YUKON RIVER TECHNICAL REPORT

1987

Prepared By

The U.S. - Canada
Yukon River Joint Technical Committee

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INTRODUCTION

David Colson and John Davis, the respective heads of the U.S. and Canadian delegations to the Yukon River negotiations directed members of the Yukon River Joint Technical Committee (JTC) to address the following issues:

1. Develop mutually acceptable escapement targets for chinook and fall chum salmon stocks.

2. Examine ways to improve the reliability of annual estimates of total returns, total escapements and escapement indices (including examination of aerial and foot surveys, hydroacoustical counts, weir counts and mark recapture methods).

3. Identify depressed chinook and fall chum salmon stocks and develop strategies for stock rebuilding.

4. Discuss applications for managing chinook and fall chum salmon stocks based on current stock identification techniques and information (including a review of stock identification studies initiated since the last JTC report).

The JTC met in Anchorage during March 17-19, 1987. Time and data limitations precluded a full discussion of all agenda items and the JTC devoted most of its attention to the development of escapement targets and a review of new stock identification information. Assignments were made for developing various scenarios for rebuilding depressed stocks using the new escapement requirements which will be included in the JTC's oral presentation in April.

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JTC members also exchanged and discussed 1986 fishery and stock status information that had not been previously reported. Much of this information is contained in the Appendix which includes annual catches and escapements through 1986.

Members of the JTC in attendance were:

<u>Alaska Department of Fish and Game</u> (ADF&G)
- Ron Regnart (Co-Chair)
- Linda Brannian
- Larry Buklis
- Richard Randall
- Craig Whitmore
- Fred Andersen

<u>U.S. Fish and Wildlife Service</u> (USFWS)
- Dick Marshall
- Rod Simmons

<u>National Marine Fisheries Service</u> (NMFS)
- Aven Andersen

<u>Canadian Department of Fisheries and Oceans</u> (DFO)
- Mike Henderson (Co-Chair)
- Gordon Zealand
- Terry Beacham
- George Cronkite

<u>Yukon Territorial Government</u>
- Mark Hoffman

Others in attendance during some portion of the meeting included: Bill Arvey, Dan Bergstrom, Rich Cannon, John Wilcock, Peggy Merritt, all from ADFG, Dick Wilmot (USFWS) and Elizabeth Montagne (U.S. Dept. of State).

INTERIM ESCAPEMENT OBJECTIVES

Introduction

The JTC recommends that the escapement requirements developed during the March 1987 meeting and described in this report be referred to as interim escapement objectives. It was also agreed that these objectives be expressed as a range for the following reasons: 1) different viewpoints and recommendations of JTC members which were partially influenced by a limited escapement data base, and 2) the present fisheries cannot be managed with sufficient precision to achieve a single fixed number. These objectives will be reviewed at regular intervals and are subject to change when new information becomes available. Refinement of escapement objectives is dependent on the acquisition of spawner-recruit information and improved estimates of total returns, exploitation and total escapements for all major Yukon River stocks. Although the JTC reviewed the data base and escapement requirements for all major Yukon River chinook and fall chum salmon stocks, emphasis was placed on the development of interim escapement objectives for Canadian stocks.

Alaskan Chinook Salmon Stocks

Escapement objectives for major Alaskan stocks had been developed previously by ADF&G and are presented in Table 1. These objectives, most of which were established in 1983, were calculated from comparative unexpanded peak aerial survey counts and do not represent total escapement objectives. Field investigations have been initiated to determine if the aerial survey counts and escapement objectives can be converted to estimates of total numbers of spawners.

The best comparable records of chinook salmon escapements date back to the early or mid-1960's for most streams. The first step in determining escapement requirements was an examination of long-term escapement trends. In most instances the objectives are the average annual peak aerial survey counts made during the 1978-1982 period when escapements (and returns) were above average in magnitude after rebounding from the low escapements of the 1960's. Although spawner-recruit information (total returns from escapements) is not available, some of the very low escapements observed prior to 1978 resulted in above average harvests and escapements in recent years.

Escapement objectives for lower river stocks have been consistently achieved or exceeded during the last 4 years. Escapements of middle river (Tanana) stocks have been variable with objectives achieved in 3 out of the last 4 years in the Chena River, but only 1 of 4 years in the Salcha River.

Closer examination of aerial survey data used to calculate these objectives reveals that one annual count for most streams was made under unacceptable survey conditions. If these counts were excluded, the escapement objectives for most streams would increase 10-15%.

Canadian Chinook Salmon Stocks

As described in the October 1985 JTC report, DFO initially proposed a 55,000 preliminary escapement target for chinook salmon in the Canadian portion of the drainage excluding the Porcupine River. This target was based on the assumption that better than average escapements had been achieved in 1980, 1981, and 1984. The expansion factor was based on the ratio between index counts and total escapement estimates from mark-recapture studies in 1982 and 1983. The resultant escapement objective, therefore, represented the average of the estimated total escapements for 1980, 1981, and 1984.

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A review of this analysis revealed that some of the annual index counts for the Nisutlin and Big Salmon Rivers were for different portions of stream and were not comparable. Comparable index counts and new information on the ratio between index counts and estimated total escapements from the mark recapture studies were used to recalculate escapement requirements.

Table 2 presents comparable index counts in all areas thought to have consistent escapement records in recent years. Aerial and foot survey counts are from the same section of stream. Aerial survey counts made during incomplete surveys or during poor survey conditions were not used to calculate total or average index counts. The relationship between mark-recovery estimates of total escapements and index counts for 1985 was combined with 1982 and 1983 data for development of an updated expansion factor (Table 3). Finally, data from other base year periods (e.g. 1979-1984 excluding 1982) and other index areas were used to generate a range of escapement objectives (Table 4).

Using methods identical to those used in the October 1985 report, a revised escapement target of 37,912 was generated (compared to 55,000 in the original analysis). Utilizing different index area counts and base years resulted in escapement targets ranging from 31,979 to 37,912.

The ratios of the escapement index counts to the total escapement estimate for 1986 were not used in the above analysis due to poor or borderline aerial survey conditions for some portions of the index areas. However, the 1985 and 1986 ratios were similar and if the 1986 data were used, the resultant escapement targets would be very similar to those reported.

There was considerable discussion among JTC members regarding the selection of an interim escapement objective from the information presented. Criteria examined for selecting an objective ranged from interpreting the available data base as explained in the aforementioned analysis to use of spawner-recruit information for British Columbia stocks. DFO members proposed setting escapement objectives relatively high so as to be able to measure the results from these elevated escapements. The JTC finally selected an interim escapement objective of 33,000 - 43,000 chinook salmon which was similar to the range in calculated escapement levels in the aforementioned analysis (Table 1). There was consensus that the interim escapement objective range was biologically sound and should provide the information required to further refine the objective. Achieving this objective will require changes in management regimes and the rate that it is achieved will be partially dependent on future returns and improved methods for making in-season estimates of stock abundance and harvest.

Estimated total escapements to Canada (excluding Porcupine River) calculated from mark-recapture studies were 20,200 in 1982, 29,500 in 1983, 10,800 in 1985 and 17,500 in 1986 (Yukon River JTC Report, September 1985). The mark-recapture study was not conducted in 1984, but escapement indices that year indicate that total escapement may have approached or exceeded 30,000. Therefore, during the last 5 years the interim escapement objective (range of 33,000-43,000) was not achieved except possibly at the low end of the range in 1984.

Alaskan Fall Chum Salmon Stocks

Comparable fall chum salmon escapement records for most Alaskan spawning areas date back to only the 1970's. Recently the escapement data base was revised by ADF&G for three major Alaskan spawning stocks in the Delta, Toklat, and Sheenjek Rivers (Table 5).

The revised data base used to calculate these objectives was based on the conversion of escapement index counts to estimates of total escapements using several methods which included replicate surveys and stream residence (length of time that adult salmon remained in the stream before dying) as well as relationships between aerial surveys and weir or sonar counts. The new objectives for these three streams represent the 1974-1986 average estimated total escapement excluding the two smallest escapements in 1982 and 1984 and the two largest escapements in 1975 and 1979. Exclusion of the high and low counts was made due to the extreme fluctuations in annual escapements. The new interim escapement objectives for these spawning stocks are 11,000 for the Delta River, 33,000 for the upper Toklat River, and 62,000 for the Sheenjek River (Table 1).

During the last 4 years these new escapement objectives have been achieved or exceeded during 2 years in the Sheenjek (1985, 1986) and Delta (1984, 1985) Rivers. Toklat River escapements have been below objectives during all 4 years.

Escapement objectives have not been developed for several other Alaskan spawning stocks in the upper Koyukuk, Tanana, and Chandalar Rivers due to a limited data base. The Chandalar River escapement was monitored by side scan sonar for the first time in 1986 and a count of 59,313 was obtained.

Canadian Fall Chum Salmon Stocks

Mainstem Yukon

These stocks spawn upstream of Dawson including the Kluane River and the mainstem Yukon near Minto. They do not include Porcupine River stocks which are discussed later in this report. Similar to the discussion regarding chinook salmon, the JTC examined several criteria for selecting an interim escapement objective for this stock. Since the data base is more limited than that for chinook salmon, consideration was given for not developing any escapement objectives at this time. This action was eventually determined inappropriate in light of the low returns of all stocks expected at least through 1988, and the need to establish some basic conservation requirements.

DFO has made estimates of total escapements of these stocks from mark-recapture studies. These estimates are 34,000 in 1982, 89,000 in 1983, 59,000 in 1985 and 88,000 in 1986. The mark-recapture project did not operate in 1984. Aerial survey counts of escapements in this area are very limited.

JTC recommends an interim escapement objective of 90,000-135,000 for these stocks (Table 1). The relatively wide range indicates we are less certain of escapement objectives for these stocks due to the limited nature of the data base. The low end of the range (90,000) was chosen because two of the four mark-recapture estimates approached this number. The upper end (135,000) of the range was selected by simply doubling the 4-year average escapement estimate of 67,500 fish.

Porcupine River

Table 6 presents escapement records obtained since 1971 for the Fishing Branch River, the major fall chum spawning area in the Canadian portion of the Porcupine River. Estimates of total escapement were made for six years by operation of a weir (1974-75, 1985-86), a combined weir count and mark-recapture estimate (1972) and expansion of a peak aerial survey count (1971). Only peak aerial survey counts are available for the other years. The JTC could not agree on methods for developing a comparable escapement data base or on other criteria required to develop an interim escapement objective.

Although an escapement objective was not developed, Fishing Branch River escapements should benefit from efforts to achieve interim escapement objectives for the Canadian mainstem stock since there is evidence that both stocks may be equally vulnerable in some downstream fisheries.

Discussion and Recommendations

Estimates of total returns and total escapements for Canadian origin chinook salmon are available for each year since 1982, except for 1984. Estimates of total escapements for this stock are made possible by DFO's mark-recapture project that is operated in the mainstem Yukon between the U.S.-Canada border and Dawson. This information, in conjunction with estimates of stock harvests in downstream fisheries from ADF&G's scale patterns analysis study, allows reconstruction of the annual return of this stock (total return, fishery exploitation, and total escapement). Similar "run reconstruction" information is currently not available for the majority of the other chinook and fall chum salmon stocks. The ability to accurately reconstruct runs in this manner over several salmon generations will yield important spawner-recruit information necessary to evaluate and refine interim escapement objectives.

Escapement records for a majority of Alaskan chinook stocks consist of peak aerial survey counts which represent comparable minimum estimates of total escapement. Escapements of fall chum salmon stocks throughout the drainage have been monitored by a variety of methods including aerial surveys, foot surveys, weir and sonar. DFO also makes a mark-recapture estimate of total fall chum salmon spawning escapement in the mainstem Yukon drainage upstream of Dawson.

Accurate estimates of total runs or escapements for Alaskan chinook salmon stocks by the use of sonar have not been possible due to the "masking" effect of the more abundant summer chums. Previous mark-recapture studies in the lower river in Alaska have been limited by an inability to release or recapture sufficient numbers of marked fish.

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Studies are either proposed or underway to acquire better estimates of total escapements, total returns, and exploitation by stock. Consideration is being given to converting some aerial and foot survey index counts to estimates of total escapements for selected areas and stocks. ADF&G has recently initiated studies to determine if total escapement estimates can be made from replicate aerial surveys and stream residence information. Due to budgetary, logistical, and periodic turbid water conditions associated with chinook salmon surveys, this approach may be feasible in only a few streams. The relationship between aerial survey counts and tower, sonar, or weir counts represents potentially useful information for converting aerial survey counts to estimates of total escapement. It is recommended that greater effort be made in conducting aerial surveys in areas upstream of all weir, sonar and tower sites to further define the relationship between aerial counts and total escapements.

Another technique employing SPA study results for estimating exploitation, total return and total escapement for middle river stocks is being investigated. This assumes mixing and identical exploitation rates of upper river (Canadian) and middle river (U.S. Tanana River) stocks in the Alaska fishery downstream from the Yukon - Tanana River confluence.

Total escapement estimates for Canadian chinook and fall chum salmon and reconstruction of Canadian chinook salmon runs are greatly dependent on DFO's mark-recapture program. Data input, assumptions and potential biases associated with these estimates have not been given adequate review by the JTC and it is recommended that this be given high priority in future meetings.

As discussed later in this report, stock identification studies are being expanded to provide more precise estimates of in-river exploitation rates by stock. ADF&G has contracted to the Fisheries Research Institute (University of Washington) for estimating the exploitation of Yukon River chinook salmon in

Japanese high seas gillnet fisheries. Exploitation estimates in offshore fisheries are necessary to complete the evaluation of population dynamics for Yukon River salmon stocks.

Because of the variability in age, sex, and size composition in annual escapements, it is not sufficient to merely count the numbers of salmon spawners. This is particularly true for chinook salmon escapement compositions which are greatly influenced by fishing gear selectivity, different maturity schedules between the sexes, and variable brood year production. For example, an escapement of 500 chinook salmon may contain more females and be more productive than an escapement of 1,000 fish. It is vital that all major spawning stocks are adequately sampled for age, sex, and size composition. Consideration should also be given to expressing escapements and escapement objectives in numbers of females or in potential egg deposition, not just in number of spawners.

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STOCK IDENTIFICATION STUDIES

Fall Chum Salmon Electrophoresis Study, 1984-1986

Terry Beacham (DFO) used electrophoresis of fish tissue proteins to estimate contributions of Yukon River fall chum salmon component stocks in 1985 and 1986 to the District 1 test fishery catches. Samples from individual spawning populations used to establish stock standards were gathered from the following locations:

	1984	1985	1986
Canada	Fishing Branch	Fishing Branch	
	Kluane	Koidern	
	Mainstem Yukon	Kluane	
		Teslin	
		Mainstem Yukon	
United States		Toklat	Toklat
		Delta	Delta
		Sheenjek	Sheenjek
			Chandalar

In addition, mixed stock samples were collected from the Dawson commercial fishery, and the Indian food fishery at Old Crow in 1985, and from the Emmonak test fishery in 1985 and 1986.

Seven loci, or protein genetic locations, have been identified as useful stock discriminators. Study methods and preliminary results for this study through the 1985 season were presented in the April, 1986, Joint Technical Committee report to the negotiating delegations. Genetic differences between spawning stocks using pooled data from 1984-1986 were similar to previous results using only 1984-1985 data. Koidern and Kluane samples had genetic frequencies which were very similar to each other and were treated as a single group. Samples from the Fishing Branch

River and the mixed stock fishery at Old Crow were likewise similar and therefore pooled. Sheenjek samples were genetically very similar to the Kluane and Koidern samples. Samples from the Chandalar, Old Crow, Fishing Branch, and mainstem Yukon were all genetically similar to each other. These genetic similarities of spawning stocks from one country-of-origin to stocks from the other country present sources of bias in catch allocations. Delta and Toklat stocks were somewhat similar to each other, but were fairly distinct from other samples.

Revised study results presented in this report became available after the March meeting of the JTC. Thus these results have not undergone full committee review and represent preliminary data. Emmonak test fishing samples collected in 1985 were reallocated using stock standards updated with 1986 samples. Estimated contributions of Alaskan stocks increased sharply using updated stock standards from an average of 39% using only 1984 and 1985 escapement data to approximately 62% using 1984-1986 data. The inclusion of Chandalar River samples was the primary reason for the differences between present and previous results.

Samples collected from Emmonak test fishing catches were divided into weekly time segments for the 1986 fall chum salmon fishing season. Stock contributions for individual spawning stocks were calculated and then summed to estimate Canadian and Alaskan stock contributions by week. Estimated Alaskan contributions from 16 July to 25 August averaged 39% and ranged from 10% to 61%.

Contribution estimates for Alaskan stocks in 1986 using the updated stock standards do not seem to support observed escapement abundance estimates from the various portions of the drainage, particularly the Sheenjek and Chandalar Rivers. Computer printouts of stock composition estimates for individual stocks by week will be supplied to ADF&G to compare individual spawning stock run timing estimates with information from prior tagging studies and observed catch and escapement timing.

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Analysis of Yukon River Chinook Salmon Scale Characters

Terry Beacham presented results of an analysis of the variation in Yukon River chinook salmon scale characters for scales collected by ADF&G during 1981-1985. The two objectives for this study were: 1) determine if consistent variation exists to determine country-of-origin during the fishing season, and 2) use scale characters to estimate country-of-origin stock composition in lower Yukon fisheries with a maximum likelihood estimator (MLE) to compare accuracy and precision of this technique with results obtained from linear discriminant function (LDF) analyses used by ADF&G.

For any method of estimating stock contributions, there are two approaches which can be used to calculate the contribution of individual spawning stocks to larger groupings such as country- and region-of-origin. The first method is to pool all individual spawning stocks into standards which represent each group ("pool-allocate" method). The second approach is to allocate each individual stock and sum the individual stock estimates into an estimate of contribution for the larger group ("allocate-sum" method). Previous ADF&G stock allocation studies using scale patterns have used a combination of these two apportionment methods. Because LDF models generally perform better with the fewest possible number of groups to allocate, samples from individual spawning escapements in Alaska were pooled into two distinct geographic regions-of-origin, the lower and middle Yukon, with the number of samples from each river determined by spawner abundance as indicated by aerial surveys. Contributions of Alaskan origin fish in mixed stock fisheries were estimated by summing allocations for the lower and middle Yukon stocks. Stock standards for the upper Yukon (Canada) were composed primarily of samples from the Dawson commercial fishery as these samples were considered to be the most representative composite available for

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upper Yukon stocks. For most years, only limited samples were available for individual Canadian spawning escapements.

Beacham found that variation of scale characters among stocks within regions was high. To remove the effects of these differences among stocks within a region, it was recommended that future allocations be performed using estimates of individual spawning stock contributions summed to estimate region-of-origin. Implementation of this recommendation will require increased effort to sample individual spawning escapements in Canada.

Significant interactions were found between region and sampling year and between age and sampling year. These interactions indicate that relative differences among the regions and between the ages examined were not consistent over time, and that scale features are not appropriate for estimating stock composition in-season. The variation in scale features between ages also indicate that it is necessary to ensure that the same ages are compared for all regions.

It was noted that samples used in scale patterns investigations conducted by ADF&G have been aged by a single person in any year to ensure that aging is consistent for all regions and fisheries. Although some of the assigned ages may indeed be inaccurate, it was pointed out that if aging is consistent between regions, misaged fish should contribute less error to allocation studies than to age structure and escapement quality studies. To ensure that ages are accurate, it was recommended that the feasibility of using fin rays to determine age be investigated, and that scale characteristics used to assign freshwater ages be standardized for the use of scale readers from both countries and validated using samples from juvenile fish.

Scale data from one year, 1984, were used by Beacham to compare the performance of a maximum likelihood estimator with the linear discriminant functions used by ADF&G to apportion chinook salmon harvests since 1980. The MLE produced a classification accuracy for age 1.3 fish that was 18% higher than accuracy for the LDF model and estimated a larger contribution of Canadian fish for this age class. Classification accuracy for age 1.4 fish was similar for both methods (4% higher for MLE than for LDF). Precision of contribution estimates was also somewhat higher for both age groups using the MLE method.

Application of estimated stock compositions to the 1984 catch in Districts 1 and 2 yielded an estimate of total Canadian contribution that was only 2,462 fish higher for the MLE than for the LDF, and was due primarily to differences in the estimation of age 1.3 contributions. It was pointed out that this difference was small in relation to the size of the harvest (2.6% of total District 1 and 2 allocated harvest). ADF&G staff also expressed concern that using all six of the scale characters examined, without suitable transformation, may violate the assumption of independent variables inherent for MLE.

An additional recommendation was made that electrophoretic analysis of chinook salmon stocks begun in 1986 for Canadian escapements be continued and expanded to include investigations of genetic differences in spawning stocks of the United States.

Feasibility of In-season Chinook Salmon Stock Identification

John Wilcock (ADF&G) evaluated the feasibility of using historic SPA data to generate in-season estimates of Yukon River chinook salmon stock contributions to fishery harvests. Linear discriminant functions were calculated using several methods of pooling historic scale patterns data. These historic LDF models were used to estimate region-of-origin in District 1 and 2 catches for the years 1982-1985. Results were compared to published estimates presented annually by ADF&G in its Technical Data Report series using stock standards and mixed stock fishery samples collected in the same year.

Differences in stock composition estimates of middle and upper Yukon stocks between same year LDF models and historic models were generally large. Estimated lower Yukon contributions were generally similar for historic and same year models. However, the large differences observed for the middle and upper Yukon stocks lead to the same general conclusion reached by Beacham in his analysis of variation in scale characters, that in-season use of scale features using present measurement techniques is not appropriate due to large interannual variations in scale features.

Feasibility of Fall Chum Salmon Stock Identification from Scale Patterns

Preliminary results of a study by ADF&G to determine the feasibility of using scale patterns analysis to identify spawning stocks of fall chum salmon in Yukon River mixed stock fisheries were verbally presented. Stock standards have been constructed for age 0.3 and 0.4 fish using escapement samples from the Toklat, Delta, Sheenjek, and Fishing Branch Rivers, in addition to samples from tagging study fishwheel catches from the mainstem Yukon River in Canada. Overall accuracies for all models examined were low.

Pooling of stocks into regional groups was deemed inappropriate as scale feature differences between individual stocks within the Tanana River drainage (Toklat and Delta) and within the Porcupine River drainage (Sheenjek and Fishing Branch) were similar to differences among major regions. Cluster analysis of electrophoresis results indicated some clustering of stocks within major tributary drainages for the Toklat and Delta in the Tanana River drainage; the Fishing Branch, Chandalar, and Old Crow samples in the Porcupine River drainage; and the Kluane and

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Koidern stocks in the White River system. In contrast, cluster analysis of scale characters indicated little similarity between stocks within major tributary drainages. However, the highest accuracy for an individual stock was obtained for the Sheenjek River in the age 0.3 model. Because genetic similarity to Canadian escapements for this stock was a possible source of error in electrophoretic analyses, this difference in scale features may offer some utility in increasing stock discrimination using methods which combine scale patterns and electrophoretic data.

Little discrimination was found between a summer chum salmon standard (Anvik, Andreafsky, Nulato, and Tanana River samples pooled) and a pooled fall chum salmon standard. Likewise, few differences were observed between samples from the two major summer chum salmon producing tributaries, the Anvik and Andreafsky Rivers.

Differences in scale features, observed for both fall and summer chum salmon, were largest for comparisons between age groups, indicating that scale features will probably not be useful for in-season management.

Discussion and Recommendations

Age Determination:

Correct aging of salmon is very dependent upon the ability of the scale reader to interpret annular characteristics of the fish structure being aged. Because salmon resorb parts of their scales as a source of energy during upstream migration, samples collected from fish on or near the spawning grounds frequently cannot be aged due to resorption of annular rings near the scale edge. In many cases, the true age may be inferred from the appearance of the scale, but this is highly subject to reader experience and inclination, and the chances of error are high.

In addition to problems in obtaining ocean age due to scale resorption, the accuracy of assigning freshwater age is questionable. Yukon River chinook salmon juveniles are believed to spend either one or two winters residing in fresh water, and the accurate interpretation of freshwater age from scale characteristics depends heavily upon reader experience. Methods of age determination using other boney parts of the fish, especially structures not subject to resorption, should be investigated. In addition, samples should be collected from juvenile chinook salmon to validate freshwater ages and to investigate the time of freshwater annulus and migratory check formation.

Skeletal parts of the fish which do not undergo the same resorption as scales such as vertebrae, otoliths, and fin rays may be used to obtain more accurate ages for spawning salmon. Vertebrae have been used successfully for aging fall chum salmon from escapements in Alaska and should be collected from escapements in Canada in the future. For chinook salmon, however, vertebrae are not useful for determining freshwater ages and otoliths are unacceptable due to large variability in reader interpretation. Fin rays have recently been shown to be useful for determining both freshwater and ocean ages for chinook salmon from escapements in British Columbia. The feasibility of using fin rays for Yukon River chinook salmon should be investigated.

Aging of any body structure is highly dependent upon the experience of the ager. For instance, DFO scale agers frequently assign more 2 freshwater ages than do Alaskan agers for the same samples. Because of the highly subjective nature of using body parts to age fish and the importance of obtaining accurate data, periodic transboundary workshops should be held to exchange aging methodology information and to standardize interpretations of aging structures.

Scale Patterns Analysis:

Previous SPA investigations of Yukon River chinook salmon have used stock standards composed of samples from individual spawning streams pooled into regional standards. The historic SPA data base should be re-examined using discrete baseline spawning stocks to estimate individual contributions which are summed to estimate region-of-origin, and evaluate the effects of pooling on accuracy and precision. If model performance is significantly improved using discrete spawning groups, then sampling of upper Yukon stocks, which have previously been represented using mixed stock fishery samples from Dawson, should be expanded to cover a larger number of major escapements in Canada.

Age 1.5 chinook salmon may comprise up to 15% of the lower Yukon commercial catch in some years. Catches and sample sizes have been small for this age group in most years, however scale patterns analysis to estimate stock contributions should be initiated for years when significant catches occur.

Scale patterns analysis of Yukon River fall chum salmon using standard techniques has not proven to be a suitable technique for estimating stock contributions in mixed stock fisheries. However, observations of investigators have indicated that differences in scale shape and overall scale size may offer possibilities for stock differentiation. New techniques which permit measurement and evaluation of scale shape and total scale size should be investigated.

Genetic Stock Identification:

Preliminary results of genetic stock identification studies (electrophoresis) of Yukon River fall chum salmon have indicated that this technique may be useful in identifying some component stocks in mixed stock Yukon River fisheries, and should be continued. Samples of selected baseline standards should continue to be collected to verify interannual stability of allelic frequencies and to provide samples with which to evaluate discriminatory power for additional loci. An unknown number of fall chum salmon are believed to spawn in the upper portion of the Tanana River drainage. Efforts should be made to obtain samples from these stocks for inclusion in the analysis. USFWS is currently planning to conduct electrophoretic studies of previously sampled streams (Delta, Toklat, Sheenjek, and Chandalar Rivers), additional Tanana River stocks, and lower Yukon test fishing catches in 1987. Fall chum salmon tissue samples collected from Canadian spawning stocks will be analyzed as well. Sampling and analysis of selected summer chum salmon stocks (Anvik, Andreafsky, and possibly Nulato, Koyukuk, and Tanana Rivers) will also be initiated in 1987.

Genetic stock investigations of chinook salmon should be expanded. Sampling was conducted on a number of spawning populations in Canada during 1986 and should be continued. Sampling of adult and juvenile tissues should be initiated for the four major Alaskan spawning stocks which are sampled annually for scales: the Andreafsky, Anvik, Chena, and Salcha Rivers. Every effort should be made to obtain paired samples of scales and tissues from adults to permit the use of analyses utilizing both types of data.

Maximum Likelihood Estimation:

Maximum likelihood estimation has recently gained wide acceptance for estimating stock contribution in mixed stock fisheries with a high degree of accuracy and precision. Computer software and hardware capabilities to perform this analysis may soon be available through the U.S. Fish and Wildlife Service and the feasibility of using this technique to allocate Yukon River salmon should be further investigated.

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Maximum likelihood estimation offers a further advantage in that stock discrimination data from several sources, such as scale patterns, electrophoresis, age composition, and fish length, may be used simultaneously to identify stocks with greater accuracy and precision than any one method. Application of these techniques to Yukon River salmon will require that all age determination and fish length measurements be standardized for samples from the United States and Canada.

Chinook Salmon Parasite Stock Identification:

In addition to electrophoretic analysis, juvenile chinook salmon samples collected in 1987 will be examined by DFO for parasites which may be used for stock identification studies.

REBUILDING DEPRESSED STOCKS

Spawning escapements of some Yukon River chinook and fall chum salmon stocks have been below interim escapement objectives in recent years. The initial goal of the rebuilding program is to achieve interim escapement objectives for all major stocks as soon as practical which should prevent a long-term decline in salmon production. At present there is a lack of quantitative information to determine if the interim escapement objectives will achieve optimum sustained salmon production which is the ultimate goal of the rebuilding program. The rebuilding program is expected to be a dynamic process which incorporates new information on spawner-recruitment to further refine escapement objectives in an attempt to achieve optimum sustained production.

The JTC did not have adequate time to complete discussion of this subject during the March meeting. Assignments were made for developing models illustrating catch and escapement projections based on management regimes with and without run rebuilding. This information will be included in the JTC's oral presentation to the joint delegations.

Table 1. Interim escapement objectives for Yukon River chinook and fall chum salmon stocks.

CHINOOK SALMON	
Alaska	
Andreafsky River, East Fork	1,600 1/
Andreafsky River, West Fork	1,000 1/
Anvik River (mainstem from Yellow R. to McDonald Creek)	500 1/
Nulato River, North Fork	500 1/
Nulato River, South Fork	500 1/
Gisasa River	650 1/
Chena River	1,700 1/
Salcha River	3,500 1/
Canada	
Mainstem Yukon drainage excluding Porcupine River	33,000-43,000 2/
FALL CHUM SALMON	
Alaska	
Upper Toklat River	33,000 3/
Delta River	11,000 3/
Sheenjek River	62,000 3/
Canada	
Mainstem Yukon drainage excluding Porcupine River	90,000-135,000 2/

1 Developed by ADFG in 1983 and represent minimum estimates of total escapement objectives.

2/ Developed by JTC in March 1987 and represent estimates of total escapement objectives.

3/ Developed by ADFG in 1986 and represent estimates of total escapement objectives.

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Table 2. Canadian chinook salmon escapement counts, 1979-1986.

Index area	1979	1980	1981	1982	1983	1984	1985	1986	AVERAGES 1980, 1981, 1984	AVERAGES 1979-1984 Excl. 1982
Whitehorse fishway 1/	1184	1383	1555	473	905	1042 4/	508 4/	557 4/	1327	1214
Big Salmon R. 2/										
B.S. Lake - Scurvy Cr	555	470	930	174	189	228	202	306		
Scurvy Cr - Souch Cr	77 5/	966	1357	583	351	816	599	439 5/		
Totals	632 5/	1436	2287	757	540	1044	801	745 5/	1589	1327
Nisutlin R. 2/										
100 mile Cr - Sidney Cr	713	975	1626	578	701	832	409	459 5/	1144	969
Wolf R. 2/										
Wolf Lake - Red R.	183 5/	230	395	104	95	124	110	109 5/		
Red R - Fish L outlet	-	252	107	121	157	250	116	162		
Totals	183 5/	482	502	225	252	374	226	271 5/	453	403
Tatchun Cr 3/	150	222	133	73	264	161	190	155	172	186
Totals - all areas	2047 5/	4498	6103	2106	2662	3453	2134	712 5/	4685	4179
Totals - Whitehorse Fishway, Big Salmon R. (Bis. Lake - Souch Cr), Nisutlin R.	1897 5/	3794	5468	1808	2146	2918	1718	557 5/	4060	3582

1/ total escapement (direct count)
2/ escapement index (aerial survey)
3/ escapement index (foot survey)
4/ inclu[illegible] fish taken for hatchery spawning: 65, 92 and 183 in 1984, [illegible]85, and 1986, respectively
5/ inco[illegible] survey and/or poor survey conditions: these counts not [illegible] in calculation of "totals" or "averages"

Table 3. Relationship of total escapement estimates (mark-recapture studies) to escapement index counts for Canadian chinook salmon.

	Tot. Esc. (A) 1/	Esc. Index (B) 2/	Esc. Index (C) 3/	Ratios B/A	Ratios C/A
1982	20,200	1807	2105	.08946	.10421
1983	29,500	2146	2662	.07275	.09024
1985	10,800	1718	2134	.15907	.19759
1986	17,500	4/	4/	4/	4/
		Totals		.32128	.39204
		Averages (1982, 1983, 1985)		.10709	.13068

1/ from September 1986 Yukon River Technical Report (Note: slightly different estimates are listed in recent reports that cannot be reconciled at this time)

2/ from Table 2: combined totals of Whitehorse fishway count and peak aerial survey counts for Big Salmon River (Souch Cr-Big Salmon L.) and Nisutlin River (Sidney-100 Mile Creeks)

3/ from Table 2: combined totals of Whitehorse fishway count, peak aerial survey counts for Big Salmon River (Souch Cr-Big Salmon L.), Nisutlin River (Sidney-100 Mile Creek), Wolf River (Fish Lake outlet-Wolf L.) and foot survey counts of Tatchun Creek

4/ data not used due to poor survey conditions in portions of the Big Salmon, Nisutlin and Wolf River index areas

Table 4. Calculation of escapement objectives for Canadian chinook salmon (excluding Porcupine River System)

	Whitehorse fishway, Big Salmon & Nisutlin Rivers	All Index Areas
1980, 1981, 1984		
Av. Esc. 1/ / Av. Ratio (B/A) 2/	4060/.10709=37,912	
Av. Esc. 1/ / Av. Ratio (C/A) 2/		4685/.13068=35,851
1979-1984 excl.1982		
Av. Esc. / Av. Ratio (B/A)	3582/.10709=33,449	
Av. Esc. / Av. Ratio (C/A)		4179/.13068=31,979

1/ Data from Table 2.
2/ Data from Table 3.

Table 5. Yukon River fall chum salmon estimated total escapements for the Delta, Upper Toklat, and Sheenjek Rivers, 1974-1986.

Year	Delta 1/	U. Toklat 2/	Sheenjek 3/
1974	5,915	43,484	89,966
1975	3,734 p	90,984	173,371
1976	6,312 p	53,882	26,354
1977	16,876 p	36,462	45,544
1978	11,136	37,057	32,449
1979	8,355	179,627	91,372
1980	5,137	26,373	28,933
1981	23,508	15,775	74,560
1982	4,235	3,601	31,421 s
1983	7,705	20,807	49,392 s
1984	12,411	16,511	27,130 s
1985	17,276 p	22,805	152,768 s
1986	6,703 p	18,903	83,197 s
1974-86 Average	9,946	43,559	69,727

1/ Total escapement estimates made from migratory time density curve (Barton 1986) unless otherwise indicated; (p) population estimate from replicate foot surveys and stream life data.

2/ Total escapement estimates using Delta River migratory time density curve and percentage of live salmon present at survey date in the upper Toklat River area.

3/ Total escapement estimates using sonar to aerial survey expansion factor of 2.221 unless otherwise indicated; (s) sonar estimate.

000705

Table 6. Escapement records for Fishing Branch River fall chum salmon.

Year	Peak aerial survey Counts (Date) 1/	Estimated total Escapement
1971	115,000 (10/12)	250,000-300,000 2/
1972	11,600 (9/22)	35,325 3/
1973	-	15,989 4/
1974	5,800 (11/19) 5/	31,525 6/
1975	130,000 (10/3) 7/	353,282 8/
1976	15,000 (10/25)	-
1977	32,500 (10/19)	-
1978	15,000 (10/13)	-
1979	44,080 (10/25)	-
1980	20,319 (10/13) 9/	-
1981	10,549 (10/6) 9/	-
1982	5,846 (10/12	-
1983	10,000 (10/	-
1984	5,570 (10/16)	-
1985	53,812 (10/16) 10/	56,016 10/
1986	7,836 (10/4) 11/	31,173 11/

1/ Data source: ADF&G Tech. Rpt. No. 121 unless otherwise indicated; survey conditions not reported prior to 1975; counts may include small numbers of salmon observed downstream of weir site.

2/ Data source: DFO Report PAC/T-76-1 pg 25: peak aerial survey count expanded by factors of 2.1739 - 2.6086.

3/ Data source: DFO Tech. Rpt. 1973-5, estimate based on several methods: weir count - 17190 (weir installed late), mark-recapture estimate prior to weir installation - 17,935, aerial survey count of spawners downstream of weir - 200.

4/ Data source: DFO Report PAC/T-76-1, pg 14, weir count.

5/ Late survey made after weir was removed.

6/ Data source: DFO Report PAC/T-75-1 and PAC/T-76-1, weir count.

7/ Data source: DFO Report PAC/T-76-1, Pg 6.

8/ Data source: DFO Report PAC/T-76-1, Pg 5, weir count

9/ Poor survey conditions.

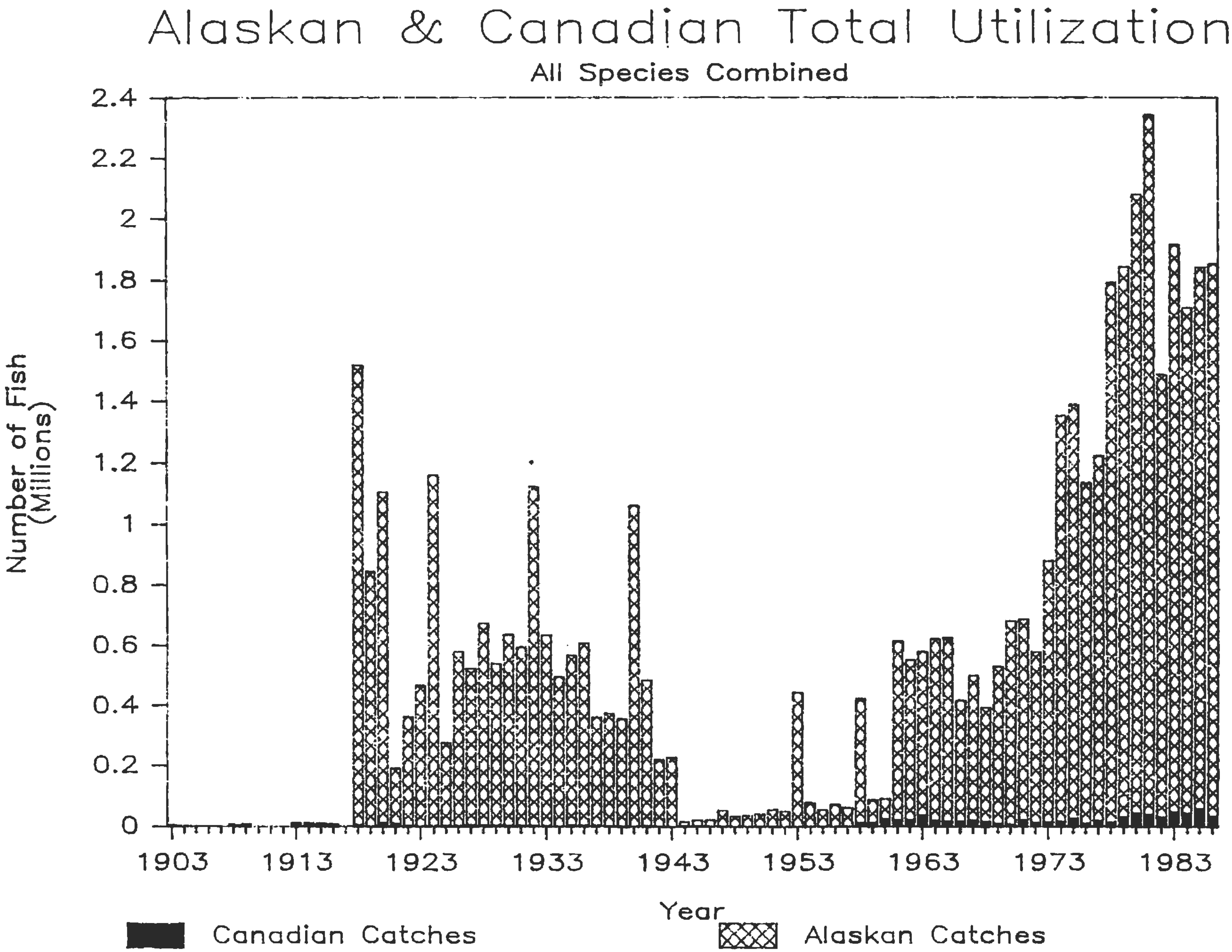
10/ Data source: ADF&G Yukon Area Management Report, 1985; weir count.

11/ Preliminary data reported by DFO, weir count.

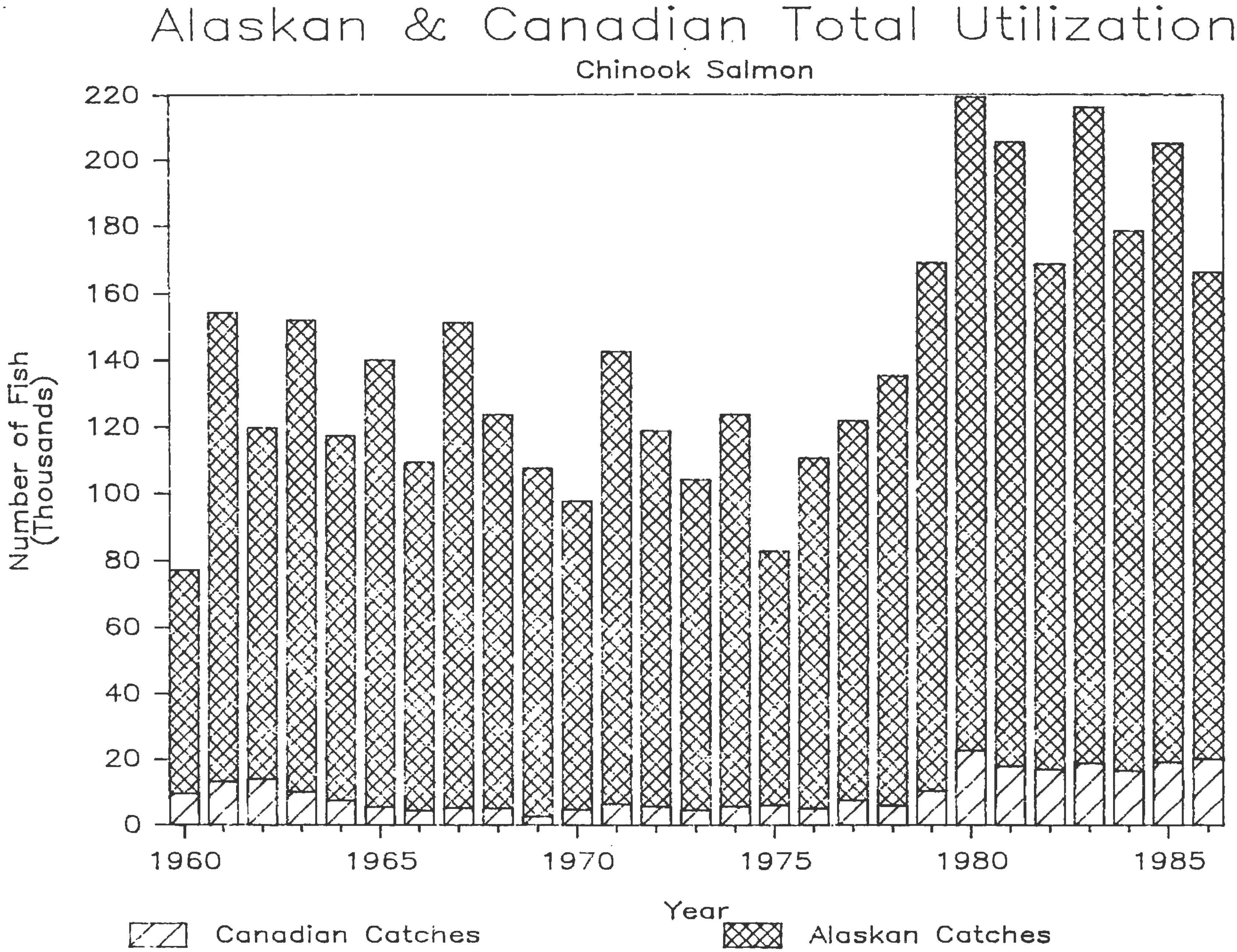
APPENDIX

000707

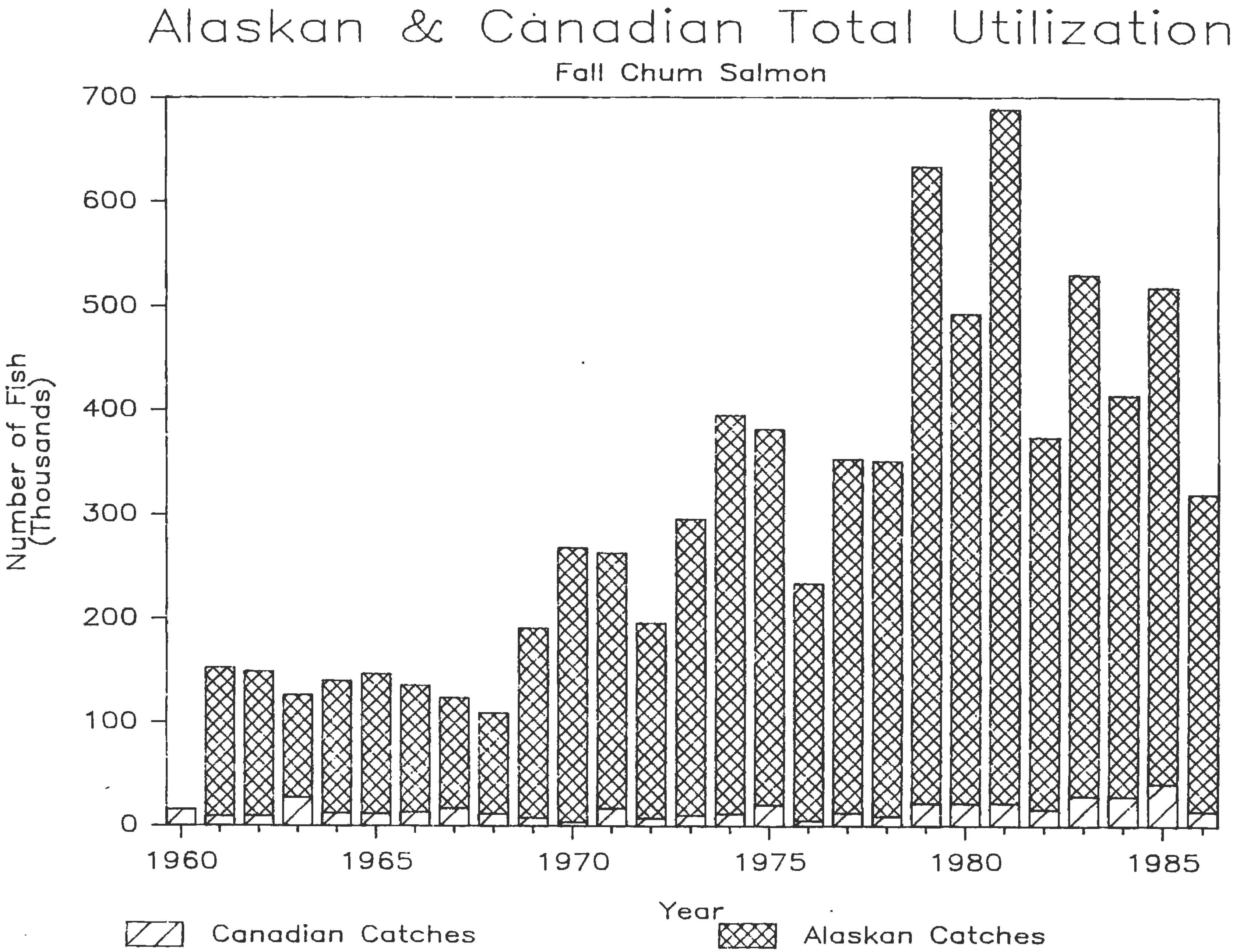
Appendix Figure 1.



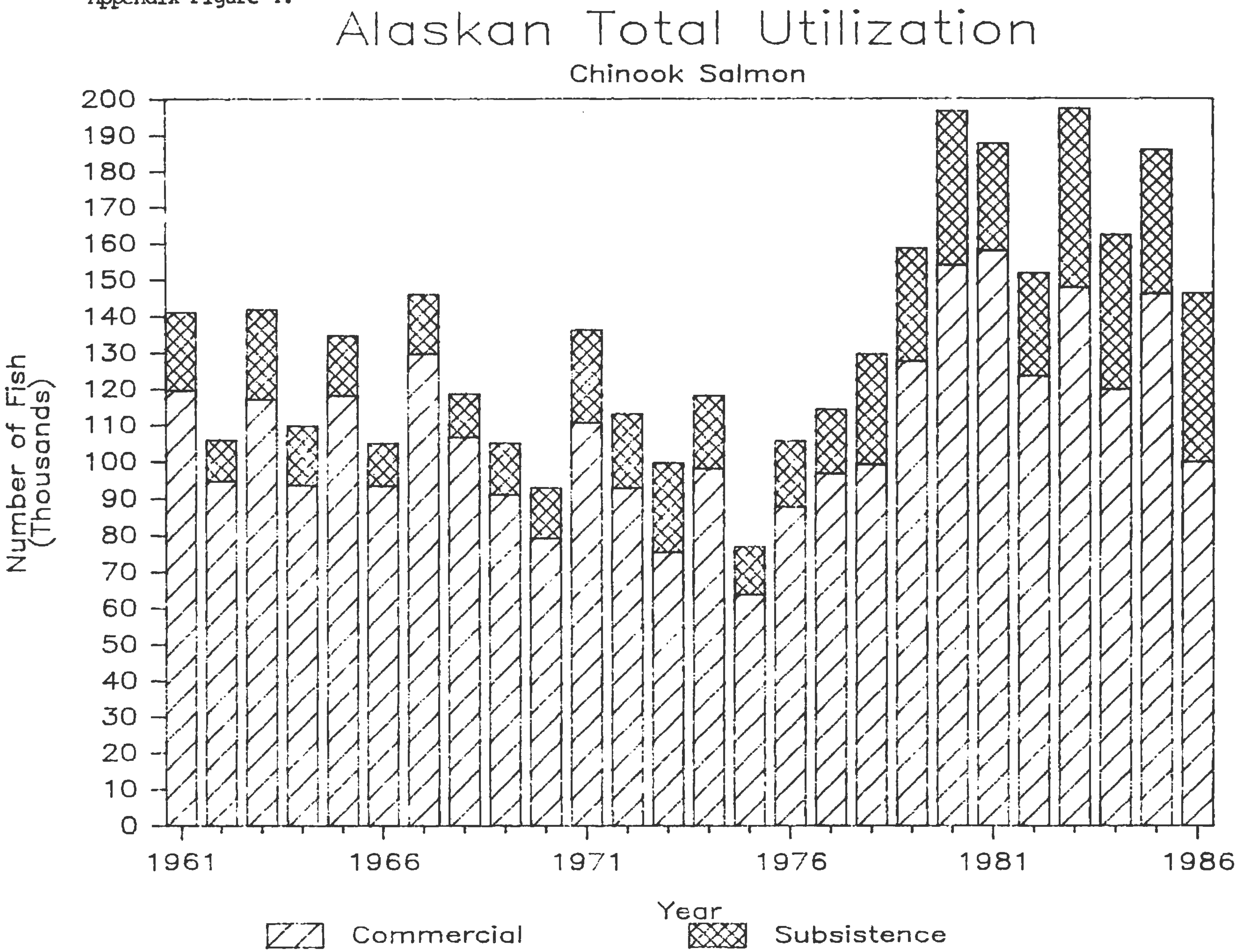
Appendix Figure 2.



Appendix Figure 3.



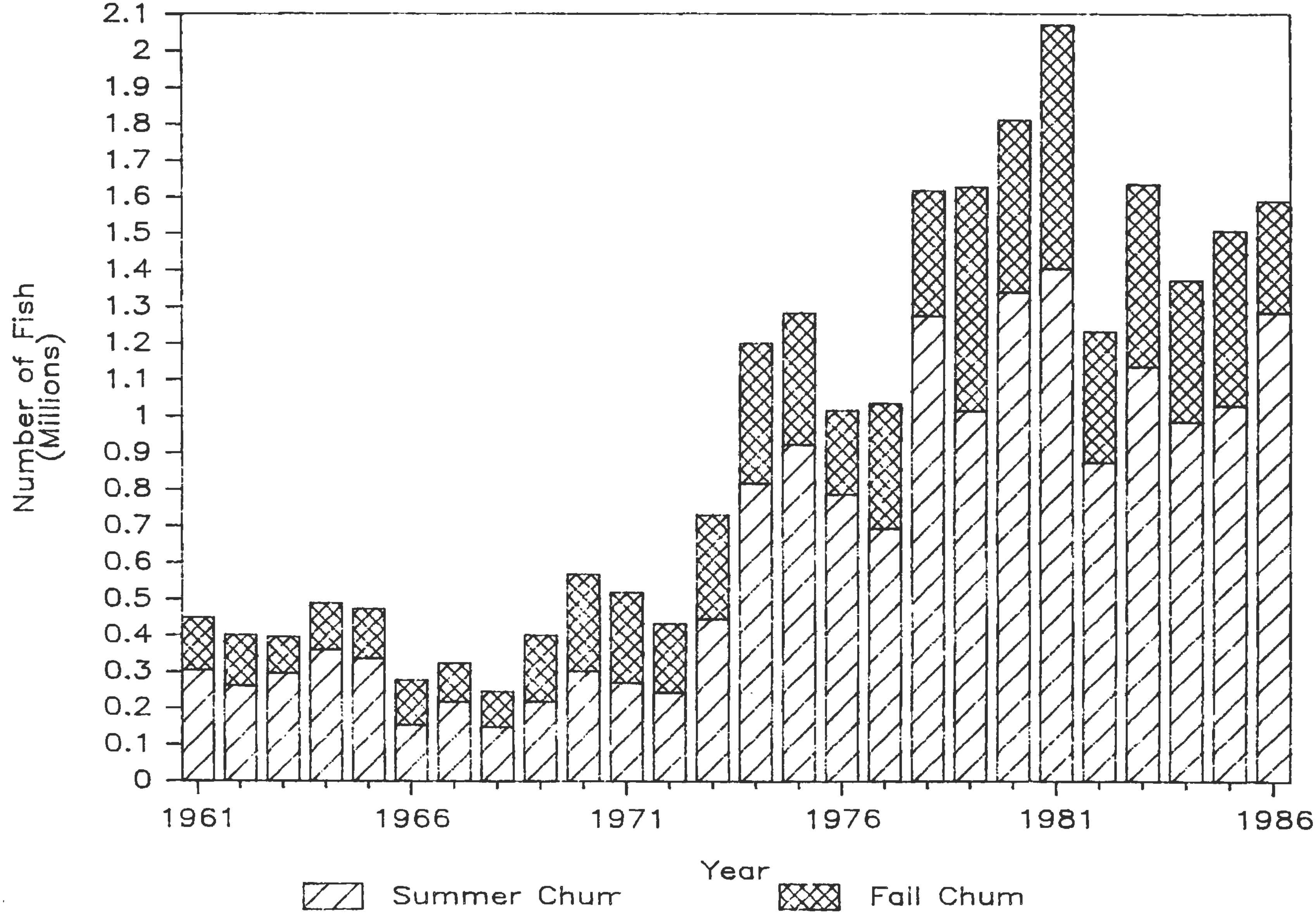
Appendix Figure 4.



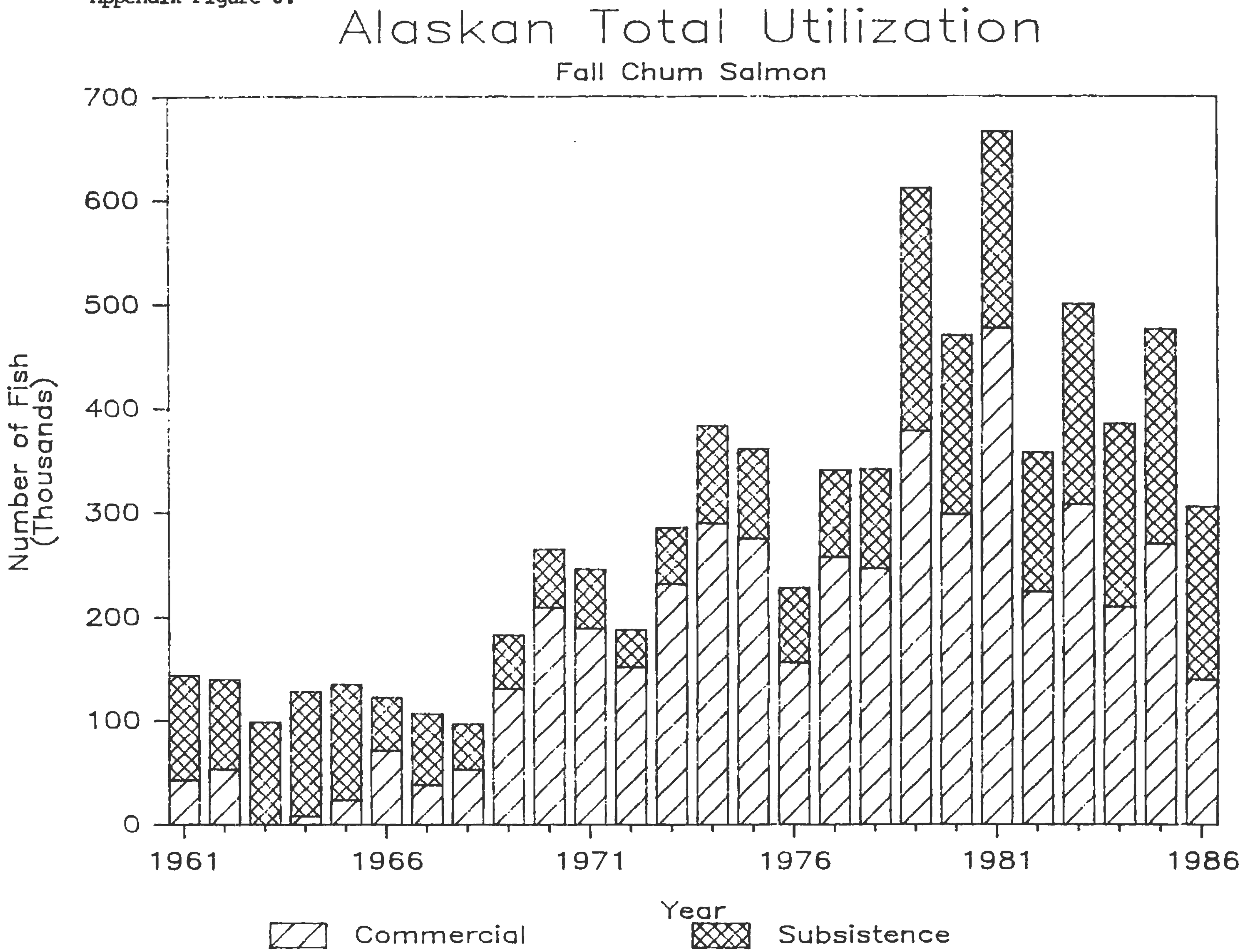
Appendix Figure 5.

Alaskan Total Utilization

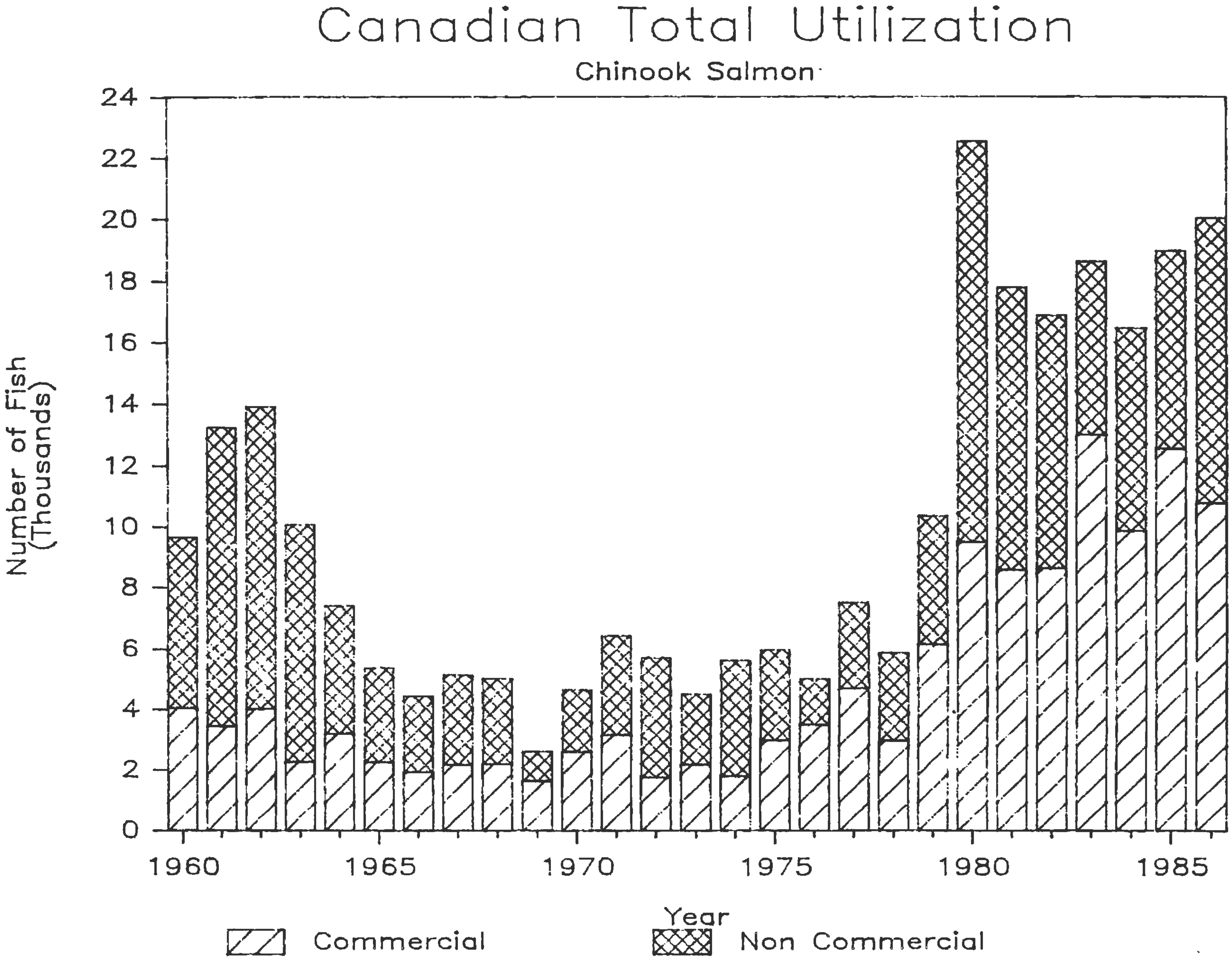
Summer & Fall Chum Salmon



Appendix Figure 6.



Appendix Figure 7.



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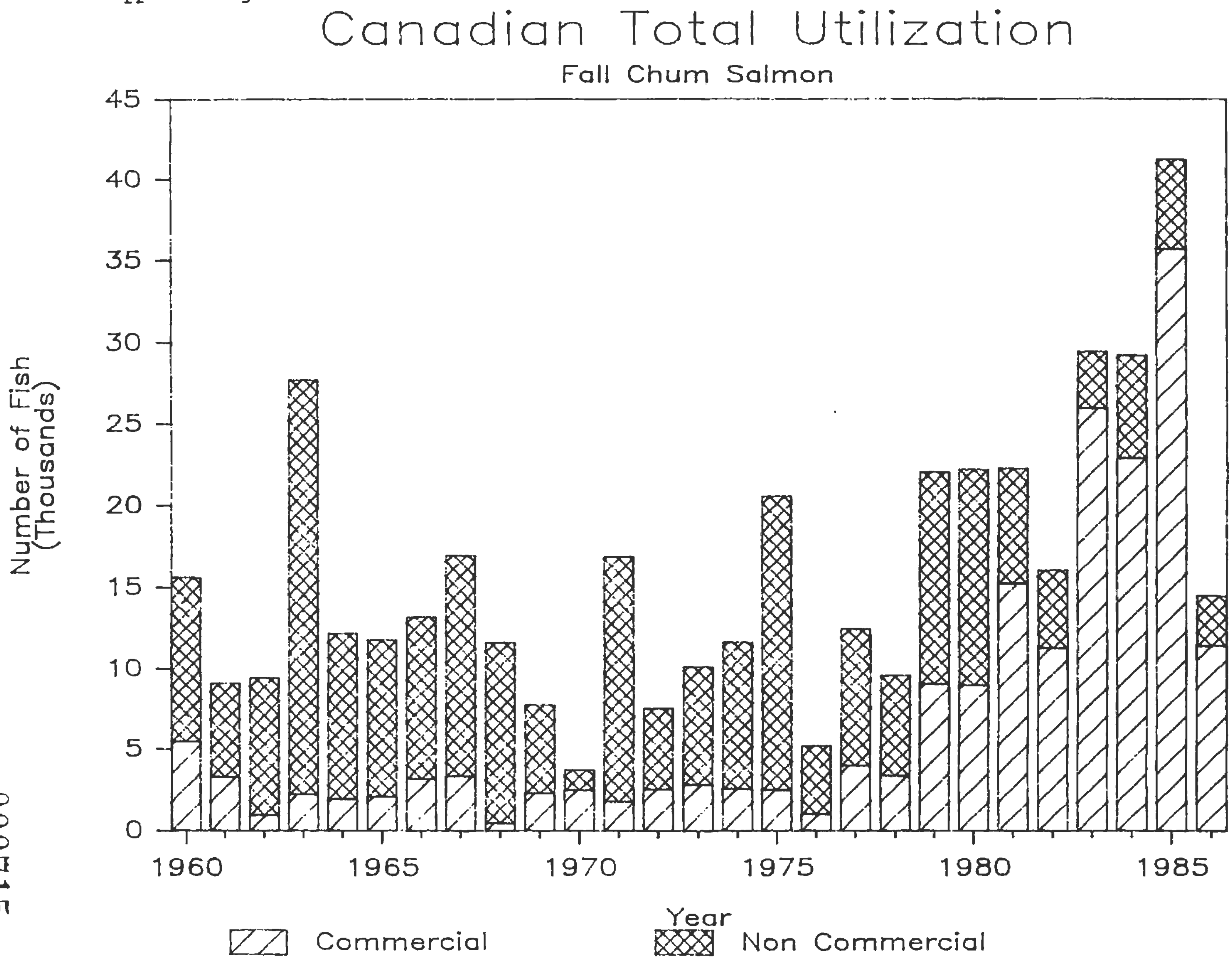
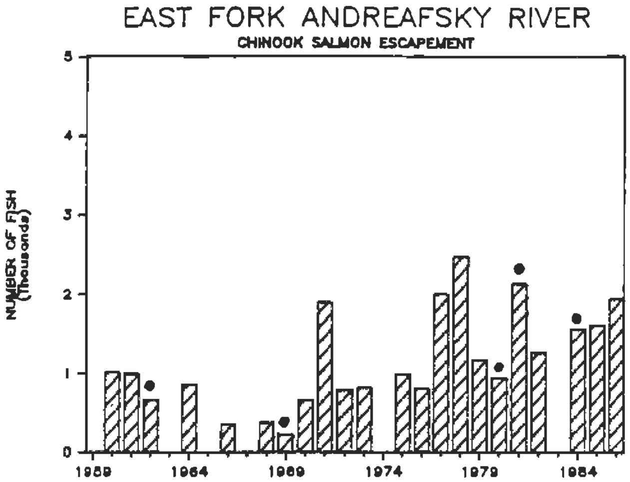
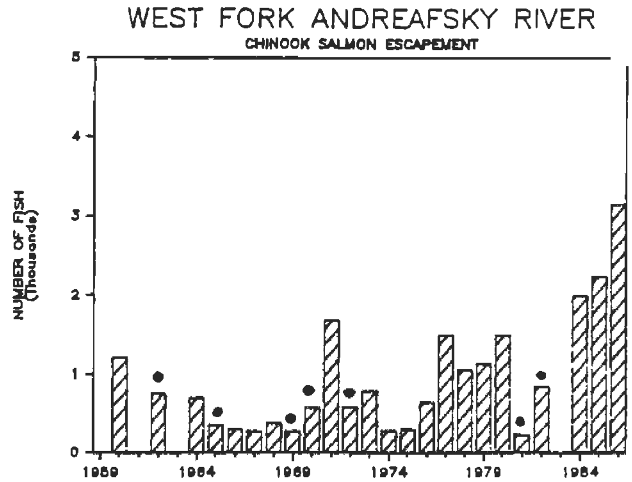
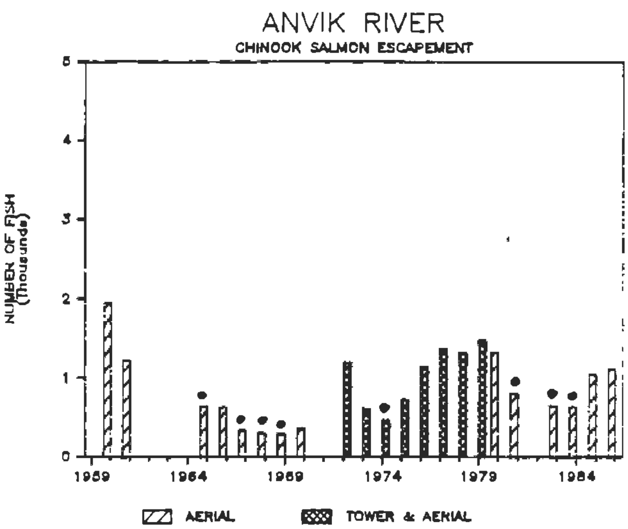
Appendix Figure 8.

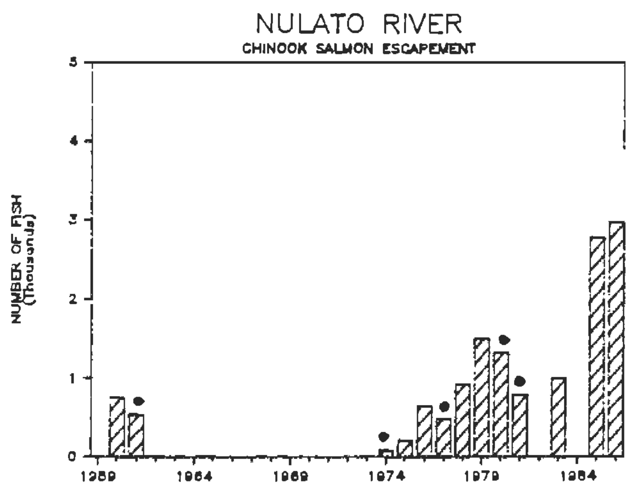


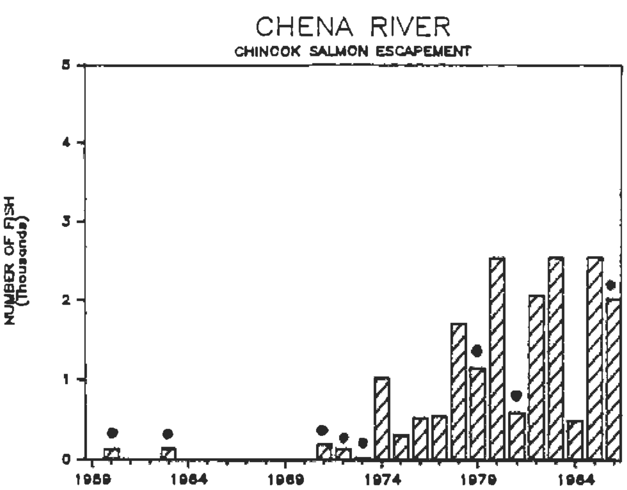
Appendix Figure 9.

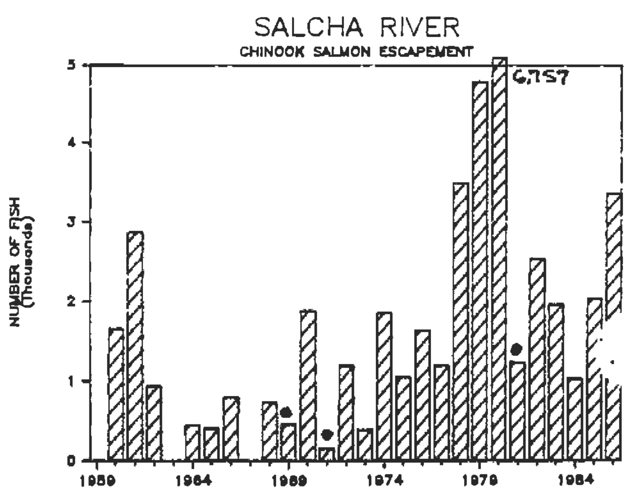












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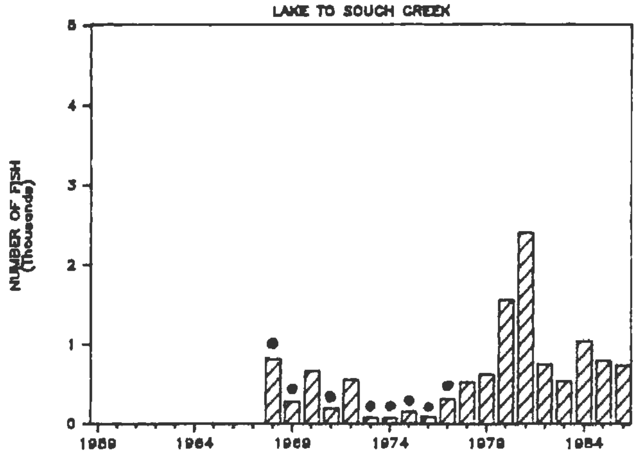
Appendix Figure 9 (continued)

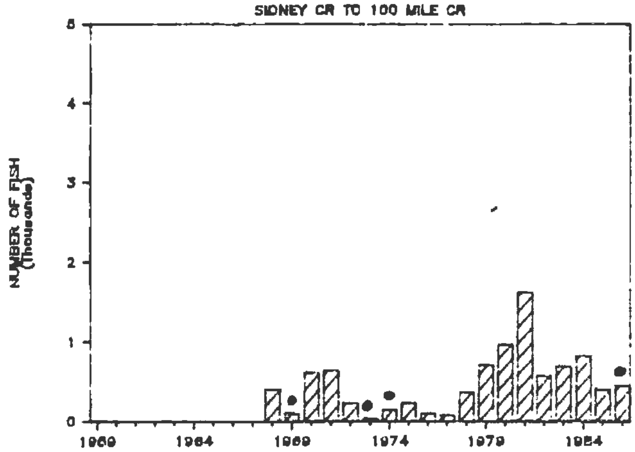
BIG SALMON RIVER CHINOOK

LAKE TO SOUCH CREEK



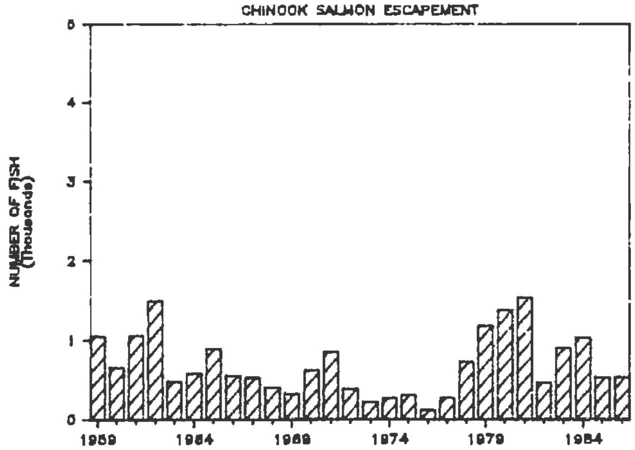
NISUTLIN RIVER CHINOOK

SIDNEY CR TO 100 MILE CR



WHITEHORSE DAM FISHWAY

CHINOOK SALMON ESCAPEMENT



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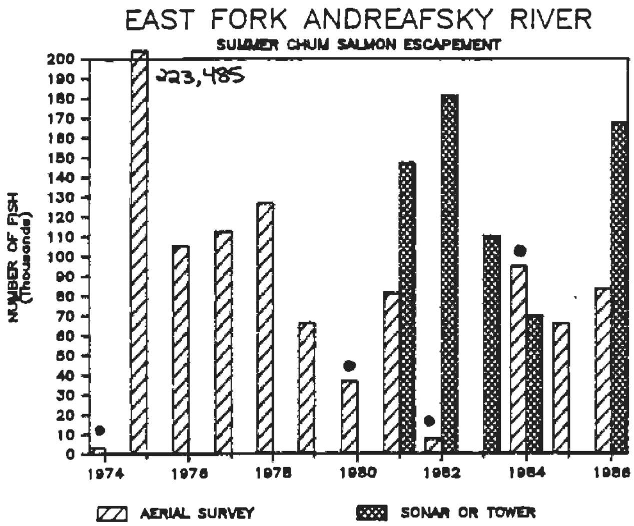
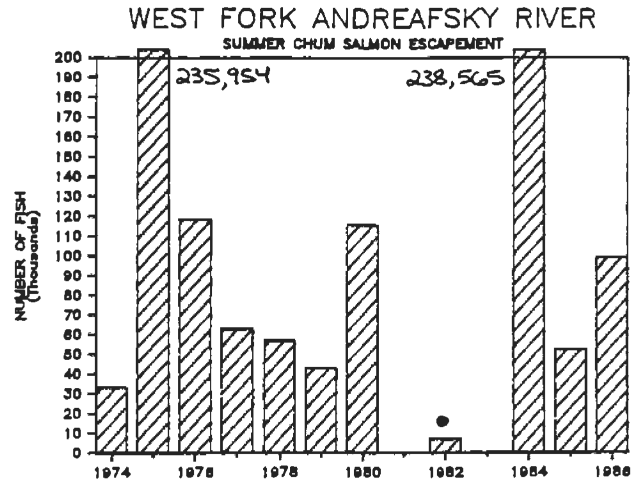
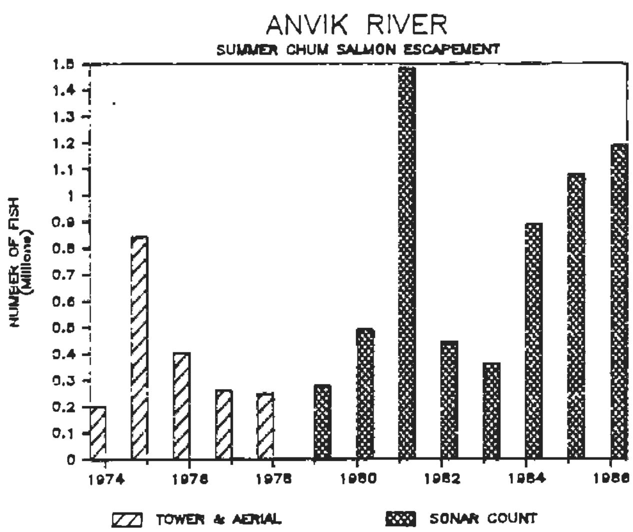
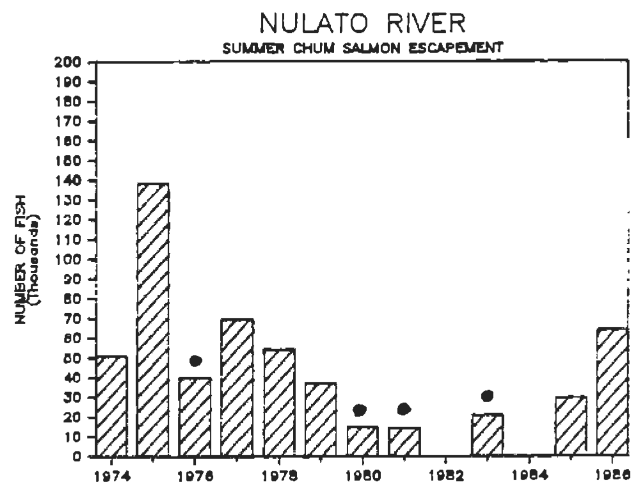
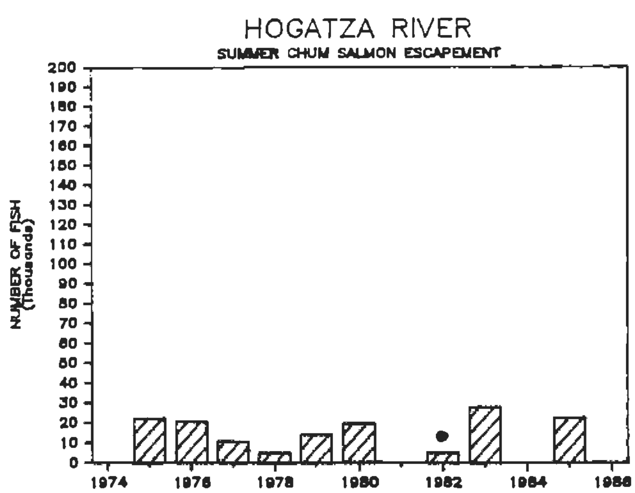
Appendix Figure 10.

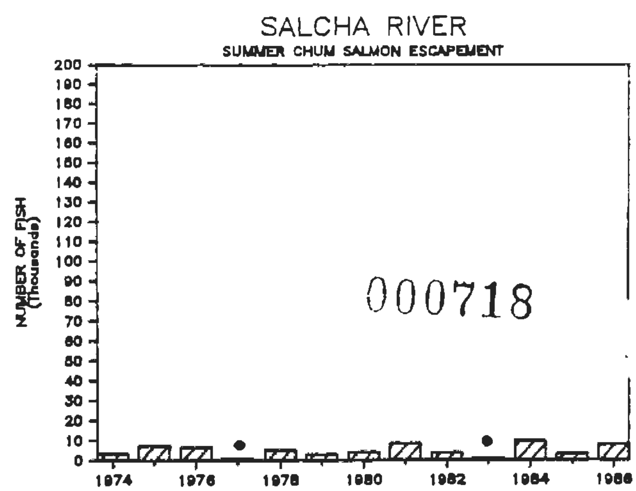












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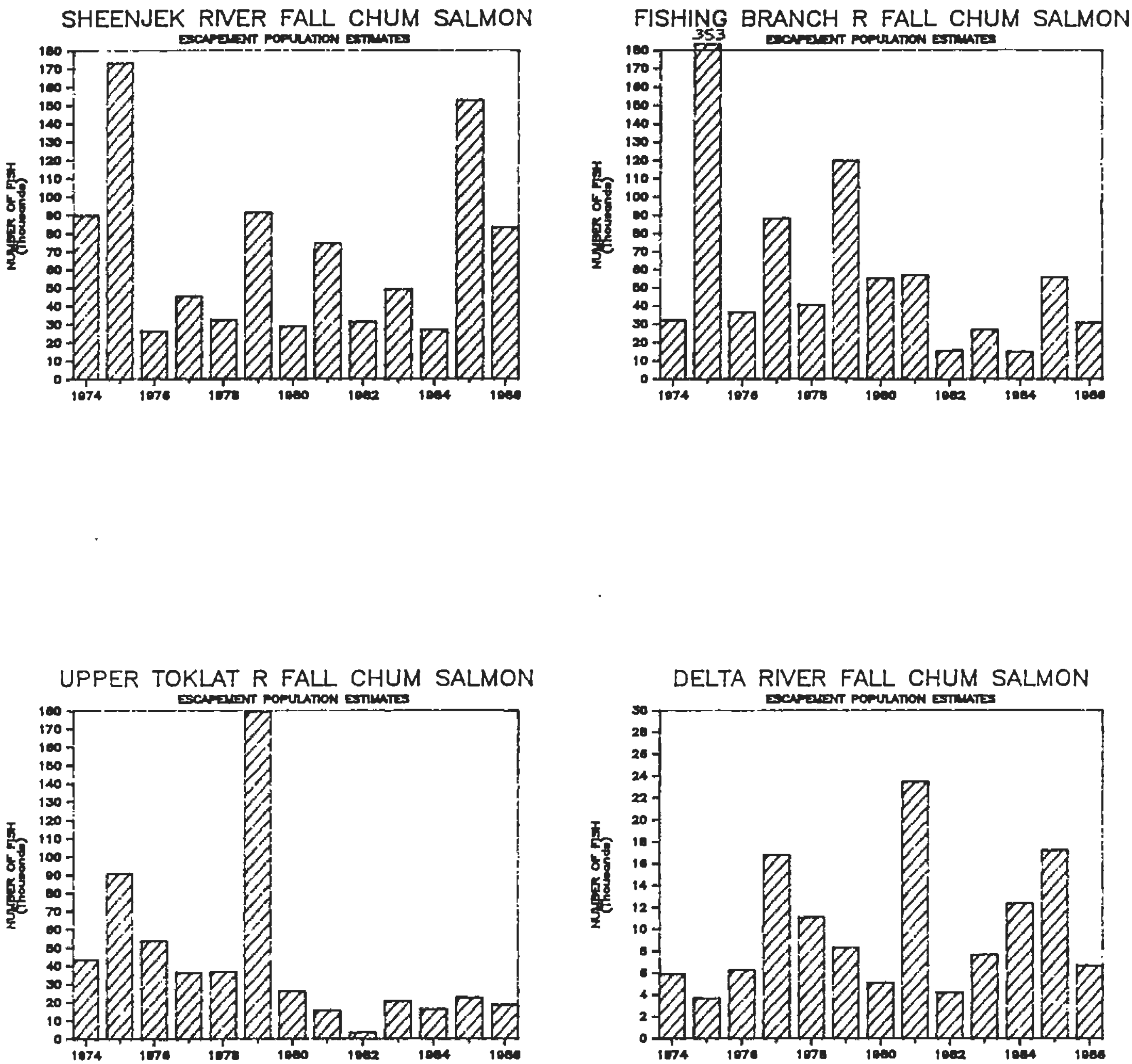
Appendix Figure 11.



000719

Appendix Table 1. Alaskan and Canadian total utilization of Yukon River salmon, 1903-1986. a

Year	Alaska Chinook	Alaska Other Salmon	Alaska Total	Canada Chinook	Canada Other Salmon	Canada Total	Total Chinook	Total Other Salmon	Total Total
1903						4,666			4,666
1904									
1905									
1906									
1907									
1908						7,000			7,000
1909						9,238			9,238
1910									
1911									
1912									
1913						12,133			12,133
1914						12,573			12,573
1915						10,466			10,466
1916						9,566			9,566
1917									
1918	12,239	1,500,065	1,512,304			7,066	12,239	1,500,065	1,519,370
1919	104,822	738,790	843,612			1,800	104,822	738,790	845,412
1920	78,467	1,015,655	1,094,122			12,000	78,467	1,015,655	1,106,122
1921	69,646	112,098	181,744			10,840	69,646	112,098	192,584
1922	31,825	330,000	361,825			2,420	31,825	330,000	364,245
1923	30,893	435,000	465,893			1,833	30,893	435,000	467,726
1924	27,375	1,130,000	1,157,375			4,560	27,375	1,130,000	1,161,935
1925	15,000	259,000	274,000			3,900	15,000	259,000	277,900
1926	20,500	555,000	575,500			4,373	20,500	555,000	579,873
1927		520,000	520,000			5,366		520,000	525,366
1928		670,000	670,000			5,733		670,000	675,733
1929		537,000	537,000			5,226		537,000	542,226
1930		633,000	633,000			3,660		633,000	636,660
1931	26,693	565,000	591,693			3,473	26,693	565,000	595,166
1932	27,899	1,092,000	1,119,899			4,200	27,899	1,092,000	1,124,099
1933	28,779	603,000	631,779			3,333	28,779	603,000	635,112
1934	23,365	474,000	497,365			2,000	23,365	474,000	499,365
1935	27,665	537,000	564,665			3,466	27,665	537,000	568,131
1936	43,713	560,000	603,713			3,400	43,713	560,000	607,113
1937	12,154	346,000	358,154			3,746	12,154	346,000	361,900
1938	32,971	340,450	373,421			860	32,971	340,450	374,281
1939	28,037	327,650	355,687			720	28,037	327,650	356,407
1940	32,453	1,029,000	1,061,453			1,153	32,453	1,029,000	1,062,606
1941	47,608	438,000	485,608			2,806	47,608	438,000	488,414
1942	22,487	197,000	219,487			713	22,487	197,000	220,200
1943	27,650	200,000	227,650			609	27,650	200,000	228,259
1944	14,232		14,232			986	14,232		15,218
1945	19,727		19,727			1,333	19,727		21,060
1946	22,782		22,782			353	22,782		23,135
1947	54,026		54,026			120	54,026		54,146
1948	33,842		33,842				33,842		33,842
1949	36,379		36,379				36,379		36,379
1950	41,808		41,808				41,808		41,808
1951	56,278		56,278				56,278		56,278
1952	38,637	10,868	49,505				38,637	10,868	49,505
1953	58,859	385,977	444,836				58,859	385,977	444,836
1954	64,545	14,375	78,920				64,545	14,375	78,920
1955	55,925		55,925				55,925		55,925
1956	62,208	10,743	72,951				62,208	10,743	72,951
1957	63,623		63,623				63,623		63,623
1958	75,625	337,500	413,125	11,000	1,500	12,500	86,625	339,000	425,625
1959	78,370		78,370	8,434	3,098	11,532	86,804	3,098	89,902
1960	67,597		67,597	9,653	15,608	25,261	77,250	15,608	92,858
1961	141,152	452,521	593,673	13,246	9,076	22,322	154,398	461,597	615,995
1962	105,844	425,277	531,121	13,937	9,436	23,373	119,781	434,713	554,494
1963	141,910	401,700	543,610	10,077	27,696	37,773	151,987	429,396	581,383
1964	109,818	492,233	602,051	7,408	12,187	19,595	117,226	504,420	621,646
1965	134,706	472,798	607,504	5,380	11,789	17,169	140,086	484,587	624,673
1966	104,887	296,310	401,197	4,452	13,192	17,644	109,339	309,502	418,841
1967	146,104	335,436	481,540	5,150	16,961	22,111	151,254	352,397	503,651
1968	118,632	259,185	377,817	5,042	11,633	16,675	123,674	270,818	394,492
1969	105,027	416,623	521,650	2,624	7,776	10,400	107,651	424,399	532,050
1970	93,019	582,049	675,068	4,663	3,711	8,374	97,682	585,760	683,442
1971	136,191	530,537	666,728	6,447	16,911	23,358	142,638	547,448	690,086
1972	113,098	454,085	567,183	5,729	7,532	13,261	118,827	461,617	580,444
1973	99,670	769,023	868,693	4,522	10,135	14,657	104,192	779,158	883,350
1974	118,053	1,218,032	1,336,085	5,631	11,646	17,277	123,684	1,229,678	1,353,362
1975	76,883	1,286,437	1,363,320	6,000	20,600	26,600	82,883	1,307,037	1,389,920
1976	105,582	1,021,708	1,127,290	5,025	5,200	10,225	110,607	1,026,908	1,137,515
1977	114,338	1,090,330	1,204,668	7,527	12,479	20,006	121,865	1,102,809	1,224,674
1978	129,465	1,650,942	1,780,407	5,881	9,566	15,447	135,346	1,660,508	1,795,854
1979	158,678	1,654,445	1,813,123	10,375	22,084	32,459	169,053	1,676,529	1,845,582
1980	196,709	1,840,123	2,036,832	22,546	22,218	44,764	219,255	1,862,341	2,081,596
1981	187,708	2,115,459	2,303,167	17,609	22,281	40,090	205,517	2,137,740	2,343,257
1982	151,802	1,306,171	1,457,973	16,908	16,091	32,999	168,710	1,322,262	1,490,972
1983	197,388	1,673,071	1,870,459	18,652	29,490	48,142	216,040	1,702,561	1,918,601
1984	162,232	1,502,911	1,665,143	16,495	29,267	45,762	178,727	1,532,178	1,710,905
1985	185,959	1,597,127	1,783,086	19,001	41,515	60,516	204,960	1,638,642	1,843,602
1986	145,252	1,669,826	1,815,078	20,064	14,836	34,900	165,316	1,684,662	1,849,978

a Commercial and subsistence harvest combined in numbers of fish, including "equivalent fish" converted from roe sales. See ADF&G 1985 Yukon Area Annual Management Report for data sources and methods of catch estimation used for some years.

000720

Appendix Table 2. Alaskan and Canadian total utilization of Yukon River chinook and fall chum salmon, 1960-1986. a

	Chinook			Fall Chum		
Year	Canada b	Alaska c	Total	Canada b	Alaska c	Total
1960	9,653	67,597 d	77,250	15,608	— e	15,608
1961	13,246	141,152	154,398	9,076	144,233	153,309
1962	13,937	105,844	119,781	9,436	140,401	149,837
1963	10,077	141,910	151,987	27,696	99,031 f	126,727
1964	7,408	109,818	117,226	12,187	128,707	140,894
1965	5,380	134,706	140,086	11,789	135,600	147,389
1966	4,452	104,887	109,339	13,192	122,548	135,740
1967	5,150	146,104	151,254	16,961	107,018	123,979
1968	5,042	118,632	123,674	11,633	97,552	109,185
1969	2,624	105,027	107,651	7,776	183,373	191,149
1970	4,663	93,019	97,682	3,711	265,096	268,807
1971	6,447	136,191	142,638	16,911	246,756	263,667
1972	5,729	113,098	118,827	7,532	188,178	195,710
1973	4,522	99,670	104,192	10,135	285,760	295,895
1974	5,631	118,053	123,684	11,646	383,552	395,198
1975	6,000	76,883	82,883	20,600	361,600	382,200
1976	5,025	105,582	110,607	5,200	228,717	233,917
1977	7,527	114,338	121,865	12,479	340,757	353,236
1978	5,881	129,465	135,346	9,566	341,878	351,444
1979	10,375	158,678	169,053	22,084	611,759	633,843
1980	22,546	196,709	219,255	22,218	471,107	493,325
1981	17,809	187,708	205,517	22,281	666,261	688,542
1982	16,908	151,802	168,710	16,091	357,889	373,980
1983	18,652	197,388	216,040	29,490	500,592	530,082
1984	16,495	162,332	178,827	29,267	385,383	414,650
1985	19,001	185,959	204,960	41,265	476,741	518,006
1986	20,064	145,252	165,316	14,536	304,053	318,589
Average						
1961-65	10,010	126,686	136,696	14,037	129,594	143,631
1966-70	4,386	113,534	117,920	10,655	155,117	165,772
1971-75	5,666	108,779	114,445	13,365	293,169	306,534
1976-80	10,271	140,954	151,225	14,309	398,844	413,153
1981-85	17,773	177,038	194,811	27,679	477,373	505,052

a Catch in numbers of fish, including "equivalent fish" converted from roe sales.
b Commercial, Indian Food, and Domestic catches combined.
c Commercial and Subsistence catches combined.
d Commercial catches only; subsistence catches not documented.
e Subsistence catch not documented; commercial fishery did not operate.
f Subsistence catch only; commercial fishery did not operate.

000721

Appendix Table 3. Alaskan catch of Yukon River chinook salmon, 1961-1986. a

Year	Subsistence	Commercial	Total
1961	21,488	119,664	141,152
1962	11,110	94,734	105,844
1963	24,862	117,048	141,910
1964	16,231	93,587	109,818
1965	16,608	118,098	134,706
1966	11,572	93,315	104,887
1967	16,448	129,656	146,104
1968	12,106	106,526	118,632
1969	14,000	91,027	105,027
1970	13,874	79,145	93,019
1971	25,684	110,507	136,191
1972	20,258	92,840	113,098
1973	24,317	75,353	99,670
1974	19,964	98,089	118,053
1975	13,045	63,838	76,883
1976	17,806	87,776	105,582
1977	17,581	96,757	114,338
1978	30,297	99,168	129,465
1979	31,005	127,673	158,678
1980	42,724	153,985	196,709
1981	29,690	158,018	187,708
1982	28,158	123,644	151,802
1983	49,478	147,910	197,388
1984	42,428	119,904	162,332
1985	39,771	146,188	185,959
1986	45,282	99,970	145,252
Average			
1961-65	18,060	108,626	126,686
1966-70	13,600	99,934	113,534
1971-75	20,654	88,125	108,779
1976-80	27,883	113,072	140,954
1981-85	37,905	139,133	177,038

a Catch in numbers of fish.

000722

Appendix Table 4. Canadian catch of Yukon River chinook salmon (including Porcupine River), 1960-1986. a

Year	Commercial	Non Commercial: Domestic	Non Commercial: Indian Food Fish	Non Commercial: Combined	Total
1960	4,058		5,595	5,595	9,653
1961	3,446		9,800	9,800	13,246
1962	4,037		9,900	9,900	13,937
1963	2,283		7,794	7,794	10,077
1964	3,208		4,200	4,200	7,408
1965	2,265		3,115	3,115	5,380
1966	1,942		2,510	2,510	4,452
1967	2,187		2,963	2,963	5,150
1968	2,212		2,830	2,830	5,042
1969	1,640		984	984	2,624
1970	2,611		2,052	2,052	4,663
1971	3,178		3,269	3,269	6,447
1972	1,769		3,960	3,960	5,729
1973	2,199		2,323	2,323	4,522
1974	1,808	406	3,417	3,823	5,631
1975	3,000	400	2,600	3,000	6,000
1976	3,500	500	1,025	1,525	5,025
1977	4,720	531	2,276	2,807	7,527
1978	2,975	421	2,485	2,906	5,881
1979	6,175	1,200	3,000	4,200	10,375
1980	9,500	3,500	9,546	13,046	22,546
1981	8,593	237	8,979	9,216	17,809
1982	8,640	435	7,833	8,268	16,908
1983	13,027	400	5,225	5,625	18,652
1984	9,885	260	6,350	6,610	16,495
1985	12,573	478	5,950	6,428	19,001
1986	10,797	342	8,925	9,267	20,064
Average					
1961-65	3,048	--	6,962	6,962	10,010
1966-70	2,118	--	2,268	2,268	4,386
1971-75	2,391	403	3,114	3,275	5,666
1976-80	5,374	1,230	3,666	4,897	10,271
1981-85	10,544	362	6,867	7,229	17,773

a Catch in numbers of fish.

000723

Appendix Table 5. Alaska catch of Yukon River chum salmon, 1961-1986. a

	Summer Chum			Fall Chum			Total Chum		
Year	Subsistence b	Commercial	Total	Subsistence b	Commercial	Total	Subsistence b	Commercial	Total
1961	305,317		305,317	101,772	42,461	144,233	407,089	42,461	449,550
1962	261,856		261,856	87,285	53,116	140,401	349,141	53,116	402,257
1963	297,094		297,094	99,031		99,031	396,125	0	396,125
1964	361,080		361,080	120,360	8,347	128,707	481,440	8,347	489,787
1965	336,848		336,848	112,283	23,317	135,600	449,131	23,317	472,448
1966	154,508		154,508	51,503	71,045	122,548	206,011	71,045	277,056
1967	206,233	10,935	217,168	68,744	38,274	107,018	274,977	49,209	324,186
1968	133,880	14,470	148,350	44,627	52,925	97,552	178,507	67,395	245,902
1969	156,191	61,966	218,157	52,063	131,310	183,373	208,254	193,276	401,530
1970	166,504	137,006	303,510	55,501	209,595	265,096	222,005	346,601	568,606
1971	171,487	100,090	271,577	57,162	189,594	246,756	228,649	289,684	518,333
1972	108,006	135,668	243,674	36,002	152,176	188,178	144,008	287,844	431,852
1973	161,012	285,509	446,521	53,670	232,090	285,760	214,682	517,599	732,281
1974	227,811	589,892	817,703	93,776	289,776	383,552	321,587	879,668	1,201,255
1975	211,888	710,295	922,183	86,591	275,009	361,600	298,479	985,304	1,283,783
1976	186,872	600,894	787,766	72,327	156,390	228,717	259,199	757,284	1,016,483
1977	159,502	534,875	694,377	82,771	257,986	340,757	242,273	792,861	1,035,134
1978	197,137	1,077,987	1,275,124	94,867	247,011	341,878	292,004	1,324,998	1,617,002
1979	196,187	819,533	1,015,720	233,347	378,412	611,759	429,534	1,197,945	1,627,479
1980	272,398	1,067,715	1,340,113	172,657	298,450	471,107	445,055	1,366,165	1,811,22[illegible]
1981	208,284	1,196,006	1,404,290	188,525	477,736	666,261	396,809	1,673,742	2,070,551
1982	260,969	614,222	875,191	132,897	224,992	357,889	393,866	839,214	1,233,080
1983	240,386	894,878	1,135,264	192,930	307,662	500,592	433,316	1,202,540	1,635,856
1984	230,747	755,821	986,568	174,823	210,560	385,383	405,570	966,381	1,371,951
1985	264,828	765,622	1,030,450	206,472	270,269	476,741	471,300	1,035,891	1,507,191
1986	290,888	993,160	1,284,048	164,034	140,019	304,053	454,922	1,133,179	1,588,101
Average									
1961-65	312,439	—	312,439	104,146	31,810	129,594	416,585	25,448	442,033
1966-70	163,463	56,094	208,339	54,488	100,630	155,117	217,951	145,505	363,456
1971-75	176,041	364,291	540,332	65,440	227,729	293,169	241,481	592,020	833,501
1976-80	202,419	820,201	1,022,620	131,194	267,650	398,844	333,613	1,087,851	1,421,464
1981-85	241,043	845,310	1,086,353	179,129	298,244	477,373	420,172	1,143,554	1,563,726

a Catch in numbers of fish, including "equivalent fish" converted from roe sales.

b Includes small numbers of pink and coho salmon during the period 1961-1976.

000724

Appendix Table 6. Canadian catch of Yukon River chum salmon (including Porcupine River), 1960-1986. a

		Non Commercial			
Year	Commercial	Domestic	Indian Food Fish	Combined	Total
1960	5,493		10,115	10,115	15,608
1961	3,276		5,800	5,800	9,076
1962	936		8,500	8,500	9,436
1963	2,196		25,500	25,500	27,696
1964	1,929		10,258	10,258	12,187
1965	2,071		9,718	9,718	11,789
1966	3,157		10,035	10,035	13,192
1967	3,343		13,618	13,618	16,961
1968	453		11,180	11,180	11,633
1969	2,279		5,497	5,497	7,776
1970	2,479		1,232	1,232	3,711
1971	1,761		15,150	15,150	16,911
1972	2,532		5,000	5,000	7,532
1973	2,806		7,329	7,329	10,135
1974	2,544	466	8,636	9,102	11,646
1975	2,500	4,600	13,500	18,100	20,600
1976	1,000	1,000	3,200	4,200	5,200
1977	3,990	1,499	6,990	8,489	12,479
1978	3,356	728	5,482	6,210	9,566
1979	9,084	2,000	11,000	13,000	22,084
1980	9,000	4,000	9,218	13,218	22,218
1981	15,260	1,611	5,410	7,021	22,281
1982	11,312	683	4,096	4,779	16,091
1983	25,990	300	3,200	3,500	29,490
1984	22,932	535	5,800	6,335	29,267
1985	35,746	279	5,240	5,519	41,265
1986	11,464	222	2,850	3,072	14,536
Average					
1961-65	2,082	--	11,955	11,955	14,037
1966-70	2,342	--	8,312	8,312	10,655
1971-75	2,429	2,533	9,923	10,936	13,365
1976-80	5,286	1,845	7,178	9,023	14,309
1981-85	22,248	682	4,749	5,431	27,679

a Catch in numbers of fish.

000725

Appendix Table 7. Chinook salmon escapement index counts for selected spawning areas in the Yukon River drainage, 1959-1986. a

	Andreafsky		Anvik							
	E Fork	W Fork	Aerial	Tower	Nulato	Chena	Salcha	Big Salmon	Nisutlin	Whitehorse Fishway
1959										1,054
1960	1,020	1,220	1,350		756	132 b	1,660			660
1961	1,003		1,226		543 b		2,878			1,068
1962	675 b	762 b					937			1,500
1963						137 b				484
1964	867	705					450			587
1965		355 b	650 b				408			903
1966	361	303	638				800			563
1967		276	336 b							533
1968	380	383	310 b				739	827 b	407	414
1969	231 b	274 b	296 b				461 b	286 b	105 b	334
1970	665	574 b	368				1,882	670	615	625
1971	1,904	1,682				193 d	158 b	200 b	650	856
1972	798	582 b		1,198		138 d	1,193	560	237	391
1973	825	788		613		21 b	391	75 b	36 b	224
1974		285		471 b	78 b	1,035 c	1,857	70 b	150 b	273
1975	993	301		730	204	316 c	1,055	153 b	239	313
1976	818	643		1,154	648	531	1,641	86 b	102	121
1977	2,008	1,499		1,371	487 b	563	1,202	316 b	77	277
1978	2,487	1,062		1,324	920	1,726	3,499	524	375	725
1979	1,180	1,134		1,484	1,507	1,159 b	4,789	632	713	1,184
1980	958 b	1,500	1,330		1,323 b	2,541	6,757	1,568	975	1,383
1981	2,146 b	231 b	807 b		791 b	600 b	1,237 b	2,411	1,626	1,539
1982	1,274	851 b				2,073	2,534	757	578	473
1983			653 b		1,006	2,553	1,961	540	701	905
1984	1,573 b	1,993	641 b			501	1,031	1,044	832	1,042
1985	1,617	2,248	1,051		2,780	2,553	2,035	801	409	536
1986	1,954	3,158	1,118		2,974	2,031 b	3,368	745	459 b	541

a Data obtained by aerial survey unless otherwise noted. Only peak counts are listed.

b Incomplete survey and/or poor survey timing or conditions resulted in minimal or inaccurate count.

c Boat survey.

d Boat survey that was incomplete or conducted under poor conditions.

000726

Appendix Table 8. Summer chum salmon escapement population estimates and index counts for selected spawning areas in the Yukon River drainage, 1974-1986. a

	Andreafsky			Anvik				
	E Fork Aerial	E F Sonar or Tower	W Fork Aerial	Tower & Aerial	Sonar	Nulato	Hogatza	Salcha
1974	3,215 b		33,578	201,277		51,160		3,510
1975	223,485		235,954	845,485		138,495	22,355	7,573
1976	105,347		118,420	406,166		40,001 b	20,744	6,474
1977	112,722		63,120	262,854		69,660	10,734	677 b
1978	127,050		57,321	251,339		54,480	5,102	5,405
1979	66,471		43,391		280,537	37,104	14,221	3,060
1980	36,823 b		115,457		492,676	14,946 b	19,786	4,140
1981	81,555	147,312			1,479,582	14,348 b		8,500
1982	7,501 b	181,352	7,267 b		444,581		4,984 b	3,756
1983		110,608			362,912	21,012 b	28,141	716 b
1984	95,200 b	70,125	238,565		891,028			9,810
1985	66,146		52,750		1,080,243	29,838	22,566	3,178
1986	83,931	167,614	99,373		1,189,602	64,265		8,028

a Data obtained by aerial survey unless otherwise noted. Only peak counts are listed.
b Incomplete survey and/or poor survey timing or conditions resulted in minimal or inaccurate count.

Appendix Table 9. Fall chum salmon expanded population escapement estimates for selected spawning areas in the Yukon River drainage, 1974-1986.

Year	Delta a	Upper Toklat b	Sheenjek c	Fishing Branch d	Total
1974	5,915	43,484	89,966	32,525 w	171,890
1975	3,734 p	90,984	173,371	353,282 w	621,371
1976	6,312 p	53,882	26,354	36,584	123,132
1977	16,876 p	36,462	45,544	88,400	187,282
1978	11,136	37,057	32,449	40,800	121,442
1979	8,355	179,627	91,372	119,898	399,252
1980	5,137	26,373	28,933	55,268	115,711
1981	23,508	15,775	74,560	57,386 e	171,229
1982	4,235	3,601	31,421 s	15,901	55,158
1983	7,705	20,807	49,392 s	27,200	105,104
1984	12,411	16,511	27,130 s	15,150	71,202
1985	17,276 p	22,805	152,768 s	56,100 w	248,949
1986	6,703	18,903	83,197 s	31,173 w	139,976

a Total escapement estimates made from migratory time density curve (Barton 1986) unless otherwise indicated; (p) population estimate from replicate foot surveys and stream life data.

b Total escapement estimates using Delta River migratory time density curve and percentage of live salmon present by survey date in the upper Toklat River area.

c Total escapement estimates using sonar to aerial survey expansion factor of 2.221 unless otherwise indicated; (s) sonar estimate.

d Total escapement estimates using weir to aerial survey expansion factor of 2.72 unless otherwise indicated; (w) weir estimate.

e Initial aerial survey count was doubled before applying the weir/aerial expansion factor of 2.72 since only half of the spawning area was surveyed.

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Appendix Table 10. Yukon River salmon escapement data, 1986. a

Stream (drainage)	Date	Survey Rating	Chinook	Summer Chums	Fall Chums	Coho	Pinks
Andreafsky River							
East Fork (Tower Count)	6/25-7/14		1,530 b	167,614 c	—	—	124,618 b
East Fork (Aerial)	7/14	Fair	1,954	83,931	—	—	2,230
West Fork (Aerial)	7/14	Good	3,158	99,373	—	—	—
Yukon River (Pilot Station)							
Main River Sonar d	6/9-9/12		86,449	1,943,558	526,814	199,798	1,055,746
Anvik River							
Aerial Counts							
Mainstem River	7/28	Good	1,027	—	—	—	—
McDonald Creek	7/28	Good	8	—	—	—	—
Otter Creek	7/28	Good	43	—	—	—	—
Yellow River	7/28	Good	40	—	—	—	—
Sonar Count e	6/21-7/15		—	1,189,602	—	—	no est
Nulato River							
Below Forks	7/12,22	Fair	27	5,295	—	—	—
South Fork	7/12,22	Fair	1,522	16,848	—	—	—
North Fork	7/12,22	Fair	1,425	42,122	—	—	—
Koyukuk River Drainage							
Gisasa River	7/12,22	Fair-Good	1,346	12,114	—	—	—
Henshaw Creek	7/28	Fair	561	2,475	—	—	—
South Fork Koyukuk River	7/28,29	Good-Fair	556	1,576	—	—	—
Jim River	7/28,29	Good-Fair	238	869	—	—	—
Middle Fork Koyukuk River	7/29	Fair	49	—	—	—	—
Bettles River	7/29	Good	—	5	—	—	—
Melozitna River							
Fox Creek	7/12	Fair	—	90	—	—	—
Melozi Hot Springs Creek	7/22	Fair	5	2,958	—	—	—
Tozitna River	7/28	Good	222	1,778	—	—	—

Appendix Table 10. Yukon River salmon escapement data, 1986 (continued).

Stream (drainage)	Date	Survey Rating	Chinook	Summer Chums	Fall Chums	Coho	Pinks
Lower Tanana River Drainage							
Kantishna River Drainage							
Toklat River							
Barton Creek	7/27,10/17	Poor,Fair	5	—	50	496	—
Geiger Creek f	10/16	Fair	—	—	1,287	5	—
Sushana River	10/17	Good	—	—	711	2	—
Toklat Ri (vic Rdhse)	9/29	Good	—	—	10,710	0	—
Bearpaw River (mainstem)	10/29	Fair	—	—	0	—	—
Moose Creek	10/29	Fair	—	—	205	23	—
Nenana River Drainage							
Lost Slough	10/29	Fair	—	—	—	794	—
Seventeen Mile Slough g,h	8/2,10/29	Good,Poor	306	72	—	218	—
Julius Creek							
Clear Creek weir count	7/6-8/5		168 i	79	—	—	—
(aerial survey)	7/27	Fair-Poor	47	—	—	—	—
(boat/foot survey) g	10/8		—	—	1	605	—
Foster Creek f,g	10/8		—	—	1	30	—
Wood Creek weir count g	9/7-10/24		—	—	560 j	1,664 k	—
Chatanika River	8/9	Fair	79	190	—	—	—
Chena River	8/4	Fair	2,031 l	1,509	—	—	—
Population Estimate m			13,398 u	—	—	—	—
Salcha River	8/4	Good	3,368	8,028	—	—	—
Upper Tanana River Drainage							
Bear Creek	8/11	Fair	6	—	—	—	—
Benchmark #735 Slough (vic)	10/30	Fair	—	—	33	—	—
Slough in vic Little Delta Ri	10/30	Fair	—	—	189	—	—
Slough in vic Delta Creek	10/30	Fair	—	—	15	—	—
Richardson Clearwater River	10/30	Poor	—	—	—	146	—
Vicinity of Andersen Slough	10/30	Fair	—	—	70	—	—
Delta River							
Aerial Counts	10/30	Good	—	—	25,967	—	—
Ground Counts	11/12	Fair	—	—	25,785	0	—
Population Estimate n	9/30-11/26		—	—	6,703		—
South Bank Tanana River	10/30	Poor	—	—	1,610	—	—
Bluff Cabin Slough f	11/4	Good	—	—	3,458	9	—
Bluff Cabin Spring f	10/17	Good	—	—	—	291	—
Clearwater Lake Outlet Slough	10/17	Good	—	—	475	—	—
Clearwater Lake and Outlet	10/17	Good	—	—	—	3,577	—
Delta Clearwater River h,o	11/20-21	Fair-Good	—	—	—	10,857	—
Onemile Slough	10/17	Good	—	—	1,949	300	—
Tanana slough adj to Onemile Sl	10/30	Fair	—	—	148	—	—
Tanana just upstr of Onemile Sl	10/17	Good	—	—	853	—	—
T[illegible]na slough vic Gerstle River	10/30	Fair	—	—	108	—	—
[illegible] Creek Slough	10/30	Fair	—	—	556	—	

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Appendix Table 10. Yukon River salmon escapement data, 1986 (continued).

Stream (drainage)	Date	Survey Rating	Chinook	Summer Chums	Fall Chums	Coho	Pinks
Whitehorse Fishway Counts q	7/7-8/30		557 t	--	--	--	--
Mainstem Yukon River							
Vic Ft Selkirk to Carmacks q	10/7		l	--	825	--	--
Population Estimate m,q			36,479	--	101,826	--	--

a Only peak aerial survey counts listed including carcasses, all data is preliminary.
b This is an incomplete estimate as tower project ended early.
c This is an expanded season population estimate based upon the tower count and historic timing pattern.
d Biosonics sonar estimate of total run upstream of Pilot Station (River Mile 122), not a spawning escapement estimate.
e Bendix Side Scan Sonar.
f Foot survey.
g F.R.E.D. Division estimate.
h Boat survey.
i Includes 60 chinook used in a F.R.E.D. Division egg-take.
j None allowed to spawn wild.
k Includes 383 coho used in a F.R.E.D. Division egg-take.
l An additional 257 chinook carcasses were removed from river prior to this survey.
m Population estimate based upon mark and recapture study.
n Population estimate based upon replicate foot surveys.
o Sport Fish Division estimate.
p U.S. Fish and Wildlife Service (USFWS) estimate.
q Canada Department of Fisheries and Oceans (DFO) estimate.
r Test netting results.
s Periodic spot checks.
t Includes 150 chinook taken for hatchery brood stock of which 90 died prior to egg-take.
u Preliminary estimate.

Appendix Table 10. Yukon River salmon escapement data, 1986 (continued).

Stream (drainage)	Date	Survey Rating	Chinook	Summer Chums	Fall Chums	Coho	Pinks
Bear Creek f	7/11		—	56	—	—	—
Chandalar River							
Sonar Estimate e,p	8/9-9/27		—	—	59,313	—	—
Mainstem (aerial)	7/29,10/7	Poor,Poor	19	—	4,035	—	—
Porcupine River Drainage							
Sheenjek River (aerial)	10/2	Poor	—	—	12,659	—	—
Sonar Counts e	8/17-9/24		—	—	83,197	—	—
Fishing Branch River (weir) q	9/1-10/9		—	—	31,173	—	—
Aerial q	10/4		—	—	7,836	—	—
Yukon Territory Streams							
Fortymile River q,r	9/12-18		1	7	—	—	—
Klondike River q	8/11	Poor	10	—	—	—	—
Stewart River							
McQuesten River q	8/17	Fair	0	—	—	—	—
White River q	10/27		—	—	0	—	—
Donjek River							
Kluane River q	10/27	Good	—	—	16,686	—	—
Tincup Creek q	8/20	Good	220	—	—	—	—
Koidern River q	10/27	Good	—	—	14	—	—
Pelly River							
Blind Creek q,s	8/?		25	—	—	—	—
Ross River q	8/18	Fair	72	—	—	—	—
Prevost River q	8/18	Fair	0	—	—	—	—
Tatchun Creek f,q	8/23	Good	155	—	—	—	—
Little Salmon River q	8/27	Poor	54	—	—	—	—
Big Salmon River							
Weir Count q	8/1-9/3		1,816	—	—	—	—
ADFG Peak Aerial Counts (upstr of Souch Cr)	8/21	Fair-Poor	745	—	—	—	—
Teslin River (mainstem) q	10/28	Fair	—	—	200	—	—
Nisutlin River	8/21	Good-Poor	703	—	—	—	—
Wolf River	8/21	Fair-Poor	271	—	—	—	—
Takhini River q	8/29	Fair	216	—	—	—	—