MONTANA FISH AND GAME REPORT

In Cooperation with U.S. Forest Service

Fisheries Division

Job Progress Report

ANNUAL PROGRESS REPORT
ELK LAKE - NARROWS CREEK STUDY,
MAY 1, 1972 - OCTOBER 1, 1972

by

John A. Lund

January 15, 1973

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BACKGROUND

The Elk Lake-Narrows Creek study area lies in the Centennial Valley of Southwestern Montana at an elevation of 6675 feet. The lake has an area of 283 acres and a maximum depth of 70 feet.

Narrows Creek is the principle spawning stream running into Elk Lake for trout and Artic grayling (Thymallus arcticus). Prior to 1972, two other stream, Limestone and Horse Creeks, entered the lake; however, only Limestone Creek has shown any potential as a spawning stream. Horse Creek was diverted from the lake in 1972 because of high temperatures and lack of flow. It now enters Elk Creek just below the outlet of Elk Lake.

Narrows Creek, in the past, has provided most of the natural recruitment of Arctic grayling and cutthroat trout (Salmo clarki) to Elk Lake. It has also produced small numbers of rainbow trout (Salmo gairdneri) and rainbow-cutthroat hybrids. Although recruitment is fairly low at present, the potential for increasing it through stream protection and increased spawning areas seems possible.

Further references and background material are given in the Annual Progress Report (Peterson, 1972).

OBJECTIVES

The 1972 study was a continuation of the 1971 study with several additions. As in 1971, fry recruitment from Narrows Creek, fishing intensity, total yield and composition of catch were studied. In 1972, spec composition of the Narrows Creek spawning run, fecundity of females in the spawning run, and chemical measurements were added.

It is hoped that by understanding the exact requirements for increasing natural recruitment a higher yield to sport fishing can be obtained.

PROCEDURES

A two-way weir was built to capture adult spawners in Narrows Creek. This adult trap was designed to catch fish entering and leaving the stream. The trap was made of plywood and one-half inch galvanized screen with overall dimensions of six feet wide by eight feet long. The adult trap was placed immediately upstream from the mouth of Narrows Creek on May 8, 1972 and removed on July 28, 1972.

All adults going upstream were counted, sexed and checked to determine species. The adults returning to the lake were weighed, measured for total length, sexed, checked for hatchery marks, checked to determine species, tagged, and checked to determine whether or not the females had spawned. These adult traps were checked three times a day, at 8:30 a.m., 1:00 and 6:30 p.m.

The fry trap assembly used in 1972 was the same one described by Peterson (1972) and used in 1971. It was placed just downstream from the adult trap in Narrows Creek on June 15, 1972 and was removed on September 15, 1972. The fry trap was checked three times a day at 8:30 a.m., 12:30 and 8:00 p.m. Migrating fry and fingerling were counted and placed downstream. Fry were classified as trout or grayling and fingerling were identified, if possible, to species. Approximately ten percent of all fry trapped were sacrificed and placed in ten percent formalin for size and species determination at a later date.

A creel census was also conducted on a daily basis from May 8 to September 15, 1972. As many fishermen as practicable were interviewed. The data obtained included length of time fished, total number in the fishing party, methods of fishing, and the species, number, weight and total length of the fish caught. Cutthroat trout were also checked for hatchery fin clips which had been placed on some or all of the yearly plants since 1967.

The maximum and minimum daily temperatures of Narrows and Limestone Creeks were taken from May 8 to September 15, 1972. Discharge of Narrows Creek was determined at approximately weekly intervals during the summer. All flows and temperatures were taken at or near the mouths of the two streams. Chemical analyses of the waters from Elk Lake, Narrows Creek and Limestone Creek were taken at monthly intervals along with temperature profiles of Elk Lake. Oxygen profiles were also determined for Elk Lake.

FINDINGS

Narrows Creek

Arctic grayling and cutthroat trout, rainbow trout, and cutthroat-rainbow hybrids passed through the adult trap on spawning runs in 1972. The run started on May 10 when two rainbows and one hybrid were captured in the upstream trap. The first cutthroat was trapped on May 13 and the first grayling on May 17, 1972. Peak upstream movement for cutthroat occurred on May 20 and for grayling on May 29. Hybrids and rainbow peaked on May 14 and 15, respectively. Peak downstream movement for cutthroat occurred on June 2 and for grayling on June 11. Rainbow and hybrids were the first to spawn and the first to return to the lake, followed by cutthroat and then by grayling. The numbers, sizes, weights and species of spawners are given in Table 1. The measurements were taken during downstream movement of the fish so that weights will be somewhat less than when they first entered the stream, especially spawned females.

Table 2 gives a breakdown of marked hatchery cutthroat which entered Narrows Creek to spawn.

Three cutthroat and three grayling females were sacrificed for fecundity determinations. The three cutthroat averaged 17.4 inches in total length and had an average of 2066 eggs per female, while

TABLE 1. Species, numbers, sizes, and weights of spawners which entered Narrows Creek in 1972.

Species	Total counted	Total measured	Size range total ins.	(ave.)	Total weighed	Wt. range in lbs.	(ave.)	% of Total
Grayling	297	287	11.6-18.5	(15.5)	286	0.46-1.90	(1.19)	57.2
Rainbow	20	20	10.8-21.2	(16.4)	20	0.46-3.22	(1.62)	3.9
Rainbow-cutthroat hybrids	35	35	12.1-21.4	(18.8)	35	0.68-3.30	(2.30)	6.7
Cutthroat--unmarked 1/	70	70	13.7-19.8	(16.8)	68	1.00-2.90	(1.91)	13.5
Cutthroat--marked,hatchery	97	93	13.4-19.4	(17.2)	93	1.02-2.80	(1.92)	18.7
Grand Total	519	505			502			100.0

1/ Unmarked cutthroat trout would include wild and unmarked hatchery trout.

TABLE 2. Number, size and weight of marked hatchery cutthroat trout which spawned in Narrows Creek, 1972.

Mark (fin clip)	Year marked	Size range total ins.	(ave.)	Wt. range in lbs.	(ave.)	Number measured	% of total
Left pectoral	1968	17.1-19.4	(18.3)	1.60-2.74	(2.12)	16	17.6
Adipose, right pelvic 1/	1969	13.9-19.1	(17.0)	1.0202.80	(1.90)	69	75.8
Adipose	1970	13.4-17.6	(16.2)	1.08-1.68	(1.47)	4	4.4
Right pelvic	1970	15.4-17.2	(16.3)	1.83-2.24	(2.03)	2	2.2
Grand Totals						91	100.0

1/ Combination of both marks.

the grayling averaged 16.3 inches and had 9067 eggs per female. More fish must be sacrificed in 1973 so that these figures will be made more reliable.

Fry and fingerling were trapped in Narrows Creek from June 16 to September 15, 1972. The first grayling fry was caught on June 22 and the first cutthroat fry on July 4 (Table 3).

Distribution of fry during the migration period is shown in Table 4 and Figure I. The grayling fry migrated downstream first and peaked on June 27, while the cutthroat peaked on July 14; this compares with 1971 data, although peak migrations were one week later. A total of 618 grayling fry and 7502 cutthroat fry migrated in 1972, compared with 15,980 grayling and 7394 cutthroat in 1971. No reason was found for the drastic decrease in grayling fry this year over 1971; however,

TABLE 3. The numbers and species composition of fingerling and fry caught during downstream migration in Narrows Creek, 1972

Species	Number	Percent of Fry	Date extremes of Capture
Fingerlings			
Rainbow	20		7-1 to 9-14
Cutthroat	57		7-1 to 9-14
Rainbow-cutthroat hybrids	85		7-1 to 9-13
Species not determined on these trout	111		6-16 to 7-1
Subtotal	273		
Fry			
Grayling	618	7.6	6-22 to 7-4
Cutthroat[1/]	7502	92.4	7-4 to still migrating on 9-15
Grand Total	8393	100.0	

1/ Includes all cutthroat, rainbow, and rainbow-cutthroat hybrids.

cutthroat fry remained about the same for the two years. The increase in the number of fry and fingerling migrating during the first two weeks of September coincided with increased water flow and decreased water temperatures.

A small percent of the fry which entered the trap were sacrificed so that total lengths and species determinations could be made later. Table 5 shows the average lengths of migrating fry and fry captured during stream electrofishing on October 1, 1972.

Cutthroat, rainbow and hybrid fingerlings were also captured in fry traps during downstream migration from June 16 to September 15, 1972. It is still unknown whether these fish overwinter in Narrows Creek, come from the lake in the spring, or overwinter in the pond on Narrows Creek and then enter the lower section of the stream. Numbers and dates of capture are given in Table 3. Average sizes of migrating fingerling are shown in Table VI. An increase in average size is shown from June through August in the fingerling, especially hybrid fingerling.

Also captured in the fry trap were a few sculpin (Cottus sp.). A total of eighteen were captured between June 19 and September 11.

A population estimate was made in Narrows Creek to determine the number of fry and fingerling left in the stream below the pond on October 1. Three sections (upper, middle, and lower) of the stream were electrofished. A total distance of 350 feet was

TABLE 4. Numbers of fry counted and extrapolated[1/] during four-day periods from the fry trap assembly in Narrows Creek, 1972.

Date	Number Counted	Number Extrapolated	Estimated Total
June 20-23	51	0	51
24-27	338	70	408
June 28-July 1	147	10	157
July 2-5	5	0	5
6-9	523	0	523
10-13	2712	0	2712
14-17	3054	0	3054
18-21	720	0	720
22-25	230	0	230
26-29	81	0	81
July 30-Aug. 2	31	0	31
Aug. 3-6	15	0	15
7-10	5	0	5
11-14	4	0	4
15-18	3	0	3
19-22	6	0	6
23-26	6	0	6
27-30	1	0	1
Aug. 31-Sept. 3	4	0	4
Sept. 4-7	19	0	19
8-11	69	0	69
12-15	16	0	16
Total			8120

1/ The extrapolated numbers are from on-site observations combined with the best estimate of loss due to high water over traps.

sampled. A total of 245 fry were captured, giving an estimated total of 2550 fry for the 0.69 miles of stream. The numbers of fingerling in the stream was estimated to be 96. All fry and fingerling were cutthroat, rainbow or hybrids. These estimates are probably low because only about 90 percent of the total fish present were captured. All fish captured were fin clipped so that it can be determined if any overwinter in the stream.

Limestone Creek

Only limited work was done on Limestone Creek in 1972; however, some spawning activity was noted. Grayling were seen spawning in the stream on June 4. Grayling fry were trapped between June 29 and July 9 with a total of 70 migrating to the lake during that period. This total represents about half of the total since only about half the flow ran through the fry trap.

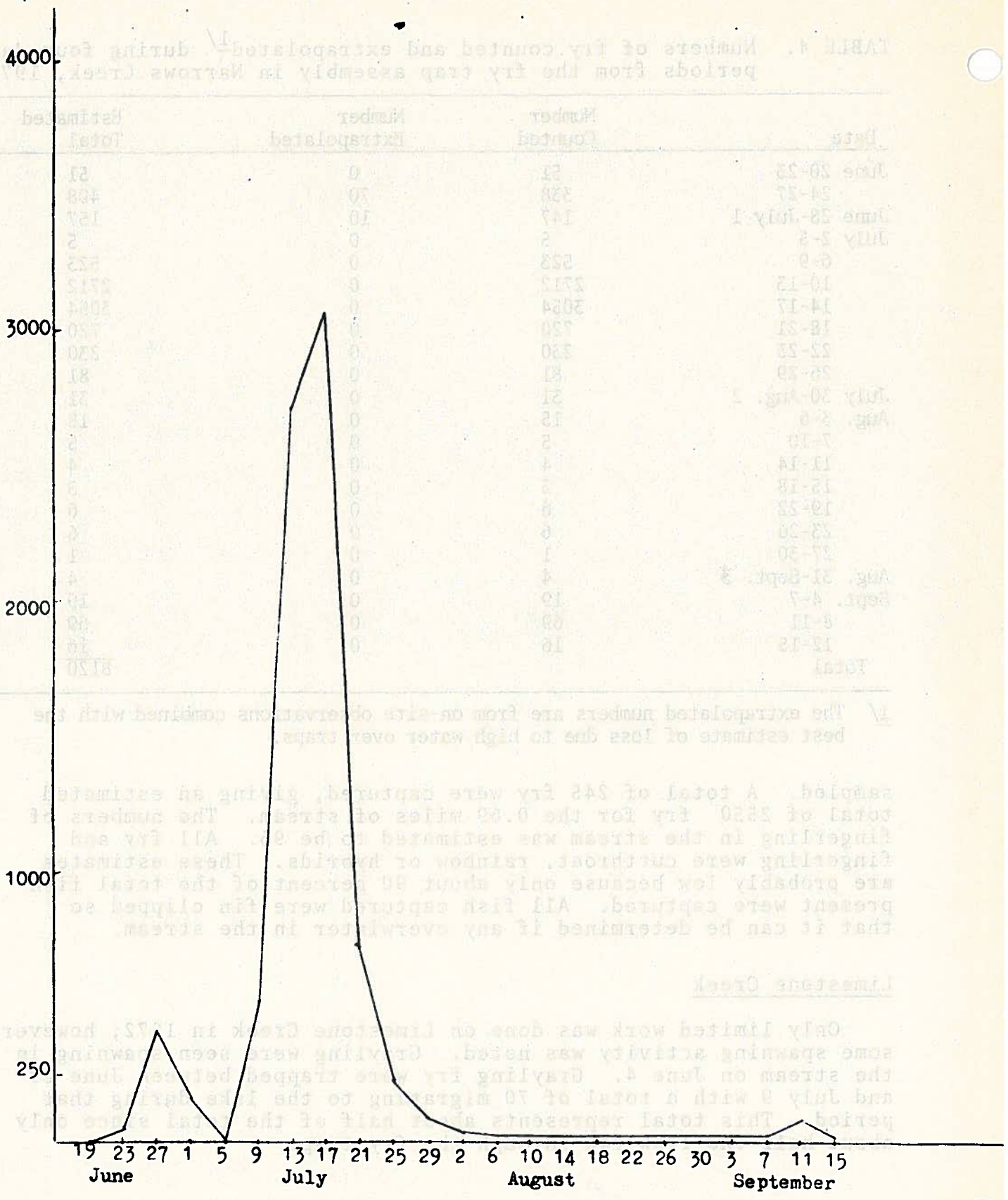

Figure 1. Estimated four-day totals of fry captured in the fry trap assembly in Narrows Creek, 1972.

TABLE 5. Mean total length of Arctic grayling and cutthroat fry caught during migration or captured in Narrows Creek, 1972

Date	Species	Sample Size	Mean Length
In Trap			
June 23-27	Grayling	16	14.3 mm
June 28-July 4	Grayling	2	16.5 mm
July 6-10	Cutthroat[1/]	38	25.5 mm
11-14	Cutthroat[1/]	40	25.1 mm
15-19	Cutthroat	40	25.8 mm
21-25	Cutthroat	14	26.0 mm
26-30	Cutthroat	8	26.1 mm
Aug. 1-4	Cutthroat	4	28.1 mm
5-10	Cutthroat	2	33.0 mm
20-23	Cutthroat	2	38.5 mm
Sept. 1-5	Cutthroat	2	46.7 mm
9-13	Cutthroat	6	51.5 mm
In Stream			
Aug. 5-10	Cutthroat[1/]	2	44.0 mm
21	Cutthroat[2/]	4	48.5 mm
Oct. 1	Cutthroat[2/]	245	50.5 mm

1/ Includes all cutthroat, rainbow, and rainbow-cutthroat hybrid fry.
2/ Captured during electrofishing operation to estimate trout population in Narrows Creek and includes cutthroat, rainbow, and rainbow-cutthroat hybrid fry.

TABLE 6. Monthly total length averages (in inches) for migrating fingerling in Narrows Creek, 1972. (Number in sample in parentheses).

Month	Cutthroat	Hybrid	Rainbow	Not separated to species	Over-all Average
June	--	--	--	3.53 (108)	3.53
July	4.38 (8)	3.84 (50)	3.43 (15)	--	3.81
August	4.28 (4)	4.61 (8)	--	--	4.50
September	4.31 (45)	4.23 (26)	4.14 (5)	--	4.27
				Grand Ave.	3.86

Elk Lake

A trap net was set and pulled daily in Elk Lake from July 10 to August 12, 1972. The results are shown in Table 7. It was hoped that an estimate of the burbot population could be made, however, only 10 percent of the marked fish were recaptured so that a reliable estimate could not be made.

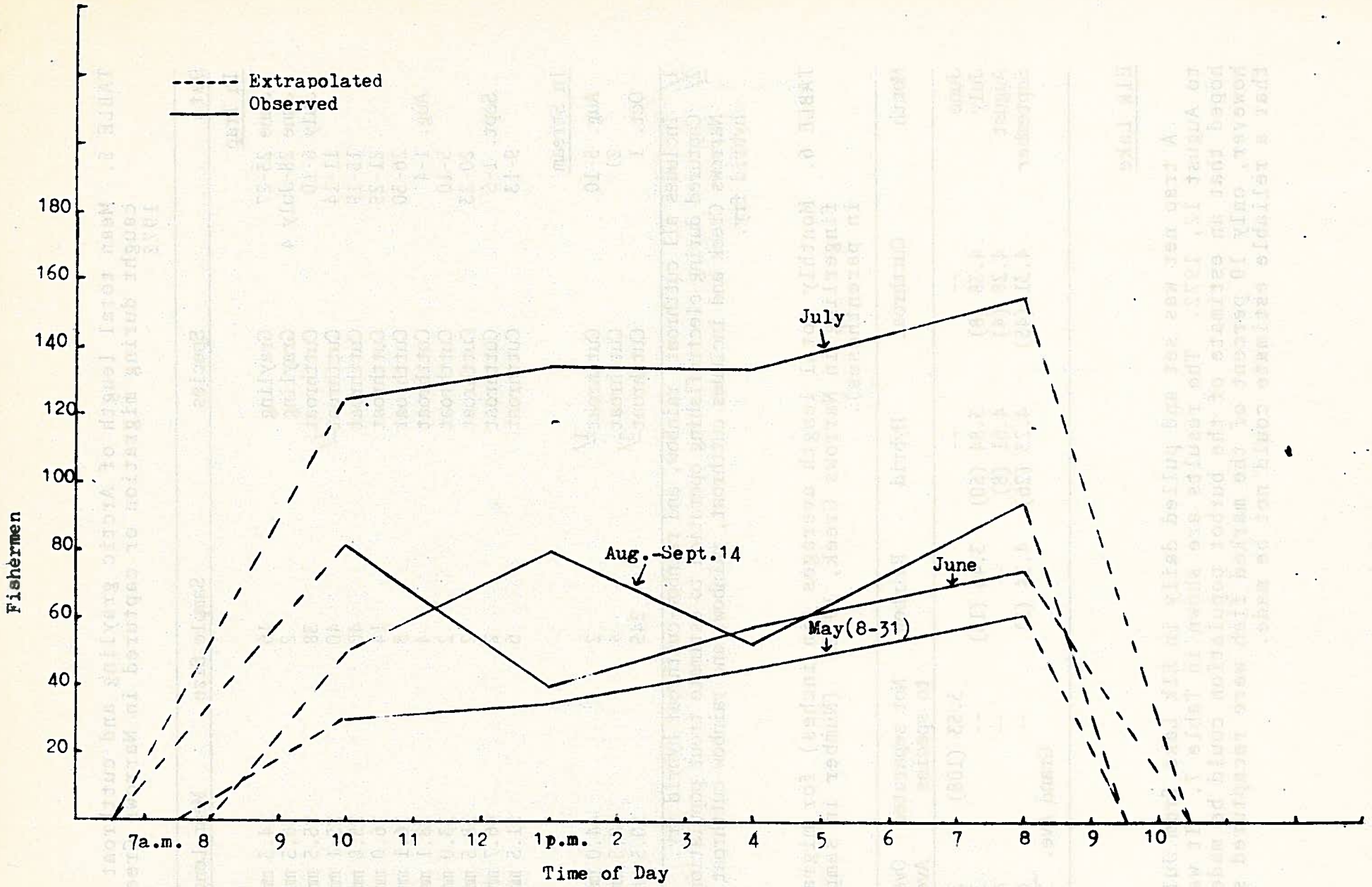

Figure II. Fishing intensity curves for May 8-31, June, July and August to September 14, 1972, for Elk Lake.

TABLE 7. Species, numbers, and sizes of fish captured in trap net from July 10 to August 12, 1972.

Species	Numbers	Ave. for 26 sets	Percent of Total catch	No. Meas.	Size range Total ins. (ave.)
White suckers	3859	148.4	91.5	25	3.9-17.4 (12.1)
Burbot	330	12.7	7.8	12	6.8-17.5 (12.9)
Lake trout	7	0.3	0.2	7	7.4-12.8 (8.6)
Arctic gralying	0	0.0	0.0	0	-- --
Cutthroat trout-hatchery	18	0.7	0.4	17	11.4-18.6 (13.4)
Cutthroat trout-unmarked	1	0.0	0.0	1	18.4 --
Rainbow-cutthroat hybrid	3	0.1	0.1	3	4.8-6.7 (5.5)
Rainbow	1	0.0	0.0	1	4.2 --
Grand Total	4219	162.2	100.0		

The high numbers of white suckers and burbot found in trap nets does not mean that they are much more numerous than the game species because the areas where nets could be set were good habitat for suckers and burbot.

The results of the creel census are shown in Table 8. Cutthroat trout were the most numerous fish in the creel. The marked hatchery cutthroat in the creel were divided by their respective years of marking in Table 9.

The total fishermen-hours during the period of the creel census (May 8-September 14, 1972) was estimated by constructing monthly "fishing intensity curves" as described in Peterson (1970). The total harvest of game fish for each month was estimated as the product of the total fishermen-hours and the catch rate per hour for that period. Figure II shows the monthly intensity curves, and Table 10 shows the catch rates and the estimates of total yield.

The number of boat fishermen outnumbered shore fishermen by a large margin. Only in May did the percentage of shore fishermen approach that of the boat fishermen (Table 11). This was probably due to fishermen trying to catch fish spawning near the shore.

A total of 43 fish tagged in the spawning run were caught by fishermen in the lake. The breakdown by species gives 32 cutthroat, 8 rainbow-cutthroat hybrid, 2 grayling, and 1 rainbow. No population estimates of adults were made because the ages of these fish were not yet determined.

Physical and chemical measurements of Elk Lake and its tributaries

Stream temperatures (Figure III) were taken in Limestone and Narrows Creeks throughout the summer with minimum-maximum thermometers. Daytime temperatures averaged higher on Limestone Creek until July 10, from then on they were lower than Narrows Creek. Lack of vegetation on the lower part of Limestone Creek in May and June coupled with the

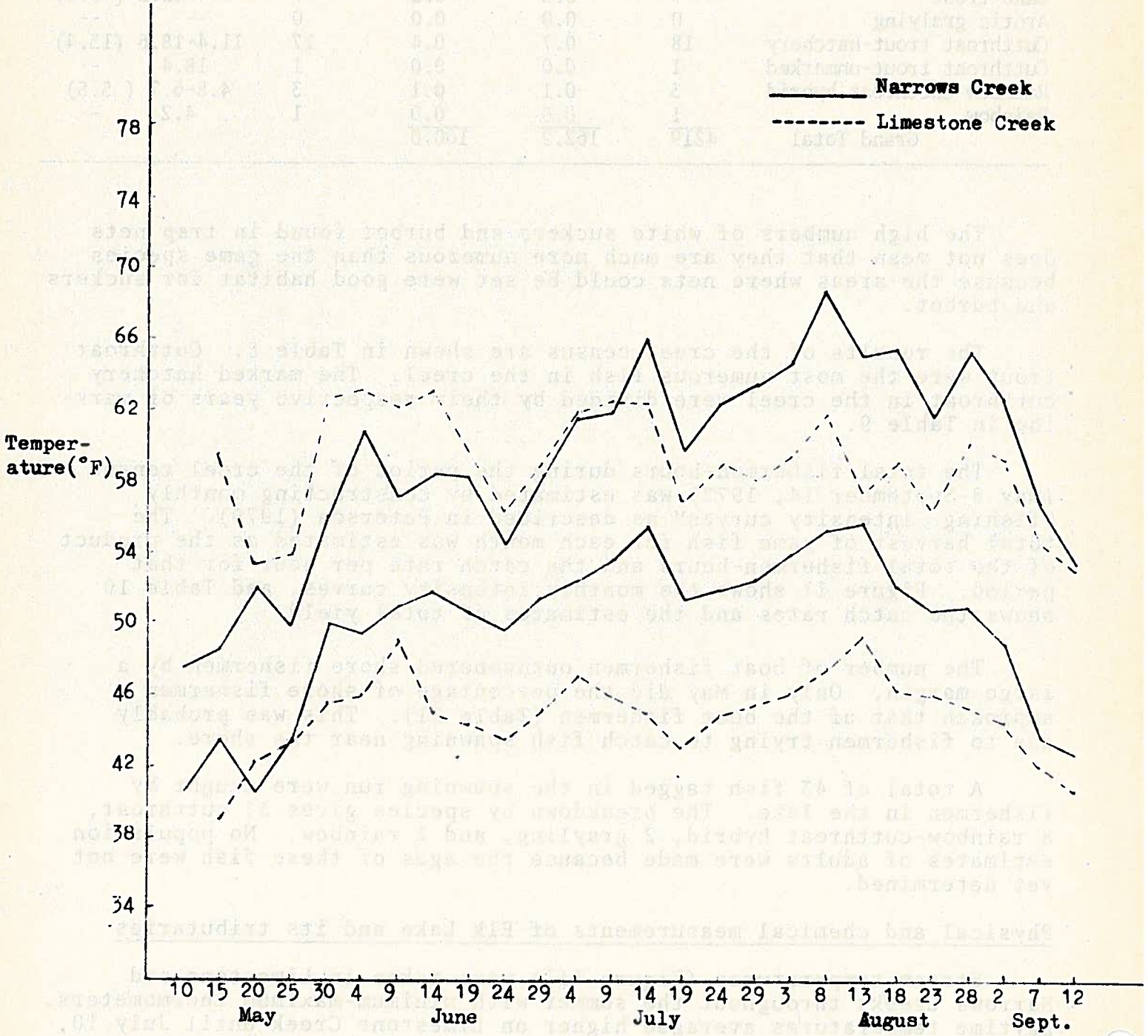

Figure III. Average five-day maximum and minimum temperatures for stations near the mouths of Narrows and Limestone Creeks, 1972.

TABLE 8. Species, numbers and size of measurable game fish which were observed in fishermen's creels at Elk Lake, 1972.

Species	Total Counted	Percent of Catch	Total Measured	Size Range in Total Ins.	(Ave.)
Lake Trout	49	9.8	35	12.8-18.3	(16.4)
Artic grayling	21	4.2	16	13.4-17.5	(15.3)
Cutthroat-unmarked 1/	131	26.1	111	11.5-21.6	(15.6)
Cutthroat-marked hatchery	189	37.7	172	10.5-20.4	(13.6)
Rainbow-cutthroat hybrid	55	11.0	47	11.2-20.0	(16.4)
Rainbow	15	3.0	14	11.6-18.5	(15.6)
Cutthroat 2/	41	8.2	--	--	--
Grand Total	501	100.0	395		

1/ Unmarked cutthroat trout would include wild and unmarked hatchery trout.
2/ Cutthroat which were not checked for marks.

TABLE 9. Number and size of marked hatchery cutthroat trout which were observed in fishermen's creels at Elk Lake, 1972.

Mark	Year Marked	Total Counted	Total Measured	Size Range In Total Ins.	(Ave.)
Adipose	1968	1	1	19.4	--
Left pectoral	1968	5	5	17.8-18.4	(18.0)
Adipose and right pelvic 1/	1969	25	20	15.6-20.4	(17.7)
Adipose	1970	1	1	16.9	--
Right pelvic	1970	8	6	14.3-16.6	(15.1)
Left pelvic	1971	149	139	10.5-15.3	(12.7)
Grand Total		189	172		

1/ Combination of both marks.

TABLE 10. Estimated game fish yield and catch rate for Elk Lake, May 8-September 14, 1972.

Date	Fishermen Contacted	Fish in Creel	Catch Per Hour	Total Fishermen-hrs.	Total Game Fish Yield
May (8-31)	70	67	0.38	517	196
June	141	182	0.36	823	295
July	171	217	0.37	1778	666
Aug.-Sept. 14	159	78	0.14	811	117
			Ave. 0.30	Total 3929	Total 1274

moderating effects of the pond on Narrows Creek probably caused these changes. Overnight temperatures were always lower on Limestone except for one week in May.

Flow readings (Figure IV) were taken approximately every week on Narro s Creek from May 18 to September 14, 1972, using the float method

TABLE 11. Number of shore and boat fishermen observed at Elk Lake, 1972 (percents in parentheses).

	May (8-31)	June	July	August	Sept. (1-14)	Summer Totals
Boat	90 (52.9)	191 (75.8)	505 (92.7)	199 (91.3)	50 (87.7)	1035 (83.3)
Shore	80 (47.1)	61 (24.2)	40 (7.3)	19 (8.7)	7 (12.3)	207 (16.7)

for calculation. A high reading of 2.41 cubic feet per second was recorded on May 18, and a low reading of 0.24 c.f.s. was recorded on August 15 and August 22. There was a slight rise in the flow in September after a general downward trend for the summer. No flows measurements were taken on Limestone Creek; however, they were visibly lower during early summer but somewhat higher in late summer as compared to Narrows Creek.

Secchi disc readings were taken seven times during the summer from June 20 to September 14. The readings were taken on June 20, July 9 and 29, August 22 and 26, and September 2 and 14. The results were 13'3", 15'11", 15'5", 17'5", 16'3", 15'4" and 13'6", respectively.

Temperature profiles were taken eight times on Elk Lake between July 1 and September 7, 1972 (Figure V). A thermocline was present at about the 30 foot depth.

Dissolved oxygen profiles were also taken on six occasions from June 29 to September 14. The averaged values for each depth, subsurface, 20', 25', 30', 35', and 50' were 8.8 ppm, 8.9 ppm, 8.1 ppm, 4.3 ppm, 0.9 ppm and 0.4 ppm, respectively. Each profile showed definite oxygen depletion below 30 feet.

Chemical analyses, including conductivity, harness, alkalinity, and pH, were made on water samples from Elk Lake, Limestone and Narrows Creek (Table 12).

TABLE 12. Results of chemical analyses of water samples taken on July 15 and August 26, 1972.

Place	pH		Alk. (ppm)		T. Hardness (ppm)		Cond. (m.mhos)	
	7-15	8-26	7-15	8-26	7-15	8-26	7-15	8-26
Elk Lake, subsurface	8.60	8.73	173.4	204.0	82.0	73.0	218	175
Elk Lake, 40' depth	7.34	7.21	190.4	188.6	85.4	84.0	230	205
Narrows Creek[1/]	7.26	7.58	54.0	73.4	28.4	32.0	90	115
Limestone Creek[1/]	8.00	8.04	227.6	229.8	115.8	115.0	260	240

1/ Samples taken near mouths of these streams.

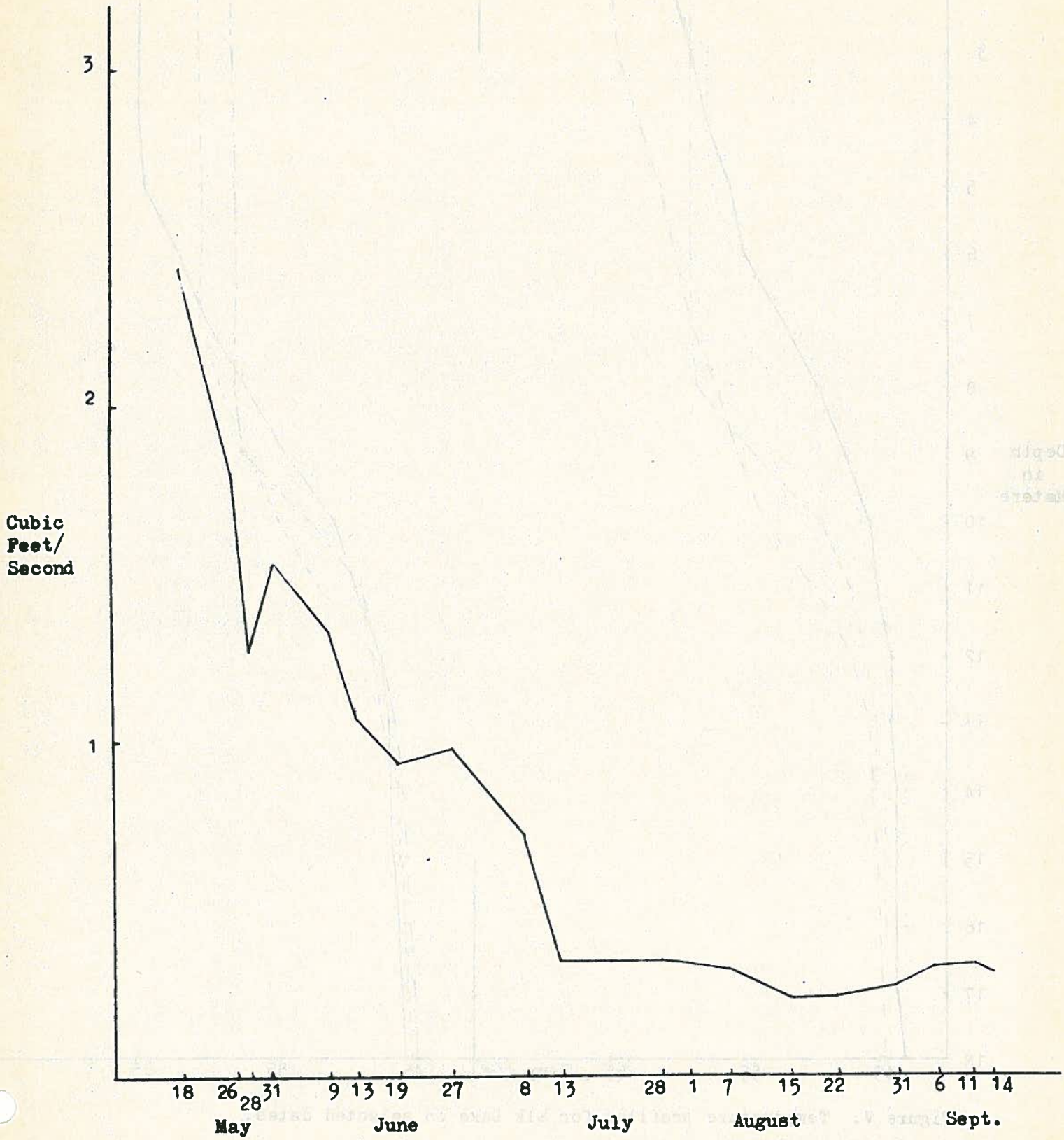

Figure IV. Flow levels taken in Narrows Creek May 18 to Sept. 14, 1972.

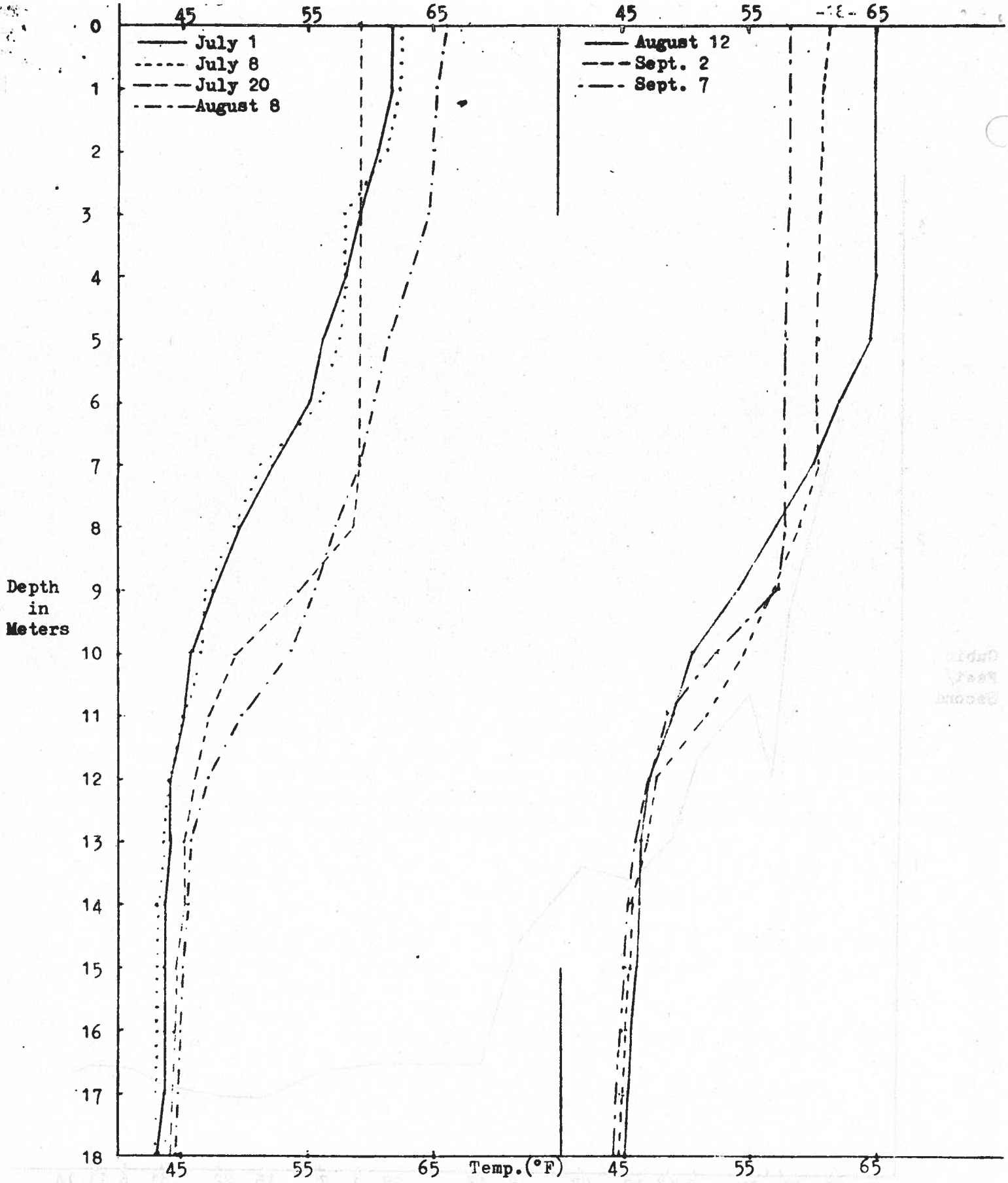

Figure V. Temperature profiles for Elk Lake on selected dates.

RECOMMENDATIONS

All the spawners should again be trapped in Narrows Creek in 1973 so that their age, length, weight, and numbers can be obtained. The fecundity of spawning cutthroat and grayling should be obtained by sacrificing a number of females so that a reproduction potential can be estimated. The adult population of trout in the lake can be estimated by marking all spawners and checking the marked to unmarked ratio in the creel.

The fry trap assembly should again be used in Narrows Creek to determine total numbers of fry and fingerling migrating downstream. This will give another year of baseline production of fry and fingerling from Narrows Creek. An attempt was made during 1972 to open up more spawning areas by the removal of debris from sections of Narrows Creek. Effects caused by this operation should be evaluated for increased production, farther migration upstream of spawners, and changes in redd sites.

The spawning activity and fry production on Limestone Creek should again be checked this year. All fry should be trapped on downstream migration.

The temperatures and flows can be monitored on Narrows and Limestone Creeks so that their effects can be studied.

The effects of siltation and loss of shrub-type vegetation have greatly reduced the use of Narrows Creek for spawning, especially in the lower one-third section. It is recommended that all of Narrows Creek below the pond be fenced to stop siltation and improve vegetation along the stream. The same is recommended for Limestone Creek if it is thought this stream is needed for production. Both streams, because of their size, need a maximum protection if production of large numbers of fry are expected. Siltation and loss of vegetation will lower production through loss of redds and increased stream temperatures.

The following measures, in addition to fencing, may help increase grayling and cutthroat recruitment to Elk Lake. Widening of the stream channel by removing silt and replacing with spawning gravel. This is especially needed in the lower section of Narrows Creek. Addition of gravel wherever needed should be considered. The pond on Narrows Creek must be maintained because its loss would cause heavy siltation downstream. At present, the pond helps spread out the spring runoff so that scouring of the redds and streambank is minimal. Consideration should be given to increasing the flow by use of a pump or storing more water in the pond to be used in late summer if the flow should become too low. It was noted that fry and fingerling migrate in greater numbers during increased flows.

More information is needed about lake security for fry and fingerling. The use of SCUBA and/or snorkling equipment after ice break-up in spring would show what security habitat is available before vegetation begins growth. The addition of artificial reefs or other devices may improve fry and fingerling survival in the lake. An attempt should be made to determine predation of fry and fingerling by lake trout and

burbot by taking stomach samples of these two predators. Attempts should also be made to estimate the lake population of both lake trout and burbot.

LITERATURE CITED

Peterson, N. W. 1970. The yield of wild and hatchery trout from Big Spring Creek, Montana. M.S. Thesis, Montana State University, 35 pp.

Peterson, N. W. 1972. Annual progress report, Elk Lake-Narrows Creek study, July 1, 1971 - June 30, 1972. Unpublished, 20 pp.