FISHERIES DIVISION

TECHNICAL REPORT

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EFFECT OF AN ABNORMAL DISCHARGE OF SEDIMENT FROM THE LANSING CLUB IMPOUNDMENT ON THE TROUT POPULATION IN THE PIGEON RIVER, OTSEGO AND CHEBOYGAN COUNTIES, MICHIGAN

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INTRODUCTION

In early July 1984, an abnormal discharge of sediment, containing large quantities of organic material, was released abruptly from the Lansing Club Dam into the Pigeon River, Otsego and Cheboygan counties, Michigan. From observations of dead and dying fish, made within a day of the initial sediment release, it was evident that a substantial fish kill had occurred.

As part of a comprehensive evaluation by the Michigan Department of Natural Resources (MDNR) of the effects of this sediment discharge on the biota of the river, the Fisheries Division conducted surveys of the trout population in a number of river segments during late July and August of 1984 and 1985. These trout population estimates, taken both above and below the sediment discharge point, were used to judge the impact on the trout stock. Since trout population and angler use data existed for a number of years prior to the release of the sediment, these data served as baseline or reference information to evaluate the consequences of the sediment release on the trout population and angling.

The trout population estimates were also used to make projections of the probable recovery time for the trout population and the consequences of the trout losses on angling.

METHODS

Trout population estimates of the Pigeon River were obtained using standard mark-and-recapture methodology (Bailey 1951, Ricker 1975). Fish were captured using DC electrofishing gear. Two sampling runs were made in each segment of river. All fish caught during the first electrofishing run were marked by clipping part of their caudal fin and then released back to the river near the capture site. The second electrofishing run was made a day or two after the first run to determine the proportion of marked (fin-clipped) fish in the populations. Trout abundance was estimated based on the proportion of marked fish present in the second run.

The procedure used to calculate the population estimates (P) was the Bailey modification of the Petersen formula where $P=M\ (U+R+1)/R+1$, where M signifies marked fish on the first electrofishing run, U the unmarked fish, and R the marked fish caught on the second electrofishing run. Separate estimates were made for various size groupings of trout (i.e., 1.0–4.9, 5.0–7.9, 8.0–11.9, and 12.0 inches) because recapture ratios change with size of fish (Shetter 1957). The total trout population was then determined by summing the estimates of the various size groups.

These mark-and-recapture trout population estimates were made on various segments of the Pigeon River in late summer of 1984 and 1985. One sample segment of river was the entire 6 mile reach immediately below the Lansing Club Dam. This segment, called A-E, is subdivided into subsections termed A, B, C, D, and E (Fig. 1) with E being the upstream

section. In this case the entire segment of 6 miles was electrofished. The second reach of river where trout populations were estimated was from section A to M68 (A-M68) (Fig. 1). This reach, about 15.5 miles long, was electrofished at the Red Bridge and McIntosh Landing. These segments were each 2,000 feet in length during the 1984 population surveys. To arrive at the trout population for the entire A-M68 segment of river, the number of trout per acre in the Red Bridge and McIntosh Landing stations was calculated and multiplied times the total number of acres in the segment (82.67 acres).

The third area of the river sampled was above the Lansing Club Dam. The segment called the Panorama Ranch is located about 5 miles upstream from the impoundment (Fig. 1). This segment was 2,000 feet in length in 1984 and 1,000 feet in length in 1985. The Panorama Station serves as a reference (control) because it is far enough upstream from the Lansing Club Dam to be unaffected by the dam drawdown and released sediment.

Fisheries Division crews also conducted trout population estimates in 1976, 1979, and 1980; before the abnormal sediment discharge in July of 1984. They used the same procedures as described above except in 1976 only 1,000 feet of river were sampled at Red Bridge, McIntosh Landing, and Panorama Ranch. Due to this reduced sampling area, trout populations were compared between years on a per area (acre) basis.

In addition to background data on trout populations, the MDNR Fisheries Division conducted an extensive creel census of portions of the Pigeon River in 1979 (Lockwood and Ryckman 1980). This creel census provided the background information on fishing pressure, catch, and catch per hour of trout for the A-E sections and A-M68 reach of the river.

RESULTS

Trout populations in the Pigeon River in 1984, below the Lansing Club Dam, were abnormally low following the release of large quantities of sediment to the river. Reductions were greatest in river sections nearest the dam. The population of trout present above the Lansing Club Dam, an area unaffected by the sediment release, showed little change between pre- and post-sediment release years.

The immediate effect of sediment on trout numbers present in the A-E segment of the Pigeon River can be seen by comparing data from 1984 with baseline data from 1979 and 1980. These data show that the stock was significantly lower in 1984 (Table 1). The population in 1984 was only 9,729 trout compared to a normal stock of 20,727 trout, a reduction of 53% in total abundance. Legal-size trout (≥8.0 inches) were reduced 67%, while sublegal trout were reduced 52%.

The trout population in the A-M68 segment of the Pigeon River was also significantly lower in 1984 than the baseline information from 1976. Trout populations averaged 423 fish

per acre in 1976 but only 296 in 1984. This amounts to a 30% lower stock in 1984 than normal (Table 2). Legal-size trout were reduced 26%, while sublegals were reduced 30%.

Trout abundance in the Pigeon River above the Lansing Club Dam in 1984 and 1985 changed little from the baseline information collected in 1976 (Table 3). This area, of course, did not receive any of the sediment discharge from the dam.

Further evidence indicating a cause-and-effect relationship between trout stocks and the sediment release from the dam is the magnitude of difference in trout populations as you go from the dam downstream toward M68. As stated in the methods section, the A-E, 6-mile segment of river can be subdivided into five smaller sections, each about 1.2 miles long. These sections are called A, B, C, D, and E, with section E being closest and section A furthest from the dam (Fig. 1). Trout abundance in section E was 92% lower than baseline, D was 75% lower, C was 45% lower, B was 25% lower, and A was 36% lower (Table 4). The trout population data for the A-M68 reach of river show that trout abundance was about 30% lower than baseline in 1984 (Table 2).

Mark-and-recapture trout population estimates were obtained for sections A-E in 1985 to assist in determining the long term effect of the sediment induced kill on the trout population. Projected estimates of the probable impact on trout stocks for 1986 through 1989 were also made (Table 1). The 1985 population estimate showed the stock of young trout recovered quickly. However, stocks of larger and older fish were still reduced in 1985. For example, abundance of legal-sized trout was still 54% lower than the baseline data (Table 1). Projected estimates in Table 1 show the stocks of legal-size trout will not be rejuvenated to normal levels until about 1987.

Trout population projections for the A-M68 segment of the Pigeon River for years 1985 through 1988 are given in Table 2. These estimates indicate that stocks of sublegal-size trout will recover by 1986. Stocks of legal size trout will probably recover by 1987.

The estimated number of wild trout absent from the river, as a consequence of the July 1984 fish kill, is given in Table 5. The wild trout population of the A-E segment of river was reduced by a total of 12,868 trout from 1984 to 1986. An estimated 10,517 of these were sublegal and 2,351 were legal-size fish. In the A-M68 reach of the river, the population was reduced by an estimated 20,833 wild trout. About 18,436 of these fish were of sublegal size, whereas 2,397 would have been legal. The estimated 21.5% of the legal-size trout in the Pigeon River population weigh a pound or more and the average weight of this group of fish is 1.52 pounds. In the fall of 1984, 23,300 hatchery-reared fingerlings (3.7-inch average) brook trout were planted in the A-E segment of the Pigeon River to help offset the losses from the fish kill. Survival of these planted fish was poor. It was estimated that only 1,121 of these fish (4.8%) survived until late summer of 1985. It was further estimated that only 198 of these fish

would survive and grow to become available as legal-size fish for anglers during the 1986 trout season, 168 in segment A-E and 30 in the A-M68 reach of the river.

The impact on angling of sediment released in the Pigeon River was estimated from two sets of information. First, the angler usage and success was estimated for the river from an intensive census made in 1979 (Table 6). Secondly, the reduction from normal populations of legal-size fish was estimated as above. Angler effort on a body of water is directly related to the availability of legal-size fish in the population (Butler and Borgeson 1965, Bleser and Hansen 1985). Estimates of lost angler trips and hours of fishing are given in Table 7 for A-E and A-M68 parts of the river. It was judged that all angler use ceased for the 1984 season after the sediment release in early July of 1984. Waters were extremely turbid with many mud bars present and the general esthetic qualities of the river for fishing or viewing were poor all summer. The lost fishing activity for 1985 and 1986 was judged to be proportional to the decreases in stock of available legal-size trout. In determining the stock of legal fish, the contribution made to the population by the hatchery trout was taken into account in mitigating the effect of lost wild fish on fishermen (Table 5).

DISCUSSION

The discharge of over one-half million pounds of organic sediments from the Lansing Club Dam during the first day of the incident reduced dissolved oxygen below the tolerance of trout. It also elevated suspended solids and dissolved toxic gasses to intolerable levels (Evans 1986). Such changes in water quality were enough to cause a significant kill of trout in the Pigeon River. The kill was greatest in river areas nearest the dam. Dilution by incoming groundwater, deposition of the sediment in the channel, and re-oxygenation of river water as it passed over riffles in route downstream reduced the trout kill in the lower reaches of the river. It is predicted recovery of trout stocks is will be nearly complete by the summer of 1987. Stocks of young-of-the-year trout returned to baseline levels within a year, demonstrating no apparent permanent damage to the river in terms of habitat available for reproduction. Numbers of older and larger fish will take more time to recover because the source of old fish are the young recruits which must grow and survive for a number of years.

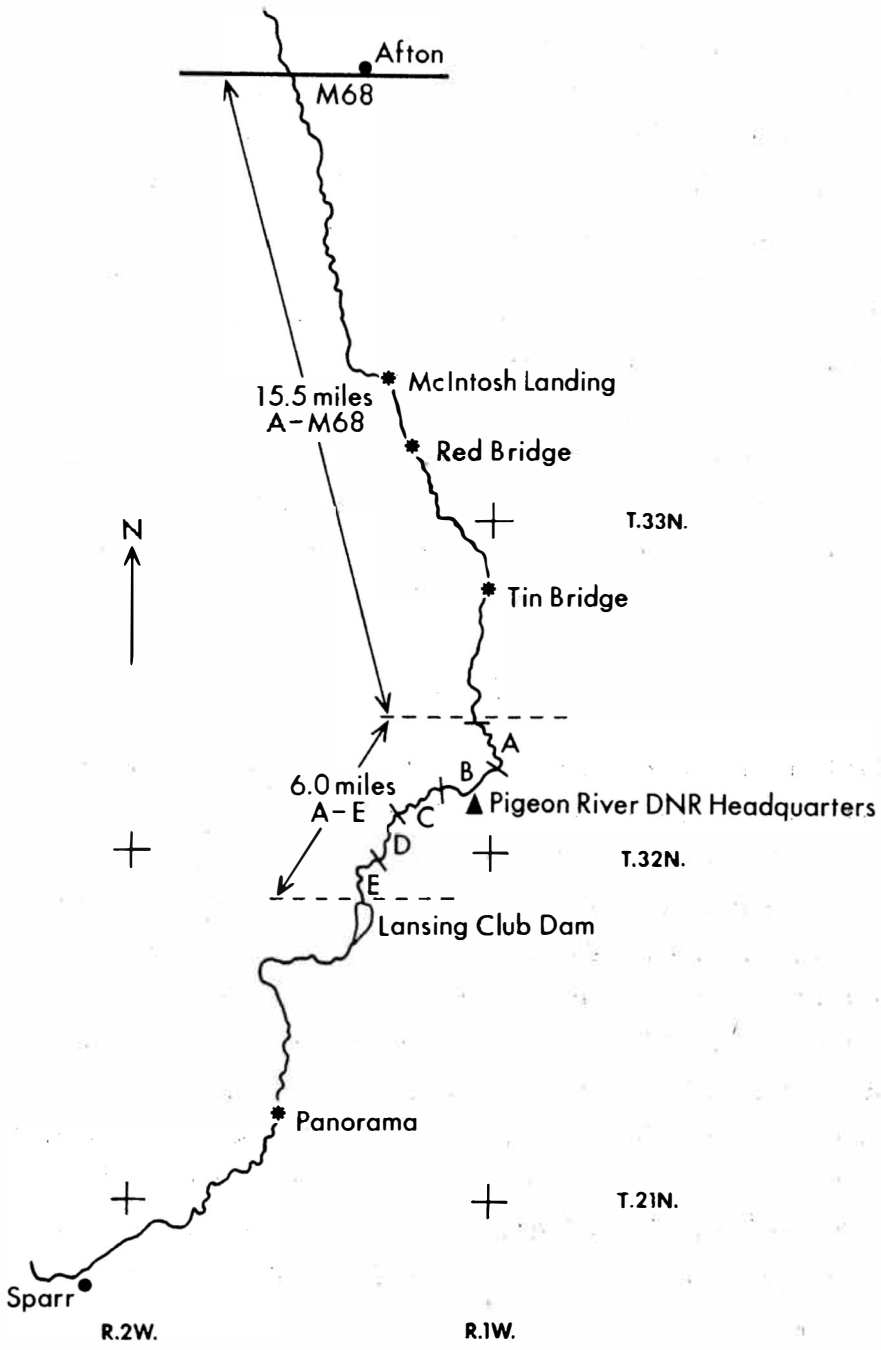

Figure 1. Map of the Pigeon River showing the areas above and below the Lansing Club Dam.

Table 1. Population estimates of wild trout in A-E segment of Pigeon River in 1979–80 before sediment discharge, 1984–85 after discharge, and 1986–89 predicted from 1979–80 survival rates.

	Inch group						
Year	1.0–4.9	5.0–7.9	8.0–11.9	≥12.0	1.0–7.9	≥8.0	Total
Actual estimates							
1979–80	16,244 ±633	3,019 ±115	1,032 ±53	432 ±39	19,263 ±643	1,464 ±66	20,727 ±647
1984	6,273 ±646	2,972 ±165	260 ±46	224 ±36	9,246 ±667	484 ±58	9,729 ±669
1985	16,679 ±1,248	2,085 ±144	414 ±42	257 ±28	18,764 ±1,256	671 ±52	19,435 ±1,266
Projected estimates							
1986	16,244 ±633	3,100 ±687	713 ±67	173 ±25	19,344 ±934	886 ±72	20,230 ±937
1987	16,244 ±633	3,019 ±641	1,060 ±244	298 ±42	19,263 ±901	1,358 ±248	20,621 ±934
1988	16,244 ±633	3,019 ±641	1,032 ±229	444 ±112	19,263 ±901	1,476 ±255	20,739 ±936
1989	16,244 ±633	3,019 ±641	1,032 ±229	432 ±106	19,263 ±901	1,464 ±252	20,727 ±936

Table 2. Population estimates of wild trout per acre in A-M68 segment of Pigeon River based on the average of the Red Bridge and McIntosh Landing segments. Estimates for 1985 and after are based on the survival rates of trout determined from 1976 baseline information.

	Inch group						
Year	1.0–4.9	5.0–7.9	8.0–11.9	≥12.0	1.0–7.9	≥8.0	Total
Actual estimates							
1976	209 ±42	172 ±48	28 ±6	14 ±5	381 ±64	42 ±8	423 ±64
1984	79 ±29	186 ±19	19 ±6	12 ±3	265 ±35	31 ±7	296 ±35
Projected estimates							
1985	209 ±42	65 ±24	30 ±11	10 ±5	274 ±48	40 ±12	314 ±50
1986	209 ±42	172 ±36	11 ±5	15 ±8	381 ±55	26 ±9	407 ±56
1987	209 ±42	172 ±36	28 ±15	6 ±3	381 ±55	34 ±15	415 ±57
1988	209 ±42	172 ±36	28 ±15	14 ±10	381 ±55	42 ±18	423 ±58

Table 3. Population estimates of wild trout per acre in Panorama Ranch segment of the Pigeon River for the years 1976, 1984, and 1985.

Year	Inch group						Total
	1.0–4.9	5.0–7.9	8.0–11.9	≥12.0	1.0–7.9	≥8.0	
1976	418 ±209	142 ±42	34 ±11	26 ±11	560 ±224	60 ±22	620 ±198
1984	480 ±289	134 ±44	35 ±13	11 ±5	614 ±284	46 ±18	660 ±224
1985	428 ±176	221 ±64	60 ±30	12 ±6	649 ±223	72 ±30	721 ±267

Table 4. Populations estimates of wild trout in sections E, D, C, B, and A in the A-E segment of Pigeon River before and after the sediment discharge.

Year	Inch group						Total
	1.0–4.9	5.0–7.9	8.0–11.9	≥12.0	1.0–7.9	≥8.0	
Section E							
1979–80	2,854 ±223	489 ±53	282 ±34	88 ±20	3,336 ±229	370 ±39	3,706 ±233
1984	134 ±96	144 ±42	9 ±5	2 —	278 ±105	11 ±5	289 ±105
1985	1,586 ±384	296 ±40	101 ±14	24 ±8	1,882 ±386	125 ±16	2,007 ±386
Section D							
1979–80	2,754 ±254	567 ±52	261 ±22	95 ±16	3,321 ±259	356 ±27	3,677 ±260
1984	538 ±180	313 ±59	55 ±25	18 ±10	851 ±189	73 ±27	924 ±191
1985	2,418 ±466	340 ±40	125 ±20	69 ±10	2,758 ±468	194 ±22	2,952 ±468
Section C							
1979–80	4,187 ±330	626 ±51	155 ±18	59 ±11	4,813 ±334	214 ±21	5,027 ±334
1984	1,769 ±427	847 ±84	69 ±18	57 ±18	2,614 ±435	126 ±25	2,740 ±436
1985	4,115 ±616	541 ±94	82 ±28	57 ±14	4,656 ±622	139 ±31	4,795 ±624
Section B							
1979–80	3,413 ±313	562 ±49	133 ±21	79 ±13	3,975 ±317	212 ±25	4,187 ±318
1984	2,286 ±319	733 ±55	64 ±14	64 ±20	3,019 ±324	128 ±24	3,147 ±325
1985	4,804 ±662	346 ±50	46 ±12	43 ±10	5,150 ±664	87 ±16	5,239 ±664
Section A							
1979–80	3,036 ±281	783 ±52	202 ±20	111 ±23	3,819 ±286	313 ±30	4,132 ±287
1984	1,546 ±303	937 ±109	63 ±31	83 ±21	2,483 ±322	146 ±37	2,629 ±324
1985	3,756 ±612	562 ±82	60 ±16	64 ±16	4,318 ±616	124 ±23	4,442 ±618

Table 5. Estimated number of wild trout absent from the population of the Pigeon River in late summers of 1984, 1985, and 1986 as a result of the kill in July 1984.

Shortage	Sublegal	Legal
A-E segment		
1984	10,018 ±920	980 ±88
1985	499[1] ±1,411	793 ±84
1986	0 ±1,134	578[2] ±98
A-M68 segment		
1984	9,590 ±6,030	909 ±879
1985	8,846[3] ±6,614	165 ±1,192
1986	0 ±6,976	1,323[4] ±995

[1]This number becomes 0 when mitigating the wild fish population because of planted fish.

[2]This number becomes 410 when mitigating the wild fish population because of planted fish.

[3]This number becomes 8,674 when mitigating the wild fish population because of planted fish.

[4]This number becomes 1,293 when mitigating the wild fish population because of planted fish.

Table 6. Estimates of angler use and catch statistics of the Pigeon River based upon the 1979 intensive creel census.

Angler	Time period		
	Apr-Jun	Jul-Sep	Total season
A-E segment			
Hours	3,018 ±916	2,807 ±1,425	5,825 ±1,695
Trips	1,051 ±353	1,407 ±655	2,458 ±744
Catch per hour	0.1329 ±0.0723	0.1254 ±0.0909	0.1293 ±0.0596
Catch	401 ±199	352 ±182	753 ±270
A-M68 segment			
Hours	5,559 ±1,917	6,649 ±3,296	12,208 ±3,810
Trips	2,040 ±775	2,235 ±1,097	4,275 ±1,346
Catch per hour	0.2935 ±0.1905	0.2644 ±0.2568	0.2776 ±0.1654
Catch	1,632 ±897	1,758 ±1,468	3,390 ±1,721

Table 7. Pigeon River angler hours and trips lost in direct proportion to fewer 8-inch and larger trout available to anglers.

Year	Number of anglers hours and trips lost	
	Hours	Trips
A-E segment		
1984	2,807 ±1,408	1,407 ±654
1985	3,156 ±952	1,331 ±431
1986	1,629[1] ±554	688[1] ±208
1987	64[1] ±154	27[1] ±67
A-M68 segment		
1984	6,649 ±3,296	2,235 ±1,097
1985	580 ±4,197	203 ±1,470
1986	4,440[1] ±3,570	1,555[1] ±1,251
1987	2,270[1] ±4,946	794[1] ±1,733

[1]Estimates adjusted for contribution of legal-size hatchery fish to the population.

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