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,

JULY 1, 1971 - JUNE 30, 1972

by

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BACKGROUND

Elk Lake is located in the northweast corner of the Centennial Valley in southwestern Montana. This lake lies in an outlet channel that at one time drained a large lake occupying the entire valley (Vincent, 1962). Elk Lake lies at an elevation of about 6,800 feet, has a surface area of 283 acres, has precipitous shores and a maximum depth between 65 and 70 feet (Figure 1). Vincent (1962) discussed the possibility of lake trout (Salvelinus namaycush) being indigenous to Elk Lake; however, he noted that the relic stock may no longer be pure. Other game fish present in Elk Lake are Artic grayling (Thymallus arcticus), cutthroat trout (Salmo clarki), rainbow trout (Salmo gairdneri) and rainbow-cutthroat hybrids.

Fingerling cutthroat trout were planted in Elk Lake from 1954 to 1963 and subcatchables have been planted annually since 1965.

Narrows Creek is the primary spawning stream for grayling, cutthroat, rainbow and rainbow-cutthroat hybrids. This stream is intermittent and peak flows are generally around 2 cfs. The spawning potential of Narrows Creek is not great because of its size; however, improvements of the spawning channel coupled with improving flows during low water years would greatly increase the spawning potential and the annual recruitment to Elk Lake.

ABSTRACT

An estimated total of 23,449 fry, 68.4 percent of which were classified as grayling and 31.6 percent were classified as cutthroat trout, passed through the fry trap assembly during their downstream migration to Elk Lake in 1971. The downstream migration period for grayling fry was earlier and distinctively shorter than for cutthroat fry. The dates when the largest numbers of grayling and cutthroat fry were trapped were July 6 and July 19, respectively. A negative photoperiod response with respect to downstream movement was exhibited by grayling and cutthroat fry; however, grayling exhibited this response to a lesser degree than did cutthroat. The mean length of grayling fry was smaller than cutthroat fry when these species were first trapped. Statistical analysis indicated that grayling and cutthroat fry did not horizontally avoid the first trap box in preference of the two trap boxes placed downstream. Species compositon and average size of the lake population were determined with the aid of gill nets. Total yields for July to September 2 were estimated with the aid of creel checks and fishermen counts. Marked hatchery cutthroat trout contributed most and grayling contributed least to the creel. Minimum and maximum temperatures and discharges of the streams flowing into and the temperature conditions of Elk Lake are given.

OBJECTIVES

Fry recruitment from Narrows Creek, species composition in Elk Lake, fishing intensity and total yield from Elk Lake were studied. The data were collected to give information from which a comprehensive management plan for Elk Lake could be devised. The management plan should include provisions for enhancing, if possible, the natural propagation of cutthroat trout (Salmo clarki) and Arctic grayling (Thymallus arcticus). It is hoped natural recruit-

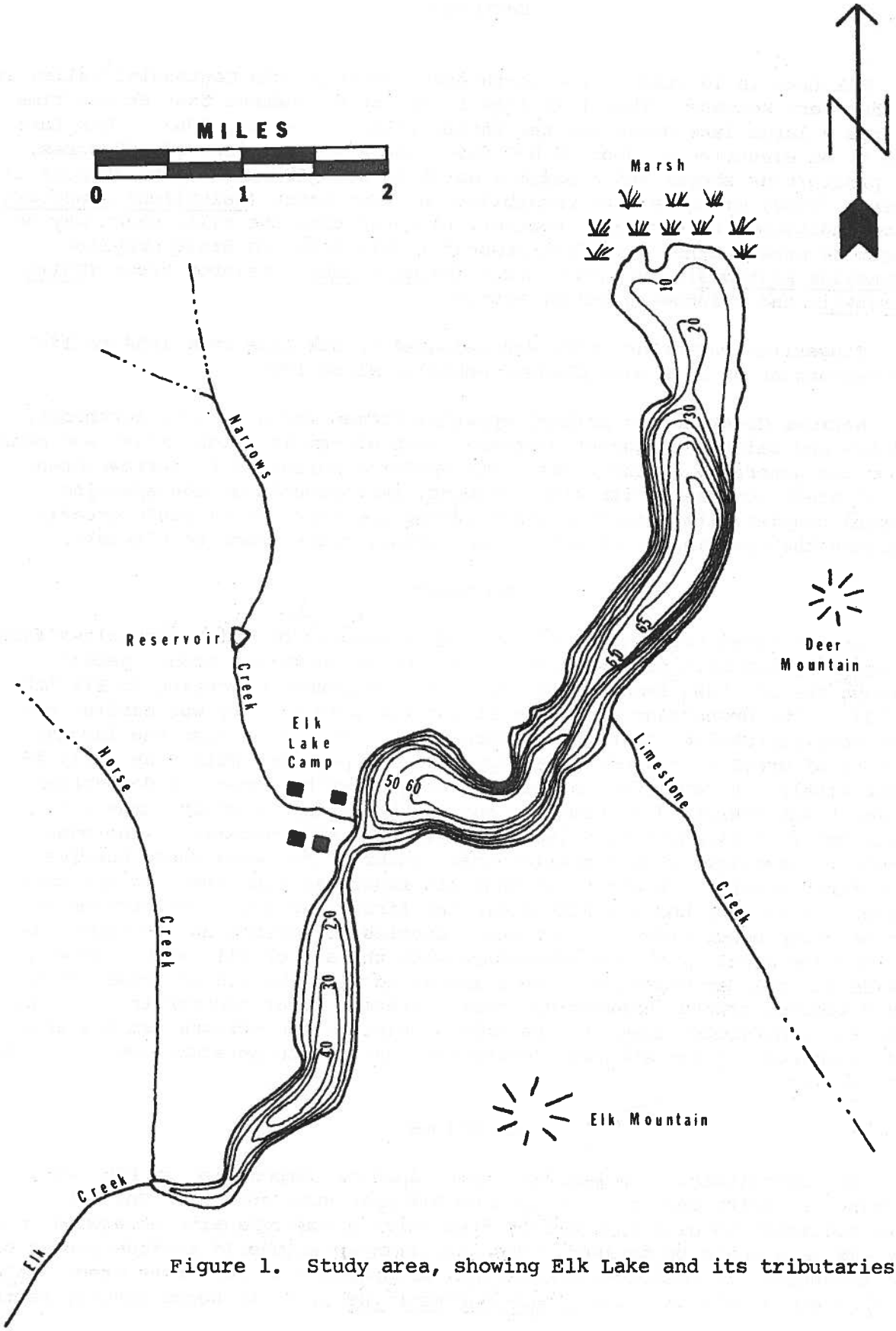

Figure 1. Study area, showing Elk Lake and its tributaries.

ment can be increased to the point that it could provide a good sport fisheries on an annual sustained basis in Elk Lake.

PROCEDURES

A fry trap assemply (Figures 2, 3 and 4) was constructed and placed immediately upstream from the mouth of Narrows Creek on June 24, 1971. The fry trap assembly was constructed in such a way that each trap box received approximately 1/3 of the flow (Figure 2). This division was constructed to ascertain whether or not fry would horizontally avoid and/or prefer any particular trap box passage.

The original assembly provided an insufficient area for adequate drainage through the nylon screen material (mesh size, 15½ per inch). This resulted in the loss of numerous fry due to overflow and mortality caused by fry being crushed against the sides. Overflow occurred when the trap remained unattended for any prolonged period. Many uncounted fry were lost through the flexible opening on top of the boxes (Figure 4) from July 1 through July 3. On July 4, the fry trap assembly was reassembled so that the size of trap box number 3 was doubled by adding another trap box to it. Trap boxes numbers 1 and 2 were removed and approximately two-thirds of the stream was allowed to flow unrestricted through their openings. On July 8, the sizes of trap boxes 1 and 2 were also doubled and reconnected to the assembly. More than twice as much drainage area as in the original trap box assembly resulted from these modifications. This modified assembly, shown in Figure 2, proved adequate and further overflowing of the boxes and large scale fry mortality did not occur. Debris, however, did continue to partially plug the screens and the screens had to be cleaned twice daily. A larger mesh size in the screen material would not have plugged as often; however, fry could have escaped from a larger screen material.

Fry were removed from the trap boxes twice daily (8:00 a.m. and 9:30 p.m.) until August 16. After August 16, fry were removed only in the morning.

Approximately 10 percent of the fry trapped each day were sacrificed and placed in dated jars containing a solution of 10 percent formalin. These samples were taken for the purposes of future species identification and obtaining mean length information. Weisel's (1966) key and a comparison of many fry were aids used in species identification. Fry samples were measured to the nearest 0.1 mm in total length.

A total of 11 floating and 4 sinking 125-foot standard experimental gill nets were set overnight in Elk Lake. Each net consisted of 25-foot panels of 3/4, 1, 1¼, 1½ and 2-inch square mesh netting. One floating gill net was set overnight in the pond upstream in Narrows Creek.

Fishermen were counted at 10:00 a.m. and 1:00, 4:00 and 8:00 p.m. to determine the daily distribution of fishing intensity. Only fishermen who were actually fishing at the time were counted. As many fishermen as practicable were interviewed from 8:00 a.m. to dark to obtain such information as 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. All fish in the creel were measured to the nearest 0.1 inches, weighed to the

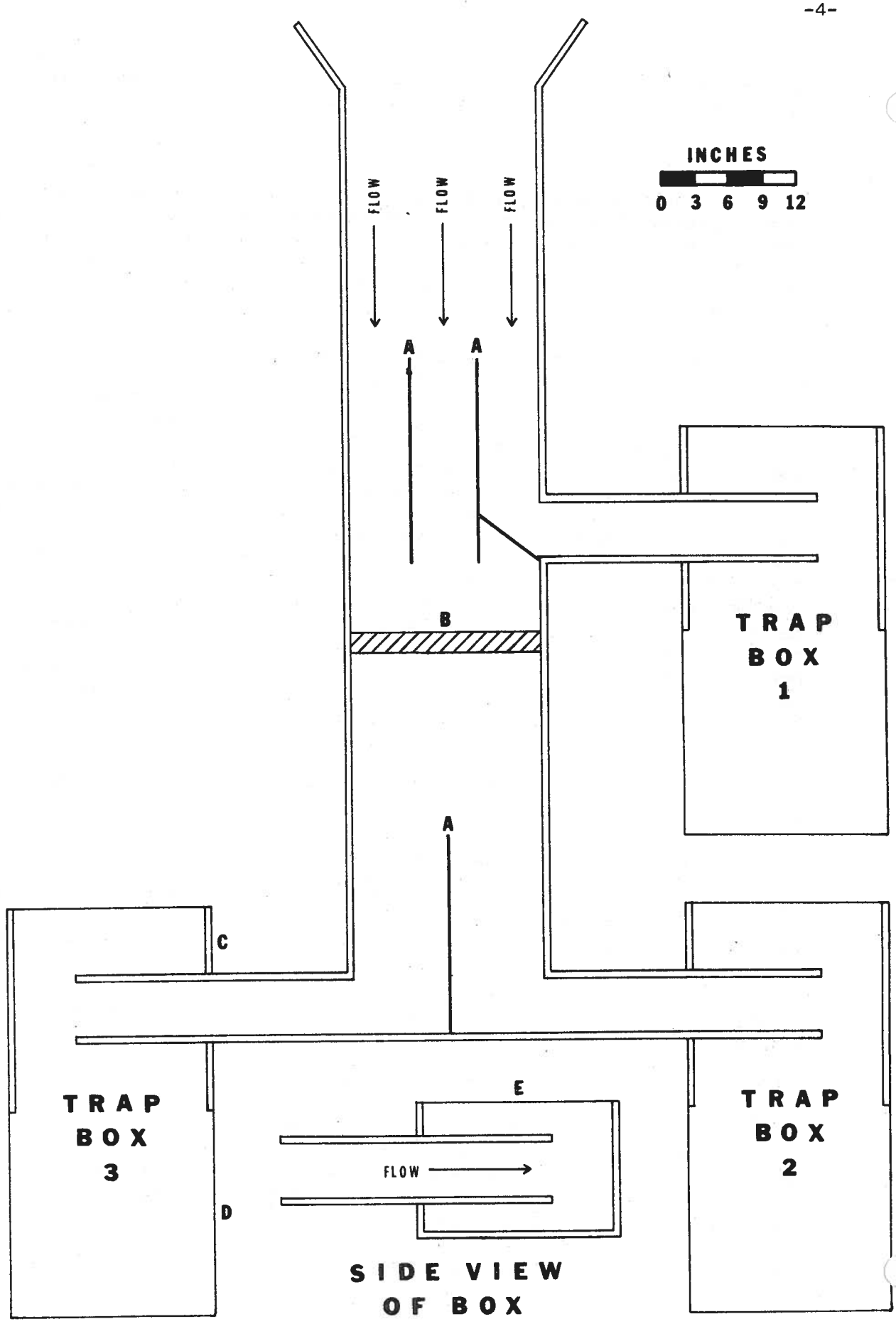

Figure 2. Fry trap assembly placed in Narrows Creek, 1971. A. Flow divider boards. B. 1 x 2 inch baffle board placed on floor of trough to cause a mixing effect. C. One inch thick board. D. Nylon screen material. E. Trap box lids made of nylon screen material.

Figure 3. Showing the fry trap assembly placed in Narrows Creek, 1971.

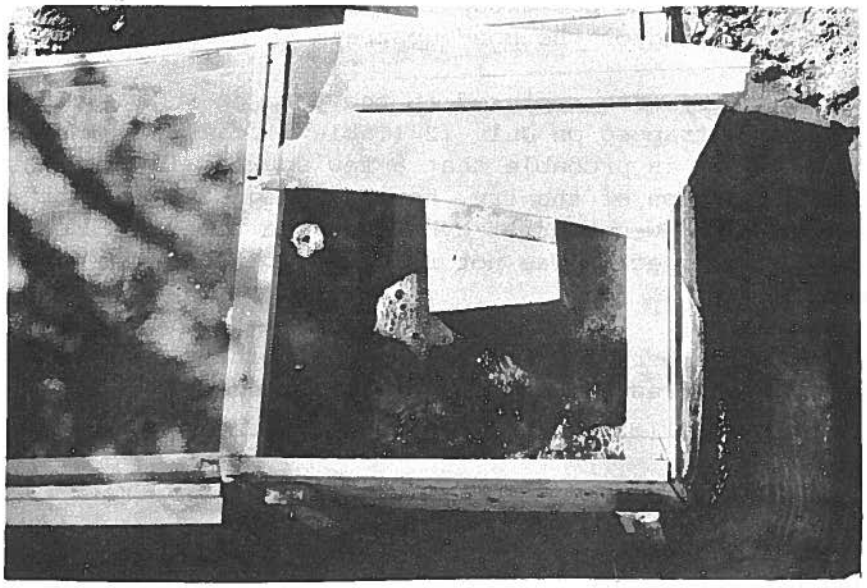

Figure 4. An overhead view of trap box 1 showing the internal design.

nearest 0.01 pounds and checked for the presence of fin clips. Fish stocked in Elk Lake from 1967 to the present have been marked with a variety of identifying fin clips.

The discharges of the three streams flowing into the lake were checked periodically and the maximum and minimum daily temperatures of these streams were recorded. All flow and temperature measurements were taken near the mouths of the respective streams.

The bottom profile of Elk Lake was determined with the aid of a Fish Lo-K-Tor (Lowrance Electronics Mfg. Corp., Tulsa, Oklahoma). The temperature conditions of the lake were recorded in July and again in August.

FINDINGS

Narrows Creek

Cutthroat trout and Arctic grayling were observed spawning in Narrows Creek on June 1 and 8, 1971, but not during an earlier trip to the area on May 4. A few spawning grayling but no spawning cutthroat were observed in the stream on June 24. Rainbow trout were not observed spawning in the stream at any time but were probably present in small numbers.

From June 24 to June 28, about 75 rainbow and rainbow-cutthroat hybrids, averaging 74.0 mm in total length, were captured in the fry trap. Scales were taken from these trout to determine their age. Age I annuli were not yet clearly formed on most scales. A few scales did, however, have what appeared to be an annulus on the edge. Laakso and Cope (1956) stated that some fish that overwinter in streams fail to form the initial annulus on their scales. Many of the fingerling scales were similar to what Laakso and Cope (1956) classified as having stream nuclei. These rainbow and hybrids were therefore classified as belonging to age group I and were believed to have overwintered in Narrows Creek and/or the pond upstream in Narrows Creek (Figure 1).

The first grayling fry were captured in the trap on June 29, whereas the first cutthroat fry were trapped on July 12 (Table 1). Although no spawning rainbows were observed, it is probable that a few spawned in Narrows Creek; therefore, an unknown portion of the fry, herein designated as cutthroat, may be rainbow and/or rainbow-cutthroat hybrids. The time of first emergence from the gravel by either species was not recorded, but, no fry were observed in the stream on June 24.

TABLE 1. The estimated numbers and species composition of fingerlings and fry during downstream migration in Narrows Creek, 1971.

Species	Number	Percent of Fry	Date Extremes of capture
Fingerlings			
Rainbow	1		6-27
Rainbow-cutthroat hybrids	15		6-24 to 27
Rainbow and hybrids counted but not separated by species	59		6-28
Fry			
Grayling	15,980	68.4	6-29 to 7-22
Cutthroat	7,394	31.6	7-12-still migr. on 9-3
Total	23,449		

The downstream migration period for grayling fry was distinctively shorter than the cutthroat fry migration period. The extreme dates of downstream migration are listed in Table 1.

The grayling migration period was distinctively earlier than the cutthroat migration period (Figure 5). An estimated 73 grayling were trapped after July 13, the low point of downstream migration (No. C, Figure 5). An estimated 12 cutthroat were trapped before July 14.

The estimated total number of fry that moved downstream through the fry trap area during the study period was 23,372 (Table 2). Of that total, approximately 68.4 and 31.6 percent were grayling and cutthroat fry, respectively (Table 1). The dates when the largest numbers of grayling and cutthroat fry were trapped were June 6 and July 19, respectively (Figure 5).

Table 2. Numbers of fry counted and extrapolated[1/] during four-day periods from the fry trap assembly in Narrows Creek, 1971.

Date	Number Counted	Number Extrapolated	Estimated Total
June 28-July 1	490	1,000	1,490
July 2-5 [2/]	2,070	4,027	6,097
6-9 [3/]	2,300	4,943	8,243
10-13	87	0	87
14-17	713	0	713
18-21	4,263	300	4,563
22-23	1,231	0	1,231
26-29	458	0	458
30-Aug 2	167	0	167
Aug. 3-6	156	0	156
7-10	48	0	48
11-14	32	0	32
15-18	33	0	33
19-22	20	0	20
23-26	11	0	11
27-30	12	0	12
31-Sept 3	11	0	11
		Estimated grand total	23,372

1/ The extrapolated numbers are from on-site observations combined with the best estimate of loss.
2/ The fry trap assembly was remodeled on July 4 so that approximately 30 percent of the fry were being captured.
3/ Trap boxes one and two were replaced on July 8 so that 100 percent of the fry could be trapped.

The numbers uncounted and lost due to trapping mortality during the period July 1 through July 3 could only be roughly estimated by extrapolation from totals of trapped totals before and after the losses occurred and the totals that remained in the trap. The numbers uncounted and lost during the period July 4 through July 7, a period when only trap box 3 was in operation, were estimated as 70 percent of the total since trap box 3 would trap approximately 30 percent of the total when all three trap boxes were in operation. It is unfortunate that more precise numbers would not be known during these periods

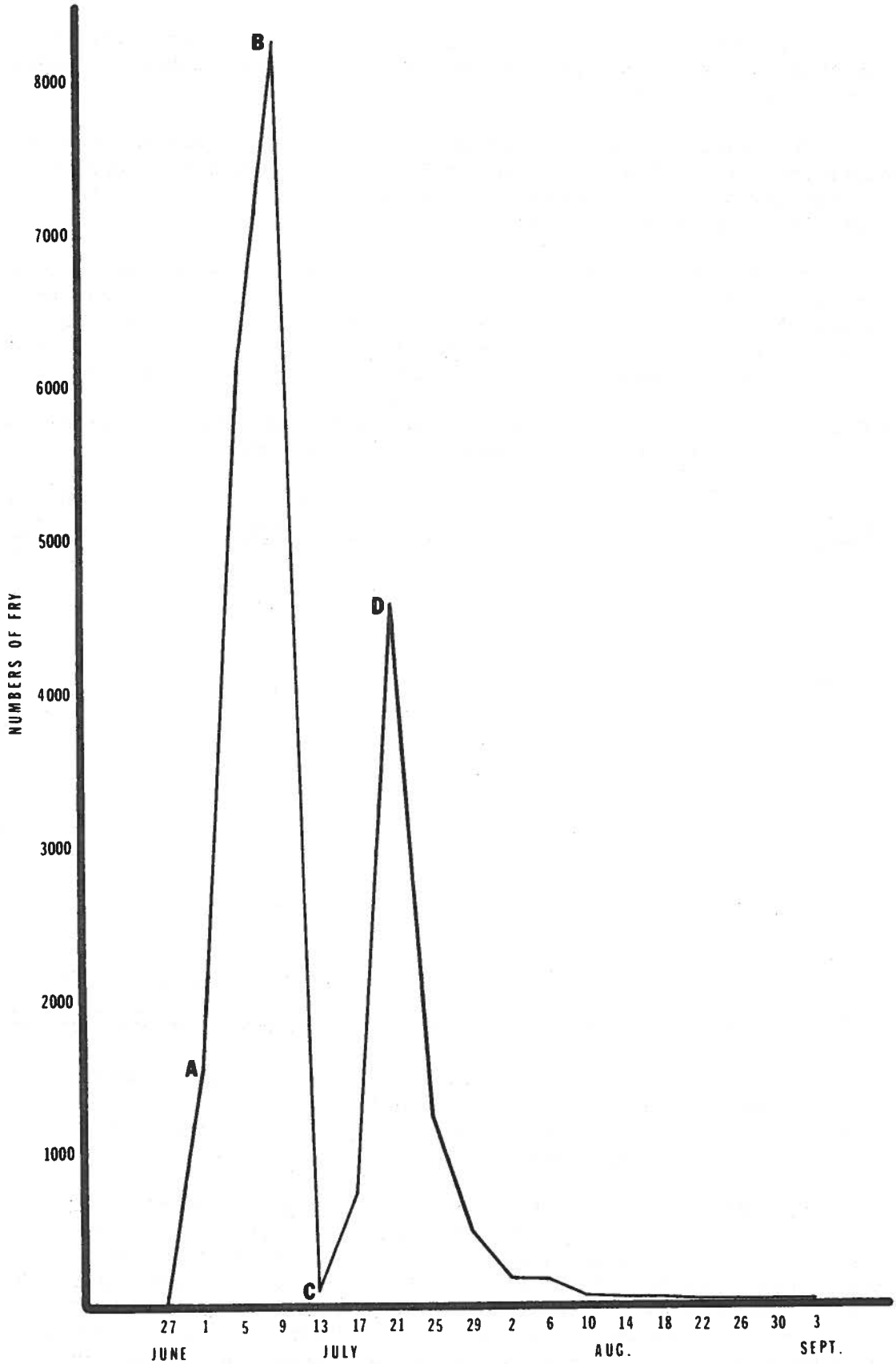

Figure 5. Estimated four-day totals of fry captured in the fry trap assembly in Narrows Creek, 1971. A. Grayling fry began emergence and/or downstream migration on June 29. B. Peak numbers of captured grayling fry on July 6. C. Cutthroat fry began emergence and/or downstream migration on July 12. D. Peak numbers of captured cutthroat fry on July 19.

since they were periods when large numbers of grayling fry migrated downstream.

A negative photoperiod response with respect to downstream movement was exhibited by the fry. Grayling fry exhibited this response to a lesser degree than did cutthroat. During the period when fry collections were made both in the morning and the evening, 65.5 percent of the grayling and 96.2 percent of the cutthroat fry were trapped in the evening and collected from the trap in the morning.

The mean length of grayling fry when they first entered the trap was 15.0 mm and that of cutthroat fry was 23.9 mm (Table 3). On similar dates (i.e., July 17-23), however, they were approximately the same length (i.e., about 24 mm).

TABLE 3. Mean total length of arctic grayling and cutthroat fry during downstream movement in Narrows Creek, 1971.

Date	Species	Sample Size	Mean Length
July 2-5	Grayling	12	15.0 mm
6-9	Grayling	12	15.7 mm
10-13	Grayling	7	18.3 mm
14-16	Grayling	- 1/	- 1/
17-22 2/	Grayling	7	24.0 mm
16-14	Cutthroat	12	23.9 mm
20-23	Cutthroat	12	24.2 mm
24-27	Cutthroat	12	26.1 mm
28-31	Cutthroat	12	28.1 mm
Aug. 1-4	Cutthroat	11	28.1 mm
5-12 3/	Cutthroat	12	36.8 mm
17&21	Cutthroat	2	41.5 mm

1/ No grayling samples taken during this period since only 2 were captured.
2/ Samples were taken on 3 separate days during this 6-day period.
3/ Samples were taken on 4 separate days during this 8-day period.

Chi-square values were computed to check the differences between the trapping frequencies of trap boxes 1, 2 and 3. The observed capture rate from each trap was checked against the expected capture rate of 1/3 (Steel and Torrie, 1960). The only days used in the computations were days when all traps were in operation and when nothing inadvertent happened to the trapping operation. The sampling period was divided into three strata; stratum I was from July 8 through July 13 and corresponded to the period of grayling fry migration, stratum II was from July 14 through July 26, and stratum III was from July 27 through September 3.

The total chi-square value for each trap and each day within strata I, II and III was 87.6, 626.4 and 280.4, respectively (Table 4). This means that one cannot expect that each trap box during each stratum will contain 1/3 of the fry on a daily basis. There was a significant daily deviation from the expected capture rate of fry for each trap box except trap box 2 during stratum I (Table 4). During stratum 1, trap box 2 did not deviate significantly from the expected 1/3 value but this was the only time trap box 2 contained approximately

1/3 of the fry within any stratum.

All of the chi-square values were significantly different from the expected when the capture rate of each trap box was tested using the sum total of the daily capture rates for each of the three strata as degrees of freedom (Table 5). This means that one cannot expect that 1/3 of the fry will be captured in any of the three trap boxes during any of the three strata. Trap box number 1 had the lowest chi-square value, 13.4 (Table 5). I therefore assume that, over the entire fry migration period, 1/3 of the fry can more nearly be expected to be captured in trap box number 1. Since the chi-square values show that trap box number 1 was closest to the expected capture rate of 1/3, it appears that fry do not appreciably avoid number 1 in preference of the other two trap boxes. The greatest proportion of the fry being captured in number 2 might be explained if, through fry trap design, a greater proportion of the flow was directed into trap box number 2. However, micro-measurements of flows within the fry trap assembly were not made to determine the proportion directed into each trap box.

TABLE 4. Chi-square values using the daily sums of captured fry in each box and comparing the observed capture rate of each trap box with the expected capture rate of 1/3 within each of the tree strata.

Stratum	Trap Box	Chi-square Value	Degree of Freedom
I	1	48.2 1/	5
	2	9.2 2/	5
	3	30.2 1/	5
	Total	87.6 1/	
II	1	185.9 1/	12
	2	297.6 1/	12
	3	142.6 1/	12
	Total	626.4 1/	24
III	1	89.1 1/	31
	2	142.8 1/	31
	3	48.5 1/	31
	Total	280.4 1/	62

1/ Significantly different from the expected 1/3 at the 0.05 level.
2/ Not significantly different from the expected 1/3 at the 0.05 level.

TABLE 5. Chi-square values using the sum total of captured fry in each box for each stratum as degrees of freedom and comparing the observed capture rate of each box with the expected capture rate (1/3) over the entire study period, 1971.

Trap Box	Chi-square Value	Degrees of Freedom
1	13.4 1/	2
2	76.5 1/	2
3	33.7 1/	2
Total	123.6 1/	4

1/ Significantly different from the expected 1/3 at the 0.05 level.

A floating gill net was set overnight in the pond in Narrows Creek (Figure 1) on August 1, 1971. A total of 16 fish were captured, 9 rainbows and 7 cutthroat-rainbow hybrids. The rainbows averaged 9.8 inches with a range of 5.8 to 13.9 inches. The hybrids averaged 13.8 inches and ranged from 10.2 to 18.6 inches.

Elk Lake

Several attempts were made to obtain a sufficient number of marked fish with the aid of trap nets in order that lake population estimates could be made. However, because of the small numbers of fish captured, this operation was cancelled.

Gill nets were set to obtain an index of species composition of the fish population in Elk Lake (Table 6). White suckers were predominant and comprised 82.6 percent of the total. Artic grayling comprised only 1.5 percent of the total. Unmarked cutthroat trout were predominant in the catch of game fish. Marked hatchery cutthroat trout had the largest average size of all fish captured with gill nets.

"Fishing intensity curves" (Peterson, 1970) could only be constructed for July and August through September 2 (Figure 6) since fishermen counts were not made during May and June. Total fishing pressure for each of the two periods thus became the total fishermen-hours under that period's curve. Both sides of the curves were closed by extrapolation from contact information.

Total fishermen-hours was estimated to be 1,556 and 652 for July and August-September 2, respectively (Table 7). The catch rate was highest during June and lowest in August (Table 7).

The total game fish yield was estimated as the product of the total fishermen-hours and the catch rate. Game fish yield for the two periods are shown in Table 7. Since one could not get into Elk Lake with two or four wheel drive vehicles until after May 10, 1971, and since less than 100 game fish are taken annually during the winter period (Bill Green, resort owner, personal communication), I assume that the total yield of game fish for the entire year was about 1,000 or less. This yield is very small considering the large numbers recruited to the lake and that the annual hatchery plant is about 20,000.

A total of 251 game fish (Table 7) were counted during creel surveys in 1971. Of the total counted, 230 were not dismembered and could be measured (Table 8). Unmarked and marked hatchery cutthroat trout contributed the most to the creel (Table 8). Although arctic grayling are apparently being naturally recruited to the lake in large numbers, this species comprises only 3.9 percent of the catch.

Of the marked hatchery cutthroats, those from the 1969 plant contributed, by far, the most to the catch (Table 9) even though only 5,015 were planted (Table 10). The 1970 plant averaged over 12 inches at the time they were caught, a size assumed to be large enough to be kept by fishermen; however, only 5 from this group were checked in the creel.

TABLE 6. Species numbers and size of fish captured in gill nets in Elk Lake, 1971. (All common names correspond to "A List of Common and Scientific Names of Fishes From the United States and Canada", American Fisheries Society Special Publication No. 6, 1970.)

Species	Floating Gill Net (11)	Sinking Gill Net (4)	Percent of Total Catch	% of Game Fish Catch	Size Range in Total Ins. (Ave.)
White suckers	123	95	82.6		6.8-16.8 (13.3) 1/
Burbot	0	10	3.8		9.2-15.2 (12.4)
Lake trout	0	2	0.8	5.6	13.0-15.0 (14.0)
Arctic grayling	3	1	1.5	11.1	9.8-13.4 (10.8)
Cutthroat trout - unmarked 2/	9	4	4.9	36.1	11.6-18.9 (15.0)
Cutthroat trout - marked hatchery	6	2	3.0	22.2	15.1-17.8 (16.5)
Rainbow-Cutthroat hybrids	2	1	1.1	8.3	7.3-18.3 (14.3)
Rainbow trout	6	0	2.3	16.7	6.1-18.3 (14.4)
Grand Total	149	115	100.0	100.0	

1/ Not all white suckers were measured. Sample size measured totaled 16.

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

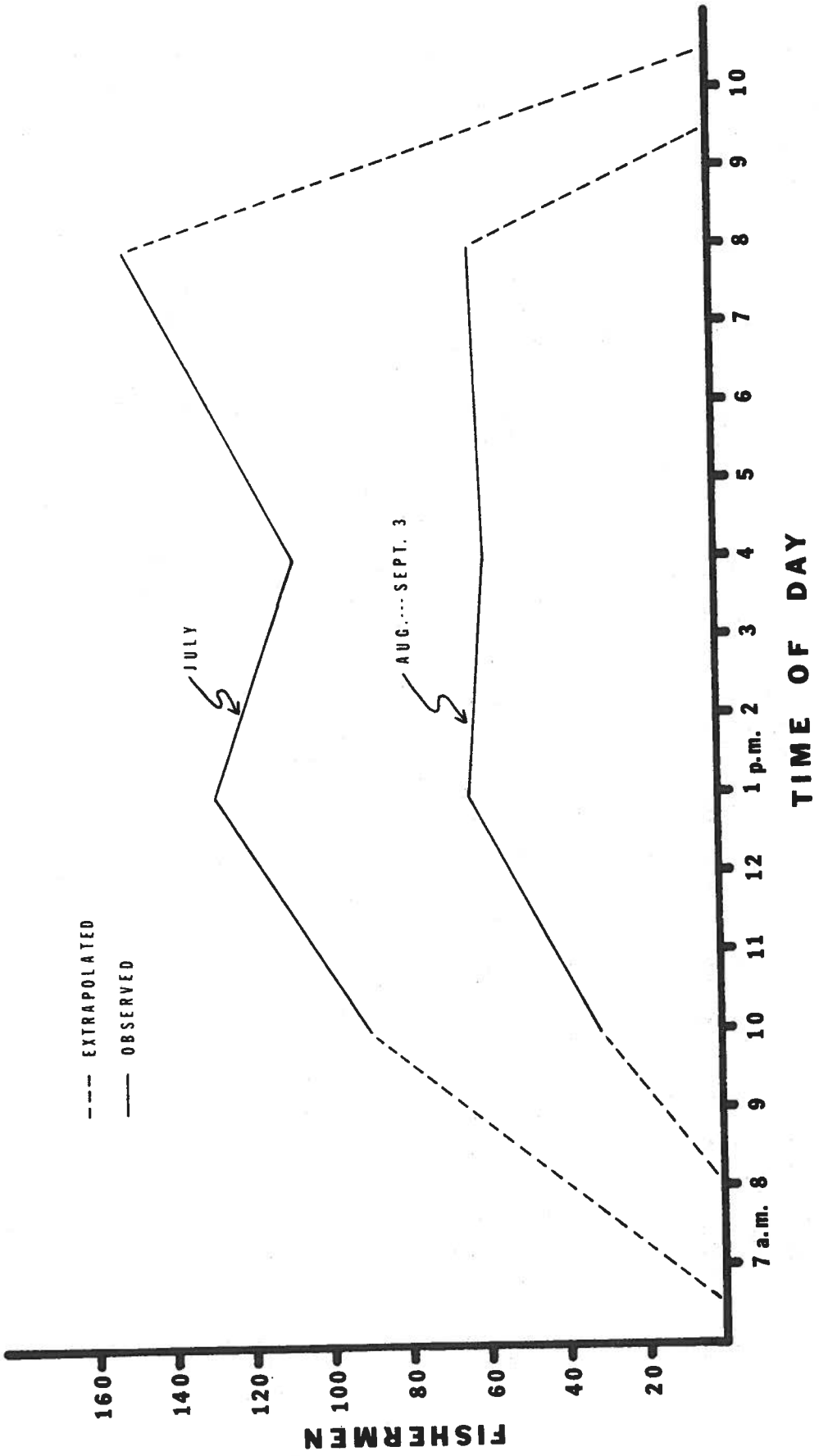

Figure 6. Fishing intensity curves for July and August to September 3 for Elk Lake, 1971.

TABLE 7. Estimated game fish yield and catch rate for Elk Lake, 1971.

Date	Fishermen Contacted	Fish in Creel	Catch Per Hour	Total Fishermen-hrs.	Total Game Fish Yield
May	44	19	0.11	1/	1/
June	26	29	0.39	2/	2/
July	458	208	0.28	1,556	436
Aug-Sept 2	128	5	0.04	652	26

1/ The road to Elk Lake was not opened until May 10; therefore, it can be assumed that the majority of fishing was done during the latter part of the month.

2/ Creel checks were made only from June 20 to the end of the month.

TABLE 8. Species numbers and size of measurable game fish which were observed in fishermen's creels at Elk Lake, 1971.

Species	Total Measured	Size Range Total Ins.	(Ave.)	Total Counted	% of Catch
Lake Trout	21	14.3-18.2	(15.9)	22	9.6
Artic grayling	7	11.1-17.0	(15.2)	9	3.9
Cutthroat-unmarked 1/	38	9.0-19.1	(14.4)	60	26.1
Cutthroat-marked hatchery	84	8.6-18.4	(16.2)	84	36.5
Rainbow-cutthroat	22	10.1-20.6	(16.1)	30	13.0
Rainbow	23	8.0-19.2	(15.9)	25	10.9
Grand Total	195			230	100.0

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

TABLE 9. Number and size of marked hatchery cutthroat trout which were observed in fishermen's creels at Elk Lake, 1971.

Mark	Year Marked	Number	Size range in total ins.	(Average)
Adipose	1968	8	16.1-18.2	(17.0)
Left pectoral	1968	3	15.3-18.0	(17.1)
Adipose & right pelvic 1/	1969	68	11.3-18.4	(16.4)
Adipose	1970	2	11.1-13.6	(12.4)
Right pelvic	1970	3	8.6-15.6	(11.9)

1/ Combination of both marks.

TABLE 10. A summary of the stocking program of cutthroat trout from 1967 through 1971 in Elk Lake

Date Planted	Number Planted	Number Marked	Percent Marked	Ave. Length Total Ins.	Identifying Clip
10-9-67	4,000	1,600	40.0	4.7 1/	Left pelvic
6-21-68	5,736	2,116	36.9	8.2 1/	Adipose
9-12-68	12,000	4,000	33.3	4.6 1/	Left pectoral
6-23-69	5,015	5,015	100.0	9.5 1/	Adipose & right pelvic 3/
5-10-70	19,998	2,080	10.4	4.0 2/	Right pelvic
5-10-70	10,005	2,065	20.6	5.0 2/	Adipose
7-7-71	20,063	20,063	100.0	4.0 2/	Left pelvic

1/ At time of marking.
2/ At time of stocking.
3/ Combination of both marks.

The average size of the trout in the 1969 plant was larger than that of the 1970 plant at their respective planting dates (Table 10). This larger size may be a factor in the different harvest rates of these trout and perhaps in their survival in the pelagic environment of Elk Lake.

During the fishermen counts in July, 76.6 percent were observed to be fishing from boats and 23.4 percent from shore. From August 1 through September 2, 89.4 percent were observed to be fishing from boats and 10.6 percent from shore. Few boats were out before 8:00 a.m. and fishing prior to that time was mostly from shore. During creel checks, 92.4 and 88.3 percent of the fishermen claimed to have been fishing from boats in July and August-September 2, respectively (Table 11). The difference between observed and contacted data during July may be due to contact bias; in July many fishermen were contacted on shore before 10:00 a.m., but, by the fishermen counts at 10:00 a.m., these same fishermen could have been fishing from boats.

TABLE 11. Numbers of shore and boat fishermen contacted on Elk Lake, 1971. (Percents in parentheses)

	May	June	July	Aug-Sept 2	Total
Boat	27 (61.4)	18 (69.2)	423 (92.4)	113 (88.3)	581 (88.6)
Shore	17 (38.6)	8 (30.8)	35 (7.6)	15 (11.7)	75 (11.4)

Physical measurements of Elk Lake and its tributaries

The flows of Narrows Creek never got above 0.20 cfs at any time when measurements were taken. But, flows were not measured in May and early June when the discharges were visably higher. The discharge measurements for June 25, July 3, 9, and 13, and August 19 were 0.19, 0.20, 0.15, 0.14, and 0.07 cfs, respectively.

The discharge in Limestone Creek was measured at 0.18 cfs on August 19. Horse Creek had a discharge of 0.73 cfs on July 9. However, by July 20 this stream had no flow near its mouth.

The average five-day maximum and minimum temperatures of Narrows, Limestone and Horse Creeks are recorded in Figure 7. During comparable dates, Narrows Creek had consistently higher temperatures than Limestone Creek. The maximum temperature of Horse Creek exceeded 90° F before it went dry at the measuring station. Maximum temperatures of Horse Creek exceeded 70° F a good portion of the time when its temperatures were being recorded. Temperatures greatly in excess of 70° F for extended periods would seem to be high for survival of the eggs and sac fry of cutthroat and grayling.

Temperature conditions of Elk Lake were recorded on two different dates at a depth of 60 feet (Figure 8). There was a tendency towards stratification near the 30 foot level in both July and August.

RECOMMENDATIONS

A two-way weir should be placed and monitored in Narrows Creek. The fecundity of spawning cutthroat and grayling, the total number of spawners ascending the stream, the age and sex of spawners and spawning mortality of the adults should be determined. The spawners should also be tagged. If this is done, an estimate of the adult population of cutthroat, rainbow and rainbow-cutthroat trout, and grayling in Elk Lake can be attempted by observing the ratio of marked to unmarked fish in the creels.

The spawning areas in Narrows Creek should be investigated to determine whether or not the confined channel contributes greatly to natal stream mortality from the over-lapping of redds.

A fry trap assembly should again be placed in Narrows Creek to determine the total number and timing of emigrating fry to estimate natal stream mortality. The fry trap should be set in Narrows Creek before June 20 and should be monitored daily until at least August 15.

The spawners activity in and fry emigration from Limestone Creek should be more thoroughly checked.

An attempt should be made to keep livestock out of the streams and to keep human harassment of spawning adults to a minimum by fencing both Narrows and Limestone Creeks. Disturbance of the streambank material by livestock will cause the silting in of redds, increased stream temperatures and plugging of the fry trap screens; therefore, fencing should be done as soon as possible.

The flows and temperatures of Narrows and Limestone Creeks should be continually monitored throughout the study period.

An investigation of the availability of suitable food and the security levels for fry around their rearing areas in the pelagic environment should be undertaken. SCUBA and/or snorkling equipment would be required for this phase of the study.

An attempt should be made to determine the timing, major areas and magnitude

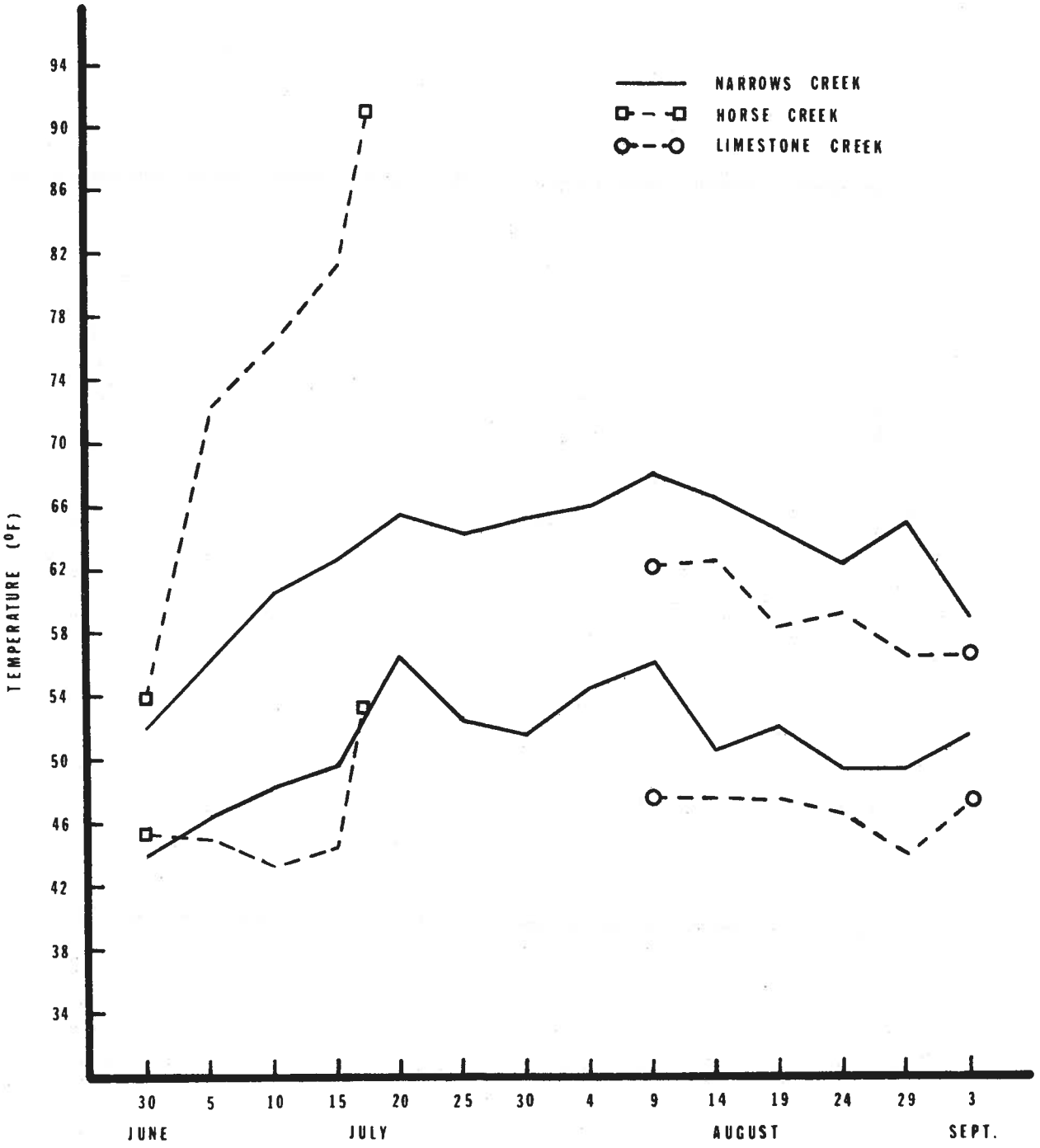

Figure 7. Average five-day maximum and minimum temperatures for stations on Narrows, Horse and Limestone Creeks, 1971. (Last average on Horse Creek is for two days).

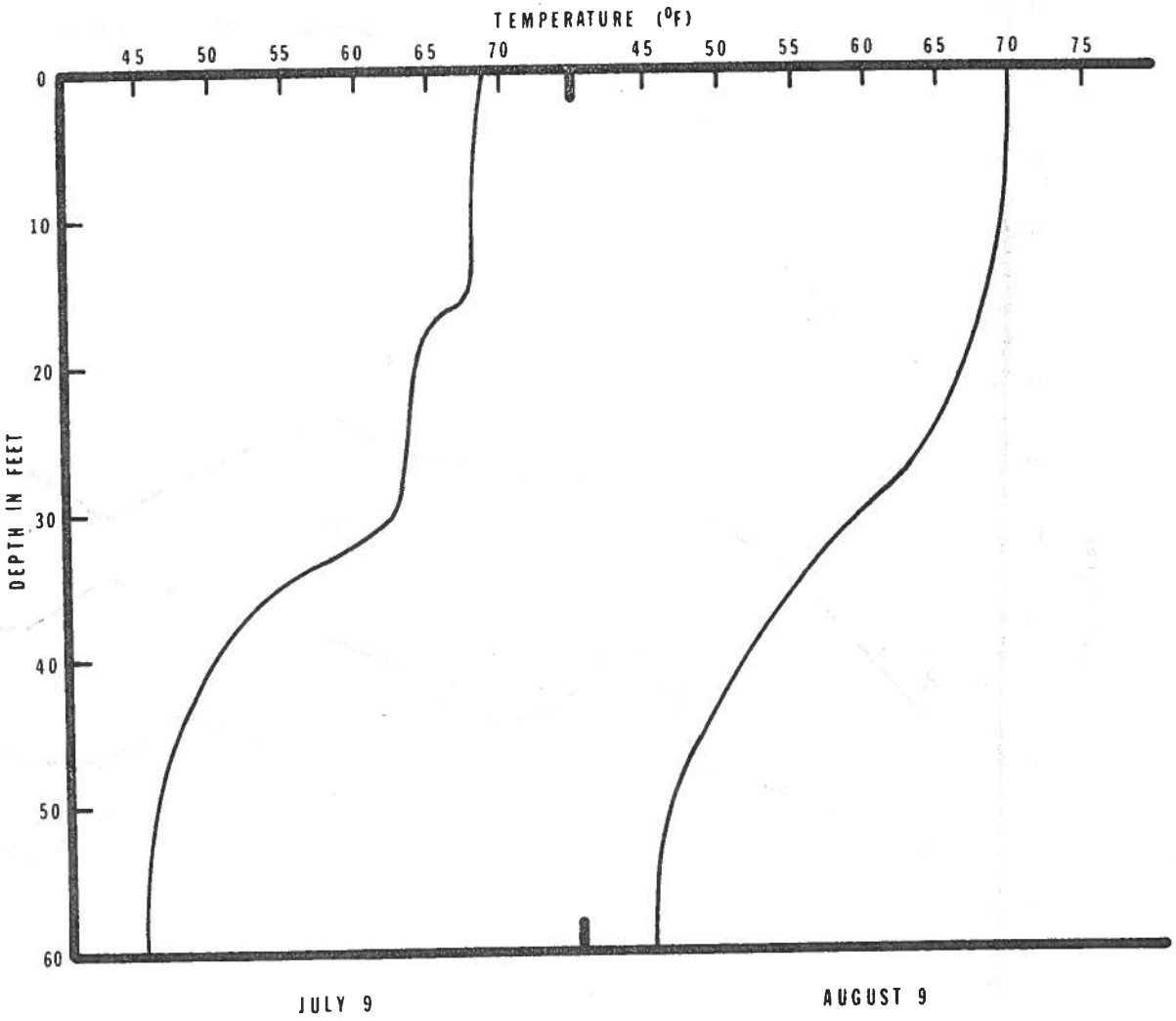

Figure 8. Temperature conditions in Elk Lake on July 9 and August 9, 1971.

of predation upon the fry and fingerlings by burbot and lake trout. Observations and stomach sample investigations of the predators would aid here.

Hatchery cutthroat trout should again be marked with identifying fin clips prior to planting. Gill nets should be set in the lake in the fall to determine the size obtained by that year's planted hatchery trout before the winter period.

A partial creel survey and complete fishermen count at pre-set hours should again be conducted as the basis for an estimate of the total harvest from Elk Lake.

The following measures, in addition to streambank fencing, should be considered as a means for increasing grayling and cutthroat recruitment to Elk Lake.

1. Widen the stream channel and improve the spawning area by replacing sediment with a gravel bed in selected areas of the stream(s). These measures should resolve some of the problems related to natal stream mortality.

2. Increase the flow of Narrows Creek when it becomes intermittent. A pump assembly could bring water from the lake during these critical periods and the pump could be maintained by the proprietors of Elk Lake Camp.

3. If the security levels for fry are low in and around the rearing and/or wintering areas and post-emergent mortality of fry is very high due to predation in Elk Lake, consideration should be given to providing an artificial substrate in these critical areas. Everest (1969) found that juvenile chinook and steelhead demonstrated a thigmotactic response to the bottom at temperatures below 41^{o} F and would enter the available stream bottom substrate. This thigmotactic response is not unique since other authors have reported on it. Artificial reefs constructed with rock material of suitable size (40 cm or larger, Everest, 1969) would provide security from predation when the fry emigrate from the stream and during the winter or early spring periods. These reefs could be deposited on the ice during the winter and would deposit themselves upon the bottom during the spring break-up of ice.

A future solution to the problems of increasing the return of hatchery trout, if desired or needed, may be to plant 4-6 inch fish, if they were available, earlier in the season, possibly following the spring break-up of ice. By fall, they should be large enough to insure a better overwinter survival rate.

LITERATURE CITED

Everest, F. H. 1969. Habitat selection and spacial interaction of juvenile chinook salmon and steelhead trout in two Idaho streams. Doctoral disertation, Univ. of Idaho, 77 pp.

Laakso, Martin and O. B. Cope. 1956. Age determination in the Yellowstone cutthroat trout by the scale method. Jour. Wildl. Mgt., 20(2): 138-153.

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

Steel, R. G. O., and J. H. Torrie. 1960. Principles and procedures of statistics. McGraw-Hill Book Co., Inc.

Vincent, R. E. 1963. The native range of lake trout (Salvelinus namaycush) in Montana. Copiea, 1: 188-189.

Weisel, G. F. 1966. Young salmonoid fishes of Western Montana. Proceedings Mont. Acad. of Sciences, 26: 1-21.