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U.S./Canada Negotiation Studies

Prepared By

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Alaska Department of Fish and Game
Division of Commercial Fisheries, AYK Region
333 Raspberry Road
Anchorage, Alaska 99518

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OEO/ADA STATEMENT

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INTRODUCTION

The United States and Canada began negotiations on Yukon River salmon in March 1985. When in progress, negotiations are held about twice per year. The negotiations have relied heavily on information supplied by the Alaska Department of Fish and Game (ADF&G) about the salmon fisheries and stocks in the Yukon River drainage. Some of that information has been gained because of specific appropriations from Congress passed through the Department of Commerce to ADF&G. Federal FY 1998 funds were passed through to ADF&G to provide support for negotiation meeting costs and field data collection for the period 1 July 1998 through 30 June 1999 through grant Award No. NA76FP0208-1.

The purpose of the program supported by Federal funds for Yukon River salmon negotiation studies is to help provide the technical support necessary to effectively manage the complex Yukon River salmon fisheries in the context of the U.S./Canada negotiation process, as well as to help provide support for the treaty negotiation process.

The Yukon River (Figures 1 and 2) is the largest river in Alaska, and one of the largest in North America. It drains an area of approximately 330,000 square miles, nearly two-thirds of which is in Alaska. For perspective, the Yukon River drainage exceeds the combined areas of the U.S. Pacific coast states of Washington, Oregon, and California combined. The area is mostly remote, undeveloped, and in its natural pristine condition. The Yukon River supports one of the largest runs of chinook and chum salmon in the world.

Providing harvest opportunity among the many users along the river in both the United States and Canada, and conserving specific stocks in a fully developed fishery harvesting from a mixture of stocks, makes the Yukon River one of the most challenging salmon fisheries to manage for optimum sustainable yields. The Yukon River Joint Technical Committee (JTC) has determined that the technical program, for both countries, is inadequate to meet the requirements that might be expected with a treaty management regime.

This report serves as a completion report in summary form for six field data collection projects or activities funded with this grant for the period 1 July 1998 through 30 June 1999, which was essentially the 1998 field season for these projects. The salmon catch and escapement sampling activity is ancillary to the stock identification project. Specifically, the projects or activities described in this report are as follows:

1) Chinook Salmon Stock Identification Using SPA, 1998
2) Yukon River Salmon Stock Identification Using GSI, 1998
3) Salmon Catch and Escapement Age-Sex-Length Sampling, 1998
4) Subsistence Harvest Estimation, 1998

5) Spawning Escapement Surveys, 1998
6) Lower Yukon River Sonar at Pilot Station, 1998

Results from each of these projects or activities will be summarized in the subsequent individual sections of this completion report. Reference will be provided to specific reports in preparation or already completed which provide a more comprehensive source of information on the background for these projects or activities, the methods used, the results and discussion, and literature references. Bergstrom et al. (1999) provides a comprehensive review of the Yukon River salmon fisheries and overall field program for 1998, some additional aspects of which were in part supported by this grant, such as test fishing and fishery monitoring activities.

CHINOOK SALMON STOCK IDENTIFICATION USING SPA, 1998

Yukon River chinook salmon are harvested in subsistence and personal use fisheries in Alaska, Aboriginal and domestic fisheries in Canada, and commercial and sport fisheries in both Alaska and Canada. Chinook salmon harvested in the Yukon River fisheries consist of a mixture of stocks destined for spawning areas throughout the Yukon River drainage. More than 100 spawning streams have been documented. Aerial surveys of chinook salmon escapements indicate that the largest concentrations of spawners occur in three distinct geographic regions. Chinook salmon stocks within these three geographic regions are collectively termed the Lower, Middle, and Upper Yukon River stocks. The lower region consists of tributaries in Alaska that drain the Andreafsky Hills and Kaltag Mountains between river miles 100 and 500. Upper Koyukuk River and Tanana River tributaries in Alaska between river miles 800 and 1,100 make up the middle river stocks. Tributaries in Canada that drain the Pelly and Big Salmon Mountains, and the Yukon River mainstem between river miles 1,300 and 1,800 are considered upper river stocks.

Evaluating stock productivities, spawning escapement goals, and management strategies requires information on the stock composition of the harvest. The U.S. and Canada have been engaged in treaty negotiations concerning management and conservation of stocks spawned in Canada. Biological information on these stocks provides the technical basis for the negotiations. The objective of this project is to classify all chinook salmon harvests in the Yukon River drainage to run of origin, primarily using scale pattern analysis (SPA).

Chinook salmon age-sex-length (ASL) samples were collected from commercial, subsistence, and test fishery catches, and escapement projects, providing age and sex composition, length data, and SPA information. Commercial catch samples were collected from Districts 1, 2, 5, 6 and subsistence catch samples were collected from District 4. There was no commercial harvest of chinook salmon in District 3 in 1998. Escapement samples used for scale pattern analysis were collected from the East Fork Andreafsky, Anvik, Chena and Salcha Rivers in Alaska, and from test fishing fish wheels in Canada. Live salmon were sampled on the East Fork Andreafsky River at a weir project operated by the U.S. Fish and Wildlife Service (USFWS), whereas carcasses and spawned-out fish were the source of the other spawning ground escapement samples. Fish wheel samples collected in Canada for Upper River stock standards were collected by personnel from the Canadian Department of Fisheries and Oceans (DFO) in Yukon Territory, Canada. The age composition of Lower and Middle Yukon stocks was estimated by combining the age composition of individual spawning tributaries in each area.

Attainment of sample size objectives presented in the annual sampling plan is usually a fair measure of operational success. However, acceptable sample quality depends on biological and sampling factors. For all escapements which contribute to the standard three-way classification model, sample sizes were poor to good in 1998. The lack of scale samples in 1998 was the result of an age class failure (age-1.4 fish) more so than quality of samples.

Sampling upper Yukon tributaries in Canada is of continuing concern. The Upper Yukon stock is currently sampled in Canada near the U.S.-Canada border at the DFO tagging project sites. Total abundance estimates for the Upper Yukon stock have been obtained from that study, and scales taken from chinook salmon have provided the Upper Yukon stock scale pattern standard when commercial harvest samples and/or escapement samples are inadequate or unavailable. For assignment of harvests to stock of origin, the approach of using samples from the DFO mainstem Yukon River test fish wheels to build stock allocation models assumes that those samples are representative of Canadian-spawned chinook salmon. Escapement samples from the Upper Yukon stock could improve the construction of the composition model for that stock. However, due to the lack of resources, escapement sampling is not conducted in conjunction with escapement abundance estimation for the Upper Yukon River stock standard. At this time the scales collected from tagging fish wheel catches are accepted as the best available source. The dominant age classes which are used in modeling for the SPA analysis are usually adequate. Test fish wheels most likely do not catch all sizes of chinook salmon in proportion to their abundance due to the size selectivity of fish wheels. Therefore, a selectivity coefficient factor developed by ADF&G in 1996 is applied to the fish wheel age proportions to more accurately estimate Canadian escapement age composition.

In the past, linear discriminant functions (LDF) analysis of scale pattern data were used to classify the two major age classes, e.g., ages 1.3 and 1.4, to stock of origin. The remaining minor age classes were estimated using the major age class results in conjunction with observed differences in age composition between escapements and geographic occurrence. Schneiderhan (1997) provides a review of historical methods. Stock identification feasibility studies using scale pattern analysis began in 1980 for Yukon River chinook salmon. Programs to expedite the analytical procedures were developed in 1985, and revised in 1988. These programs were written for DOS, and because of the numerous individual programs and steps required, tendency for errors is increased. Since 1988, these programs had not been procedurally or statistically examined. With this in mind, beginning in 1997, a dedicated effort began in developing a less cumbersome and more statistically valid means of processing and expressing SPA information.

The previous analysis procedure required that a number of separate computer programs be run in sequence, requiring manual interpretation of results and preparation of one program's output as input to a subsequent program. This procedure was inefficient, and offered unnecessary opportunity for errors to be made. A program was developed to combine these multiple programs into a single program, taking advantage of the increased capacity and speed of modern desktop computers. At the same time, manually completed tasks are now automated with improved methods being implemented wherever possible. Improvements in methodology occurred primarily in two areas (Bromaghin and Bruden, 1999). The first improvement involves the method of estimating the stock composition of major age classes. The linear discriminant model used previously is now replaced with a maximum likelihood mixture model. The second improvement involves the adoption of robust estimators of sample means and variance-covariance matrices, which reduces the influence of extreme observations on estimates. These changes have substantially decreased the time required to complete an analysis, as well as increased the statistical quality of stock composition estimates. Data from 1997 (Lingnau and Bromaghin, 1999) have been analyzed. To date, historical data back to 1993 (JTC, 1999) have been reanalyzed. Results from 1992 and 1991 have more recently been reanalyzed, but results are preliminary and have yet to be finalized. It is intended that historical data will continue to be reanalyzed using the new program so as to standardize the historical database to the extent feasible.

For 1993, 179,689 chinook salmon were harvested in Alaska and Canada combined, with an estimated stock composition of 22% Lower, 25% Middle and 53% Upper stock group. Of the 193,533 chinook salmon harvested in 1994, an estimated 18% were Lower, 22% Middle and 60% Upper stock group. In 1995, 198,550 fish were harvested with an estimated 18% Lower, 22% Middle and 60% Upper stock group. Results for 1994 and 1995 were virtually identical. For 1996, 158,234 chinook salmon were harvested with an estimated 21% Lower, 10% Middle and 69% Upper stock group. Of the 191,153 chinook salmon harvested in 1997, an estimated 26% were Lower, 17% Middle and 57% Upper stock group.

The 1998 Yukon River harvest totaled 106,152 chinook salmon. The Upper stock group was the largest run component, contributing an estimated 52,884 fish, or 49.8% of the total drainage harvest (Lingnau, 1999). The Lower stock group was next in abundance with an estimated 34,759 fish (32.7%), and the Middle stock group contributed an estimated 18,509 fish, or 17.4% of the total. In general, proportional results of the total drainage harvest that were attributed to the Lower, Middle, and Upper stock groups in 1998 were within the range of historical results.

YUKON RIVER SALMON STOCK IDENTIFICATION USING GSI, 1998

Chum Salmon

ADF&G developed a study design to estimate the timing of entry and migration patterns of summer- and fall-run chum salmon entering the Yukon River to be conducted in field seasons 1999, 2000, and 2001. Chum salmon enter the Yukon River as two distinct runs, summer and fall. Fall-run chum salmon differ from summer-run chum salmon in that they are larger in size and tend to be more ocean bright on river entry (Buklis and Barton 1984). However, there is overlap in the physical appearance of summer- and fall-run chum salmon; they cannot be distinguished by visual inspection alone. Summer-run chum salmon begin to enter the river in late May, and by mid July fall-run chum salmon are thought to be predominant. All chum salmon entering the Yukon River after 15 July are considered fall run for purposes of in-season management.

There may be overlap in the timing of river entry of these two runs. Genetic stock identification methods developed by the USFWS, the U. S. Geological Survey-Biological Resources Division (BRD), and ADF&G using allozyme loci can accurately and precisely discriminate summer- and fall-run chum salmon. Use of genetic markers to estimate timing of entry and run-timing patterns of the two runs will provide a better understanding of these run characteristics.

Chum salmon entering the Yukon River will be sampled during July 1999, 2000, and 2001 to determine the timing of entry of fall run stocks. A total of four weekly stock composition estimates will be made on mixture samples of 200 fish. Fish will be sampled from species apportionment netting conducted twice daily at the sonar site at Pilot Station. Muscle, liver, and heart tissues from 30 fish will be collected from each species apportionment sampling period. Fish will be randomly selected, regardless of physical appearance. Tissues will be frozen on liquid nitrogen, and shipped to the ADF&G Genetics Laboratory.

In the laboratory, the 200 samples for each weekly estimate will be subsampled proportionally to the weekly passage estimates by day and by bank orientation from the sonar counts. Multilocus allozyme genotypes of the fishery samples will be determined.

Stock contributions of the mixed fishery samples will be estimated via maximum likelihood for a summer run and a fall run reporting group. The precision of the stock composition estimates will be estimated by a parametric bootstrap.

Chinook Salmon

Staff from USFWS and ADF&G made two baseline collections of chinook salmon during the 1998 field season: Andreafsky River (N=40) and Chena River (N=150). For both collections, juvenile chinook salmon were captured in minnow traps. These samples were assayed for allozyme variation at 55 loci. No allele frequency differences were observed between these population samples and corresponding samples analyzed by USFWS (Wilmot et al. 1992): Andreafsky River 1988, 1998: G-statistic=21.06, df=15, P=0.135; Chena River 1987 and 1988, 1998: G-statistic=24.34, df=18, P=0.1441. This indicates that allele frequencies within the Andreafsky River and the Chena River are temporally stable. Also, the temporal stability and lack of deviation from Hardy-Weinberg expected genotype frequencies indicates that it is unlikely that only a few families groups were sampled (Allendorf and Phelps 1981).

These collections will be used for maintenance of the allozyme baseline for chinook salmon from the Yukon River and were also submitted to the coastwide baseline for chinook salmon maintained by National Marine Fisheries Service, Seattle. An updated baseline for chinook salmon, including populations from California to Russia, will be available in the fall of 1999. This is the first baseline for chinook salmon containing data from chinook populations in Alaska.

SALMON CATCH AND ESCAPEMENT AGE-SEX-LENGTH SAMPLING, 1998

Samples for age, sex, and length (ASL) composition of salmon were obtained in conjunction with sampling of salmon for stock identification purposes. Salmon were sampled at selected locations in the Alaska portion of the Yukon River drainage from commercial, subsistence, and test fishery catches, and from escapements, for ASL data. Some of the ASL data presented here was collected from projects that were not funded with this U.S. Department of Commerce grant, but the information is presented here in order to provide a more complete overview of the ASL information.

Sampling objectives for each species were established and were designed to provide acceptable levels of accuracy and precision (delta = 0.10, alpha = 0.05) of composition analyses. The sample size required for a three age category analysis of chum salmon, assuming a ten percent rate of unusable samples, was 160 fish. A four age category analysis for chinook salmon, assuming a 10 percent or smaller rate of unusable samples, required samples from 180 fish. In order to attain a 10 percent or smaller rate of unusable samples for chinook, three scales, rather than one, were taken from each fish. The sample size required for a two age category analysis of coho salmon, assuming a 10 percent or smaller rate of unusable samples, required samples from 120 fish.

Total useable samples collected in 1998 from the Yukon River drainage were approximately 6,900 chinook, 5,500 summer chum, 1,600 fall chum, and 1,100 coho salmon. Commercial catch samples totaled approximately 2,700 chinook and 1,100 summer chum salmon. There were subsistence samples of approximately 100 chinook and 100 summer chum salmon. Test fishing samples totaled approximately 1,400 chinook, 1,700 summer chum, 1,200 fall chum, and 700 coho salmon. Escapement sampling was conducted on the Andreafsky, Anvik, Nulato, Gisasa, Chena, Salcha, Chatanika, Toklat, Delta and Delta Clearwater Rivers in Alaska. Escapement samples totaled approximately 1,500 chinook, 2,600 summer chum, 300 fall chum and 500 coho salmon.

DFO sampled over 700 chinook salmon from the White Rock and Sheep Rock tagging project fish wheels just upriver from the U.S.-Canada border, and over 400 drift test fishing chinook salmon samples.

The total estimated chinook salmon harvest for the Yukon River drainage in 1998 was approximately 106,000 fish. Of that, approximately 100,000 chinook were harvested in the Alaska portion of the drainage. Less than half of the overall total was commercially harvested (45,000), with 43,000 of that being taken in the Lower Yukon River districts. Of the eight commercial fishing periods in the lower river during the summer season, seven were with unrestricted mesh size gillnets. In Districts 1 and 2, commercial chinook salmon harvest periods with unrestricted mesh gillnet gear were dominated by age-5 and age-6 fish, with age-5 fish dominating all periods, contributing approximately 55% of the total catch. Districts 5 and 6 commercial catch samples taken from fish wheel gear were predominately age-5 fish with a combined total of approximately 71%. Females comprised approximately 22% of the fish wheel samples. The high percentage of males in commercial catch samples from fish wheel gear is thought to be due to gear selectivity for the smaller fish, which are typically males. District 6 commercial catch samples taken from unrestricted mesh gillnet were predominantly age-6 fish with approximately 58%.

Overall, chinook salmon commercial and subsistence catch samples indicated that the 5-year-old component was dominant (54% to 90%) in all but one of the districts sampled. The second largest contributing age group were 6-year-olds (8% to 35%). The one exception was a sample from unrestricted mesh size gillnets in District 5C, in which 6-year-olds were more abundant, with 57%, followed by 5-year-olds at 29%. Males were predominant in all of the commercial catch samples, ranging from 51% to 91% and averaging 63%.

In recent years, because of weak market conditions for summer chum salmon, there have been fewer restricted mesh size fishing periods in the Lower Yukon River districts. Because of the unexpectedly weak chinook salmon return in 1998, management was conservative, holding commercial harvest far below average. Season harvests from mostly unrestricted mesh-size fishing periods are usually composed of proportionally larger, older chinook salmon. Sex ratios in unrestricted mesh fishing periods tend to be comprised of a larger proportion of females than are found in restricted mesh fishing periods. However, younger fish and males were predominant throughout the run in 1998.

Age composition of Lower Yukon River chinook salmon test fishing gillnet samples was slightly different than commercial catch samples, with a more equal distribution of 5 and 6-year-old salmon. Age composition of Canadian test fishing gillnet and fish wheel catch samples was similar to the lower river commercial catch samples, with a higher proportion of 5-year-old fish followed by 6-year-old fish. Differences in sex composition were also noticeable in the different test fish samples. The Lower Yukon River test fishing samples had nearly equal proportions of males and females, whereas the test fishing samples from Canada were predominantly males.

Selective nature of the capture gear is certainly a factor in differences among samples. For the first year, test fishing samples from the Pilot Station Sonar project were analyzed. The age composition of those samples was similar to the lower river commercial catch samples, with predominantly 5-year-old fish. Sex composition was equally split between males and females.

Chinook salmon escapement samples from various projects throughout the Yukon River drainage had similar results concerning age composition, reflecting the results from commercial and test fishing samples. The primary contributing age group was the 5-year-old age group. With two exceptions, the 6-year-old age group was next largest in abundance. The two exceptions were the samples from the Nulato and Andreafsky Rivers, in which the 4-year-old age component was next in abundance. As in most previous samples, males were predominant, ranging from 59% in the Chena River to 84% in the Gisasa River.

Summer chum salmon commercial catch samples from Districts 1 and 2 were approximately 65% age-0.3, 32% age-0.4, and 3% age-0.5. Females accounted for 38% of the samples. A subsistence fish wheel sample from District 4A was 76% age-0.3, 22% age-0.4 and 2% age-0.5, with females accounting for 54%. A subsistence fish wheel sample from District 4B was quite different, with 46% age-0.3, 51% age-0.4, and 3% age-0.5, with females accounting for 34%.

Age composition of samples collected from Big Eddy and Middle Mouth test fishing projects (5.5 inch set gillnets) was 63% age-4, 33% age-5, and 4% age-6. Sex composition was 56% female for Big Eddy and 50% female for Middle Mouth.

Age and sex composition from escapement projects throughout the drainage were quite varied. The Andreafsky River and Anvik River escapement samples were fairly similar with roughly 82% age-0.3 fish, 16% age-0.4 fish and 2% age-0.5 fish. Sex composition was 59% female. Samples from the Gisasa and Nulato Rivers differed, with 51%, 40% and 9% age-0.3, age-0.4 and age-0.5 fish in the Gisasa River, and 67%, 32% and 1% age-0.3, age-0.4 and age-0.5 fish in the Nulato River. Samples from the Gisasa River consisted of 51% females, whereas the Nulato River sample was 63% female.

There was no commercial fall chum salmon fishing allowed in 1998 due to the weak return, therefore, no commercial catch samples were collected. Estimated age composition collected from Big Eddy and Middle Mouth fall chum salmon test fishing samples (6.0 inch set gillnets) was 1% age-0.2, 67% age-0.3, 30% age-0.4 and 2% age-0.5 fish. Sex composition was 45% female. Age composition of escapement samples collected from the Delta River and Toklat River was approximately 3% age-0.2, 72% age-0.3, 23% age-0.4 and 2% age-0.5. Sex composition was 45% female for the Delta River sample, and 65% female for the Toklat River sample.

There was no commercial coho salmon fishing allowed in 1998, therefore, no commercial catch samples were collected. Age composition of test fishing samples from Big Eddy and Middle

Mouth using 6.0 inch mesh set gillnets was approximately 2% age-1.1, 96% age-1.2 and 2% age-1.3. Sex composition was approximately 46% female. Escapement samples were collected from the Andreafsky and Delta Clearwater Rivers. Age composition of samples from the Andreafsky River weir was 2% age-1.1, 94% age-1.2 and 4% age-1.3. Sex composition was 37% female. Age composition of samples collected from the Delta Clearwater River was 5% age-1.1, 92% age-1.2 and 3% age-1.3 fish. Sex composition was 49% female.

SUBSISTENCE HARVEST ESTIMATION, 1998

Successful management of Yukon Area fishery resources is dependent upon obtaining accurate estimates of subsistence and personal use harvests. Subsistence salmon fishing activities in the Yukon Area primarily occur from late May through early October. However, salmon fishing in May and October is highly dependent on the ice conditions on the river. Fishing activities are usually based from a fish camp or a home village. Extended family groups, which represent two or more households, often work together to harvest, cut, and preserve salmon for subsistence use.

A significant portion of the salmon harvested are frozen, dried, or smoked for later human consumption. The majority of the large (greater than 21 inches in length) chinook salmon harvested are used for human consumption. Although a large proportion of the small chinook salmon are also used for human consumption, a significant proportion of the small chinook salmon, often referred to as "jacks," are used for dog food. Summer chum, fall chum, and coho salmon are also used for human consumption; however, a relatively large percentage of these salmon is harvested to feed dogs. Dogs are often fed scraps that become available during the processing of freshly harvested salmon, and relatively few whole fresh salmon are fed to dogs. The majority of summer chum salmon is dried for a winter supply of dog food. Additionally, fall chum and coho salmon are commonly "cribbed" for dog food. Cribbing is the freezing of fish by natural air temperature for use later in the winter. There is usually little wastage of fish taken for subsistence purposes, although damp weather may cause some drying fish to spoil.

Subsistence harvest surveys have been conducted annually by the department since 1961. Survey methodologies prior to 1988 were varied, although in all cases surveyors attempted to census all known fishing families in a village. A fishing family was defined as one or more households that fished together. Methodology was standardized in 1988, and further refined in subsequent years. Borba and Hamner (1999) provide a review of historical methods and results, as well as a thorough analysis for 1998.

Permits for subsistence and personal use salmon fishing are required in select areas of the Upper Yukon Area. The areas that require salmon fishing permits and the type of permit required (subsistence or personal use) have varied through time.

Personal interviews and returned permits are the primary sources of information used to estimate the number of subsistence and personal use salmon harvested in the Yukon Area. Test fisheries are used throughout the Yukon River drainage to index salmon runs. Salmon harvested in test fisheries are made available to meet local subsistence needs. Salmon provided to subsistence households by these test fisheries are documented by each individual project. Information from surveys, permits, and test fisheries are combined to estimate Yukon Area subsistence and personal use harvests.

In 1998, as in 1993 and 1994, many subsistence households did not meet their needs for both human and dog food. To assist subsistence households that did not meet their needs, chum and pink salmon from other locations in the state were collected and transported by various organizations into the communities that needed them. The subsistence salmon harvest estimates documented in this report are based on fish harvested in the Yukon Area. For this reason, fish brought into the area from other regions of the state are not included in the subsistence harvest estimates of the Yukon Area. These additional resources have played an important role in meeting needs in years when the Yukon Area has experienced low subsistence harvests.

The 1998 survey program utilized subsistence harvest calendars, postseason household interviews, and postseason household telephone interviews and postal questionnaires. Stratified random sampling techniques were used to select Yukon Area households to be interviewed. Surveyors contacted 970 households in the surveyed villages throughout the Yukon Area in 1998. Information provided by these surveyed households were expanded to estimate the harvest of households that were not contacted. A total of 45,722 chinook, 120,634 chum (76,603 summer chum and 44,031 fall chum salmon), and 8,781 coho salmon were estimated to have been harvested by subsistence households in the survey portion of the Yukon Area in 1998.

In permitted areas, fishermen are required to document their harvest on the permit and return the permit to the department at the end of the fishing season. A total of 390 households were issued subsistence permits in 1998, of which 367 permits or 94 percent were returned. Of the returned permits, 198 households indicated that they fished. The reported permit harvest was 6,924 chinook, 6,117 summer chum, 15,096 fall chum, and 7,617 coho salmon. This reported harvest does not include Stevens Village household permit harvest information. The Yukon River permit information reported by Stevens Village residents was used to supplement the postseason survey of that village.

One non-subsistence area is located within the Yukon Area in which salmon harvests are monitored with household personal use permits. A total of 104 households were issued personal use permits in 1998, of which 102 permits or 98 percent were returned. Of the returned permits, 52 households indicated that they fished. The reported personal use harvest was 357 chinook, 84 summer chum, 2 fall chum, and 9 coho salmon.

The number of fish provided to households for subsistence use from various Yukon Area test fish projects was also documented. In 1998, a total of 1,478 chinook, 4,646 summer chum, 3,774 fall chum, and 1,723 coho salmon were provided to households for subsistence use from test fishery projects throughout the drainage.

Combining survey, permit, and test fishery information, an estimated 54,481 chinook, 87,450 summer chum, 62,903 fall chum, and 18,130 coho salmon were harvested by an estimated 1,477 Yukon Area subsistence and personal use fishing households in 1998.

SPAWNING ESCAPEMENT SURVEYS, 1998

An essential requirement for management of the Yukon River salmon fisheries is the documentation of annual salmon spawning escapements. Such documentation provides for determination of appropriate escapement levels or goals for selected spawning areas or management units; evaluation of escapement trends; evaluation of the effectiveness of the management program, which in turn forms the basis for proposing regulatory changes and management strategies; and evaluation of stock status for use in projecting subsequent returns.

The Yukon River drainage is too extensive for comprehensive escapement coverage of all individual salmon spawning streams during any given season. Consequently, low-level aerial surveys from single-engine fixed-wing aircraft or helicopters form an integral component of the escapement assessment program. Nevertheless, comprehensive assessment projects employing such techniques as intensified ground surveys, mark-recapture methods, counting towers, weirs, and hydroacoustics are also conducted. Regardless of the method utilized, the overall objective of escapement assessment in the Yukon River drainage is to estimate abundance (or often indices of relative abundance), timing, and distribution of spawning salmon populations.

Perhaps the greatest advantage of aerial surveys is the cost-effectiveness of obtaining escapement information throughout an extremely vast area, most of which is remote. Another advantage to aerial surveillance is that current or potential habitat-related problems arising from natural or man-induced causes can be readily identified. Among the disadvantages are that results may be highly variable. Variability in aerial survey accuracy is dependent upon a number of factors such as weather and water conditions (turbidity), timing of surveys with respect to peak spawning, aircraft type, survey altitude, experience of both pilot and observer, and species of salmon being estimated. It is generally recognized that aerial estimates are lower than actual stream abundance due to these factors. Further, peak spawning abundance measured by aerial survey methods is significantly lower than total season abundance due to the die-off of early spawners and subsequent arrival of later fish. Given these sources of variability, aerial estimates in a given stream may demonstrate a wide range in the proportion of fish being estimated. To the extent that this variability can be controlled, peak aerial counts may serve as indices of relative abundance for examination of annual trends in escapement.

Aerial escapement estimates are obtained from as many spawning streams as possible within the confines of fiscal, personnel, and weather constraints. However, selected spawning streams have been identified and receive highest priority. Index areas have been designated due to their importance as spawning areas and/or by their geographic location with respect to other salmon spawning streams in the general area. A more comprehensive source of information is presented by Bergstrom et al. (1999) on the background of the escapement survey project, the methods used, the results and discussion for 1998, and literature references. Some of the spawning escapement information presented here was collected from field projects that were not funded with this U.S. Department of Commerce grant, but the information is presented here along with the escapement survey data funded by the grant in order to provide a more complete overview of the escapement information.

Biological escapement goals (BEG's) have been established for several Yukon River salmon spawning streams or areas. These goals represent the approximate minimum number of spawners considered necessary to maintain the historical yield from the stocks and are based upon historical performance, i.e., they are predicated upon some measure of historic averages. Establishment of escapement goals for specific spawning stocks based upon a rigorous analysis of maximum sustained yield (MSY) is not feasible at this time due to the nature of the Yukon River mixed stock fisheries, lack of sufficient stock identification data, and the inability to reconstruct inriver stock-specific returns.

Chinook Salmon

Chinook salmon escapement goals established by ADF&G for eight Alaskan streams, or index areas, are: East (>1,500) and West Fork (>1,400) Andreafsky, Anvik (>1,300 entire drainage or >500 Yellow River to McDonald Creek), North (>800) and South Fork (>500) Nulato, Gisasa (>600), Chena (>1,700), and Salcha (>2,500) Rivers. These escapement goals are based upon aerial survey index counts which do not represent total escapement.

Prior to 1998, escapement data from selected tributaries indicated that spawning escapement goals for lower river stocks (Yukon River drainage below the upper Koyukuk River) were generally achieved in recent years, except for 1996. Escapement goals for middle river stocks (primarily the Tanana River drainage) were readily achieved since 1993. Efforts to increase escapements to the Canadian mainstem Yukon River had been successful, resulting in spawning escapements averaging over 29,000 fish in the Canadian mainstem Yukon from 1992 through 1997.

Yukon River chinook salmon abundance in 1998 was assessed as weak, based on commercial harvest data and on escapement estimates from selected tributaries. Total chinook salmon run abundance was estimated to be approximately 176,000 fish based on run reconstruction using

Pilot Station sonar passage estimates and estimated harvest and escapement down river of the sonar site. This was well below the total run reconstruction estimates for 1995 and 1997 of 363,000 and 341,000 chinook salmon, respectively. Chinook salmon escapements in 1998 were below the recent 4- or 5-year averages throughout the drainage with minimum escapement goals achieved in only three surveyed tributaries. The return of five-year-old chinook salmon was less than expected given the large return of four-year-olds in 1997. In addition, production from the 1992 parent year appears to be poor given the escapements documented that year.

Chinook salmon escapement to the Andreafsky River appeared to be near escapement goal levels. An aerial survey count of 1,249 chinook salmon in the West Fork Andreafsky was 11% below the minimum escapement goal of 1,400 salmon. The East Fork Andreafsky River aerial survey count of 1,027 chinook salmon was 32% below the minimum escapement goal of 1,500 salmon. The USFWS weir count of 4,011 chinook salmon for the East Fork Andreafsky River was 19% below the recent 4-year average weir count of 4,946.

An aerial survey of the Anvik River on 23 July, conducted under poor conditions, resulted in a count of 648 chinook salmon within the escapement index area, which exceeded the minimum goal of 500 salmon by 30%.

Minimum aerial survey index escapement goals are 800 chinook salmon for the North Fork and 500 for the South Fork Nulato River. Aerial surveys with fair ratings resulted in counts of 546 and 503 chinook salmon in the North Fork and South Fork, respectively. An estimate of chinook salmon escapement was provided from a salmon counting-tower project operated by the Nulato Tribal Council, Bering Sea Fishermen's Association (BSFA), and ADF&G. The tower count of 1,536 chinook salmon was 30% below the recent 4-year average of 2,182 chinook salmon. However, water clarity problems mid-channel in the Nulato River varies within and between years, which makes it difficult to compare chinook escapements between years.

On 31 July an aerial survey was conducted on the Gisasa River, a tributary to the Koyukuk River. A total of 889 chinook salmon was observed on this survey under poor conditions. The minimum escapement goal is 600 chinook salmon. The USFWS counted 2,273 chinook salmon through the Gisasa River weir, which was approximately 28% below the recent 4-year average of 3,157.

Although no chinook salmon escapement goals have been established for other streams in the Koyukuk River drainage, aerial surveys were flown on selected Koyukuk River tributaries. Aerial surveys flown under poor conditions observed 31 chinook salmon in the South Fork Koyukuk River on 1 August and 70 chinook salmon in the Kateel River on 31 July. Aerial surveys flown under fair conditions observed 45 chinook salmon in the Jim River and 97 chinook salmon in Henshaw Creek on 1 August. A weir was not operated by the USFWS on the South Fork of the Koyukuk River in 1998 due to flood conditions.

Since 1993, inseason assessment of chinook salmon escapement to the Tanana River drainage has been based on counts of chinook salmon at the Chena and Salcha River tower sites operated by Sport Fish Division of ADF&G. Mark-recapture escapement population estimates are available for both streams from 1987 through 1992. High, turbid water hampered the operations on the Chena and Salcha Rivers several times during the 1998 season. The preliminary tower count estimate for the Chena River was 4,423 chinook salmon, which was the lowest escapement since 1991. The preliminary tower count estimate for Salcha River was 4,990 chinook salmon, which was the lowest escapement since 1989. The minimum aerial survey escapement goals for the Chena River and Salcha River index areas are 1,700 and 2,500 salmon, respectively. High water resulted in poor aerial survey conditions on both rivers, although multiple attempts were made from 16 July through 10 August. The highest count was 427 chinook salmon for the Chena River index area. The highest count of 2,055 chinook salmon for the Salcha River index area was only 28% below the minimum escapement goal.

Observations on chinook spawning escapements in other tributaries of the Tanana River drainage were made in the Chatanika and Goodpasture Rivers. A counting tower was operated on the Chatanika River by Sport Fish Division in 1998. The preliminary estimate was 819 chinook salmon for the period of 6 through 31 July. A mark-recapture study conducted by Sport Fish Division in the Chatanika River in 1997 resulted in an escapement estimate of 3,809 chinook salmon. No escapement goal exists for this stream, however aerial surveys have been conducted intermittently in past years. An aerial survey flown 2 August on the Goodpaster River with a survey rating of fair observed 591 chinook salmon.

The DFO mark-recapture population estimate of chinook salmon entering the Canadian portion of the mainstem Yukon in 1998 was 22,600. Subtracting the estimated Canadian commercial and non-commercial harvest (excluding Old Crow) from this population estimate results in a spawning escapement estimate to the Canadian mainstem Yukon River of 16,750 chinook salmon. This was well below the rebuilding step goal of 28,000 chinook salmon.

Summer Chum Salmon

Summer chum salmon escapement goals established by ADF&G for seven spawning streams are: East (>109,000) and West Fork (>116,000) Andreafsky, Anvik (>500,000), North Fork Nulato (>53,000), Clear Creek (>8,000) and Caribou Creek (>9,000) in the Hogatza River drainage, and the Salcha River (3,500) in the Tanana River drainage. With the exception of the Anvik River goal, which is a total assessment based upon sonar counts, all other goals are based upon aerial survey indices of abundance during periods of peak spawning.

Prior to 1998, escapements in the Anvik River, the largest single producer of summer chum salmon in the Yukon River drainage, were above the escapement goal each year since 1991. Spawning escapements to other Yukon River tributaries, based on limited aerial survey information, appeared to have been below desired levels in 1993. In general, escapement objectives appear to have been met in the majority of the drainage from 1994 through 1996. Severe flooding in August 1994, particularly in the Koyukuk River drainage, and the lack of snowfall during the winter of 1995-1996, are factors that may affect production from the 1994 and 1995 parent years.

Postseason analysis of comparative commercial harvest and escapement data indicates the summer chum salmon run was very weak in 1998. Total summer chum salmon run abundance was estimated to be approximately 980,000 fish based on run reconstruction using Pilot Station sonar passage estimates and estimated harvest and escapement down river of the sonar site. This was well below the total run reconstruction estimates for 1995 and 1997 of 4.1 million and 1.6 million summer chum salmon, respectively. Spawning escapements to selected tributaries were below most other years. No escapements in monitored tributaries met minimum goals or were considered adequate; results ranged from 27% to 81% below recent year averages. Aerial surveys were hampered by poor weather conditions in most of the drainage. The severe flooding in the Koyukuk River drainage in August 1994 may have affected salmon returns there in 1998.

The Anvik River sonar-based escapement estimate of 471,886 summer chum salmon was approximately 6% below the minimum escapement goal of 500,000 and the sixth lowest since 1979. The run was lower than expected based on parent year escapements of 517,000 and 1,125,000 in 1993 and 1994, respectively.

Weir projects were operated by USFWS on the East Fork Andreafsky and Gisasa Rivers. A total of 67,591 summer chum salmon was counted through the weir on the East Fork Andreafsky River. This count was 49% below the recent 4-year-average of 133,180 fish. Aerial surveys were not conducted on the Andreafsky River for summer chum salmon in 1998 due to poor survey conditions. The weir count indicated the minimum escapement goal for the East Fork Andreafsky River was not met.

A total of 17,825 summer chum salmon was counted through the Gisasa River weir. A summer chum salmon escapement goal has not been established for this river. However, the 1998 weir count was 44% below the 1997 weir count and the lowest on record since project inception in 1994.

Counting-tower projects were operated on Kaltag Creek, Nulato River, Clear Creek, and the Chena, Salcha, and Chatanika Rivers. The Kaltag Creek tower project was operated by the City of Kaltag and funded by the Alaska Cooperative 4-H Extension Service and BSFA. USFWS and TCC operated a counting tower on Clear Creek, a tributary of the Hogatza River within the Koyukuk River drainage.

The estimated escapement of 8,113 summer chum salmon in Kaltag Creek in 1998 was 85% below the recent 4-year-average escapement of 55,546 fish. While no escapement goal has been established for Kaltag Creek, this escapement was considered poor.

The estimated summer chum salmon escapement into the Nulato River (both forks combined) was 49,140 salmon, which was 71% below the recent 4-year-average of 168,330 fish. Based on this tower count, the aerial escapement goal of 53,000 summer chum salmon was not met. An aerial survey of the Nulato River for summer chum salmon was not conducted due to poor weather conditions.

This was the fourth consecutive year the Clear Creek tower on the Hogatza River was operated. No chum salmon were counted passing through the weir prior to 2 July. High water precluded counting beginning on 2 July. Partial counts on 9 and 13 July totaled 174 summer chum salmon. The recent 3-year average is 98,034 summer chum salmon for the entire season. The aerial escapement goal is a minimum of 8,000 summer chum salmon. An aerial survey on 31 July with a poor rating observed 120 summer chum salmon.

Aerial surveys were flown on selected Koyukuk River tributaries and on the Melozitna River. Aerial surveys flown with a survey rating of fair resulted in a count of 395 summer chum salmon in the Melozitna River on 22 July, 1,237 in the Dakli River on 31 July, and 24 in the Jim River and 151 in Henshaw Creek on 1 August.

High, turbid water hampered tower counting operations on the Chena and Salcha Rivers at times during the 1998 season. The 1998 Chena River tower count was 6,011 summer chum salmon, which was 36% below the 1993, 1994, 1996, and 1997 average count of 9,410 fish. The Salcha River tower count of 17,682 summer chum salmon was 53% below the recent 5-year (1993-1997) average of 37,324 fish. Aerial surveys of both rivers were conducted either too early (prior to peak spawning) or under poor weather conditions. An aerial survey of the Salcha River flown on 4 August under poor survey conditions estimated 390 summer chum salmon.

In addition to the Chena and Salcha River projects, the Sport Fish Division also operated a counting tower on the Chatanika River in 1998. The preliminary estimate was 628 summer chum salmon for the period of 6 through 31 July. No escapement goal exists for this stream, however aerial surveys have been conducted intermittently in past years.

Fall Chum Salmon

The most complete database on Yukon River fall chum salmon escapements dates back to the early 1970's and exists for four spawning areas: the Delta, Upper Toklat, Sheenjek, and Fishing Branch Rivers. Escapement goals for these spawning areas are >11,000, >33,000, >64,000, and 50,000-120,000 fall chum salmon, respectively. These goals are of total estimated abundance for these streams or spawning areas, and are based upon ground surveys for the Delta and Upper Toklat Rivers, sonar passage estimates for the Sheenjek River, and a weir count for the Fishing Branch River, which is located in the Canadian portion of the Porcupine River drainage. In addition to these estimates, annual estimates of border passage and subsequent spawning escapement are available since 1982 for the fall chum stock in the mainstem Yukon River in Canada. The escapement goal for this stock is >80,000 fall chum salmon spawners.

Fall chum salmon runs in 1992 and 1993 were weak, with spawning escapements below goals in most systems. Fall chum abundance and subsequent escapements were much greater from 1994 through 1996, with all fall chum salmon spawning escapement goals achieved in 1994 and 1995. However, the lack of snowfall during the winter of 1995-1996 may affect production from the 1995 parent year.

The 1998 Yukon River fall chum salmon run was approximately 10 days later than average (among the latest on record), and well below the preseason projected return of 880,000 fish. Total run size of just over 400,000 fall chum was estimated as the Pilot Station sonar passage estimate, together with subsistence harvest below the sonar site. This measure of total run size was less than half of the preseason projection. Spawning escapements were below average throughout the entire drainage.

Assessment of escapement to the Porcupine River drainage was based upon observations made in the Sheenjek and Fishing Branch Rivers. Although sonar operations were suspended in the Sheenjek River for six to seven days due to prevailing high water conditions early in the season, total escapement was estimated to have been approximately 33,000 fall chum salmon for the 45-day period 17 August through 30 September. This is likely the weakest escapement observed to the Sheenjek River since inception of sonar counting operations in 1981, given the historic dates of project operation, and is 48% below the Sheenjek River minimum escapement goal of 64,000 fall chum salmon. Similarly, the escapement goal for the Fishing Branch River was not achieved in 1998. Only 13,248 chum salmon were enumerated through the DFO weir during the 42-day period of 26 August through 8 October, the lowest on record and 74% below the minimum escapement goal of 50,000 fish.

In the Chandalar River, the sonar-estimated escapement made by USFWS was 75,800 chum salmon for the 48-day period of 8 August through 25 September, well below the 1995-1997 average of 228,000.

The preliminary fall chum salmon mark-recapture abundance estimate made by USFWS for fish passing the tagging site at Rampart Rapids was approximately 187,900 chum salmon for the period 3 August through 19 September. This abundance estimate is approximately 52% below the 1997 estimate of 393,000, and 71% below the 1996 estimate of 654,000.

Tanana River fall chum salmon escapement in 1998 was evaluated to be extremely weak for the second consecutive year. The population estimate for the Toklat River, based upon expanded ground surveys of Toklat Springs, was 15,600 fall chum salmon. This is 53% below the minimum escapement goal of 33,000 fish. For the upper Tanana River (upstream of the Kantishna River), the mark-recapture abundance estimate through 5 October was 62,400 ± 23,700 (95% C.I.) fall chum salmon, the lowest abundance estimate obtained in the four years the tagging study has operated. It was approximately 13% below the 1997 estimate of 72,000, 54% below the 1996 estimate of 135,000, and 77% below the 1995 estimate of 268,000 chum salmon. Ten ground surveys were conducted of the spawning areas in the Delta River during the period of 29 September through 2 December 1998. The highest daily count was obtained on 5 November when 5,703 chum salmon were counted. A total spawner abundance estimate of 7,804 chum salmon was obtained using the area-under-the-curve method. This was 29% below the minimum escapement goal of 11,000 fish for the Delta River. Although no escapement goals exist for other fall chum salmon spawning areas in the upper Tanana River, a peak ground count of 2,110 chum salmon was obtained on 5 November by BRD personnel in Bluff Cabin Slough (Big Delta region). This is 63% below the 1988-1997 average of 5,666 chum salmon.

The 1998 preliminary DFO mark-recapture estimate of spawning escapement for Canadian mainstem Yukon River fall chum salmon was 46,300 fish. This was 42% below the escapement goal minimum of 80,000 fall chum salmon.

Coho Salmon

Coho salmon spawning escapement assessment is very limited in the Yukon River drainage due to funding limitations and often marginal survey conditions which prevail during the periods of peak spawning. Presently, only one escapement goal has been established for coho salmon in the Yukon River drainage. The Delta Clearwater River (DCR) in the Tanana River drainage has a minimum goal of 9,000 coho salmon based upon a boat survey during peak spawning. While most escapement information on coho salmon is from the Tanana River drainage, cooperative efforts of USFWS and BSFA in 1998 allowed the East Fork Andreafsky River summer season weir operation to be extended into September for the fourth consecutive year. This provided additional information on the timing and abundance of coho salmon to a tributary in the lower Yukon River. A total of 5,417 coho salmon was passed through 13 September, the last day of weir operations in 1998. However, no fish passage estimates were possible for 11 days during the period 17-28 August due to high water conditions. The 1998 estimate compares to a 1995-1997 average passage of approximately 9,500 coho salmon.

In 1998, the Sport Fish Division conducted a boat survey of the DCR index area on 20 October and estimated 11,100 coho salmon present, 23% above the minimum goal. An additional 2,775 coho salmon were estimated present in tributaries of the DCR by aerial survey on 21 October.

The Sport Fish Division also documented 2,775 coho salmon present in the outlet stream of Clearwater Lake from an aerial survey flown on 20 October.

In the Toklat River drainage, only 157 coho salmon were counted by ground survey in Geiger Creek. Coho salmon index counts in the Nenana River drainage included 1,360 in Lost Slough, 1,413 in Seventeen Mile Slough, 2,771 in the mainstem Nenana River upstream of the Teklanika River, and 370 in the Glacier and Clear Creek complex in the Julius Creek drainage. Some of these estimates were from ground surveys conducted by the Tanana Chiefs Conference (TCC).

LOWER YUKON RIVER SONAR AT PILOT STATION, 1998

Salmon are harvested for commercial and subsistence purposes over more than 1,600 km of the Yukon River in Alaska and Canada. These salmon fisheries are critical to the people and economy of dozens of communities along the river, in many instances providing the largest single source of food and/or income to local residents. Management of the fisheries is complex and difficult for many reasons, including the broad geographic distribution of the many individual salmon spawning stocks that support these fisheries.

Sonar-based estimates of fish passage from the lower Yukon River sonar project at Pilot Station are available in a more timely and comprehensive manner than can be obtained from other sources. The project design incorporates fish passage estimates from shore-based single-beam sonar data, and species composition estimates from drift gillnet CPUE data from a suite of different mesh size gillnets, to estimate daily passage of fish by species. Deployed at the historical location at river km 197 near Pilot Station, the sonar project is far enough upriver to avoid the wide multiple channels of the Yukon River delta, but far enough downstream to provide timely information for inseason management of the Yukon River commercial and subsistence fisheries.

This project has produced estimates of daily fish passage annually since 1986, except for 1992, when it was operated for experimental purposes only, and 1996 when it was operated for training purposes only. Project sonar equipment was reconfigured prior to the 1993 season to operate at a frequency of 120 kHz as compared to the former 420 kHz. This frequency change has significantly extended the effective range of the sonar beams and avoids signal loss encountered at the 420 kHz operating frequency. Project objectives in 1998 were to provide daily and cumulative passage estimates for chinook and chum salmon during the project operational period, and to estimate the precision of those estimates. Estimates of the number of coho salmon and combined "other" species were also generated. Passage estimates for 1998 are only comparable to 1995 and 1997 because of the higher frequency equipment and different aiming criteria used prior to 1995. A more comprehensive source of information on the background of this project, the methods used, the results and discussion for 1998, and literature references can be found in Maxwell (In Prep).

The sonar project was operational from 6 June through 9 September in 1998. Passage estimates were available daily to fishery managers in the Emmonak field office. An estimated 1,768,255 ± 16,379 (s.e.) fish passed through the sonar sampling area, 34% along the right bank and 66% along the left bank. Included were an estimated 83,175 ± 4,441 large chinook salmon (>700 mm long), 38,871 ± 3,122 small chinook salmon (<700 mm), 830,633 ± 15,058 summer chum salmon, and 397,157 ± 7,696 fall chum salmon. Coho salmon monitored during the operational period totaled an estimated 176,792 ± 6,666. Other species totaled 241,627 ± 7,936 and included pink salmon, whitefish spp., sheefish, burbot, sucker spp., Dolly Varden, sockeye salmon, and northern pike. It is not the intent of this project to document complete coho or pink salmon runs. Post-season run reconstruction estimates based on upstream catch and escapement data from a variety of sources agreed well with sonar-based estimates of total passage from the Yukon River sonar project.

Bottom profiles conducted along the left and right banks at the transducer locations revealed linearly sloping areas suitable for sonar deployment. No changes were noted in the steeply sloping, rocky bottom along the right bank during the field season. The sandy, gently sloping left-bank bottom remained largely unchanged throughout the field season. Weekly drifts conducted down the central portion of the river using a down-looking sonar revealed very few fish tracings outside the sampling area of the shore-based units throughout the course of data collection. No offshore passage estimates were estimated with these drift data.

The right (north) bank sonar site has a stable, rocky bottom that drops off steeply to the thalweg. The transducer was deployed approximately 5-10 m from this shore at a depth of 1.5 m and aimed along the bottom, sampling three strata from 0-50 m, 50-100 m, and 100-150 m. The left bank river bottom drops off gradually, with a slightly steeper slope from 0 to roughly 50 m. A transducer was deployed nearshore, approximately 10 m from the shoreline, sampling three horizontal strata from 0-360 m. The range divisions of the individual strata varied dependent on river bottom linearity and degree of range-dependent signal loss. The transducer was aimed low along the river bottom for the nearshore strata, then tilted upward slightly to skim the river bottom at the further ranges. The left bank offshore transducer was deployed briefly during the early portion of the 1998 season. It's use was discontinued after it was determined that the range normally covered by this transducer was more easily ensonified using the nearshore transducer. Changing water levels required the periodic relocation of both transducers during the field season. The left and right bank sampling areas are approximately across the river from each other, at a point over 1,000 m wide. This width varies considerably as water level fluctuates.

Historical salmon passage estimates at Pilot Station have been based upon a sampling design in which acoustic data were typically collected on each bank for 9.0 hours daily divided amongst three periods with gillnet sampling periods scheduled between the acoustic sampling periods. This sampling design was adhered to during the 1998 field season.

Five twenty-four hour and three fourteen-hour sampling periods conducted during 1998 estimated an average of 6% fewer targets than routine sampling estimates from the same days. Half of the extended sampling periods produced estimates within the 90% confidence interval for that day. Uncertainties in fish behavior induced by drift gillnetting activities conducted during the extended sonar periods add to the variability of these data.

A total of 10,256 fish were captured during 2,256 drifts totaling 15,556 minutes in 1998 for the purpose of estimating species composition of the acoustic passage estimates. The catch included 5,741 chum salmon, 598 chinook salmon, 1,306 coho salmon, 980 pink salmon, 665 whitefish spp., 760 cisco spp., and 206 fish of miscellaneous species. Captured fish were measured for length, the sex of each salmon was determined, and scales were collected from each chinook salmon. Most captured fish were given to local residents for subsistence use.

Using bottom mapping techniques developed during previous years, a bathymetric map of the river in the immediate vicinity of the sonar site was generated. Maps created during the past three field seasons allow inter-annual monitoring of changes in the bottom topography which may affect fish migratory behavior and subsequent detection. The most significant change in the bathymetry of the river has been the deposition of a sand bar extending down from the upstream bend in the river. This bar was closely monitored during the field season and fished on two occasions. Three drifts totaling 37 minutes in length captured a single coho salmon. Although it doesn't appear that the presence of the sand bar altered fish passage during the 1998 field season, close scrutiny of this sand bar will be required in subsequent years.

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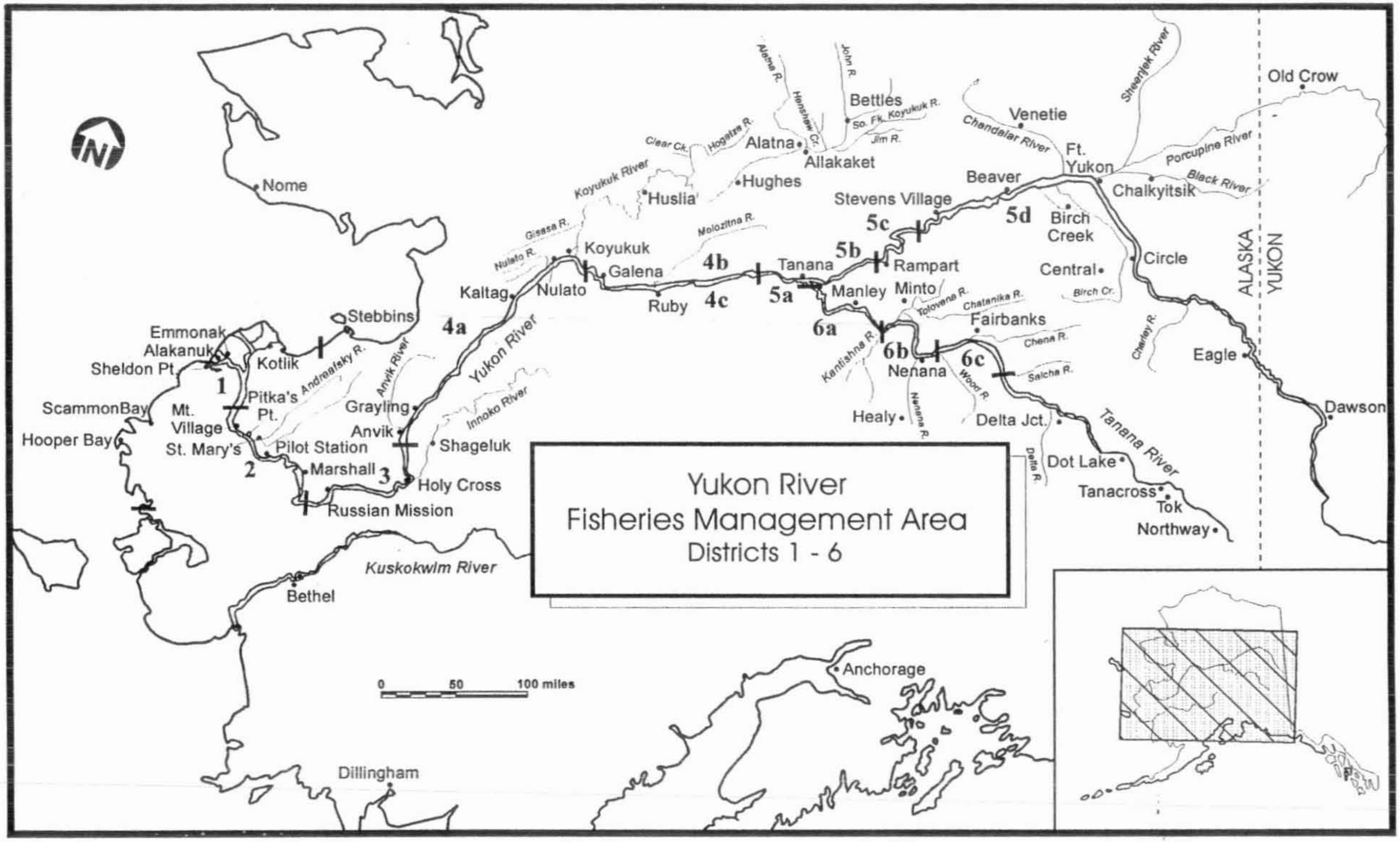

Figure 1. Map of the Alaskan portion of the Yukon River drainage.