
		Trueflies	6	T
		Stoneflies	7	.2
		Others	38	2.1
July 5	1330	Mayflies	20	.1
		Trueflies	4	T
		Stoneflies	1	T
		Others	10	.1
July 6	0845	Mayflies	278	3.8
		Trueflies	4	.1
		Stoneflies	42	2.3
		Others	62	1.8
July 6	1200	Mayflies	520	4.4
		Trueflies	20	.1
		Stoneflies	88	1.2
		Others	160	6.8
July 7	0630	Mayflies	34	.4
		Trueflies	6	.1
		Stoneflies	4	.1
		Others	12	.1
July 7	1230	Mayflies	3	.7
		Stoneflies	2	T
		Others	1	.1

Samples were taken at station 1 periodically throughout the time that the stream was subject to spraying. On July 5, an area upstream from station 2 and including station 3 was sprayed. Here again, the airplane pilots were not able to keep the DDT spray out of the stream. On July 6, an increase in the number of drifting insects was noted at station 1.

Tables 7 and 8 give the results of the drift samples taken at stations 2 and 3. These data show that a very severe insect kill occurred between these stations and above station 3 when this area was sprayed July 5. The one drift sample taken at station 4 (Table 9) also supports the data given in Tables 7 and 8. Mayflies, stoneflies, and caddisflies (others in tables) were affected most severely.

Table 7. One minute drift samples collected from Station 3, Warm Springs Creek.

Date	Time	Insects	Number	Volume
July 5	0715	Mayflies	14	.1
		Trueflies	5	T
		Stoneflies	4	T
		Others	2	T
July 5	0745	Mayflies	145	.7
		Trueflies	29	.3
		Stoneflies	64	.4
		Others	15	.2
July 5	0845	Mayflies	1266	8.4
		Trueflies	38	.2
		Stoneflies	146	2.0
		Others	228	1.4
July 5	0945	Mayflies	852	6.0
		Trueflies	38	.2
		Stoneflies	186	1.2
		Others	184	2.0
July 5	1045	Mayflies	722	6.2
		Trueflies	36	.2
		Stoneflies	106	1.4
		Others	140	1.3
July 5	1400	Mayflies	215	1.9
		Trueflies	13	.2
		Stoneflies	8	1.5
		Others	17	.5
July 6	0600	Mayflies	125	1.3
		Trueflies	2	T
		Stoneflies	15	.1
		Others	29	.7

Table 8. One minute drift samples collected from Station 2, Warm Springs Creek.

Date	Time	Insects	Number	Volume
July 5	1400	Mayflies	78	.7
		Trueflies	3	T
		Stoneflies	7	.1
		Others	15	.2
July 5	1445	Mayflies	101	.6
		Trueflies	4	T
		Stoneflies	6	.1
		Others	27	.5
July 6	0615	Mayflies	338	2.8
		Trueflies	6	.2
		Stoneflies	56	.8
		Others	95	3.5
July 6	0715	Mayflies	284	4.2
		Trueflies	4	.4
		Stoneflies	136	1.2
		Others	130	4.4
July 6	0815	Mayflies	500	6.4
		Trueflies	4	.1
		Stoneflies	84	1.3
		Others	208	5.8
July 6	0915	Mayflies	620	7.2
		Trueflies	6	.1
		Stoneflies	48	1.0
		Others	192	6.0
July 6	1115	Mayflies	514	7.8
		Stoneflies	170	3.4
		Others	160	6.4
July 6	1345	Mayflies	556	5.6
		Trueflies	8	T
		Stoneflies	100	.4
		Others	146	5.6
July 6	1515	Mayflies	190	1.8
		Stoneflies	32	.8
		Others	30	.6

Table 9. One minute drift sample and four-square-foot bottom sample, station 4, Warm Springs Creek.

Date	Time	Sample	Insects	No.	Volume
July 5	1200	Drift	Mayflies	512	5.0
			Trueflies	32	.4
			Stoneflies	44	.4
			Others	76	2.0
July 21		Bottom	Mayflies	10	.7
			Stoneflies	2	T

It is apparent from Table 7 that the greatest number of drifting insects at station 3 occurred between the hours of 0845 and 1045, July 5th. The greatest number of insects taken at station 2 occurred July 6th between 0615 and 1345 hours. An increase in the number of drifting insects was also noted for July 6th at station 1. One reason for the time delay between stations is that station 2 was three-quarters of a mile above station 1 and station 3 was one and three-quarters mile above station 2.

A fish kill occurring within the spray boundaries of this stream was brought to the attention of fishery personnel and was investigated immediately. It was determined that the trout population of a series of beaver ponds was heavily infected with a fungus, thought to be Saprolegnia. Conclusions concerning this fish kill were: (1) The small area involved did not warrant any special management measures of control or rehabilitation; (2) the most likely causal agent was the fungus; (3) DDT was not likely even a contributing factor in this kill.

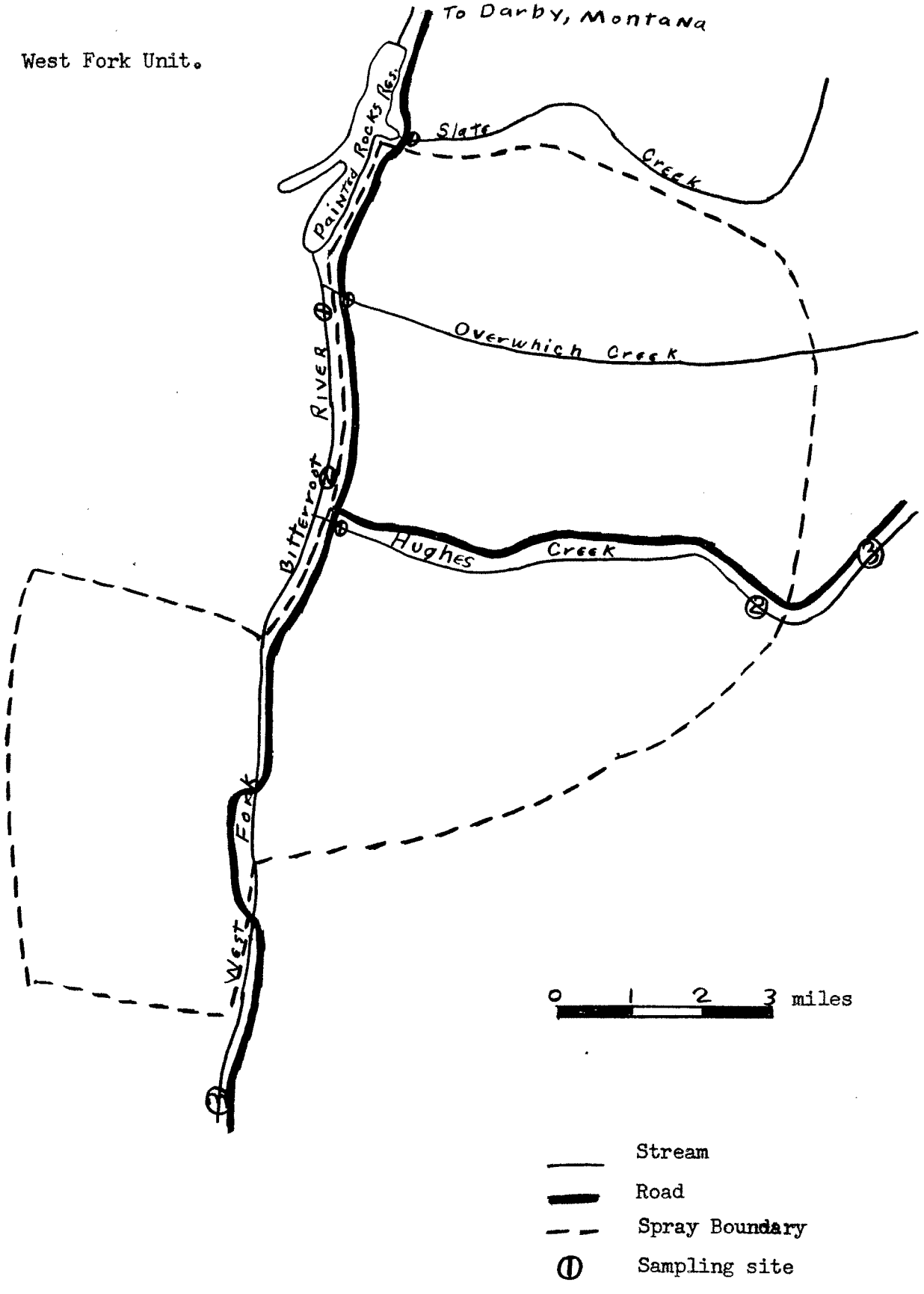
WEST FORK UNIT

West Fork of the Bitterroot River: Timbered areas within the West Fork Unit were sprayed from July 9 through July 16, 1959. Three stations were sampled in the West Fork. Stations 1 and 2 were within the spray area and station 3 was above the spray boundary. Figure 2 shows the locations of these sampling stations. Pre- and post-spray bottom samples were taken at all stations. The results of these bottom samples are given in Table 10.

Table 10. Four-square foot bottom samples, Stations 1, 2, and 3, West Fork of the Bitterroot River.

Station	Date	Sample	Insects	No.	Volume
1	July 3	Pre-spray	Mayflies	6	.2
			Trueflies	2	T
			Stoneflies	6	1.8
1	July 22	Post-spray	Stoneflies	10	3.6
			Others	2	.2
1	Sept. 25	Post-spray	Trueflies	11	T
			Stoneflies	3	1.5
2	June 29	Pre-spray	Mayflies	23	.5
			Trueflies	4	T
2	July 22	Post-spray	Stoneflies	4	T
2	Sept. 25	Post-spray	Trueflies	2	T
			Stoneflies	5	.2
3	June 29	Pre-spray	Mayflies	39	.4
			Stoneflies	4	.2
			Others	2	.1
3	July 22	Post-spray	Mayflies	19	.5
			Trueflies	1	T
			Stoneflies	2	.1
			Others	10	.3
3	Sept. 25	Post-spray	Mayflies	35	.2
			Trueflies	1	.3
			Stoneflies	22	.4
			Others	10	1.3

Figure 2. West Fork Unit.



A comparison of the bottom samples collected from stations 1 and 2 shows a reduction in the numbers of mayflies taken. The samples taken from station 3, the control, does not show this reduction. Drift samples taken at stations 1 and 2 indicate that a severe kill of mayflies occurred (Table 11). The stream between station 1 and station 2 and directly above station 2 received some DDT spray during the spraying operation. Spraying of this sector of the West Fork unit occurred the morning of July 9th.

Table 11. One-minute drift samples, stations 1 and 2, West Fork of the Bitterroot River.

Station	Date	Time	Insects	No.	Volume
1	July 9	0800	Mayflies	35	.1
			Stoneflies	4	.2
			Others	2	.1
1	July 9	1100	Mayflies	701	3.3
			Trueflies	4	T
			Stoneflies	23	.4
			Others	3	.2
1	July 9	1400	Mayflies	243	1.1
			Stoneflies	10	.5
			Others	4	.2
2	July 9	0830	Mayflies	192	1.1
			Trueflies	8	T
			Stoneflies	82	1.8
			Others	5	.2
2	July 9	1345	Mayflies	65	.3
			Trueflies	4	T
			Stoneflies	4	.1
			Others	1	T
2	July 11	1000	Mayflies	2	T
			Stoneflies	5	.2

Overwhich Creek: One station was sampled on Overwhich Creek. Figure 2 shows the site of this station. Pre- and post-spray bottom samples and drift samples were collected from this station. Tables 12 and 13 give the results of these collections. The first spraying of the timber near Overwhich Creek occurred July 9th and the second spraying on July 11th. Data from drift samples (Table 13) indicates insects were not affected much by the first spraying but a large number were killed by the July 11th spraying.

Generally, the stream bottom within the area sprayed July 9th was open, with very little timber close to the stream. The area sprayed July 11th included many places where dense stands of timber bordered the stream. The airplane pilots were able to keep the DDT out of the stream in areas where trees didn't extend to the stream shore, but were unable to keep the spray out of the stream where timber extended to the shoreline.

A comparison of the pre-and post-spray bottom samples indicate that an insect kill may have occurred in Overwhich Creek. Mayflies were the most abundant insect in the drift samples and were almost non-existant in the post-spray bottom samples.

Table 12. Four-square foot pre- and post-spray bottom samples from Overwhich Creek.

Date	Sample	Insects	No.	Volume
July 3	Pre-spray	Mayflies	5	.2
		Stoneflies	2	.8
July 22	Post-spray	Trueflies	1	.4
		Others	2	.2
Sept. 25	Post-spray	Mayflies	2	T
		Trueflies	7	T
		Stoneflies	3	T

Table 13. One minute drift samples collected from Overwhich Creek.

Date	Time	Insects	No.	Volume
July 9	0745	Mayflies	1	T
		Trueflies	12	.1
		Others	4	.1
July 9	1100	Others	1	T
July 11	0600	Mayflies	10	T
		Stoneflies	2	T
		Others	1	T
July 11	0700	Mayflies	121	.6
		Trueflies	2	T
		Stoneflies	22	.1
		Others	39	.2
July 11	0900	Mayflies	912	3.1
		Trueflies	4	T
		Stoneflies	50	.8
		Others	37	.3
July 11	1100	Mayflies	213	1.8
		Trueflies	2	T
		Stoneflies	12	.2
		Others	6	.2
July 11	1400	Mayflies	106	.6
		Trueflies	3	.1
		Stoneflies	9	.2
		Others	21	.5
July 12	0700	Mayflies	46	.2
		Trueflies	2	.1
		Stoneflies	8	.1
		Others	10	.7
July 12	1130	Mayflies	1	T
		Trueflies	1	T
		Others	2	T
July 13	0700	Mayflies	3	T
		Trueflies	1	.1
		Stoneflies	1	T
		Others	2	.1
July 13	0930	Others	1	.1

Hughes Creek: Three stations were sampled in Hughes Creek. These stations are shown in Figure 2. Station 3 was upstream from the spray boundary, the other stations were within the spray area. Pre- and post-spray bottom samples were taken at all stations. Drift samples were taken at stations 1 and 2 when areas were sprayed above the station. Table 14 gives the results of the pre- and post-spray bottom samples for all stations. Tables 15 and 16 give the drift sample data for stations 1 and 2.

Table 14. Four-square foot bottom samples, stations 1, 2, and 3, Hughes Creek.

Station	Date	Sample	Insects	No.	Volume
1	July 3	Pre-spray	Mayflies	11	.6
			Trueflies	1	T
			Stoneflies	6	1.0
			Others	2	.1
1	July 22	Post-spray	Mayflies	1	T
			Trueflies	1	T
			Stoneflies	21	3.1
			Others	1	T
1	Sept. 25	Post-spray	Mayflies	11	.1
			Trueflies	16	T
			Stoneflies	23	.7
			Others	1	T
2	July 3	Pre-spray	Mayflies	59	.6
			Trueflies	3	T
			Stoneflies	6	.4
			Others	3	.1
2	July 22	Post-spray	Mayflies	15	.3
			Trueflies	5	.6
			Stoneflies	19	1.2
			Others	7	.4
2	Sept. 25	Post-spray	Mayflies	172	2.1
			Trueflies	23	.2
			Stoneflies	46	1.3
			Others	66	.7
3	July 3	Pre-spray	Mayflies	53	.3
			Trueflies	6	.1
			Stoneflies	5	.1
			Others	5	.2
3	July 22	Post-spray	Mayflies	38	.5
			Stoneflies	4	.3
			Others	6	.4

A comparison of the bottom sample data given in Table 14 indicates that there was a temporary reduction in the numbers of mayflies present in Hughes Creek in the vicinity of stations 1 and 2. The post-spray bottom samples at these two sites shows a marked increase in the numbers of mayflies from July 22 to September 25. Samples collected from the control station show a decrease in numbers of insects found from the pre-spray to the post-spray bottom samples.

The area above station 1 was first sprayed July 11th. The drift samples for this day and for several days following are given in Table 15. Included in this table are two pre-spray drift samples taken on July 3 and July 9. These data show that this stream suffered some loss of insect life for the first day following spraying. The most numerous insects were the mayflies.

Table 15. One minute drift samples, station 1, Hughes Creek.

Date	Time	Insects	No.	Volume
July 3	Pre-spray	None		
July 9	Pre-spray	None		
July 11	0600	Mayflies	1	T
		Stoneflies	1	T
July 11	0700	Mayflies	36	.2
		Stoneflies	2	.1
		Others	4	.2
July 11	0800	Mayflies	128	.5
		Stoneflies	7	.1
		Others	5	.1
July 11	0900	Mayflies	316	1.1
		Trueflies	4	T
		Stoneflies	9	.4
		Others	14	.2
July 11	1000	Mayflies	320	.8
		Trueflies	6	.1
		Stoneflies	6	.1
		Others	10	.1
July 12	0900	Others	4	.1
July 13	0730	Others	4	.1
July 15	1545	Others	2	.1

Station 2 was about five miles upstream from station 1. The area around this station was sprayed July 15th. The drift sample data given in Table 16 indicate mayflies and caddisflies were the hardest hit by the DDT spray, although the damage was not thought to be severe.

Table 16. One minute drift samples, station 2, Hughes Creek.

Date	Time	Insects	No.	Volume
July 15	1100	Mayflies	83	.5
		Trueflies	1	T
		Stoneflies	2	T
		Others	14	.2
July 15	1200	Mayflies	90	.5
		Trueflies	2	T
		Stoneflies	1	T
		Others	19	.3
July 15	1615	Mayflies	62	.3
		Others	12	.3

Slate Creek: One station was sampled in Slate Creek. Figure 2 gives the location of this site. Pre- and post-spray drift and bottom samples were collected at this station. One pre-spray drift sample was also taken. Slate Creek was subjected to DDT on two separate days, July 11th and 13th. The July 11th spraying was not scheduled, but occurred when the airplane pilots sprayed the wrong area. Tables 17 and 18 give the results of these samples.

A comparison of the bottom samples indicates a reduction in the number and volume of insects from the pre-spray to the post-spray samples. This reduction is generally due to the decreased number of mayflies taken in these bottom samples. Note from Table 17 that the mayflies were the most abundant insect taken in the drift samples.

Table 17. One minute drift samples, Slate Creek.

Date	Time	Insects	No.	Volume
July 11	0620	Mayflies	3	.2
July 11	0720	Mayflies	1	T
		Trueflies	1	T
July 11	0930	Mayflies	16	.2
		Trueflies	20	.1
		Stoneflies	2	T
		Others	1	T
July 11	1130	Mayflies	12	.1
		Trueflies	2	T
July 11	1420	Mayflies	2	T
		Trueflies	1	T
July 12	0700	Mayflies	10	.1
		Trueflies	2	T
July 13	1630	Mayflies	100	.6
		Stoneflies	1	T
July 13	1800	Mayflies	135	1.1
		Others	21	.6
July 13	1930	Mayflies	63	.5
		Trueflies	1	.1
		Stoneflies	1	T
		Others	18	.7
July 14	0930	Mayflies	6	.1
		Stoneflies	1	T
		Others	6	.1
July 14	1500	Mayflies	2	T
		Trueflies	1	T
		Others	1	T

Table 18. Four-square foot bottom samples from Slate Creek.

Date	Sample	Insects	No.	Volume
July 3	Pre-spray	Mayflies	33	1.9
		Trueflies	2	T
		Others	2	T
July 22	Post-spray	Mayflies	7	.3
		Stoneflies	1	T
Sept. 25	Post-spray	Mayflies	5	T
		Trueflies	1	.3
		Stoneflies	12	T
		Others	1	T

An oil slick was noticed on the surface of Painted Rocks Reservoir (Figure 2) following the July 13th spraying of Slate Creek. On the evening of the same day, dead and dying fish were observed along the shoreline of this reservoir in the vicinity of the mouth of Slate Creek (Figure 2). Fish species observed dead or in distress included suckers, whitefish, rainbow trout, and eastern brook trout. The most numerous fish were the suckers and whitefish. Concentrations observed the evening of July 13 approached one dead or distressed fish per one-foot of shoreline. Observation July 14th in the same area showed a concentration of one dead fish per 100 feet of shoreline and for an area across the lake a concentration of one dead fish per 1000 feet of shoreline.

A report of dead fish being found along the shoreline before the spraying occurred was investigated. Mr. Westover, a Forest Service engineer residing on the lake, reported seeing several dead suckers on the lake shore several days before the spraying. He attributed this to a severe wind storm.

The report of dead fish before the spraying casts doubt as to the causal agent of the die-off. However, the only unusual factor known to be present during the mortality in the vicinity of the mouth of Slate Creek was the application of the DDT spray.

Additional observations by District 2 personnel indicate that this kill did not have any immediate, severe effect upon the game fish population of Painted Rocks Reservoir.

CONCLUSIONS:

East Fork Unit: Bottom samples taken from the East Fork of the Bitterroot River indicate that little damage was done to the bottom fauna of this stream. Camp Creek and Warm Springs Creek suffered large insect kills immediately following the application of the DDT spray. The drift samples showed that the mayflies were the most susceptible insects. Post-spray bottom samples, taken 2 1/2 months after spraying, indicated that these streams were recovering.

One fish kill was investigated that occurred within the spray boundaries of the East Fork Unit. This investigation showed that dead and moribund fish were heavily infected with a fungus (thought to be Saprolegnia) and that DDT was not a likely contributing factor to the kill.

West Fork Unit: Samples collected from the West Fork of the Bitterroot River indicate that the mayfly population was materially reduced for a short period following spraying, but had partially recovered by the time of the last sampling, September 25, 1959. Overwhich Creek, Hughes Creek, and Slate Creek also had large numbers of mayflies killed, but were partially re-populated by September 25th. None of the other insects in any of the principle streams were severely effected.

One fish kill occurred in the West Fork Unit, which could be associated with the spray operation. This kill occurred in Painted Rocks Reservoir. Fish mortality was heaviest near the mouth of Slate Creek but extended all around the shoreline of the lake. Conflicting reports concerning the actual beginning of this kill cause doubt as to its most probable cause. However, the only unusual factor known to be present at the time of the largest die-off was the application of the DDT spray. Positive determination of the causal agent was beyond the scope of this project, which was limited to determining whether or not it had any immediate fishery management importance. It did not.

In general, the streams or sections of streams that were timbered down to the water's edge suffered a larger insect kill than those that were free from timber. In the former instances, the spray pilots were not able to keep the spray from being blown or drifting into the stream. In another case, a heavy rain is thought to have washed DDT into a stream, changing a light insect kill into a severe kill.

Usually, the duration of the insect kills was relatively short-lived. Most of the drifting insects had passed the sample stations within four hours after the spraying was completed. The most susceptible insects were the mayflies, followed by the caddisflies in streams where the latter were found in large numbers.

Much of the DDT reaching the streams resulted from leaky shut-off valves on the spray tanks, from pilots spraying too close to the stream or lake banks, or from adverse weather conditions.

RECOMMENDATIONS:

A. Procedure

1. Spray pilots and Forest entomologists should be more firmly instructed to leave an unsprayed strip along stream and lake shores.

2. Spray equipment should be in such order that dripping shut-off valves do not occur.

3. Spray pilots should be instructed to refrain from making steep, banking turns over streams and lakes, wherever possible.

B. Investigation

1. A fishery management investigation should be made of future spray operations. The objectives should be:

   a. To locate areas of fishery damage and determine what special management measures, if any, may be necessary.

b. To observe the techniques of the spray application and make suggestions for minimizing its effects on the aquatic habitat, wherever possible.

c. To investigate any fish kills which may occur coincident with the spray project, and to determine the most likely cause(s) of each kill, where possible.

2. Insect sampling should be limited to the important fishing waters within the spray boundary.

3. Some aerial observations of the spray application should be made. Radio contact between the airplane employed for such observations and the ground crew is very desirable.

Prepared by: Joe E. Huston

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Approved by: George D. Holton

Date: Sept. 15, 1960