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cc: Education-Game
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DIVISION OF FISHERIES
MICHIGAN DEPARTMENT OF CONSERVATION
COOPERATING WITH THE
UNIVERSITY OF MICHIGAN

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April 29, 1958

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ANN ARBOR, MICHIGAN

Report No. 1544

THIRD, FOURTH AND FIFTH ANNUAL REPORTS OF THE PIGEON RIVER
TROUT RESEARCH STATION FOR 1951, 1952 and 1953

by

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Introduction

The first two annual reports on activities at the Pigeon River Trout Research Area, for 1949 and 1950 (I.F.R. reports Nos. 1250 and 1288), dealt with fish and fishing only in the river. During 1949-1950, six of the seven lakes on the area were utilized by Tanner (1952) in lake fertilization studies, and Ford Lake was utilized by Karvelis (1953) for studies on blue-gill-trout relationships; both studies were graduate problems at Michigan State College.

The present report covers the fishery activities at the Pigeon River Trout Research Area during 1951, 1952 and 1953. Final preparation of this report has been delayed considerably, and in the meantime the sixth, seventh and eighth annual reports for 1954, 1955 and 1956 have been completed (I.F.R. reports Nos. 1512, 1521 and 1527).

A new section of river, one and two-tenths miles in length, was added to the experimental area in 1953 (Fig. 1). This fifth section, Section E, extends from the Vanderbilt Road bridge up to the first large pool below

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MICHIGAN DEPARTMENT OF CONSERVATION
FISH DIVISION
PIGEON RIVER TROUT RESEARCH AREA
OTSEGO AND CHEBOYGAN COUNTIES

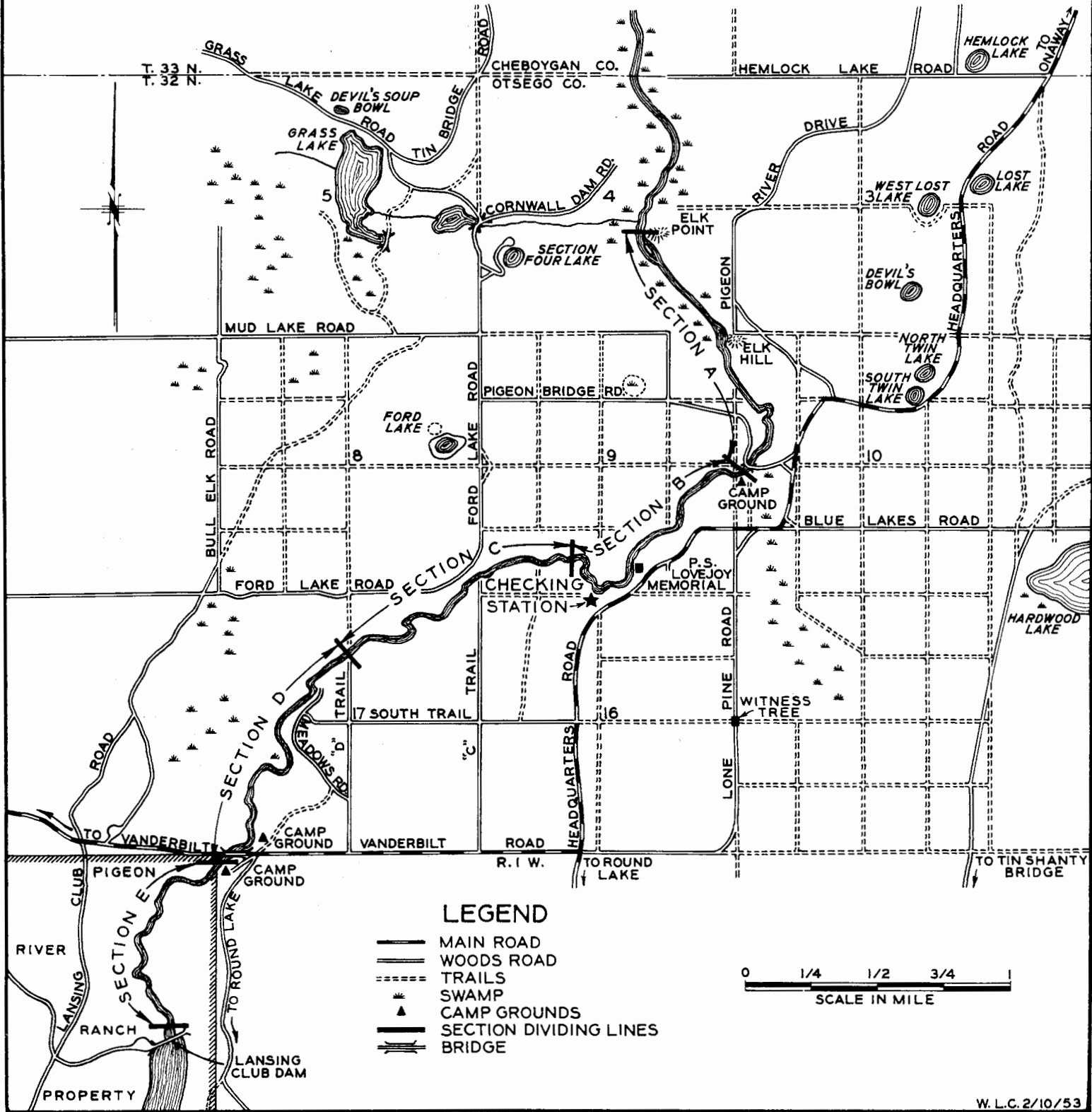


Figure 1

THE PIGEON RIVER TROUT RESEARCH AREA

This research and experimental area is located in the northeastern corner of Otsego County and in a small portion of Cheboygan County in the Pigeon River State Forest. Here six miles of the Pigeon River and seven trout lakes have been designated as experimental waters for studies on brook, brown, and rainbow trout. This program, as is also true with other functions of the Fish Division, is financed solely from the sale of fishing licenses and trout stamps. Its success depends to a large extent on the cooperation of the fishing public in supplying the information needed to maintain and improve trout fishing.

The Pigeon River in this experimental area is divided into five convenient fishing sections as indicated on the reverse side of this sheet. Seven trout lakes of unusual character are included in the trout research program. These lakes are believed to have been formed geologically through the solution of underlying limestone by ground water, and a settling of the surface layer of sand and gravel, producing cone-shaped pot holes, some with nearly vertical banks 50 to 60 feet high.

In order to obtain a complete record of the fishing in this area, each fisherman is required to register daily at the checking station, obtain a free permit to fish in any lake or portion of the stream and report back to the checking station before fishing in another lake or stream section or before leaving the area. Some experimental changes in the usual regulations governing trout fishing in Michigan are made from time to time in order to learn how necessary such restrictions are and whether changes may improve the angling quality. The special regulations will be stated on the fishing permit.

In addition to the information on fishing success collected from persons in the area, many other research projects are being followed by department personnel. Periodic estimates are made of the trout populations and information on rate of growth of the fish and their success in spawning is obtained. Studies of the returns from hatchery plantings are being made to determine their value and need.

The correct stocking programs for lakes of the type found in the Pigeon River Research Area, which lack natural spawning facilities, are being determined by plantings of different species of varying size and at different seasons of the year.

the Lansing Club dam, and is entirely within the boundary of private property. An agreement between the Lansing Club caretaker and the Pigeon River Trout Research Area staff stipulated that all anglers remain in the water when fishing in Section E. It is believed that the anglers cooperated wholeheartedly, for the arrangement proved satisfactory.

In 1949 and 1950, fishing regulations on experimental sections were:

Sections A and B--daily limit of 5 trout, minimum size 7 inches

Sections C and D--daily limit of 15 trout, minimum size 7 inches.

In 1951, new regulations were imposed on Sections C and D; they were in effect through 1953:

Sections A and B--daily limit of 5 trout, minimum size 7 inches

Sections C and D--daily limit of 2 trout, minimum size 9 inches.

For the new Section E, which was added to the experimental area in 1953, the following state-wide regulations were in effect:

Section E--daily limit of 10 trout, minimum size 7 inches.

There were no restrictions on bait for fishing in the Pigeon River during the period 1949-1953.

Fishing in the river and lakes within the Pigeon River Trout Research Area is by permit only. We believe that practically all anglers comply, and that the census of angling obtained at the checking station is virtually 100 percent complete for all fishing done on the area.

The results of the creel census and of fall population studies of trout in the river are presented, following closely the pattern set in the first two annual reports for 1949 and 1950. The results for the years 1951 to 1953 frequently were similar to results for 1949 and 1950, as for example, fishing intensity, species caught, fishing quality, residence of anglers, etc. Such

similarities can be seen by comparing the reports, and are not regularly alluded to in the present account. Rather, important differences and new findings are emphasized.

Fishing intensity and total catch on the river

Total fishing effort and catch for the five stream sections, for the three trout seasons (1951, 1952 and 1953), are summarized in Table 1. Large plantings of legal-size hatchery rainbows accounted for the large numbers of hatchery trout caught in Sections B and C during 1951. The presence of these hatchery fish presumably also accounts for the comparatively high fishing pressure in Sections B and C during 1951. All hatchery fish had been marked by either tag or fin-clip and could be recognized when caught. Returns on hatchery trout are treated more fully below.

Fishing intensity on a weekly basis is given in Table 2, which also gives the inclusive dates of the trout fishing seasons for the three years. The opening week end and legal holidays drew the greatest numbers of anglers, and fishing pressure dropped off sharply after the Labor Day week end. Nevertheless, there was a striking uniformity of fishing pressure throughout each season.

Weekly catches of wild and hatchery trout for the three fishing seasons are given in Table 3. The catch of wild trout was distributed quite evenly throughout each season, corresponding to the rather uniform distribution of angling pressure. A good seasonal spread in the catch of legal-size hatchery rainbows during 1951 was obtained by making several plantings periodically throughout the fishing season. The hatchery returns during 1952 were carryovers from the 1951 plantings of legal-size fish. The hatchery fish caught during 1953 were from plantings of sublegal trout made during late fall of

Table 1.--Fishing intensity and catch of trout in the Pigeon River, by sections, 1951, 1952 and 1953

Experimental section and year	Fishing trips			Number of hours fished	Number of trout taken [*]				Hatchery trout	Per successful trip	Per trip
	Number	Successful trips			Wild trout						
		Number	Percent		Brook	Brown	Rainbow	Total			
A: 1951	367	143	38.9	950.5	177	28	2	207	129	2.35	0.92
1952	248	90	36.3	660	170	26	14	210	12	2.47	0.90
1953	361	122	33.8	965	118	22	13	153	100	2.07	0.70
B: 1951	1,250	654	52.3	3,148	225	162	6	393	1,535	2.95	1.54
1952	604	189	31.3	1,563	234	72	19	325	27	1.86	0.58
1953	617	236	38.2	1,535	166	61	57	284	343	2.66	1.02
C: 1951	953	608	63.8	2,159	19	26	1	46	1,011	1.74	1.11
1952	259	32	12.4	758	17	13	4	34	4	1.19	0.15
1953	202	40	19.8	646	25	13	5	43	9	1.30	0.26
D: 1951	276	53	19.2	818.5	32	12	1	45	23	1.28	0.25
1952	339	57	16.8	976.5	43	16	10	69	3	1.26	0.21
1953	353	53	15.0	1,138	30	26	3	59	1	1.13	0.17
E: 1953	410	187	45.6	1,405	403	81	10	494	216	3.80	1.73
All sections:											
1951	2,846	1,458	51.2	7,076	453	228	10	691	2,698	2.32	1.19
1952	1,450	368	25.4	3,957.5	464	127	47	638	46	1.86	0.47
1953	1,943	638	32.8	5,689	742	203	88	1,033	669	2.67	0.88

*The legal length on trout during the three years was 7 inches in Sections A, B and E and 9 inches in Sections C and D.

Table 2.--Angling pressure in the Pigeon River, by weeks, 1951, 1952 and 1953

1951 season by weeks	Number of fishing trips	1952 season by weeks	Number of fishing trips	1953 season by weeks	Number of fishing trips
April 28 - May 4	185	April 26 - May 2	170	April 25 - May 1	82
May 5 - May 11	122	May 3 - May 9	62	May 2 - May 8	52
May 12 - May 18	112	May 10 - May 16	63	May 9 - May 15	56
May 19 - May 25	177	May 17 - May 23	64	May 16 - May 22	91
May 26 - June 1	167	May 24 - May 30	76	May 23 - May 29	90
June 2 - June 8	151	May 31 - June 6	137	May 30 - June 5	110
June 9 - June 15	177	June 7 - June 13	45	June 6 - June 12	115
June 16 - June 22	190	June 14 - June 20	47	June 13 - June 19	92
June 23 - June 29	170	June 21 - June 27	64	June 20 - June 26	59
June 30 - July 6	130	June 28 - July 4	116	June 27 - July 3	72
July 7 - July 13	132	July 5 - July 11	97	July 4 - July 10	185
July 14 - July 20	80	July 12 - July 18	53	July 11 - July 17	110
July 21 - July 27	116	July 19 - July 25	55	July 18 - July 24	82
July 28 - Aug. 3	122	July 26 - Aug. 1	52	July 25 - July 31	82
Aug. 4 - Aug. 10	157	Aug. 2 - Aug. 8	43	Aug. 1 - Aug. 7	78
Aug. 11 - Aug. 17	192	Aug. 9 - Aug. 15	66	Aug. 8 - Aug. 14	96
Aug. 18 - Aug. 24	136	Aug. 16 - Aug. 22	60	Aug. 15 - Aug. 21	144
Aug. 25 - Aug. 31	132	Aug. 23 - Aug. 29	68	Aug. 22 - Aug. 28	122
Sept. 1 - Sept. 7	164	Aug. 30 - Sept. 5	71	Aug. 29 - Sept. 4	94
Sept. 8 - Sept. 9	34	Sept. 6 - Sept. 12	34	Sept. 5 - Sept. 11	112
		Sept. 13 - Sept. 14	7	Sept. 12 - Sept. 13	19
Total	2,846	Total	1,450	Total	1,943

An average of 21.1 trips per day for the 135-day season for 1951.

An average of 10.2 trips per day for the 142-day season for 1952.

An average of 13.5 trips per day for the 143-day season for 1953.

Table 3.--Weekly catches of wild and hatchery trout, Pigeon River, 1951, 1952 and 1953

1951 season by weeks	Trout caught		1952 season by weeks	Trout caught		1953 season by weeks ³	Trout caught	
	Wild	Hatchery ¹		Wild	Hatchery ²		Wild	Hatchery ⁴
April 28 - May 4	66	58	April 26 - May 2	48	1	April 25 - May 1	42	2
May 5 - May 11	44	75	May 3 - May 9	24	0	May 2 - May 8	81	2
May 12 - May 18	37	104	May 10 - May 16	19	1	May 9 - May 15	25	0
May 19 - May 25	59	191	May 17 - May 23	21	2	May 16 - May 22	94	24
May 26 - June 1	33	174	May 24 - May 30	43	1	May 23 - May 29	58	6
June 2 - June 8	34	268	May 31 - June 6	41	3	May 30 - June 5	83	46
June 9 - June 15	58	230	June 7 - June 13	22	3	June 6 - June 12	97	36
June 16 - June 22	21	261	June 14 - June 20	13	0	June 13 - June 19	46	26
June 23 - June 29	37	164	June 21 - June 27	50	4	June 20 - June 26	23	32
June 30 - July 6	16	75	June 28 - July 4	45	10	June 27 - July 3	50	17
July 7 - July 13	42	78	July 5 - July 11	38	2	July 4 - July 10	79	43
July 14 - July 20	20	56	July 12 - July 18	31	1	July 11 - July 17	49	16
July 21 - July 27	25	76	July 19 - July 25	15	3	July 18 - July 24	19	9
July 28 - Aug. 3	28	119	July 26 - Aug. 1	14	2	July 25 - July 31	58	18
Aug. 4 - Aug. 10	33	153	Aug. 2 - Aug. 8	32	1	Aug. 1 - Aug. 7	24	4
Aug. 11 - Aug. 17	47	308	Aug. 9 - Aug. 15	66	4	Aug. 8 - Aug. 14	46	31
Aug. 18 - Aug. 24	29	113	Aug. 16 - Aug. 22	17	1	Aug. 15 - Aug. 21	42	16
Aug. 25 - Aug. 31	23	93	Aug. 23 - Aug. 29	19	2	Aug. 22 - Aug. 28	47	160
Sept. 1 - Sept. 7	34	80	Aug. 30 - Sept. 5	52	3	Aug. 29 - Sept. 4	27	99
Sept. 8 - Sept. 9	5	22	Sept. 6 - Sept. 12	24	2	Sept. 5 - Sept. 11	36	56
			Sept. 13 - Sept. 14	4	0	Sept. 12 - Sept. 13	7	26
Totals	691	2,698	Totals	638	46	Totals	1,033	669

¹Legal-size hatchery rainbows planted periodically throughout the season in 1951.

²Only sublegal hatchery trout planted during 1952.

³A new section (Section E) was added to the experimental area in 1953, for which records are included.

⁴Legal-size hatchery brook trout (P.R.S. "trained" fish) were planted in Section B on August 26, 1953.

1952 and early spring of 1953 and from a planting of legal-size brook trout made on August 26, 1953. The latter accounts for the sudden increase in catch of hatchery fish during the week of August 22-28, 1953.

One aspect of fishing intensity is the frequency with which a particular angler (a given person) fishes on the river. How many daily fishing trips does he make during a season? The great majority of persons who fished the experimental section of the Pigeon River made only one daily trip in a given season (Table 4); the percentages were 61, 75 and 69 for 1951, 1952 and 1953. Very few made more than three or four trips. The top figure was for a person who made 56 trips during the 1952 season. The analysis in Table 4 also shows the total numbers of individual anglers who fished on the Pigeon River, namely, 1,335 during 1951, 916 during 1952, and 1,108 during 1953.

The creel census data for the Pigeon River were summarized in a form to show the number of trout taken per angler trip (Table 5) for each of the five experimental sections of river. Half or more of the angler trips were unsuccessful, i.e., no trout were caught. This figure was 48.8 percent in 1951 when plantings of legal-size hatchery rainbows in Sections B and C made a major contribution to the fishing; it was 74.7 percent in 1952 when very few hatchery fish were available to the angler; and it was 66.8 percent in 1953 when a moderate number of hatchery trout were caught. For those stream sections and years when angling was dependent mostly on wild trout, from 60 percent to 85 percent of angling trips were unsuccessful. In Sections C and D with a creel limit of two trout, a substantial number of anglers (46.8 percent) caught their two fish where hatchery fish were available, but very few (1.9 to 5.9 percent) caught their two fish where only wild trout were available. In Sections A and B, under a five-fish limit, the total fishing

Table 4.--Distribution of individual anglers according to number of fishing trips made by each angler during the season, Pigeon River, 1951, 1952 and 1953

Number of fishing trips	1951 anglers ¹		1952 anglers ²		1953 anglers ³	
	Number	Percent	Number	Percent	Number	Percent
1	818	61.3	683	74.6	763	68.9
2	237	17.8	136	14.9	190	17.2
3	121	9.1	46	5.0	52	4.7
4	50	3.8	25	2.7	40	3.6
5	27	2.0	6	0.7	27	2.4
6	23	1.7	3	0.3	6	0.5
7	12	0.9	3	0.3	10	0.9
8	8	0.6	6	0.7	4	0.3
9	4	0.3	2	0.2	4	0.3
10	7	0.5	2	0.2	1	0.1
11	3	0.2	1	0.1	1	0.1
12	2	0.1	...	...	1	0.1
13	4	0.3	...	...	1	0.1
14	2	0.1	...	...	1	0.1
15	2	0.1	1	0.1	3	0.3
16	5	0.4	...	...	1	0.1
17	1	0.1	...	...	1	0.1
18	3	0.2	...	...	1	0.1
19	1	0.1	...	...	1	0.1
20	2	0.1	1	0.1	...	...
27	1	0.1	...	...	...	...
29	1	0.1	...	...	...	...
31	1	0.1	...	...	...	...
56	...	...	1	0.1	...	...
Totals	1,335	100.0	916	100.0	1,108	100.0

¹Total fishing trips during 1951: 2,846.

²Total fishing trips during 1952: 1,450.

³Total fishing trips during 1953: 1,943.

Table 5.--Distribution of fishing trips according to number of trout caught each trip, by stream section, Pigeon River, 1951, 1952 and 1953

Creel limits: 5 trout in Sections A and B, 2 trout in Sections C and D, and 10 trout in Section E

Trout per trip	Year	Section A		Section B		Section C		Section D		Section E [↓]		All sections	
		Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent
0	1951	224	61.0	597	47.8	346	36.3	223	80.8	...	...	1,390	48.8
	1952	160	64.5	413	68.4	227	87.7	284	83.8	...	...	1,084	74.8
	1953	240	66.5	380	61.5	162	80.2	300	85.0	216	52.7	1,298	66.8
1	1951	62	16.9	183	14.6	160	16.8	38	13.8	...	...	443	15.6
	1952	38	15.3	110	18.2	26	10.0	40	11.8	...	...	214	14.8
	1953	56	15.5	85	13.8	28	13.9	46	13.0	38	9.3	253	13.0
2	1951	25	6.9	119	9.5	446	46.8	15	5.4	...	...	605	21.3
	1952	15	6.1	35	5.8	6	2.3	15	4.4	...	...	71	4.9
	1953	27	7.5	48	7.8	12	5.9	7	2.0	41	10.0	135	6.9
3	1951	20	5.5	94	7.5	1*	0.1	...	...	...	...	115	4.0
	1952	10	4.0	22	3.6	...	...	...	...	...	...	32	2.2
	1953	18	5.0	28	4.5	...	...	...	...	31	7.6	77	4.0
4	1951	16	4.3	62	5.0	...	...	...	...	...	...	78	2.7
	1952	7	2.8	14	2.3	...	...	...	...	...	...	21	1.4
	1953	12	3.3	17	2.8	...	...	...	...	29	7.1	58	3.0
5	1951	20	5.4	194	15.5	...	...	...	...	...	...	214	7.5
	1952	18	7.3	10	1.7	...	...	...	...	...	...	28	1.9
	1953	8	2.2	58	9.4	...	...	...	...	14	3.4	80	4.1
6	1951	...	...	1 [▽]	0.1	...	...	...	...	...	...	1	0.1
	1952	...	...	...	...	...	...	...	...	...	...	...	...
	1953	...	...	1 [▽]	0.2	...	...	...	...	10	2.4	11	0.6
7	1953	...	...	...	...	...	...	...	...	7	1.7	7	0.4
8	1953	...	...	...	...	...	...	...	...	7	1.7	7	0.4
9	1953	...	...	...	...	...	...	...	...	3	0.7	3	0.1
10	1953	...	...	...	...	...	...	...	...	14	3.4	14	0.7
Total	1951	367	...	1,250	...	953	...	276	...	...	...	2,846	...
	1952	248	...	604	...	259	...	339	...	...	...	1,450	...
	1953	361	...	617	...	202	...	353	...	410	...	1,943	...

[↓]Section E was added to experimental area in 1953; no prior records.

[▽] Exceeded creel limit.

effort for the three seasons (1951-1953) was 3,447 fishing trips, with no trip yielding more than six fish. The record for Section E during 1953 was better, where 14 out of 410 trips yielded the limit of ten trout.

Indices of fishing quality

The unit of fishing quality used in this report is the catch per hour per fishing trip (see I.F.R. Report No. 1250). With this statistic and its mean and standard error, it is possible to make statistical comparisons of fishing quality. Figures on mean catch per hour, standard error, and percentage of successful fishing trips are given in Table 6. Separate tabulations were made for hatchery and wild fish. The figures show that the fishery for wild trout is rather stable from year to year in each of the experimental sections. For hatchery trout, the catch per hour for any one year and section reflects the number of trout planted during that year. The catch per hour was significantly better where and when hatchery plantings were made.

Another approach in summarizing catch records for a number of fishing trips is to simply divide total fish by total hours for a figure on average catch per hour. Such averages are given in the

Table 6.--Mean catch per hour per fishing trip, and percentage of successful trips, for trout (all species combined), by section, Pigeon River, 1951, 1952 and 1953

Stream section and fishing statistics [↓]	1951 [*]		1952		1953 [*]	
	Wild trout	Hatchery trout	Wild trout	Hatchery trout	Wild trout	Hatchery trout
<u>Section A</u>						
Mean catch per hour	0.259	0.144	0.314	0.016	0.158	0.087
Standard error of mean	0.021	0.021	0.036	0.006	0.021	0.013
Percent successful fishing trips	31.6	20.4	35.7	3.6	23.5	16.6
<u>Section B</u>						
Mean catch per hour	0.123	0.694	0.196	0.021	0.160	0.355
Standard error of mean	0.009	0.042	0.017	0.016	0.050	0.049
Percent successful fishing trips	19.9	45.7	30.1	3.6	24.3	22.2
<u>Section C</u>						
Mean catch per hour	0.024	0.760	0.049	0.010	0.071	0.020
Standard error of mean	0.005	0.033	0.037	0.005	0.015	0.010
Percent successful fishing trips	4.0	62.4	10.7	1.5	17.8	3.5
<u>Section D</u>						
Mean catch per hour	0.062	0.036	0.087	0.054	0.058	0.001
Standard error of mean	0.013	0.009	0.045	0.002	0.010	0.001
Percent successful fishing trips	13.4	7.2	16.5	1.5	14.7	0.3
<u>Section E (Opened in 1953)</u>						
Mean catch per hour	...	...	...	...	0.338	0.146
Standard error of mean	...	...	...	...	0.029	0.017
Percent successful fishing trips	...	...	...	...	39.5	26.8
<u>All sections</u>						
Mean catch per hour	0.101	0.581	0.165	0.014	0.227	0.162
Standard error of mean	0.006	0.022	0.011	0.008	0.009	0.017
Percent successful fishing trips	15.4	44.3	24.5	2.7	24.9	16.2

[↓]For numbers of fishing trips involved, see Table 5.

^{*}Years when hatchery trout were planted.

following 5-year summary for the experimental sections of the Pigeon River:

<u>Item</u>	<u>Year</u>				
	<u>1949</u>	<u>1950</u>	<u>1951</u>	<u>1952</u>	<u>1953</u>
Number of wild trout caught	1,048	1,190	691	638	1,033
Catch per hour	0.15	0.19	0.09	0.16	0.18
Percentage successful trips	26.2	27.3	15.4	24.5	24.9
Number of hatchery trout caught	1,670	2,303	2,698	46	669
Catch per hour	0.24	0.37	0.38	0.01	0.12
Percentage successful trips	32.9	36.6	44.3	2.7	16.2
Total fish caught	2,718	3,493	3,389	684	1,702
Total hours fished	6,817	6,195	7,076	3,957.5	5,689
Catch per hour (all fish)	0.39	0.56	0.47	0.17	0.30

The lower catch per hour of wild trout in 1951 coincided with the reduced creel limit of two trout and the higher size limit of 9 inches which went into effect that year on Sections C and D. The figures for hatchery trout, and for all trout, reflect the large plantings of legal-size hatchery trout made during 1949, 1950 and 1951, the absence of hatchery trout during the 1952 season, and the planting of sublegal trout plus the inclusion of Section E for the 1953 season.

Types of lures used and fishing quality

Table 7 compares the principal lures used on the Pigeon River as to extent of use, fish caught, and catch per hour. The three lures used most were worms, worms plus spinner, and artificial flies. The miscellaneous

Table 7.--Fishing success according to lure used, Pigeon River,
1951, 1952 and 1953

Year	Lure	Fishing trips		Trout caught		Average catch per hour per angler, all trout
		Number	Percent successful	Wild	Hatchery	
1951	Worms	1,254	53	225	1,398	0.79
	Worms and spinner	327	54	61	313	0.60
	Flies	772	49	294	529	0.57
	Miscellaneous	493	47	111	458	0.64
1952	Worms	430	24	171	15	0.14
	Worms and spinner	266	20	84	8	0.09
	Flies	544	33	341	21	0.28
	Miscellaneous	210	13	42	2	0.09
1953	Worms	594	33	251	258	0.35
	Worms and spinner	378	31	172	116	0.23
	Flies	634	36	473	204	0.44
	Miscellaneous	337	29	137	91	0.24

category included grasshoppers, salmon eggs, various insect larvae, minnows, Dardevle, Flatfish, Colorado Spinner, and combinations of spinners with various live baits other than worms. Worms and flies continued to be the most popular lures on the Pigeon River. Worm fishermen took the larger proportion of hatchery trout, whereas fly fishermen took the larger proportion of wild trout (Table 8).

Size of wild trout taken by anglers

Trout caught by anglers were measured at the checking station. The length-frequency data are summarized for wild trout by species and year in Table 9. (An analysis of length by stream section could be made from records on file at the station.) Brook trout were somewhat smaller, on the average, than browns and rainbows. Brooks and browns taken during 1953 averaged somewhat larger than those taken during 1951 and 1952, reflecting the higher (9-inch) size limit which was in effect on Sections C and D during 1953.

Contribution of hatchery trout to angling

Starting with 1949, the first year of operation for the Pigeon River Trout Research Station, considerable emphasis in research was put on studying returns to anglers from plantings of legal-size hatchery trout. In 1949, plantings of three species of trout (brook, brown and rainbow) were evaluated (I.F.R. Report No. 1250). Brook trout and rainbow trout gave much better returns to anglers than did browns, so that in 1950, plantings were limited to legal-size brooks and rainbows (I.F.R. Report No. 1288). In 1950, the rainbow was found to give equal returns and a better spread

Table 8.--Catch of trout according to principal lures--a 3-year (1951-1953)
summary for the five experimental sections of the Pigeon River

Lure	Number of trout caught			Percentage caught by lure		
	Wild	Hatchery	Total	Wild	Hatchery	Total
Worms	647	1,671	2,318	27.4	49.0	40.1
Flies	1,108	754	1,862	46.9	22.1	32.2
Worms and spinners	317	437	754	13.4	12.8	13.1
Miscellaneous	290	551	841	12.3	16.1	14.6
Total	2,362	3,413	5,775	100.0	100.0	100.0

Table 9.--Frequency distributions of lengths (in inches) of wild trout taken by anglers, Pigeon River, all sections combined, 1951, 1952 and 1953

Total length in inches	Brook trout			Brown trout			Rainbow trout		
	1951	1952	1953	1951	1952	1953	1951	1952	1953
6.7 - 6.9*	10	16	12	2	..	1	..	1	..
7.0 - 7.9	282	306	338	84	46	72	3	15	53
8.0 - 8.9	94	82	220	44	27	33	4	9	16
9.0 - 9.9	46	47	101	61	23	32	1	12	10
10.0 - 10.9	12	7	43	21	18	29	1	6	4
11.0 - 11.9	7	5	17	12	7	11	..	3	2
12.0 - 12.9	..	1	6	2	4	9	..	1	1
13.0 - 13.9	1	..	2	2	1	8	..	..	..
14.0 - 14.9	1	..	1	..	1	4	..	..	..
15.0 - 15.9	..	..	2	..	..	1	1	..	1
16.0 - 16.9	..	..	..	..	..	2	..	..	1
17.0 - 17.9	..	..	..	..	..	1	..	..	..
Total number	453	464	742	228	127	203	10	47	88
Average length	8.0	7.9	8.4	8.8	8.9	9.3	9.2	8.9	8.3

*A few fish, slightly under the legal size of 7 inches, were kept by anglers and are regarded as part of angler harvest in Table 1.

over time than the brook trout. Thus, in 1951, plantings of legal-size hatchery trout were limited to rainbows. Returns from the planting of legal-size trout in the Pigeon River, for 1949 to 1951, have been published by Cooper (1953).

Plantings of hatchery trout in the Pigeon River during the three years 1951 to 1953 included the legal-size rainbows planted in Sections B and C during 1951; sublegal brooks, browns and rainbows planted in Sections A and B during the fall of 1951 and the fall of 1952; sublegal brooks and rainbows planted in Section E in the spring of 1953; and legal-size brook trout planted in Section B during 1953. Returns on these plantings, through the 1953 trout season, are cited in previous sections of the present report. Hatchery fish caught during 1951 to 1953 were almost entirely fish which had been planted during these years; in other words there was almost no carryover to 1951 of legal-size hatchery trout planted during 1949 and 1950.

The plantings of legal-size rainbows made in Sections B and C during 1951 involved 4,504 jaw-tagged fish, or seven approximately equal lots of 644 fish each. The seven lots were planted at seven different times spaced about equally throughout the trout fishing season. Half of each lot was planted in Section B, and half in Section C. Section B had a 5-fish creel limit and a 7-inch minimum length on trout; Section C had 2-fish and 9-inch limits. Fish planted in Section C were over 9 inches in length. Of these 4,504 trout, anglers harvested 2,783 or 61.8 percent during 1951 (a few of these fish were from outside the research area), an additional 10 fish in 1952, and 1 fish in 1953, for a final return of 2,794 fish or 62 percent. These returns during 1951 were appreciably better than returns during 1949

when creel limits were five fish in Section B and fifteen fish in Section C. During 1949 a total of 1,500 rainbows were planted in five, 150-fish lots in Sections B and C; the total return was 44.7 percent (I.F.R. Report No. 1250).

The legal-size brook trout planted during 1953 were fish which had been "trained" by Psychological Research Services, Inc. (see I.F.R. Report No. 1510); 500 fish were put in Section B on August 26. In the nineteen remaining days of that trout season, anglers caught 289 (59.8 percent) of these fish, and 11 were caught during 1954 for a final return of 300 fish or 60 percent.

The plantings of sublegal trout which were made during 1951 to 1953, and returns through 1953, are enumerated in Table 10. The plantings made during 1951 gave poor returns--0.6 to 3.3 percent during two fishing seasons. The 1952 and 1953 plantings did better--up to 17 and 22 percent in one fishing season. Best returns came from rainbows.

Movement of trout in the Pigeon River

Records of fish caught by anglers and observations made while collecting fish by electric shocker have provided us with information on movements of trout, particularly hatchery fish.

In 1951, a mid-April planting of 644 legal-size, jaw-tagged rainbow trout was made in Section B; these fish literally raced downstream beyond the limits of the experimental area. Some of these fish were taken by shocker thirty-five miles below Section B in less than a week after they were planted. Low water temperature (43° F. at the time) was believed responsible for the movement.

Table 10.--Plantings of sublegal hatchery trout, and percentage return to the angler,
Pigeon River, 1951, 1952 and 1953

Date planted	Species planted	Quantity planted	Stream section	Type of marking	Average size (inches)	1952		1953		Total	
						Catch	Percent	Catch	Percent	Catch	Percent
1951											
Oct. 5	Brook	2,000	B	F.C. ↓	4	19	0.9	2	0.1	21	1.0
Oct. 5	Brown	400	B	F.C.	4	6	1.5	5	1.2	11	2.7
Oct. 5	Brown	300	C	F.C.	4	0	...	10	3.3	10	3.3
Oct. 8	Brook	3,000	C	F.C.	4.5	6	0.2	11	0.4	17	0.6
1952											
Oct. 22	Rainbow	303	A	F.C.	4	..	...	68	22.4	68	22.4
Nov. 26	Brook	2,500	A	F.C.	5	..	...	81	3.2	81	3.2
Dec. 2	Brown	500	A	F.C.	3.7	..	...	7	1.4	7	1.4
1953											
May 8	Brook	500	E	F.C.	5	..	...	64	12.8	64	12.8
May 8	Brook	500	E	J.T. ↘	5.2	..	...	10	2.0	10	2.0
May 12	Rainbow	500	E	F.C.	5	..	...	88	17.6	88	17.6
May 12	Rainbow	500	E	J.T.	5	..	...	33	6.6	33	6.6
Totals		11,003	...	...	...	..	...	..	...	410	3.7

↓ Fin Clipped.

↘ Jaw Tagged.

Legal-size brook trout planted in Section B on August 26, 1953 tended to move downstream much more than upstream. From the 500 fish planted in Section B, anglers caught, during the 19 days remaining in the trout season, 252 trout from Section B, 37 from Section A about a mile downstream, and none from sections upstream from B. However, during post-season population surveys made in mid-September, marked fish from this planting were found in Section E, over two miles upstream from where they had been planted.

On November 12, 1953, 2,500 fin-clipped brook trout averaging 4.9 inches long, and 467 fin-clipped brown trout averaging 4.1 inches long, were planted in Section A. During monthly experimental studies conducted in Section E, several of these marked fish were recovered, showing an upstream movement of not less than three and three-quarters miles in less than three weeks.

One 9-inch brook trout was known to have moved more than a mile upstream in less than 48 hours during population survey studies. This fish was captured by shocker, and was marked and released in Section A on September 14, 1953. On September 15, this fish was recaptured, marked a second time, and again released in Section A. On September 17, this same fish was captured in Section C, more than a mile upstream from Section A.

Sex ratio of trout in angler's catches

Some concern had been expressed by trout fishermen over the possibility that more female than male brook trout and brown trout were being caught during the latter part of each trout season and that such a condition, if it existed, would be detrimental to natural reproduction. Sex determinations were made on all brook trout and brown trout taken by anglers from the Pigeon

River during the period of August 22 to September 13, 1953 (Table 11). There was not a significant difference in numbers of male and female trout taken by anglers during this period.

Residence of anglers

This analysis of residence of anglers is based on the total number of fishing trips, rather than on anglers as individuals. An analysis of fishing trips according to residence of anglers is given in Tables 12, 13 and 14. Otsego County rated high (second) among Michigan counties because of the geographical fact that it includes the Pigeon River Area. Counties adjacent to Otsego (Montmorency, Cheboygan, Presque Isle, Antrim, Charlevoix, etc.) rated low, showing that local anglers in the "trout country" do not travel far to their preferred trout stream (Table 12). Ignoring the factor of geographical location, the most fishermen came from counties with the highest population (Tables 12 and 13), especially Wayne, Oakland, Genesee and Ingham. Nonresidents from 23 states and one Canadian province did 14 percent of the fishing on the Pigeon River during 1951-1953; Ohio residents accounted for more than half of this (Table 14).

Fall population estimates

At the end of each trout fishing season, in mid-September, an estimate is made of the number of trout in the experimental sections of the Pigeon River. A four- or five-man crew operates an electric shocker throughout the six miles of stream from the lower end of Section A to the upper end of Section E. Two "runs" are made through the entire length of stream. Each run requires 4 or 5 days. On the first run, all trout which are caught

Table 11.--Male and female trout in anglers' catch,
Pigeon River, August 22 to September 13, 1953

Weekly periods	Brooks		Browns	
	Male	Female	Male	Female
August 22	4	1	0	1
August 23 - 29	95	105	8	7
August 30 - September 5	54	46	1	2
September 6 - 12	32	34	7	1
September 13	2	1	1	0
Totals	187	187	17	11

Table 12.--Distribution of fishing trips according to residence of anglers, by Michigan counties and out-of-State totals, for the Pigeon River, 1951, 1952 and 1953

County	1951	1952	1953	County	1951	1952	1953
Alcona	3	0	0	Kent	24	30	35
Allegan	2	0	0	Lake	1	0	0
Alpena	60	7	11	Lapeer	6	8	10
Antrim	12	9	2	Lenawee	10	2	4
Arenac	1	0	3	Livingston	4	7	21
Barry	2	5	19	Macomb	56	24	36
Bay	131	50	86	Marquette	1	0	0
Berrien	26	3	5	Mason	0	0	1
Branch	33	18	7	Mecosta	15	3	3
Calhoun	18	15	17	Midland	50	29	28
Cass	1	0	1	Monroe	10	2	10
Charlevoix	15	8	4	Montcalm	31	7	10
Cheboygan	26	12	8	Montmorency	1	7	2
Clare	29	11	0	Muskegon	15	8	22
Clinton	2	3	3	Newaygo	2	0	0
Crawford	0	1	10	Oakland	151	90	100
Dickinson	0	0	2	Oceana	10	0	0
Eaton	11	3	9	Ogemaw	6	0	0
Emmet	3	4	1	Oscoda	2	2	0
Genesee	149	55	78	Otsego	530	174	183
Gladwin	0	8	0	Ottawa	4	8	3
Grand Traverse	9	3	5	Presque Isle	20	13	8
Gratiot	3	4	18	Roscommon	5	1	5
Hillsdale	6	16	12	Saginaw	58	50	64
Huron	0	0	9	St. Clair	24	6	10
Ingham	101	68	57	St. Joseph	0	2	0
Ionia	18	18	14	Sanilac	0	4	0
Iosco	0	0	1	Shiawassee	26	11	61
Iron	0	2	0	Tuscola	50	6	8
Isabella	2	4	59	Van Buren	0	0	1
Jackson	26	12	24	Washtenaw	69	51	107
Kalamazoo	63	2	36	Wayne	590	307	426
				Wexford	8	2	0
				Total, Michigan	2,531	1,195	1,659
				Out-of-State	315	255	284
				Total	2,846	1,450	1,943

Table 13.--Distribution of fishing trips according to residence of anglers, for selected Michigan counties with high populations, Pigeon River, 1949-1953

County	Population of county (thousands)	1949		1950		1951		1952		1953	
		Number of fishing trips	Per- cent of total	Number of fishing trips	Per- cent of total	Number of fishing trips	Per- cent of total	Number of fishing trips	Per- cent of total	Number of fishing trips	Per- cent of total
Wayne	2,015	517	23.1	451	20.9	590	20.7	307	21.2	426	21.9
Oakland	254	111	5.0	142	6.6	151	5.3	90	6.2	100	5.1
Genesee	228	154	6.9	139	6.4	149	5.2	55	3.8	78	4.0
Ingham	130	113	5.1	110	5.1	101	3.5	68	4.7	57	2.9
Kent	246	43	1.9	33	1.5	24	0.8	30	2.1	35	1.8
Kalamazoo	100	39	1.7	12	0.6	63	2.2	2	0.1	36	1.8
Calhoun	94	13	0.6	25	1.2	18	0.6	15	1.0	17	0.9

Table 14.--Distribution of fishing trips according to residence
for out-of-state anglers, Pigeon River, 1951, 1952 and 1953

State or province	1951	1952	1953
Ohio	232	174	173
Indiana	27	27	46
Illinois	11	21	16
New York	5	13	21
Massachusetts	0	10	0
Maryland	9	1	1
Pennsylvania	5	3	7
Missouri	3	4	2
Colorado	3	1	0
Virginia	1	1	0
West Virginia	1	0	2
Florida	1	0	0
Nebraska	1	0	0
New Jersey	4	0	2
Kentucky	3	0	0
Kansas	2	0	1
California	5	0	0
Connecticut	2	0	1
Iowa	0	0	1
Mississippi	0	0	1
Minnesota	0	0	4
Wisconsin	0	0	4
Tennessee	0	0	1
Ontario	0	0	1
Total	315	255	284

are marked by clipping off a small piece of the dorsal portion of the caudal fin, the species noted, measured for length, and released. On the second run, starting 2 to 3 days or less after the first run, all fish caught are marked by clipping off a small piece of the ventral portion of the caudal fin, species noted, measured for length, recaptures of marked fish from the first run are noted and recorded, and the fish are released.

Population estimates are made by direct-proportion computations from the records of marked, unmarked, and recaptured fish (Petersen Method). The procedure is described and illustrated in detail by Waters (1957) in I.F.R. Report No. 1512. A brief summary of the procedure is as follows: Records are sorted for fish in four length groups (0"-3.9"; 4.0"-6.9"; 7.0"-9.9"; and 10"+). For each length group, a single estimate is made for trout, all species combined, for the six miles of river. The estimate is then apportioned into component quantities for the five experimental sections of the river. This apportionment is on the basis of relative numbers of trout, of the particular size group, taken from the different sections of river during the two runs with the shocker, including recaptures of marked fish. Then the number of trout of a particular size group and section is apportioned to the three species (brook, brown and rainbow), again in proportion to the numbers of each species of the given size group taken during the two shocker runs in that section. Finally, the number of trout of a given species, stream section, and size group is apportioned to a 1-inch frequency distribution by reference to the frequency distribution of shocker-caught trout of the same species and stream section. Weights of trout are obtained by applying a length-weight curve to the 1-inch length frequency distribution.

The numbers of wild trout of all sizes taken by DC shocker during the three fall population estimates (1951, 1952 and 1953) were as follows:

<u>Year</u>	<u>Dates</u>	<u>Run</u>	<u>Number of wild trout handled</u>	<u>Number of recaptures included in catch of second run</u>
1951	September 11-20	First	3,266	...
		Second	3,963	943
1952	September 15-22	First	4,438	...
		Second	4,486	1,210
1953	September 14-25	First	5,370	...
		Second	5,234	1,631

Thus each population estimate is based on a relatively large sample (about 40 percent to 50 percent of the total trout population present--see below).

The population estimates for the fall of 1951, 1952 and 1953 are given in Tables 15, 16 and 17, respectively. These tables also give the population estimates as pounds of trout per acre, based on the following acreages (of water surface) for sections: 7.16 acres in Section A, 5.90 in B, 5.39 in C, 5.65 in D, 5.67 in E, and 29.77 acres in total.

In addition to the estimates of wild trout, a population estimate was made on the survivors of tagged, legal-size, hatchery rainbow trout planted during 1951; a total of 4,504 nine-inch rainbows had been planted, equally divided between Sections B and C, and divided into groups which were planted every 2 to 4 weeks from April to August. During the collecting by shocker for the population estimate, September 11-20, 80 hatchery rainbows were caught on the first run, and 104 on the second run. The 104 included 22 recaptures of fish marked on the first run. By direct proportion,

Table 15.--Post-season population estimates (wild trout only), Pigeon River,

September 11-20, 1951

Section	Species of trout	Size groups, in inches										
		0 - 3.9		4.0 - 6.9		7.0 - 9.9		10.0 +		All sizes		
		Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Pounds per acre
A	Brook	576	8.2	313	14.7	107	18.1	...	...	996	41.0	5.7
	Brown	98	1.5	116	4.2	86	17.9	8	5.3	308	28.9	4.0
	Rainbow	57	0.8	...	...	19	4.0	...	...	76	4.8	0.7
	Total	731	10.5	429	18.9	212	40.0	8	5.3	1,380	74.7	10.4
B	Brook	1,564	22.1	615	28.8	80	12.7	...	...	2,259	63.6	10.8
	Brown	178	2.6	249	10.2	208	38.7	29	16.5	664	68.0	11.5
	Rainbow	131	1.8	3	0.3	6	1.1	...	...	140	3.2	0.5
	Total	1,873	26.5	867	39.3	294	52.5	29	16.5	3,063	134.8	22.8
C	Brook	2,562	36.7	1,066	57.2	160	26.9	6	2.6	3,794	123.4	22.9
	Brown	155	2.2	137	7.1	190	34.8	16	9.4	498	53.5	9.9
	Rainbow	...	...	14	1.2	16	2.6	...	...	30	3.8	0.7
	Total	2,717	38.9	1,217	65.5	366	64.3	22	12.0	4,322	180.7	33.5
D	Brook	3,120	43.9	1,456	94.7	452	77.7	14	4.4	5,042	220.7	39.0
	Brown	94	1.3	155	10.9	241	45.7	82	40.8	572	98.7	17.5
	Rainbow	...	...	57	5.2	75	12.2	...	...	132	17.4	3.1
	Total	3,214	45.2	1,668	110.8	768	135.6	96	45.2	5,746	336.8	59.6
All sections	Brook	7,822	110.9	3,450	195.4	799	135.4	20	7.0	12,091	448.7	18.6
	Brown	525	7.6	657	32.4	725	137.1	135	72.0	2,042	249.1	10.4
	Rainbow	188	2.6	74	6.7	116	19.9	...	...	378	29.2	1.2
	Total	8,535	121.1	4,181	234.5	1,640	292.4	155	79.0	14,511	727.0	30.2

Table 16.--Post-season population estimates (wild trout only), Pigeon River,
September 15-22, 1952

Sec- tion	Species of trout	Size groups, in inches										
		0 - 3.9		4.0 - 6.9		7.0 - 9.9		10.0 +		All sizes		
		Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Pounds per acre
A	Brook	771	10.4	254	15.4	87	15.0	7	4.3	1,119	45.1	6.3
	Brown	137	2.0	85	3.2	61	11.8	23	19.9	306	36.9	5.1
	Rainbow	6	tr ¹	7	0.3	15	2.6	1	0.4	29	3.3	0.5
	Total	914	12.4	346	18.9	163	29.4	31	24.6	1,454	85.3	11.9
B	Brook	2,099	27.2	491	28.1	36	5.6	1	1.4	2,627	62.3	10.6
	Brown	592	8.0	243	8.6	56	11.2	25	23.0	916	50.8	8.6
	Rainbow	112	1.6	52	2.0	7	1.1	...	...	171	4.7	0.8
	Total	2,803	36.8	786	38.7	99	17.9	26	24.4	3,714	117.8	20.0
C	Brook	3,856	51.9	1,200	68.1	216	37.2	10	4.8	5,282	162.0	30.0
	Brown	564	7.8	329	11.4	95	18.7	47	32.7	1,035	70.6	13.1
	Rainbow	74	0.5	11	0.3	4	0.7	...	...	89	1.5	0.3
	Total	4,494	60.2	1,540	79.8	315	56.6	57	37.5	6,406	234.1	43.4
D	Brook	3,105	41.3	1,205	75.6	250	43.3	29	12.7	4,589	172.9	30.6
	Brown	322	4.5	217	7.4	93	19.4	69	58.7	701	90.0	15.9
	Rainbow	50	0.6	...	...	6	1.4	2	1.1	58	3.1	0.6
	Total	3,477	46.4	1,422	83.0	349	64.1	100	72.5	5,348	266.0	47.1
All sec- tions	Brook	9,831	130.8	3,150	187.2	589	101.1	47	23.2	13,617	442.3	18.4
	Brown	1,615	22.3	874	30.6	305	61.1	164	134.3	2,958	248.3	10.3
	Rainbow	242	2.7	70	2.6	32	5.8	3	1.5	347	12.6	0.5
	Total	11,688	155.8	4,094	220.4	926	168.0	214	159.0	16,922	703.2	29.2

¹ Less than 0.05.

Table 17.--Post-season population estimates (wild trout only), Pigeon River,

September 14-25, 1953

Sec- tion	Species of trout	Size groups, in inches										
		0 - 3.9		4.0 - 6.9		7.0 - 9.9		10.0 +		All sizes		
		Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Number	Weight, pounds	Pounds per acre
A	Brook	1,116	13.2	579	39.3	75	13.6	11	5.6	1,781	71.7	10.0
	Brown	211	2.9	88	6.3	108	19.1	34	25.3	441	53.6	7.5
	Rainbow	15	0.1	3	0.3	9	1.6	...	...	27	2.0	0.3
	Total	1,342	16.2	670	45.9	192	34.3	45	30.9	2,249	127.3	17.8
B	Brook	1,882	23.0	660	42.3	51	8.7	5	3.6	2,598	77.6	13.2
	Brown	228	3.2	189	13.9	164	28.0	47	45.1	628	90.2	15.3
	Rainbow	30	0.3	8	0.8	22	3.9	1	0.4	61	5.4	0.9
	Total	2,140	26.5	857	57.0	237	40.6	53	49.1	3,287	173.2	29.4
C	Brook	2,216	29.4	1,532	101.4	209	39.1	24	13.2	3,981	183.1	34.0
	Brown	250	3.7	223	13.4	395	73.5	87	70.1	955	160.7	29.8
	Rainbow	17	0.2	19	1.8	48	8.3	2	0.8	86	11.1	2.0
	Total	2,483	33.3	1,774	116.6	652	120.9	113	84.1	5,022	354.9	65.8
D	Brook	1,875	23.8	1,438	90.7	204	36.7	14	7.8	3,531	159.0	28.1
	Brown	67	0.9	91	7.4	284	51.6	67	80.1	509	140.0	24.8
	Rainbow	7	0.1	16	1.6	16	2.9	1	0.4	40	5.0	0.9
	Total	1,949	24.8	1,545	99.7	504	91.2	82	88.3	4,080	304.0	53.8
E	Brook	1,730	22.7	1,487	96.2	89	16.0	2	1.1	3,308	136.0	24.0
	Brown	63	0.9	84	5.5	169	31.1	38	53.2	354	90.7	16.0
	Rainbow	...	...	8	0.7	11	1.8	...	...	19	2.5	0.4
	Total	1,793	23.6	1,579	102.4	269	48.9	40	54.3	3,681	229.2	40.4
All sec- tions	Brook	8,819	112.1	5,696	369.9	628	114.1	56	31.3	15,199	627.4	21.0
	Brown	819	11.6	675	46.5	1,120	203.3	273	273.8	2,887	535.2	18.0
	Rainbow	69	0.7	54	5.2	106	18.5	4	1.6	233	26.0	0.9
	Total	9,707	124.4	6,425	421.6	1,854	335.9	333	306.7	18,319	1,188.6	39.9

the population of surviving hatchery rainbows was estimated to be:

$$\text{Population} = (104/22) \times 80 = 378$$

The 162 hatchery rainbows (does not include the 22 recaptures) taken during the two shocker runs were distributed by section as follows: 10 in Section A, 60 in Section B, 79 in Section C, and 13 in Section D. The indication is that most of these hatchery rainbows had remained in the stream sections where planted.

The population of hatchery fish of all sizes remaining in the stream during the fall of 1952 was computed from a first-run catch of 89 fish, followed by a second-run catch of 91 fish which included 34 recaptures. Due to high water, the second run did not include a short piece of Section D (stations 80 to 84), and an allowance was made for the shorter second run in computing the population of hatchery trout (260 fish). The 260 hatchery trout were apportioned to sections on the basis of the relative numbers of trout taken in the first run with the shocker, as follows: 14 in Section A, 12 in Section B, 170 in Section C, and 64 in Section D. These trout were apportioned to species on the basis of relative number of the three species taken in two runs, as follows: 143 brook trout, 46 brown trout, and 3 rainbow trout. Most of these fish were of sub-legal size; the few legal-size fish are listed in Table 18 for an analysis of exploitation by angling.

The population of hatchery fish of all sizes remaining in the stream during the fall of 1953 was computed from the following records on fish taken by shocker: 235 fish marked during the first run, and 192 fish taken during the second run of which 65 were recaptures of fish liberated from the first run.

$$\text{Population} = (192/65) \times 235 = 694$$

The 694 hatchery trout were apportioned to species, on the basis of

Table 18.--Exploitation of trout by angling, Pigeon River, 1951, 1952 and 1953

Year	Species	Sections A and B (plus E, 1953)			Sections C and D		
		Number of trout caught, 7" ⁺	Population estimate, September, 7" ⁺	Percent exploit- ation	Number of trout caught, 9" ⁺	Population estimate, September, 9" ⁺	Percent exploit- ation
1951	Wild Brook	402	187	68	51	41	55
	Wild Brown	190	331	36	38	154	20
	Wild Rainbow	8	25	24	2	5	...*
	Hatchery Rainbow	1,661	160	91	1,034	218	83
	Total	2,261	703	76	1,125	418	73
1952	Wild Brook	404	131	76	60	73	45
	Wild Brown	98	165	37	29	141	17
	Wild Rainbow	33	23	59	14	5	74
	Hatchery Brook	29	2	94	...	...	...*
	Hatchery Brown	6	8	43	...	2	...*
	Hatchery Rainbow	4	3	...*	7	...	...*
Total	574	332	63	110	221	33	
1953	Wild Brook	687	233	75	55	92	37
	Wild Brown	164	560	23	39	226	15
	Wild Rainbow	80	43	65	8	7	53
	Hatchery Brook	458	104	81	...	...	...
	Hatchery Brown	13	45	22	9	41	18
	Hatchery Rainbow	188	131	59	1	2	...*
Total	1,590	1,116	59	112	368	23	

* Data not sufficient for a valid calculation.

relative numbers of the three species taken in the two runs of the shocker, as follows: 234 brook trout, 196 brown trout, and 264 rainbows. Finally, the numbers of legal-size fish of each species was determined, from the ratio of legal-size to sublegal fish in the shocker collections, to be 104 brook trout, 86 browns and 133 rainbows. These figures are included in Table 18, where they are divided according to stream section for an analysis of exploitation by angling.

Rate of exploitation by angling

For legal-size trout in the Pigeon River, records are obtained by section on the number of trout taken by angling each season and on the number of trout remaining at the season's end in September. These records are used each year to compute a "rate of exploitation," which is the ratio of anglers' catch to the sum of: anglers' catch plus estimated legal trout left at the end of the season. Computed figures for exploitation of wild and hatchery trout are given in Table 18.

The tabulation demonstrates that in Sections C and D, where a 2-fish creel limit and a 9-inch minimum size limit were in effect, the rates of exploitation on both wild and hatchery fish were consistently (in 9 comparisons out of 10) lower than in those sections where a 5-fish creel limit and a 7-inch minimum size limit prevailed.

Exploitation rates for wild brook trout were consistently greater than for wild brown trout in both the 7-inch water (ranges for brook trout, 68-76 percent; for brown trout 23-37 percent) and in the 9-inch water (37-55 percent for brook trout; 15-20 percent for browns). The comparison between hatchery brook trout and hatchery brown trout in the 7-inch water followed the same pattern (range for brook trout, 81-94 percent; brown trout, 22-43 percent).

Wild rainbow trout in the 7-inch water had exploitation rates that ranged from 24 to 65 percent, while hatchery rainbow trout were exploited at rates varying from 59 to 91 percent.

Results from 2-fish, 9-inch restrictions
on Sections C and D

During 1949-1950, Sections C and D had a creel limit of 15 trout and a size limit of 7 inches on trout; starting with 1951 these limits were set at 2 trout and 9 inches for Sections C and D. Throughout 1949-1953, Sections A and B had 5-fish and 7-inch limits. The 5-fish limit was put in effect on Sections A and B in 1949 to see if this reduction from the 15-fish limit (state-wide regulation at the time) would result in a better spread of harvested trout among anglers; it was found that the reduction in creel limit from 15 trout to 5 trout had little effect on the distribution of catch because, where the limit was 15 fish, over 90 percent of the angler-trips caught five or less trout (I.F.R. Report No. 1288).

The purpose of setting limits of 2 fish and 9 inches for Sections C and D starting in 1951 was somewhat involved. Records showed that a few, experienced anglers harvested most of the trout while half of the anglers did not catch any. A creel limit of 2 fish might spread the harvest better, with an increase in the number of anglers who caught some fish. Also, studies at the Pigeon River and elsewhere had indicated that where fishing pressure is heavy, anglers harvest many brook trout shortly after they attain legal size. Under this heavy harvest,

there might be too few spawners left each fall to repopulate the stream to its carrying capacity. Thus a 9-inch size limit might result in more spawning and an increase in the population of fingerling and sublegal trout.

The special regulations on Sections C and D (2 fish, 9-inch size limit, any lure) were in effect through 1954. The significant data for the years 1949 to 1953 are included here, in Table 19. This table gives the numbers of trout harvested by anglers, and the numbers of trout under and over 7 inches present in the stream at the end of the fishing season each fall, for Sections C and D, and also for Sections A and B. The comparable data for Sections A and B should be used as a control for time, in comparing the records from Sections C and D for 1949-1950 versus 1951-1953.

The immediate effect of the 2-fish and 9-inch limits put on Sections C and D was to greatly reduce the number of legal-size fish harvested by anglers. Among the data for these first five years (1949-1953), there appears to have been no great benefit to the trout population. The number of sublegal trout in Sections C and D increased considerably, but a comparable increase occurred at the same time in Sections A and B. If we combine figures for angler harvest plus number of trout over 7 inches remaining in the fall, and obtain a production figure for "legal-size" fish, Sections C and D produced no more legal-size fish after the 9-inch limit went in effect, whereas there was an increase during the same time in Sections A and B. To this extent the result in Sections C and D was unfavorable.

Table 19.--Angler harvest, and fall population of trout left in the stream in mid-September, in relation to fishing regulations, Pigeon River, 1949-1953. Records for wild trout only; hatchery trout not included. Section E not included

Sections	Year	Fishing regulations ¹		Angler harvest ²	Fall population of trout		Angler harvest plus fall population ^{>7"}
		Creel limit	Legal size (inches)		<7"	>7"	
	1949	5	7	368	1,623	330	698
	1950	5	7	374	2,849	406	780
A + B	1951	5	7	600	3,900	543	1,143
	1952	5	7	535	4,849	319	854
	1953	5	7	437	5,009	527	964
	1949	15	7	680	5,262	516	1,196
	1950	15	7	816	6,412	573	1,389
C + D	1951	2	9	91	8,816	1,252	1,343
	1952	2	9	103	10,933	821	924
	1953	2	9	102	7,751	1,351	1,453

¹Conservation Commission orders for the Pigeon River, 1951-1953, specified that fishing in Sections C and D would be with artificial flies only, in addition to the 2-fish, 9-inch restrictions. However, the flies-only restriction was not part of the research plan for these waters (the Research Section was not definite in its recommendations to the Lansing office); and after reviewing the matter with the Lansing office, the flies-only order on Sections C and D during 1951-1953 was not enforced. Regulation posters did not include the flies-only restriction, and no problems developed.

²Data for 1949 and 1950 from I.F.R. Reports No. 1250 and No. 1288.

Ground water

The importance of ground water to trout populations in the Pigeon River was demonstrated by Norman G. Benson's (1953) doctoral studies. Benson made an intensive study of the chemical, physical and biological factors that influence trout populations in the Pigeon River. He found that:

A lack of ground water seepage in the Pigeon River was the only condition that definitely limited the density of trout populations.

Trout spawning areas were present only where ground water seepage occurred.

Survival rates of young-of-the-year brook trout appeared to be influenced by annual ground water levels.

Studies on the disappearance of dead trout and creek chubs in the Pigeon River

Studies were made at the Pigeon River Trout Research Area from March 3 to April 20, 1950, and from May 19 to June 10, 1953, to determine the length of time required for a dead trout or creek chub to disappear from a stream environment (I.F.R. Report No. 1392). The answer might be helpful in explaining how an extensive natural mortality can occur without dead fish being frequently in evidence in the stream. It took as long as 22 to 44 days (depending on water temperature) for dead fish to completely disintegrate, although most fish had disappeared in less time. It was believed that snapping turtles ate many of the dead fish.

Dead fish "staked out" in the stream became camouflaged by a coating of silt and detritus in about three days, which explains why dead fish frequently go unnoticed. In the 1953 studies, 25 brown trout, 6 to 9 inches in length, were staked out in fairly open water and near shore, scattered along the upper part of Section B; of 77 fishermen who fished this area while the dead fish were recognizably intact, no fisherman voluntarily reported seeing a dead fish.

Stream improvement in Section A

Section A of the Pigeon River has been the least productive of the experimental areas in trout production. At the lower end of Section A there is the site of a former saw mill and dam for handling logs. The dam is out, but the accumulation of "dead heads," saw logs and other vegetative debris, now known as the "Cornwall breakup," blocked the stream bed to the extent that the gradient of Section A was lower than in other sections. Due to low gradient and retarded flow, sand and silt were deposited in the downstream part of Section A, covering gravel beds and riffles, and causing the stream to split into several small channels.

To alleviate this situation in Section A, a channel was cleared through the Cornwall breakup, by cutting and removing logs and debris. Stream improvement devices, mainly deflectors, were installed to confine the river to one channel. This work was planned, supervised, and carried out during the fall of 1953 by personnel from the Lake and Stream Improvement section of the Fish Division.

Pigeon River lakes

In addition to the six miles of trout stream in the research area, there are seven small trout lakes: North Twin, South Twin, Lost, West Lost, Hemlock, Ford, and Section 4. A doctoral thesis entitled "Experimental Fertilization of Michigan Trout Lakes" by Howard A. Tanner (1952) describes six of the

lakes (all except Ford Lake) and includes data on fish plantings, fertilization, creel census records, and treatments to remove fish populations, for the period of 1948 through 1950. Ford Lake, the largest (10.6 acres), was studied by E. Karvelis during 1949 to 1952 for a master's thesis (1953) on relationships between bluegills and trout.

One of the final phases of Tanner's experimental work was the treatment in October, 1950, of six lakes with chemicals to remove the fish populations for determination of production. North Twin, South Twin, Lost, West Lost and Hemlock lakes were treated with Fish-Tox while Section 4 Lake was sprayed with emulsifiable rotenone. These lakes had an unfortunate history of remaining toxic to fish for variable periods of time until the fall of 1953.

Section 4 Lake, treated with emulsifiable rotenone in October of 1950, was checked for toxicity in April, 1951. The test seemed to indicate that the lake was then non-toxic, and on April 26, 1951, the lake was stocked with 130 legal-size and 1,300 fingerling brook trout. During the first two days of the 1951 trout season (April 28-29), anglers took 87 (67 percent) of the 130 legal-size trout, but no more trout were caught from, or seen in the lake during the remainder of that season. Apparently the lake was still toxic in April, 1951, but low toxicity allowed some of the fish to live for a few days. Toxicity tests made again in the fall of 1951 indicated that the lake was non-toxic. Subsequent plantings of hatchery brook trout were: 3,000 fry (1.25") in May, 1952; 65 legal-size fish in October, 1952; and 3,000 fry in April, 1953. The anglers' catch of 692 legal-size brook trout during 1953 indicated that there was good survival and growth of the fry planted in May of 1952. Apparently the lake had lost its toxicity by the fall of 1951.

Experience with the Fish-Tox in North Twin, South Twin, Lost, West Lost and Hemlock lakes was most unfortunate from the viewpoint of anglers. Presumably the company which supplied the Fish-Tox added a considerable quantity of toxaphene (then unknown to Institute biologists) with the result that the material was far more potent than it was supposed to be, according to the rotenone content. Toxaphene characteristically loses its toxicity slowly, so that these lakes remained toxic for a long time. Furthermore, field tests on toxicity of the lakes after treatment were misleading, because toxaphene acts more slowly on fish than does rotenone. Toxicity tests which were made on these five lakes during September, 1952, seemed to indicate that they were then non-toxic; and the lakes were stocked with fingerling and legal-size brook trout in October. The fish survived in South Twin and West Lost lakes, judging from angler harvest during 1953 (Table 20), so that these two lakes had been toxic for only two years. However, the trout planted during October, 1952 in Lost, North Twin and Hemlock lakes practically all were lost, for none were taken by anglers during 1953, and extensive gill netting in the three lakes during the summer of 1953 produced only a single brook trout in Hemlock Lake; this fish must have been especially resistant to the toxin. Lost, North Twin and Hemlock were found to be non-toxic by the fall of 1953, when they were again stocked with fingerling brook trout which gave good returns to anglers during 1954. These three lakes were out of production for three years.

Ford Lake was treated with powdered rotenone on August 22, 1952, at the completion of the study by E. Karvelis, when 15,000 bluegills and 10 brook trout were recovered. The lake lost its toxicity quickly, was

Table 20.--Creel census data for Pigeon River lakes, 1950, 1951, 1952 and 1953

Name of lake	Year	Number of anglers	Number of hours fished	Number of trout caught	Number of bluegills caught
Ford	1950	145	386	11	473
	1951	121	322	17	357
	1952 [*]	114	268.75	61	110
	1953	266	694.5	613	...
Section 4	1951	175	345	87	...
	1952	0	0	... [↓]	
	1953	293	685.5	692	
South Twin	1953	376	934.5	619	
West Lost	1953	109	243.5	92	

* Ford Lake was treated with powdered rotenone on August 22, 1952, at the completion of the bluegill-trout study. All fish were removed, and the lake was restocked with trout.

↓ Only newly planted trout fry were present in the lake during the 1952 season.

replanted with fingerling and legal-size hatchery brook trout in October of 1952, and produced excellent trout fishing during 1953 (Table 20).

Records on angling and on plantings of hatchery trout in the Pigeon River lakes for 1951 to 1953 are summarized in Tables 20 and 21. Angling records for Ford Lake during 1950 are also included.

In addition to the plantings listed in Table 21, hatchery brook trout specially "trained" by Psychological Research Services were planted in Ford, South Twin, West Lost and Hemlock lakes on August 26, 1953. Angler returns on these plantings have been summarized in I.F.R. Report No. 1510.

Acknowledgments

Personnel assigned to the Pigeon River Station, who did most of the work in collecting angling records at the checking station and in making the fall population estimates by shocker, included G. F. Myers, E. L. Wolf, G. A. Plummer, N. G. Benson, E. L. Cooper, R. L. Sides and E. H. Bacon. Additional assistance was given by H. Gowing, O. M. Corbett, R. Parsons and B. L. Jacob.

Those who assisted in the compilation and analysis of data included Messrs. Myers, Wolf, Plummer, K. G. Fukano and T. F. Waters.

Dr. A. S. Hazzard gave advice on the field research work.

Dr. E. L. Cooper was biologist in charge of the Pigeon River Station from April, 1949, to November, 1952.

The assistance of Conservation Officer Henry Holds in helping to maintain regulations on the experimental waters is also acknowledged.

Table 21.--Plantings of hatchery brook trout, Pigeon River lakes, 1951, 1952 and 1953,
and angler returns through 1954

Lake	Number of trout planted	Average size, inches	Month, year planted	Angler returns							
				1951		1952		1953		1954	
				Number	Percent	Number	Percent	Number	Percent	Number	Percent
Ford	2,650	4	Oct., 1952	...	...	...	...	269	10	209	8
	265	8.1	Oct., 1952	...	...	...	...	141	53	1	0.4
	5,850	3-4	Sept., 1953	...	...	...	...	...	...	238	4
Section 4	1,300	5	April, 1951	...	...	...	...	...	...	...	...
	130	9.1	April, 1951	87	67	...	...	...	...	...	...
	3,000	1.25	May, 1952	...	...	...	...	...	...	...	...
	65	8.1	Oct., 1952	...	...	...	...	38	59	...	...
	3,000	1.25	April, 1953	...	...	...	...	655	22*	249	4**
South Twin	971	4	Oct., 1952	...	...	...	...	514	53	84	9
	98	8.1	Oct., 1952	...	...	...	...	77	79	1	1
	2,150	3-4	Oct., 1953	...	...	...	...	...	...	353	16
North Twin	1,175	4	Oct., 1952	...	...	...	...	...	...	...	...
	118	8.1	Oct., 1952	...	...	...	...	...	...	...	...
	2,750	3-4	Oct., 1953	...	...	...	...	...	...	...	...
West Lost	925	4	Oct., 1952	...	...	...	...	73	8	10	1
	93	8.1	Oct., 1952	...	...	...	...	14	15	2	2
	2,000	3-4	Oct., 1953	...	...	...	...	...	...	331	17
Lost	875	4	Oct., 1952	...	...	...	...	...	...	...	...
	88	8.1	Oct., 1952	...	...	...	...	...	...	...	...
	2,300	3-4	Sept., 1953	...	...	...	...	...	...	49	2
Hemlock	1,475	4	Oct., 1952	...	...	...	...	...	...	...	...
	148	8.1	Oct., 1952	...	...	...	...	...	...	...	...
	3,000	3-4	Sept., 1953	...	...	...	...	...	...	427	14

*Based on 1952 planting of 3,000 fish.

**Based on 1952 and 1953 plantings totaling 6,000 fish.

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