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LOWER ARROW RESERVOIR
SPORT FISHERY STATISTICS
1987



**Province of
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LOWER ARROW RESERVOIR
SPORT FISHERY STATISTICS
1987

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ABSTRACT

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Effort and catch data on the Lower Arrow reservoir derived from creel census data are analyzed. Fisheries trends for rainbow trout, Dolly Varden and kokanee are analyzed and compared from 1967 to 1987.

INTRODUCTION

The Lower Arrow reservoir lies between the Selkirk and Monashee mountain ranges in the southeast corner of British Columbia. This system is approximately 109 km in length, with an average width of 2 km. The Lower Arrow is separated from the Upper Arrow by a small narrow stretch of water (referred to as the narrows). For the purpose of this report the Lower Arrow is defined as that portion of the Arrow Lake system extending from the Keenleyside Dam north to East Arrow Park (Fig. 1).

In 1969 the Keenleyside Dam became operational, thus adding approximately 18 meters of storage onto the former Arrow Lakes. It was estimated at that time that about 20% of the total spawning and rearing habitat of the Lower Arrow Lake would be inundated and lost (Andrusak, 1969). A subsequent study conducted in 1978 estimated losses to be 30% (Lindsay and Seaton, 1978).

To assess the impact of flooding on the fishery, the Fisheries Branch has conducted periodic creel census surveys on the Lower Arrow since 1967 (pre-impoundment). Information collected over the years will allow for some comparison of pre-impoundment and post-impoundment fishing conditions.

METHODS

In 1986 and 1987, a creel census was conducted from January to December on the Lower Arrow at the only two major access points: Scotties Marina and Syringa Park just north of the Keenleyside Dam. In 1978 a census was also conducted at the marinas as well as at Edgewood and Fauquier. For comparison purposes catch and effort statistics since 1967 have been increased by 10% to include an estimate of catch and effort from the Edgewood/Fauquier area.

In all years data was collected by on-site interviews of fishermen on five pre-determined days per month; one Saturday, Sunday, Monday and two weekdays. Appendix I describes data collection and extrapolation procedure. In this report summarized statistics have been adjusted (increased) by 25% to account for census inefficiency.

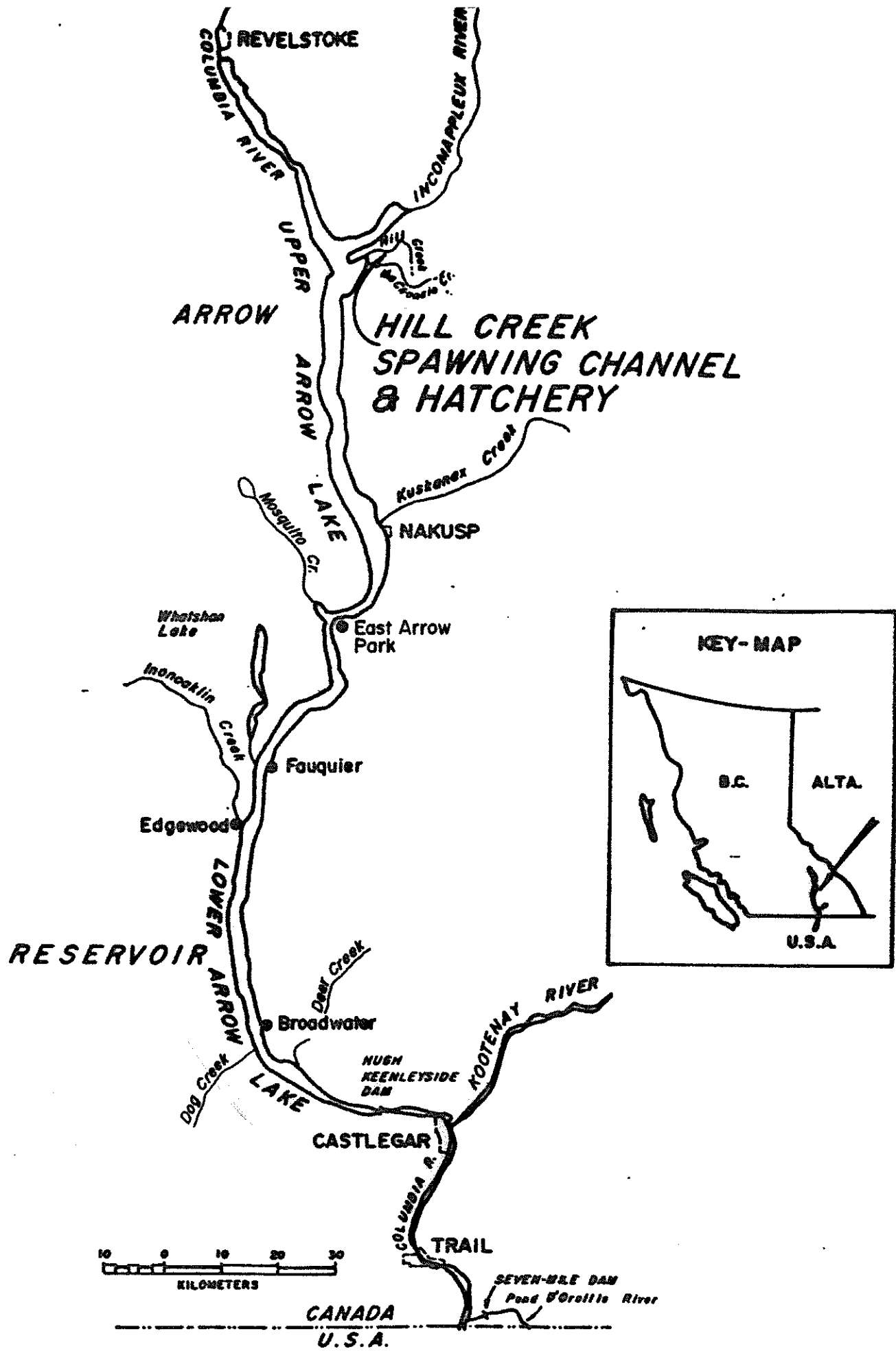


Fig. 1: Arrow Reservoir

Lower Arrow Sport Fishing - An Overview

In the past, the majority of fishing effort on the Lower Arrow reservoir has been for Dolly Varden. These fish grow to 10 kg in size and average 2.5 kg in the fishery. However, with construction of the Keenleyside Dam at Castlegar, Mica Dam on the Columbia River and more recently the Revelstoke Dam (Fig. 1), these fish have declined dramatically. As a result, success for this sportfish has been low and effort has substantially declined during the 1980's.

Similarly "trophy" sized rainbow trout (up to 16 kg) were also highly sought. Hydro developments have been even more detrimental to the large trout than Dolly Varden and now very few large trout remain. Fishing success for these fish during the 1970's and 1980's has been extremely poor.

Recently, the Fisheries Branch initiated stocking both "trophy" sized rainbow and Dolly Varden into the Arrow as part of compensation for the Revelstoke dam. Commencing in the early 1980's, fish have been raised at the Hill Creek hatchery, marked and released into tributaries to the Upper Arrow. In 1986 and 1987 some of these marked fish started contributing to not only the Upper Arrow sport fishery but also to the Lower Arrow fishery. A similar stocking program has been carried out in Lower Arrow tributary streams since 1986 for rainbow trout. This program will include Dolly Varden releases commencing in 1989. In the long term there is optimism that the Lower Arrow will once again support a highly prized "trophy" rainbow fishery as well as an abundance of Dolly Varden.

The Lower Arrow also provides good kokanee fishing during the summer months. These fish range 22-27 cm in length, are abundant and provide exceptional "family type" fishing opportunities. A few larger kokanee are caught (up to 3 kg) but these fish represent less than 1% of the total annual catch. Kokanee fishing has primarily been from Scotties Marina north to Broadwater with some good success around Edgewood and Fauquier. Kokanee are caught by trolling with lures, wedding rings, etc., and jigging with lures such as deadly dicks.

Prior to flooding of the Arrow Lakes in 1969 kokanee were quite abundant. Although kokanee losses occurred after flooding (Lindsay 1978) the fishery was not intensive enough to reflect a significant decline in the population. Even today, estimated catch (about 25,000 kokanee per year) is still quite low and insensitive to a decline in th population.

RESULTS

1. Effort and catch

In the 1960's and 70's, only the summer months were censused therefore time series information is available for June-August. Angler effort on the Lower Arrow has increased substantially since 1967 (Table I).

TABLE I
Total Angler Effort (June - August)
Lower Arrow Reservoir

Year	Effort (rod hours)
1967	5743
1971	5931
1972	4708
1974	7230
1978	7037
1986	14719
1987	11474
1988	13751
1989	

Effort increased only 18% from 1967 to 1978 but a further 37% from 1978 to 1987. In comparison effort on the Upper Arrow increased 48% from 1978-1987. Recent effort increases on the Lower Arrow is primarily due to the popular kokanee fishery during the summer months. Effort in 1986 (14719) and 1987 (11474) was comparable to effort on the Upper Arrow which was 15945 and 13776 rod hours respectively.

Total annual effort and catch (Jan.-Dec.) was estimated on the Lower Arrow in 1986 and 1987 for the first time since 1978 (Table II).

TABLE II
Angler Catch and Effort
Lower Arrow Reservoir

Year	effort	Catch				total	success
		rainbow	Dolly Varden	kokanee			
1978	15399	739	246	9309	10288	0.67	
1986	25829	195	313	17173	17681	0.69	
1987	26309	443	216	21139	21798	0.83	
1988	27677	703	219	29559	30486	1.03	
1989	26844	1121	431	14176	15728	0.59	

From 1978 to 1987 total effort increased 71%. In comparison effort on the Upper Arrow from 1978-1987 increased 5%. As previously mentioned the large increase in the Lower Arrow is attributed to the increasingly popular kokanee fishing during the summer months.

2. Rainbow trout

Rainbow catch on the Lower Arrow appears to have declined since operation of the Keenleyside Dam in 1969 and subsequent flooding of the Arrow Lakes (Lindsay, 1978). Construction of the Revelstoke Dam in 1979 also negatively impacted the rainbow stocks further to a point where success rates have become very low during the May - August period (Table III).

TABLE III
 Angler Effort & Catch for Rainbow Trout and Dolly Varden
 1971 - 1987 (May - August)

Year	Effort	Catch		Success
		rainbow	Dolly Varden	
1971	4075	739	137	0.22
1972	3989	297	289	0.15
1974	6336	389	79	0.07
1978	2455	227	93	0.13
1986	1835	23	25	0.03
1987	384	35	—	0.09
1988	4126	51	172	0.19
1989	14248	935	426	0.10

Although the summer months are not the preferred time for trout and char fishing on the Lower Arrow the very low level of effort recorded in 1987 is unquestionably a realistic reflection of how poor fishing has become in recent years. During June-August 1987 only 23 rod hours were estimated for rainbow fishing. If it were not for kokanee fishing, recreational fishing on the Lower Arrow would be virtually non-existent.

In 1978 annual rainbow catch was 739 compared to 195 in 1986, and 443 in 1987, a decline of 74% and 40% respectively. In comparison rainbow catch in 1986 and 1987 on the Upper Arrow was 1783 and 2292 respectively. The higher rainbow catch in the Upper Arrow is primarily attributed to the popularity of fly fishing for 1-3 lb size fish during the summer and particularly the fall months. These stream mouth fisheries do not exist in the Lower Arrow since, as a result of flooding, few trout spawning and rearing streams remain.

Catch of "trophy" sized rainbow in both the Upper and Lower Arrow reservoirs since the late 70's has been poor with few caught. However, in 1986 and again in 1987, some marked (fin clipped) "trophy" rainbow were caught in the

caught in the fishery. These fish were the initial products of Hill Creek yearling releases in the early 1980's. More recently, larger numbers of "Gerrard" rainbows have been released as yearlings into both the Upper and Lower Arrow systems. There is optimism that more of these trout will contribute to the sport fishery over the next few years.

3. Dolly Varden

Similar to the Upper Arrow, Lower Arrow anglers do not sufficiently discriminate in their fishing methods so that rainbow and Dolly Varden effort cannot be separated. Total effort (Jan-Dec) in 1986 and 1987 for rainbow and Dolly Varden was estimated to be 11013 and 8387 rod hours respectively. In comparison rainbow and Dolly Varden effort on the Upper Arrow in 1986 and 1987 was 9989 and 26083 rod hours respectively.

In 1986 an estimated 313 Dolly Varden were caught on the Lower Arrow compared to 295 in the Upper Arrow reservoir. In 1987 however, the number of Dolly Varden estimated caught in the Lower Arrow was 216 and in the Upper Arrow 1749. It is believed that this significant increased catch is a result of the Hill Creek hatchery releases of Dolly Varden fingerlings into both the Jordan and Illecillewaet Rivers from 1982-84. These fish are now 4-6 years old and are being recruited in the fishery. It is expected that some of these fish will also contribute to the Lower Arrow fishery. Success from the Hill Creek releases provides much optimism that a similar stocking program for the Lower Arrow (via Hill creek Hatchery expansion and subsequent fish releases in the Lower Arrow commencing 1989) will greatly improve angler success much as it has on the Upper Arrow.

4. Kokanee

Kokanee effort and catch on the Lower Arrow showed a steady decline from 1971-1974 (Table IV). In 1978 however effort and catch more than doubled and in 1986/87 increased a further fourfold.

Comparative data on kokanee fishing from 1971-1987 (Table IV) illustrates two points. Effort and catch in the 1970's was quite low but success rates were average.

TABLE IV
Kokanee Effort and Catch
on the Lower Arrow (1971-1987)

Year	Effort	Estimated Catch	C/UE
May - August			
1971	3031	2038	0.67
1972	3159	1693	0.54
1974	2340	1197	0.51
1978	5336	5052	0.95
1986	13219	17543	0.75
1987	17921	21097	1.18
1988	16986	27672	1.63

At least on the Lower Arrow, increased effort for kokanee is almost certainly a reflection of poor trout/char fishing, i.e. anglers concentrated on kokanee due to the poor trout/char opportunities.

The success rate in 1987 (1.18 fish per hour) was particularly high compared to previous years when the rates were less than 1 fish per hour. The 1987 success rate was similar to the Upper Arrow kokanee fishery which was 1.12 fish/hour. Although speculative, it is possible that large increases in kokanee production at the Hill Creek spawning channel are contributing not only to the Upper Arrow but also to the Lower Arrow.

Angler Composition

Angler composition on the Lower Arrow reservoir has not changed significantly since 1978 (Table V). A slight increase in the number of non-resident Canadians is evident in the last 9 years but this is also reflected on a regional basis as more non-resident Canadians are utilizing the Kootenay fisheries resources.

TABLE V
Angler Composition
Lower Arrow Reservoir

Year	Total Anglers Checked	% resident	% non-resident Canadian	% non-Canadian
1978	961	97	1	2
1986	1026	95	4	1
1987	1123	93	6	1
1988	1140	95	3	2
1989	893	93	5	2

The vast majority of resident anglers were from the Castlegar, Trail areas. Non-resident Canadians were primarily from Alberta and non-Canadians from Idaho and Washington.

DISCUSSION

Lower Arrow reservoir fishing trends over the last nine years has shown a significant shift in angling effort from rainbow trout and Dolly Varden to kokanee. This change in effort is reflected in much higher kokanee catches from the 1970's to the 1980's. On the other hand, since 1971 both Dolly Varden and rainbow trout catch have shown steady declines. It is believed that the sportfish data confirms the cumulative adverse effects of the Keenleyside, Revelstoke and Mica dams and subsequent reduction of natural spawning and rearing habitat for these species (Lindsay, 1978, Martin, 1976).

Ministry of Environment compensation and mitigation agreements with B.C. Hydro & Power Authority associated with the Revelstoke Dam and more recently the Keenleyside Dam have provided the Fisheries program with compensation monies for restoration of the Arrow reservoir fisheries stocks. The Hill Creek spawning channel and fish hatchery on the Upper Arrow (constructed from compensation monies received from the Revelstoke Dam settlement) are now producing significant numbers of kokanee, rainbow trout and Dolly Varden. These fish are contributing to the Upper Arrow sport fishery (Lindsay, 1986). There is some evidence that the Lower Arrow is also benefitting from fish production at Hill Creek. It is felt that with increased Lower Arrow fish production (rainbow trout and Dolly Varden via Hill Creek hatchery expansion and proposed increased kokanee production on the Lower Arrow), fishing success, particularly rainbow trout and Dolly Varden, should improve substantially over the next 2-5 years, much the same as has occurred on the Upper Arrow.

APPENDIX I

STRATIFIED RANDOM CREEL CENSUS SAMPLING AND
EXTRAPOLATION PROCEDURE

The level of effort displayed by anglers throughout a season cannot be assumed to be equal, thus normal distribution subsampling techniques are not adequate.

Fishing pressure tends to be biased towards weekends, thus setting up a "heterogeneous population". Division of this population into sub-populations (i.e. day classes), each internally homogeneous, then allows the stratified random procedure to estimate this population.

The stratified random creel census outlined below is designed to take into consideration these biases and accounts for them by biased sampling procedure.

Creel census sampling days are established by a table of random numbers and for any one month are biased by the demand for choosing one Saturday, Sunday, Monday and two random weekdays.

On any census day, it is imperative to accurately estimate the coverage of the angling public, with 100% coverage achievement strived for. Creel census in the Kootenays achieve an average of approximately 75% actual coverage of users on any one day.

Data is recorded in the field on sheets and include numbers of anglers, rods, hours, fish species, length, weight, scales (if taken), and angler residence. Road check stations stopping all anglers at the end of the day is most preferable but not always practical. Thus, individual interviews with anglers at successive times throughout the sampling period is usually the format. The result of each day's census are summarized and include:

No. of Anglers: Total of actual checks (not repeats) for those anglers for that particular species.

No. of Rods: Total of actual number of rods used to fish for a particular species (in some instances, two lines are allowed for a person alone in a boat). This summary also does not include repeat checks as additional rods.

No. of Angler Hours: For each entry on the field sheet, multiply the number of anglers by the number of hours fished. Additional hours fished as recorded by repeat checks are involved.

No. of Rod Hours: As indicated, in some instances, anglers may be allowed two lines, thus calculation of this statistic may produce higher results than angler hours.

ESTIMATED TOTAL HARVEST AND ESTIMATES

Since each census day is a sample representing a particular day class within a one month period, the estimated monthly figures for each day class is obtained by multiplying the census day figures by the number of that class in the particular month.

e.g. If there are 5 Sundays in the month, multiply the actual check data by 5.

e.g. In the case of weekdays (excluding Monday), each day represents 1/16 of the total number of days in that a month (assuming 16 weekdays). If two weekdays are sampled, then one can either multiply the results of each of the day's data by 8 and add together; or, take the mean of the two days' data and multiply by 16 to estimate the total weekday results for the month.

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