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RED SALMON SURVIVAL STUDIES IN KARLUK LAKE, KODIAK ISLAND - 1957 SALMON SURVIVAL INVESTIGATIONS FIELD REPORT

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Department of the Interior
United States Fish and Wildlife Service
Bureau of Commercial Fisheries
Alaska Region

SALMON SURVIVAL INVESTIGATIONS

Field Report

Red Salmon Survival Studies in Karluk Lake, Kodiak Island - 1957

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C. Objectives of 1957 Research Program

Part of the increasing value of the Karluk research lies in the long series of continuous data obtained. Accordingly, we planned to continue without a break all major types of data taken at Karluk Lake as well as to expand the scope of our inquiries into the causes of the decline in survival in freshwater stages.

1. Escapement Enumeration. The Karluk weir was installed and operated in the same manner as in previous years. The escapement was sampled in the same manner as it had been.

2. Survival Studies. Our objectives were systematically to isolate, study, and evaluate separate ecological factors in the freshwater environment at Karluk or Bare Lakes that conceivably could affect the survival of young salmon during any stage of their freshwater life.

(a) Basic fertility experiments. --Bare Lake was not fertilized in 1957, but studies were conducted at the lake to follow up on:

(1) Lingering physical, chemical, and limnological effects of previous fertilization.

(2) Growth of lake residents and returns of adult salmon that were reared in Bare Lake under fertilized conditions.

(b) Predation. --We continued a series of studies of the effects of fish predation upon freshwater stages of young red salmon. New work was initiated on predation in spawning streams. Some additional information was gathered on the brown bear-salmon relationship during the spawning stream studies.

(c) Timing of the escapement. --In 1957 we began a study of the amount and timing of the escapements and the quality and quantity of spawning gravels available for each portion of the yearly escapement. It is recognized that an adequate escapement into a red salmon system is dependent not upon number of fish alone but rather upon distribution of an adequate number of spawners

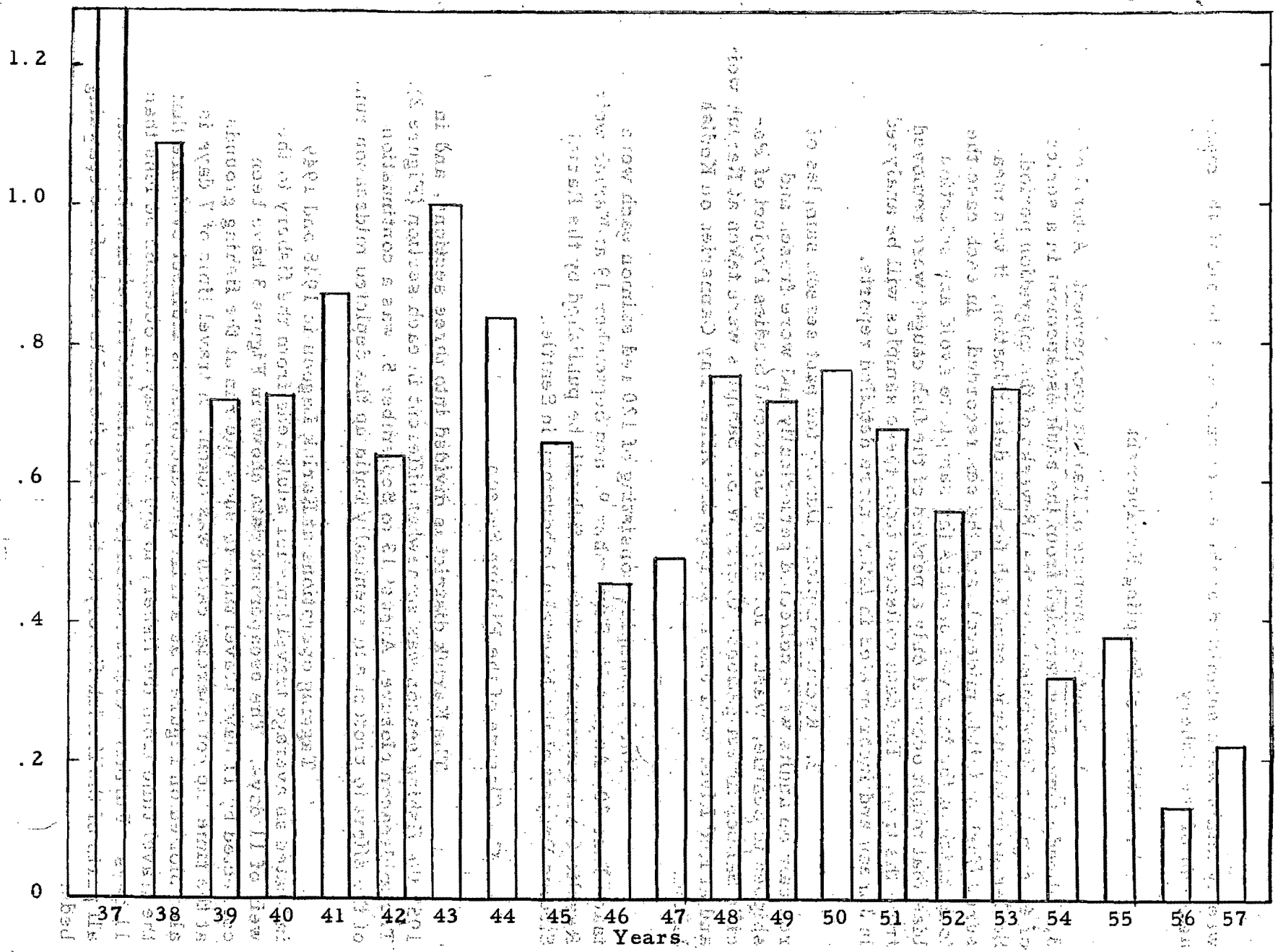

Figure 1. Yearly escapement totals for Karluk 1937 - 1957 in millions of fish

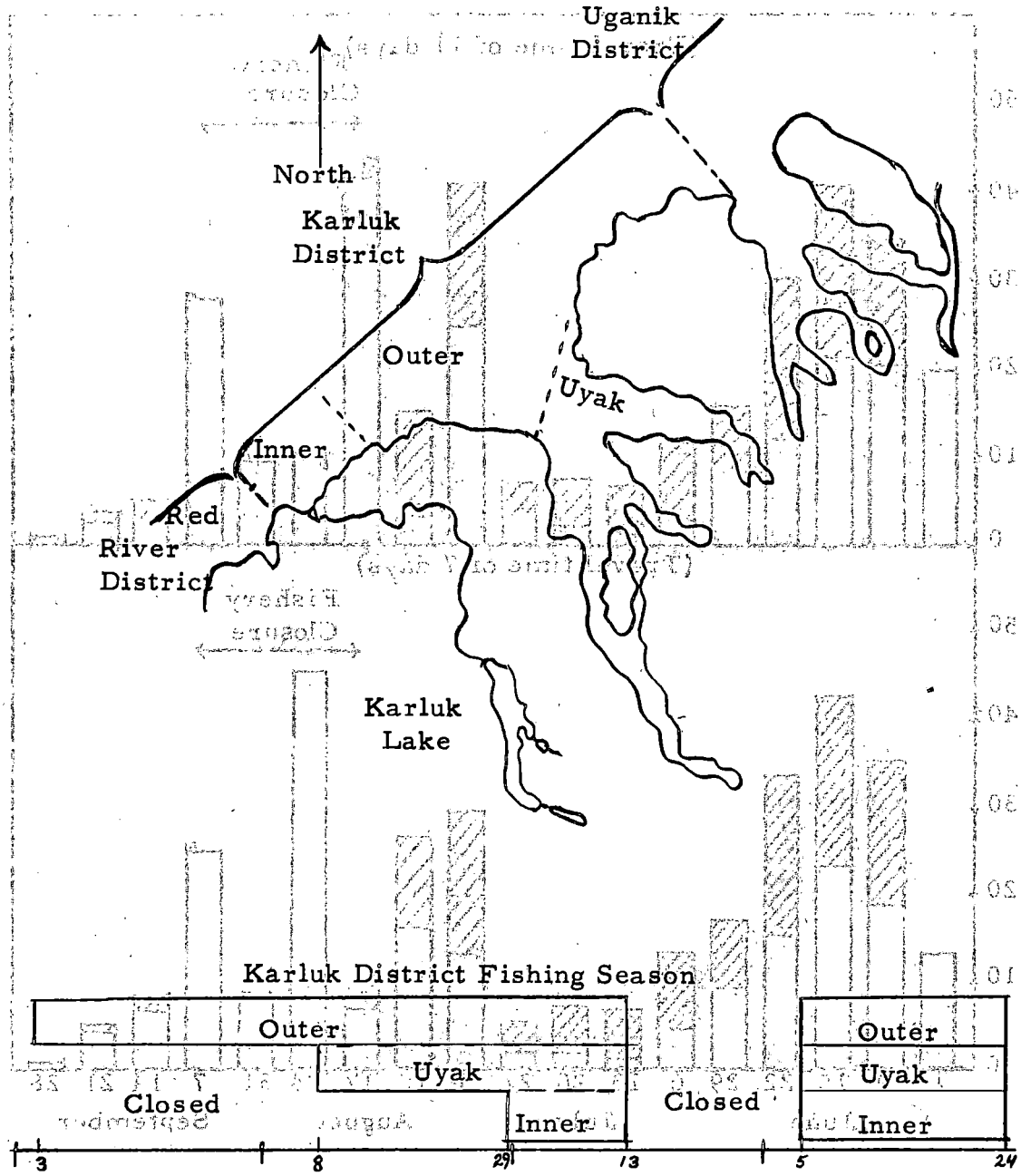

Figure 2. The Karluk District with the 1957 fishing season for each of the three subsections.

II. Survival Studies

A. Spawning Streams

1. Routine stream surveys. All spawning streams tributary to Karluk Lake were surveyed periodically for spawning activities throughout the 1957 season. Teams of two - three men walked the spawning sections of each stream once a week and counted the red salmon. They estimated the numbers accumulated at the mouths of the streams and took stream and lake temperatures. These surveys have been made for many years, hence we have estimates of the relative numbers spawning in each stream and the annual time and duration of stream spawning activities.

2. Stream types. The streams tributary to Karluk Lake can be grouped into two classes by the topography, geology, and gravel type of the region through which they flow (Figure 4).

Lateral Streams

Moraine Creek
Cottonwood Creek
Alder Creek
Grassy Point Creek
Halfway Creek
Eagle Creek
Meadow Creek
Cascade Creek
Salmon Creek (In part)
Canyon Creek (In part)

Lateral streams drain the mountain sides of the Karluk Valley. They are characterized by short, precipitous slopes and rugged combinations of boulders, slab rock, and ledges interspersed with pockets of gravel.

Terminal Streams

Lower Thumb River
Upper Thumb River
East Fork Thumb River
North Fork Thumb River
Salmon Creek (In part)
O'Malley River
Falls Creek (In part)
Canyon Creek (In part)

Terminal streams are large and drain the main axes of the southern or upper ends of the bifurcate Karluk Valley. They flow over the uniform gravel of a ground moraine which fills the broad valley floor. They are characterized by uniform slope, a more stable water supply, and a relatively unlimited bed of deep, more uniformly sized gravel. The upper end of the Karluk River, the outlet to Karluk Lake, is a terminal stream in the sense used here. The upper river provides a vast expanse of apparently excellent gravel, which is used by thousands of spawners in the fall.

Spring Creek is the sole representative of a third type of stream tributary to Karluk Lake. Spring Creek drains a chain of three very small shallow lakes in the muskeg of the lower Karluk Valley. Several hundred red salmon spawn over the bottom of these lakes. The peak of the spawning activity in 1957 was in late September.

B. Timing of Escapement and the Spawning Gravel Available to Each Portion of the Escapement.

1. Timing of the escapement. In recent years the Karluk run has had two peaks. In 1957 the spring escapement peak at the weir occurred around June 15, and the fall peak around August 30.

It was interesting to observe that while the spring spawners were distributed to all streams of the Karluk system, the fall stream spawners were found almost exclusively in the larger terminal streams entering the southern end of the lake (Figure 5).

The numbers of beach spawners increased markedly during the fall season and by late fall many thousands were seen, particularly on the gravel at the southern tips of the lake in the Thumb and O'Malley areas.

In September and October large numbers of red salmon were seen spawning in the upper Karluk River in the vicinity of the weir. These fish were not counted but an estimated 10,000 were seen. Roy Lindsley (1958) has in past years counted up to 30,000 red salmon spawning in the shallow water of the upper mile or two of the Karluk River.

2. Spawning gravels available to each portion of the escapement. The length of each stream was measured with a tape from the mouth to limit of the ascent of red salmon. The width of small streams was measured every 10 feet, and for larger streams the width was measured every 50 feet. The average width times the length gave the area between the banks.

Areas were calculated without regard to any difference in quality, which later may be shown to exist (Table 1).

Table 1.--Spawning area in square feet of terminal and lateral streams

Lateral streams	Sq. ft.	Terminal streams	Sq. ft.
Moraine Creek	58,300	Lower Thumb River	134,000
Cottonwood Creek	26,000	Upper Thumb River	64,000
Alder Creek	11,900	East Fork Thumb River	178,000
Grassy Point Creek	14,700	North Fork Thumb River	39,600
Halfway Creek	13,300	Salmon Creek (in part)1/	24,000
Eagle Creek2/	------	Subtotal Thumb System	439,600
Meadow Creek	26,500	O'Malley River	159,600
Cascade Creek	29,700	Falls Creek	14,100
Salmon Creek (in part)1/	------	Canyon Creek (in part)1/	67,200
Canyon Creek (in part)1/	------	Subtotal O'Malley Lake System	240,900
TOTAL	180,400		680,500

1/ Salmon and Canyon Creeks have their lower reaches in the "terminal" gravel beds of the Lower Thumb and O'Malley Rivers. However, the upper reaches of these streams turn and drain the mountains to the side of the valleys. In 1957 the "terminal" areas of these streams were used more heavily than the "lateral" upper reaches, especially in Salmon Creek. It is believed that in years of large escapements the upper reaches of these streams would be used much more.

2/ Small stream, not utilized in 1957.

Some idea of the relative density of spawning in the tributary stream system may be obtained by comparing the relative area per spawner as obtained by dividing the areas of the respective stream systems by the totals of fish seen in them on weekly stream surveys (Table 2).

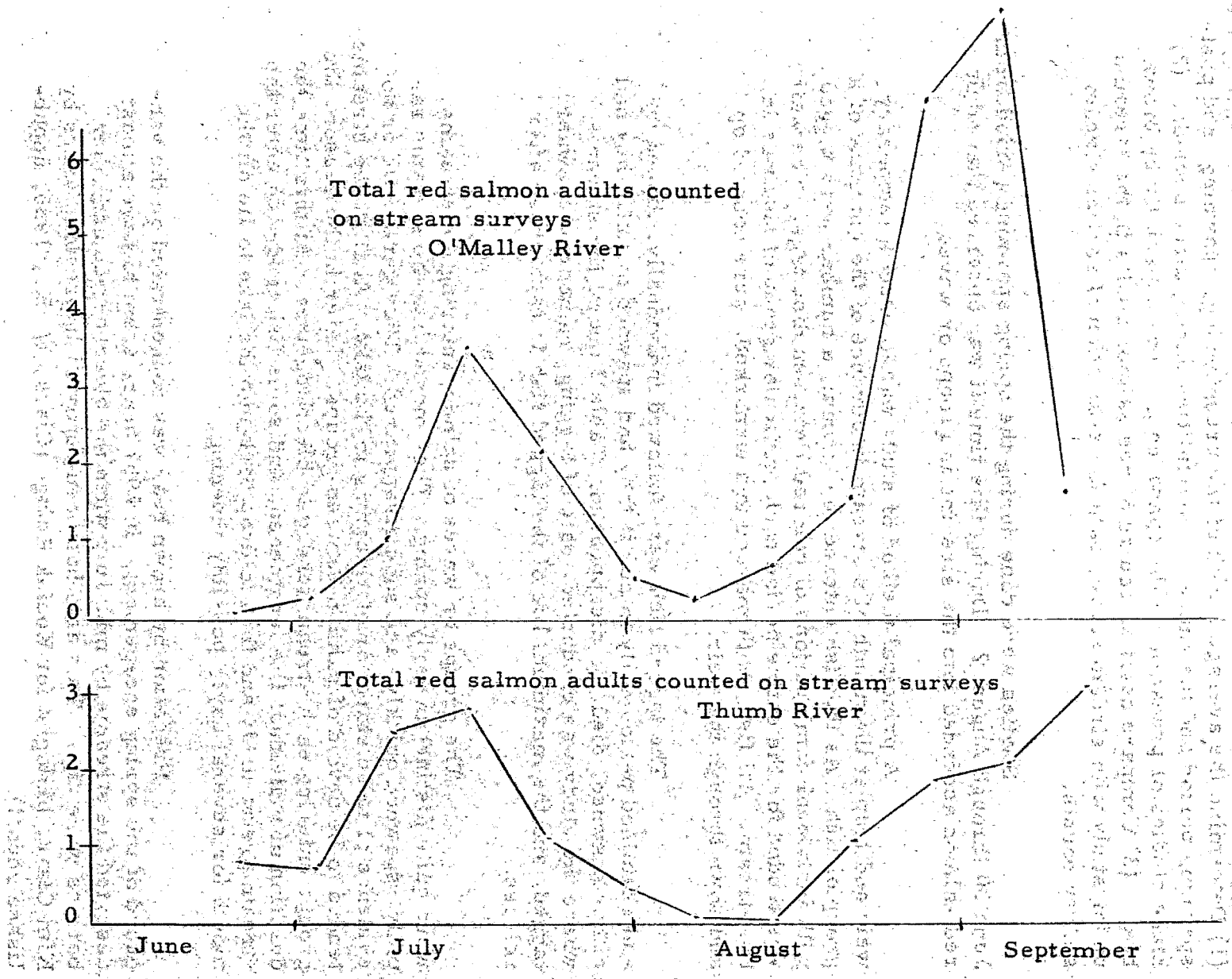

Figure 6. The timing and distribution of red salmon spawners to the Thumb and O'Malley tributaries of Karluk Lake, 1957, in thousands of fish.

and study as possible serious predators on the salmon runs (Shuman, 1950). Careful analysis of the timing of the early run, which is relatively unfished by man; the appearance of the bear, the phenology of the plants, and the dates of the annual openings of the fishing seasons suggest that predation by bears may be concentrated upon a part of the run that is relatively unimportant to the commercial fishery.

Additional pertinent factors that tend to minimize the significance of the predation of bears are that the early run apparently has a surplus of males and "jacks," which may be a loss for reproduction; bears probably fish the small lateral streams more intensively than the much larger and deeper terminal streams; lateral streams are easier to fish and are more concealed by the alders and cottonwoods than are the grassy flats in the terminal areas. Further studies of the predation by bears, if made, should be made on terminal stream systems, because they have much the greater area and have spawning fish throughout the spawning season, which is not true of lateral streams.

Table 3.--Summary of adult red salmon tagged while entering spawning streams, and the maximum life of tagged fish in each group

Stream	Group	Number tagged	Sex	Date	Maximum life in stream
Cottonwood	I	70	♂♀	30 June	5 days
Cottonwood	II	96	♂♀	7 July	7 days
Grassy Point	I	40	♀♀	15 July	12 days
Grassy Point	II	50	♀♀	21 July	16 days
Moraine Creek	I	75	♀♀	25 July	10 days
Grassy Point	III	50	♀♀	27 July	10 days
Moraine Creek	II	15	♀♀	2 August	(not followed)
Total tagged		386			

D. Eggs Deposited

A start was made in developing methods of estimating numbers of eggs deposited per unit area in the gravels of the various spawning

species, which is as yet unpublished. We are presently working on co-ordination in order to avoid duplication of earlier work.

Our work and review in 1957 indicated the importance of additional work on food habits and ecology of Dolly Varden and other species at other seasons of the year, notably at time of fry migration.

G. Studies of Lake Residents, Karluk Lake

Seine hauls for the collection of red salmon fingerling samples were made from June 28 through August 7, 1957, at various locations in Karluk Lake; fork lengths and scales were taken from these fish. Other species of fish captured in the seine hauls were enumerated and released. The samples collected are to be used as an index to growth and survival of red salmon by year class in the freshwater environment.

H. Downstream Smolt Migration, Karluk Lake

The outmigration of smolts from Karluk Lake may have begun earlier than usual in 1957. While the weir was being constructed on May 13 and 14, schools of smolts were observed moving downstream past the weir site. However, since the total 1957 smolt catch of 1,109,038 is the largest recorded at Karluk in the past four years, and since the trap catches of smolts on May 15 and 16 totaled less than 500 smolts each night, it is reasonable to assume that very little of the outmigration was missed.

The smolt migration was sampled from May 15 until July 6, when the traps were removed. Forty-three samples were collected from the migration this year. The frequency of sampling was dependent upon the number of smolts migrating which automatically weighted the samples for numbers. Individual fork lengths, wet weights, and scales were taken from each smolt in the samples collected. The analyses of the 1957 smolt samples have not been completed as yet.

Two tests were run in an attempt to improve the methods of sampling the smolt migration and of estimating the total smolt outmigration numbers. In the first test a section of "smolt chute" was constructed downstream from the weir. The objective of this test was to determine the feasibility of diverting the entire smolt migration through a section of chute and back into the river again. If this could be done, the collection of representative samples of smolts from the migration and an estimate of the total smolt migration numbers would be much simplified. Due to the early migration of smolts and lack of supervisory personnel and manpower only cursory observations could be made.

Bare Lake was considered to be either dry or too shallow to permit the free passage of adult salmon over much of the time of the adult migration period. Figure 7 gives the daily rainfall at Bare Lake and the adult red salmon migration from June 1 through September 6, 1957. The stream was surveyed on foot July 1 and by plane July 18. On July 1 the water was believed to be too low over riffle areas to permit the passage of adults, and channels were dug through these areas. On July 18 an area of approximately 150 yards of stream bed was observed to be completely dry near the confluence of Bare Creek and Red River.

2. Seaward smolt migration. The 1957 seaward smolt migration from Bare Lake totaled 7,611 smolts. Age determination of scales sampled from the migration indicates that the migration this year was composed of 91.6 percent two-year-old migrants and 8.2 percent three-year-old migrants. There is evidence from the scale samples that the Bare Lake fingerlings formed an annulus in July this year. If this is true and has happened before, inaccuracies may exist in the freshwater survival figures for past years. Nelson reported that large numbers of smolts aged as three years old left the lake in 1950 (Nelson, MS).

Since the smolt migration occurred at the same time that low water conditions existed in Bare Creek, there is a possibility that the survival of the smolts in Bare Creek may also have been adversely affected.

3. Lake resident studies. There are six species of resident fish in Bare Lake. The rainbow trout and sculpins are, from all indications, present in only minor numbers. There were no studies conducted on these two species in 1957.

Although there has never been an accurate estimate made of the numbers of stickleback present in the lake, seine hauls indicate that this may be the most numerous of any fish species present. In 1956 a life history study of the stickleback of Bare Lake was completed (Greenbank and Nelson, MS). This year at two-week intervals, length measurements were taken only from samples of seine-caught sticklebacks.

The cohos in Bare Lake were sampled both at the trap site and from seine hauls in the same manner as the red salmon smolts and fingerlings. Length measurements were made, wet weights in grams were taken, and scales were sampled on a scheduled basis as outlined in the operations plan.

The Dolly Varden population estimate, based on the modified Schnabel method, indicated another substantial increase in

numbers this season. In the three years the population estimates have been made, the Dolly Varden population has increased from an estimated 4,000 in 1955 to 6,000 in 1956 to 8,100 in 1957. Fork length measurements were taken on samples of seine-caught Dolly Varden at two-week intervals. There were 63 tag returns taken in seine hauls this year from the 1955 Dolly Varden tagging program. Fork length measurements were taken on most of these returns.

4. Limnological samples. The limnological studies at Bare Lake were continued in 1957 on the same basis as in past years. The rate of photosynthesis was estimated by the light and dark bottle oxygen production method. The nitrate, phosphate, pH., and bound and free carbon dioxide content of the water were determined on a regularly scheduled basis. The lake phytoplankton and zooplankton were sampled throughout the field season as scheduled. These samples have not been analyzed as yet and no data can be presented at this time.

5. Physical data. The weather station was maintained from May 18 through September 6, 1957. Daily air and water temperatures, lake water level, barometric pressures, wind direction and estimated velocity, and rainfall were recorded at a set hour. To date, only the daily rainfall data has been studied (Figure 7).

SUMMARY

A. The 1957 Karluk run totaled 450,405 red salmon, of which an estimated 229,730 were caught and 220,675 escaped to pass through the Karluk weir.

B. The spawning streams tributary to Karluk Lake can be classified into two contrasting types. These are the small precipitous lateral streams which drain the steep mountain side of the Karluk Valley and the terminal streams which drain the main axes of the valley above the lake. Terminal streams are large and deep and have much greater areas of rather uniform sized gravel. They have a spawning area of approximately 680,500 square feet. Lateral streams have a spawning area of 180,400 square feet. These figures are without regard to differences in quality of gravel, which are suspected to be in favor of terminal streams.

C. In 1957 the spring escapement peak at the weir occurred around June 15 and the fall escapements peak was around August 30.

Red salmon in the spring escapement go to both the terminal and the lateral streams. The red salmon adults of the "fall run" go to the terminal streams, and the lake beaches, principally near the mouths of

possible predation by Dolly Varden trout in the early spring at the time of the fry emergence.

H. Lake resident red salmon were sampled for age and growth analysis to be completed later.

I. The downstream smolt migration for 1957 probably began earlier than usual. The smolt catch of 1,109,138 for 1957 is the largest for the four years of record.

An experiment to sample smolts rather than use the index traps failed because of the unexpected early migration and a lack of supervisory personnel to keep the experiment in operation before the run was over.

J. Bare Lake--Only 225 adult red salmon returned to Bare Lake in 1957. This disappointing number is below the average although the smolt migration from the lake during their parent brood years was the largest recorded between 1950 and 1957.

An egg retention of 73.8 percent in the females examined indicated very poor spawning success in 1957.

Lack of rainfall caused the outlets of Bare Lake to dry up after only 219 adults had entered the lake. Bare Creek was believed to be impassable to fish between July 1 and July 19. After July 19 the remainder of fish entered the lake. The delay in passage may have adversely affected the Bare Lake run both in numbers and spawning effectiveness. The effect on the 1957 downstream smolt migration is unknown but may have been catastrophic, as a portion of the stream went dry for a time in July.

Downstream smolt migration in 1957 totaled 7,611. There is evidence that Bare Lake fingerlings formed an annulus in July. If this is true and has happened before, inaccuracies may exist in the survival calculations for such years, as their freshwater age would be difficult to determine upon return. Nelson reported large numbers of smolts aged as three years old leaving the lake during mid-summer in 1950.

Submitted by:

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Approved by:

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Assistant Regional Director
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February 18, 1958

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