



The reproduction of salmonids in the inlets of Elk Lake, Montana
by John Andrew Lund

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University
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Abstract:

The natural reproduction of Arctic grayling, cutthroat trout, rainbow trout and rainbow trout-cutthroat trout hybrids in the inlets of Elk Lake was studied during the spring and summer of 1972 and 1973. Grayling, cutthroat, rainbow and hybrid trout ran in Narrows Creek, while only grayling used Limestone Creek. In Narrows Creek trout runs started May 10, 1972 and May 17, 1973, coinciding with the disappearance of ice from the lake and increased stream flows. Grayling runs started 7 and 10 days later, respectively, during the two years of the study. Total number of spawners entering Narrows Creek in 1972 and 1973 were 520 and 459, respectively. Sixty-four percent of the grayling, 31 percent of the cutthroat trout, 26 percent of the hybrid trout and 30 percent of the rainbow trout tagged during the 1972 spawning run returned to spawn in 1973. The average fecundity of grayling and cutthroat trout sampled was 8,170 and 1,954 eggs per female, respectively. Fry emigrations started in late June each year with the grayling fry preceding trout fry by 12 days. A total of 79.6 percent of the grayling fry and 94.5 percent of the trout fry emigrated downstream between 8:00 p.m. and 8:00 a.m. A total of 618 and 2,082 grayling fry emigrated from Narrows Creek in 1972 and 1973, representing a spawning efficiency of 0.04 and 0.12 percent, respectively. Trout fry production was 7,502 and 2,484 fish in 1972 and 1973, representing a spawning efficiency of 2.5 and 1.2 percent. An estimated 2,797 and 2,432 trout fry also remained in Narrows Creek after the emigration periods in 1972 and 1973, respectively. A total of 196 grayling migrated upstream in Limestone Creek in 1973; however, no fry were produced in the stream. The amount of water flow in the inlets and substrate conditions were considered important factors in controlling fry production.

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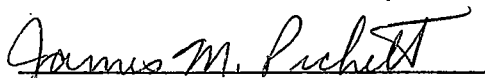
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TABLE OF CONTENTS

	Page
VITA	ii
ACKNOWLEDGMENT	iii
LIST OF TABLES	v
LIST OF FIGURES	vii
ABSTRACT	viii
INTRODUCTION	1
DESCRIPTION OF STUDY AREA	2
METHODS	6
RESULTS	10
Spawning Migrations	10
Timing of Narrows Creek Runs	10
Characteristics of Narrows Creek Runs	12
Timing of Limestone Creek Runs	21
Characteristics of Limestone Creek Runs	23
Age and Growth	24
Egg Production	29
Production of Fry and Fingerlings	32
Fry	32
Fingerling	36
Spawning Efficiency	37
Physical Factors Affecting Fry Production	38
DISCUSSION	40
LITERATURE CITED	42

LIST OF TABLES

Table	Page
1. MEASUREMENTS OF SELECTED PHYSICAL AND CHEMICAL PROPERTIES OF ELK LAKE AND ITS INLETS DURING THE SUMMERS OF 1972 AND 1973	4
2. NUMBERS, TOTAL LENGTHS AND POST-SPAWNING WEIGHTS OF FISH, BY SPECIES AND SEX, CAPTURED ON THE SPAWNING RUN IN NARROWS CREEK, 1972	14
3. NUMBERS, TOTAL LENGTHS AND POST-SPAWNING WEIGHTS OF FISH, BY SPECIES AND SEX, CAPTURED ON THE SPAWNING RUN IN NARROWS CREEK, 1973	15
4. NUMBERS, LENGTHS AND MARKS OF THE CUTTHROAT TROUT STOCKED IN ELK LAKE FROM 1967 THROUGH 1973	18
5. SELECTED CHARACTERISTICS OF MARKED HATCHERY CUTTHROAT TROUT ENTERING NARROWS CREEK DURING 1972 AND 1973	18
6. ESTIMATED AVERAGE NUMBER OF DAYS SPENT IN NARROWS CREEK BY MALE AND FEMALE CUTTHROAT TROUT AND ARCTIC GRAYLING	20
7. NUMBERS, TOTAL LENGTHS AND WEIGHTS OF GRAYLING, BY SEX, CAPTURED ON THE SPAWNING RUN IN LIMESTONE CREEK IN 1973	23
8. AGE GROUPS AND AVERAGE CALCULATED TOTAL LENGTHS AT SUCCEEDING ANNULI OF ARCTIC GRAYLING CAPTURED DURING SPAWNING RUNS FROM ELK LAKE, 1972 AND 1973	25
9. AGE COMPOSITION, BY SEX, OF ADULT CUTTHROAT, RAINBOW AND HYBRID TROUT TRAPPED IN NARROWS CREEK, 1972 AND 1973	27
10. AVERAGE CALCULATED TOTAL LENGTHS AT EACH ANNULUS FOR CUTTHROAT, RAINBOW AND HYBRID TROUT COLLECTED DURING 1972 AND 1973	28
11. RANGE AND AVERAGE NUMBER OF MATURE EGGS PER FEMALE BY TOTAL LENGTH GROUPS	29

LIST OF TABLES
(Continued)

Table	Page
12. ESTIMATED POTENTIAL EGG PRODUCTION AND EGG DEPOSITION OF GRAYLING AND TROUT IN THE INLETS OF ELK LAKE, 1972 AND 1973	31
13. AVERAGE TOTAL LENGTH OF FRY COLLECTED DURING PERIODS OF THEIR DOWNSTREAM MOVEMENT IN NARROWS CREEK	35
14. THE SPECIES COMPOSITION, NUMBER AND SIZE OF FINGERLING TROUT CAUGHT EMIGRATING FROM NARROWS CREEK IN 1972 AND 1973	37
15. ESTIMATED SPAWNING EFFICIENCIES IN THE TWO INLET STREAMS TO ELK LAKE DURING 1972 AND 1973	38
16. TOTAL NUMBER OF GRAYLING AND TROUT FRY PRODUCED IN NARROWS CREEK IN RELATION TO OVERWINTER SNOW-WATER LEVELS AND PRECIPITATION IN 1971, 1972 AND 1973	39

LIST OF FIGURES

Figure	Page
1. Map of Elk Lake and its tributaries	3
2. Weekly flows in Narrows and Limestone Creeks showing start of upstream movement by trout (A) and Arctic grayling (B)	11
3. Daily upstream movement of trout and grayling into Narrows Creek, with corresponding average daily stream temperatures and surface temperatures of Elk Lake during 1972 and 1973	13
4. Daily upstream movement of grayling into Limestone Creek, with corresponding average daily stream temperatures and surface temperatures of Elk Lake in 1973	22
5. Number of fry emigrating from Narrows Creek in 1972 and 1973. A = peak of grayling fry movements, B = peak of trout fry movements, and C = peak movement of trout caused by dewatering of stream	33

ABSTRACT

The natural reproduction of Arctic grayling, cutthroat trout, rainbow trout and rainbow trout-cutthroat trout hybrids in the inlets of Elk Lake was studied during the spring and summer of 1972 and 1973. Grayling, cutthroat, rainbow and hybrid trout ran in Narrows Creek, while only grayling used Limestone Creek. In Narrows Creek trout runs started May 10, 1972 and May 17, 1973, coinciding with the disappearance of ice from the lake and increased stream flows. Grayling runs started 7 and 10 days later, respectively, during the two years of the study. Total number of spawners entering Narrows Creek in 1972 and 1973 were 520 and 459, respectively. Sixty-four percent of the grayling, 31 percent of the cutthroat trout, 26 percent of the hybrid trout and 30 percent of the rainbow trout tagged during the 1972 spawning run returned to spawn in 1973. The average fecundity of grayling and cutthroat trout sampled was 8,170 and 1,954 eggs per female, respectively. Fry emigrations started in late June each year with the grayling fry preceding trout fry by 12 days. A total of 79.6 percent of the grayling fry and 94.5 percent of the trout fry emigrated downstream between 8:00 p.m. and 8:00 a.m. A total of 618 and 2,082 grayling fry emigrated from Narrows Creek in 1972 and 1973, representing a spawning efficiency of 0.04 and 0.12 percent, respectively. Trout fry production was 7,502 and 2,484 fish in 1972 and 1973, representing a spawning efficiency of 2.5 and 1.2 percent. An estimated 2,797 and 2,432 trout fry also remained in Narrows Creek after the emigration periods in 1972 and 1973, respectively. A total of 196 grayling migrated upstream in Limestone Creek in 1973; however, no fry were produced in the stream. The amount of water flow in the inlets and substrate conditions were considered important factors in controlling fry production.

INTRODUCTION

The Montana Fish and Game Department is attempting to manage populations of game fish on a self-sustaining basis where possible. Although both Arctic grayling (*Thymallus arcticus*) and cutthroat trout (*Salmo clarki*) spawn in the two inlets to Elk Lake, their contribution of fish to the harvest seems to be limited. Local fishermen have described fishing as "good" only after the planting of "catchable" sized trout. In 1971 the Montana Fish and Game Department began a series of investigations to, in part, provide information on how to increase the recruitment of wild fish to the fishery.

This study was part of the overall study and was designed to determine the size and composition of the spawning runs in Narrows and Limestone Creeks and to evaluate the resulting production of emigrating fry. This study was pursued during the spring and summer of 1972 and 1973.

DESCRIPTION OF STUDY AREA

Elk Lake is located in southwestern Montana approximately 40 air kilometers west of the town of West Yellowstone in the Beaverhead National Forest, Beaverhead County. It is situated in the northwest corner of the Centennial Valley in an outlet channel of a large Pleistocene lake which covered the entire valley (Vincent, 1963). The lake lies in an elongate basin at an elevation of 2,035 meters and is flanked by steep hills bearing sagebrush-grassland vegetation on the west and conifers on the east.

The lake has a maximum depth of 21.3 meters and a surface area of 115 hectares (Figure 1). It is moderately eutrophic, having dissolved oxygen levels of less than 1.5 p.p.m. below 11 meters during July and August of 1972 and 1973. Additional characteristics of the lake are given in Table 1.

Narrows and Limestone Creeks are the main tributaries of Elk Lake. The Narrows Creek drainage is 5.6 kilometers long and contains a pond lying 1.1 kilometers above the mouth of the stream (Figure 1). Springs approximately 0.8 kilometers above the pond provide most of the flow, with the stream becoming intermittent above the springs. Flows near the mouth of the creek varied from a high of about 5.0 m³/min. during May to 0.3 m³/min. during August. A resort providing lodging for fishermen and hunters is located near the mouth of the creek.

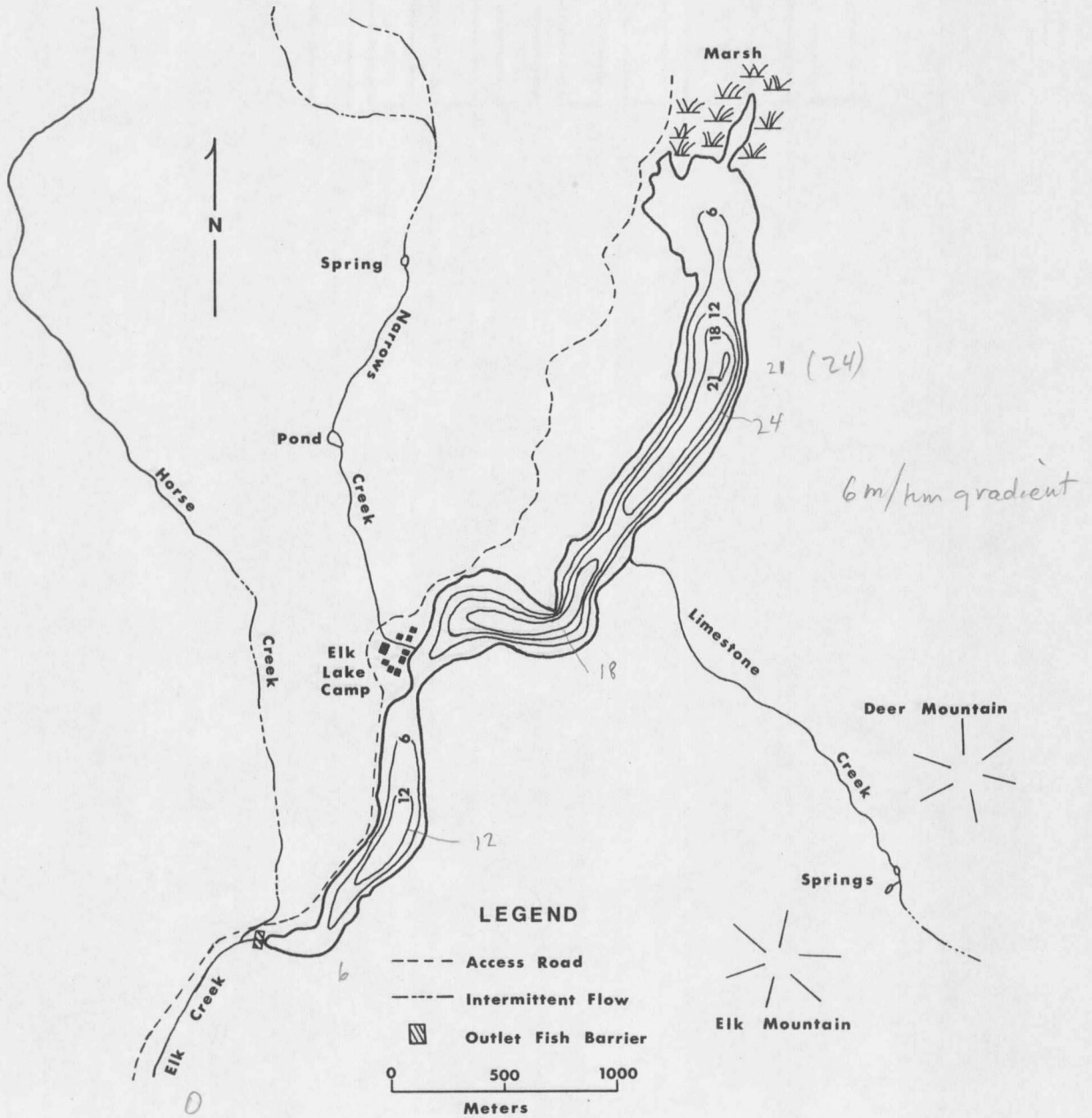


Figure 1. Map of Elk Lake and its tributaries.

TABLE 1. MEASUREMENTS OF SELECTED PHYSICAL AND CHEMICAL PROPERTIES OF ELK LAKE AND ITS INLETS DURING THE SUMMERS OF 1972 AND 1973.

Property	Elk Lake Range (average)	Narrows Creek Range (average)	Limestone Creek Range (average)
pH	7.21-8.60	7.26-7.58	7.85-8.04
Conductivity (micromhos)	175-230 (203)	84-115 (96)	230-260 (243)
Total Hardness (as ppm CaCO ₃)	73.0-85.4 (79.9)	20.0-32.0 (26.8)	110.0-115.8 (113.6)
Total Alkalinity (as ppm CaCO ₃)	120.0-204.0 (175.3)	40.0-73.4 (55.8)	155.0-229.8 (204.1)
Water Temperatures (°C) Surface (maximum)	6.2-19.4 (15.3)	5.0-20.6 (15.2)	2.8-20.0 (14.8)
Water Temperatures (°C) Surface (minimum)	3.6-7.2* (5.0)	2.8-14.4 (9.4)	0.6-11.1 (6.1)

* At lake bottom.

The Limestone Creek drainage is approximately 4.8 kilometers long, with flows being maintained by springs 2.0 kilometers from the lake. Flows near the lake varied from about 3.4 m³/min. during May to 0.3 m³/min. during July and August. The calculated values of selected chemical properties of Limestone Creek were considerably higher than those of Narrows Creek (Table 1).

Several species of fish are present in Elk Lake and its tributaries. Cutthroat trout have been stocked in the lake annually since 1954. Rainbow trout (*Salmo gairdneri*) were last stocked in 1950; however, a small naturally reproducing population still exists. Rainbow

trout-cutthroat trout hybrids are produced in Narrows Creek and found in the lake. Small numbers of rainbow trout, cutthroat trout and rainbow trout-cutthroat trout hybrids are resident in the pond on Narrows Creek. Lake trout (*Salvelinus namaycush*) are probably indigenous to Elk Lake (Vincent, 1963). However, the present stock may not be the indigenous strain because of hatchery plants made in the area during the 1890's. Arctic grayling were native to most of the lakes and streams of the valley but disappeared from Elk Lake around 1930 (Nelson, 1954). Hatchery plants in 1954, 1955 and 1957 reestablished the species in the lake. The white sucker (*Catostomus commersoni*), burbot (*Lota lota*) and mottled sculpin (*Cottus bairdi*) are also native to the area and present in the lake. Other species of fish present in the area have been prevented from entering the lake since the mid-1950's when a coarse rock and gravel barrier was placed across the outlet.

METHODS

Traps were used to capture fish entering and leaving Narrows Creek in 1972 and 1973 and Limestone Creek in 1973. In Narrows Creek adult fish were captured in a two-way weir measuring 2.4 x 1.8 x 0.6 meters constructed of plywood and galvanized hardware screen having a 1.9 centimeter mesh. The trap was placed approximately 15 meters upstream from the mouth of the stream and operated from May 8 to July 28, 1972 and from May 16 to July 5, 1973. It was checked for fish daily at 8:30 a.m., 1:00 p.m. and 6:30 p.m. A two-way weir of the same design but measuring 2.4 x 1.2 x 0.6 meters and covered with galvanized hardware screen having a mesh of 1.3 centimeters was placed in Limestone Creek about 6 meters upstream from its mouth. It was in operation from May 23 to June 25, 1973 and was checked daily at 8:00 a.m. and 5:30 p.m.

Adults caught moving upstream were counted, identified to species, classified to sex and released upstream above the traps. Adults captured returning to the lake were tagged, weighed, measured for total length, identified to species and classified to sex. Unmarked plastic "T" type anchor tags were inserted in back of the dorsal fin on downstream migrants during 1972. In 1973 numbered tags of the same type were used to allow the identification of individual fish. Also at this time scales were taken from between the dorsal fins and lateral lines of all fish for age and growth determinations, all females were

examined to determine if they had spawned, and all cutthroat trout were inspected for hatchery marks.

Ovaries were taken from small numbers of grayling, cutthroat trout and rainbow trout-cutthroat trout hybrids captured on spawning runs during both years of the study and preserved in 10 percent formalin. The number of mature eggs in each fish was estimated by weighing the entire egg mass, taking about a 10 percent subsample by weight and counting the number of eggs in the subsample. The total number of mature eggs in the fish was then estimated by proportion. Egg retention was estimated by counting retained eggs stripped from live spent females.

A fry trap was placed about 6 meters downstream from the adult trap on Narrows Creek and operated from June 15 to September 15, 1972 and from June 23 to September 13, 1973. It consisted of a 0.5 x 2.1 meters chute channeling one-third of the stream flow into each of three 0.3 x 0.5 x 0.9 meter boxes screened with twenty-mesh plastic door screen. This trap was checked at 8:00 a.m., 12:30 p.m. and 8:00 p.m. daily. All fry and fingerlings captured were counted and released below the trap. Fry were only identified as either grayling or trout, but fingerlings were identified to species. The total lengths of samples of fry and fingerlings were taken throughout the emigration period.

Fry traps were maintained in Limestone Creek from June 27 to July

22, 1972 and from June 25 to July 23, 1973. During 1972 the trap used had a single 0.3 x 0.6 x 0.6 meter box. The trap used in 1973 had a 0.3 x 0.6 x 1.2 meter box. Both boxes were enclosed with twenty-mesh plastic door screen. Fry captured were identified, counted and released downstream from the traps.

A one-way trap measuring 0.9 x 1.2 meters and covered with galvanized hardware screen having a 0.95 centimeter mesh was placed immediately below the pond on Narrows Creek and operated from May 16 to September 11, 1973. This trap was designed to capture fingerlings and advanced fry moving downstream from the pond. Fish captured in this trap were measured, identified to species when possible, and released into Elk Lake.

During the first week of October each year, estimates were made of the number of trout fry remaining in Narrows Creek from below the pond to its mouth. This portion of the stream was divided into three sections of equal length with approximately 33 meters being electro-fished in each section. The fry captured were fin clipped and released. A Peterson estimate was calculated for each subsection following the recapture run. The subsection estimates were combined and the average expanded by proportion to the entire 1.1 kilometers of stream length.

From mid-May to mid-September of 1972 and 1973, the daily temperature variations of Narrows and Limestone Creek were measured with Taylor maximum-minimum thermometers placed near the mouths of the

streams. Rates of flow were calculated for Narrows Creek in 1972 and both streams in 1973 using stream velocities determined by the "float method". Total hardness, total alkalinity and pH measurements were made on water samples using the HACH Model DR-EL Field Kit; and conductivity measurements were taken with a Beckman Solu Bridge. The depths of loose gravel at 18 spawning sites in Narrows Creek below the pond were measured.

RESULTS

Spawning Migrations

Timing of Narrows Creek Runs

Spawning runs started on May 10 in 1972 and on May 17 in 1973, coinciding with the disappearance of ice from the lake. Rainbow trout and rainbow trout-cutthroat trout hybrids dominated the early part of each run with their numbers peaking on May 14, 1972 and May 17, 1973. Cutthroat trout outnumbered the rainbow and hybrid trout in the runs after the first four days each year with their peak numbers occurring on May 20 and May 27, in 1972 and 1973, respectively. Grayling runs started 7 and 10 days later than the rainbow and hybrid runs during the two years of this study, respectively. These findings contrast with Brown (1938), who stated grayling often run in advance of rainbow and cutthroat trout. However, Kruse (1959) reported rainbow trout-cutthroat trout hybrids run one to three weeks prior to grayling in Grebe Lake, Yellowstone National Park.

Rainbow, cutthroat and hybrid trout started their upstream migrations (Figure 2) as stream flows increased from spring runoff. Snyder and Tanner (1960) and Sumner (1952) have reported a similar response by cutthroat trout to increased flows. Grayling began their runs on declining stream flows when daily lake and stream temperatures averaged approximately 7°C. During 1973 the surface temperature of the lake and the average stream temperature were near 10° and above 7°C,

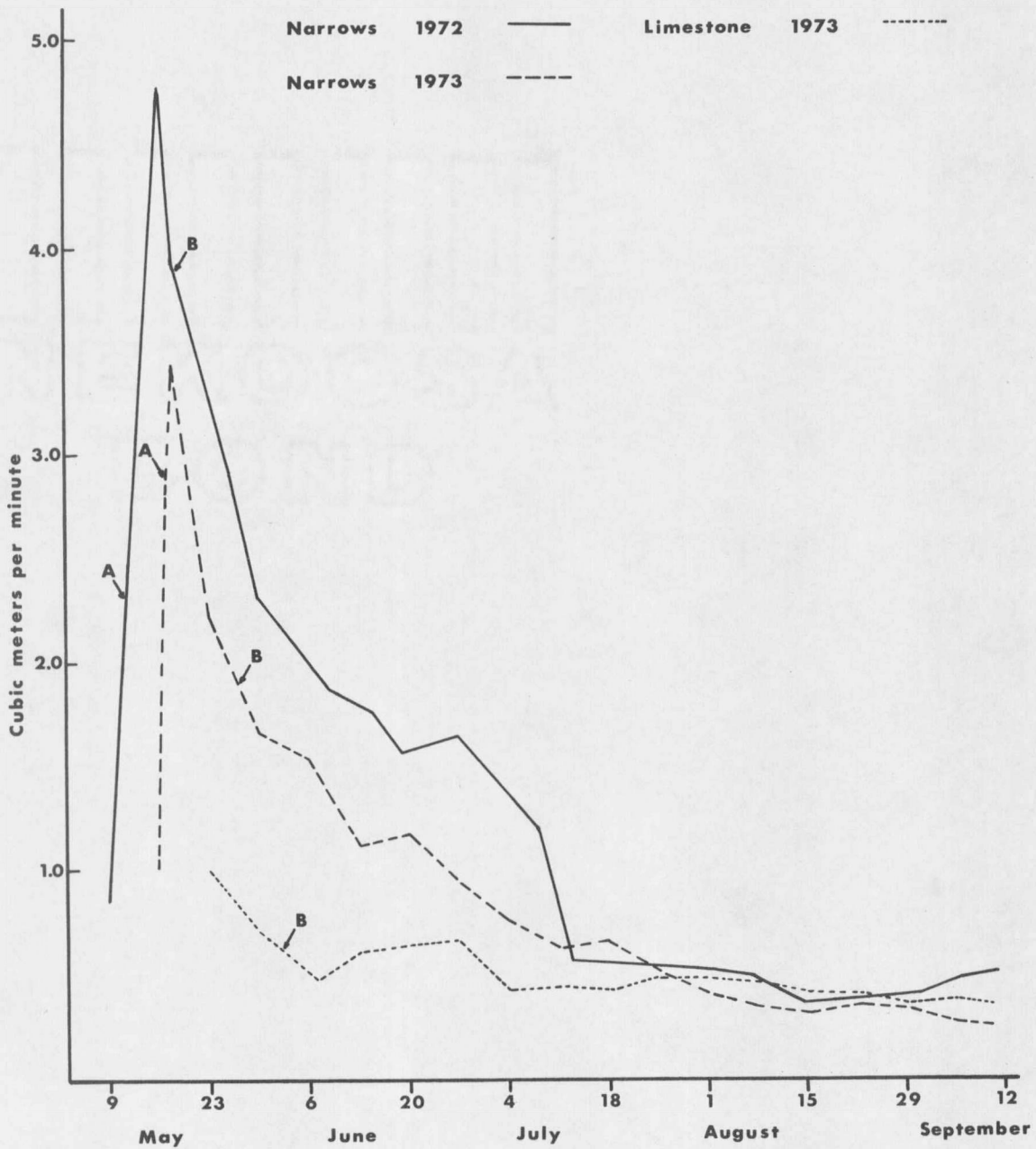


Figure 2. Weekly flows in Narrows and Limestone Creeks showing start of upstream movement by trout (A) and Arctic grayling (B).

respectively, when upstream grayling movement peaked (Figure 3). Kruse (1959) found upstream grayling movements were heaviest when lake temperatures were above 7°C; and Peterman (1972) and Tryon (1947) found most grayling migrated upstream when stream temperatures were between 7-10°C.

Daily average stream temperatures during all upstream migrations ranged from 4.4° to 14.4°C (Figure 3). Trout spawning runs occurred over this entire temperature range and did not show the sharp peaks of migration exhibited by the grayling. However, during the spawning season the upstream movements of both trout and grayling were usually inhibited by sharply lower average daily stream temperatures and accelerated by sharply higher temperatures (Figure 3).

Both grayling and trout moved upstream during the day and night. During the study 60 percent of the trout and 66 percent of the grayling entered Narrows Creek between 8:30 a.m. and 6:30 p.m. In 1973, 64 percent of the grayling and 57 percent of the trout entered the stream between 1:00 and 6:30 p.m.

Characteristics of Narrows Creek Runs

The numbers of fish caught on spawning runs in 1972 and 1973 are presented in Tables 2 and 3, respectively, by sex, with lengths and post-spawning weights. The total number of fish in the 1972 run was about 12 percent larger than in the 1973 run, and the average total length and weight of fish in 1972 was 1.0 centimeter and 0.05 kilograms

